CHAPTER

72

ENGINES

CHAPTER 72 - ENGINE

TABLE OF CONTENTS

CHAPTER 72 - ENGINE

TABLE OF CONTENTS

CHAPTER 72 - ENGINE

TABLE OF CONTENTS (Cont)

REVISION NO. 20, DATED JUL 15/99

CHAPTER/SECTION	DESCRIPTION OF CHANGE	PAGE (S)
72-00, ADJUSTMENT/ TEST	Added NOTE 3 before step I_2(1)	526B
72-02-3, INSPECTION	Revised para 1, step A. (deleted the requirement to re-install the bearings that have remaining residual life in the same engine)	1

CHAPTER 72 - ENGINE

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION	PAGE	DATE	CHAPTER/ SECTION	PAGE	DATE
72	*I thru V	Jul 15/99	72-00 (Cont)	143	Oct 1/89
				144	Sep 15/75
Contents	1 thru 2	Dec 31/95		145	Oct 1/89
	3	Oct 1/89			
				301 thru 302	Feb 1/69
72-00	1	Jun 1/84		302A/302B	Feb 1/69
	2	Dec 31/95		303	May 1/68
				304	Jun 15/71
	101	Oct 1/89		304A/304B	Jun 15/71
	102 thru 104	Jun 1/70		305	Sep 15/75
	105	Dec 1/72		306	Jun 15/71
	106	Oct 1/69		307 thru 310	Feb 1/69
	107 thru 108	Dec 1/72		311	Dec 30/78
	109	Dec 1/73		312	May 1/68
	110	Jun 1/84		313 thru 314	Feb 1/69
	111 thru 112	Dec 1/73		315	May 1/68
	112A/112B	Dec 1/73		316	Oct 1/69
	113	Dec 30/78			
	114	Dec 1/73		401	May 1/68
	114A thru 114B	Sep 15/75			
	115	Jun 1/84		501	Dec 15/77
	116	Sep 15/75		502	Sep 15/75
	116A	Dec 31/95		503	Dec 15/77
	116B	Sep 15/75		504	May 31/98
	116C/116D	Sep 15/75		504A/504B	Dec 30/78
	117	Oct 1/69		505	May 1/68
	118	Dec 1/72		506	Nov 1/70
	118A/118B	Sep 15/76		507 thru 508	Sep 15/75
	119	Sep 15/76		509 thru 512	Dec 30/78
	120	Jun 1/84		513	Dec 15/77
	121 thru 122	Sep 15/75		514 thru 515	Sep 15/75
	122A thru 122D	Sep 15/75		516	Sep 15/76
	123	Jun 1/84		517	Oct 1/89
	124	Dec 1/73		518	Sep 15/76
	125 thru 126	Oct 1/69		519 thru 523	Dec 1/73
	126A/126B	Jun 15/71		524	Jun 1/84
	127 thru 128	Jun 1/84		525	Dec 1/73
	128A/128B	Jun 1/84		526	Dec 31/95
	129	Jun 1/84		526A	Dec 31/95
	130	Dec 31/95		*526B	Jul 15/99
	131 thru 132	Oct 1/69		527 thru 530	Dec 1/73
	133 thru 134	Sep 15/76		531 thru 534	Sep 15/76
	134A thru 134B	Jun 1/84		535	Dec 31/95
	135	Dec 30/78		536 thru 537	Dec 1/73
	136 thru 141	Dec 1/72		538	Dec 15/77
	142	Dec 30/78		539 thru 540	Dec 1/73
	142A/142B	Oct 1/89		541	Dec 15/77

* Asterisk indicates pages added, changed, or deleted by this revision.

CHAPTER 72 - ENGINE (Cont)

LIST OF EFFECTIVE PAGES (Cont)

* Asterisk indicates pages added, changed, or deleted by this revision.

CHAPTER 72 - ENGINE (Cont)

LIST OF EFFECTIVE PAGES (Cont)

CHAPTER/ SECTION	PAGE	DATE	CHAPTER/ SECTION	PAGE	DATE
72-30	208	Dec 30/78	72-42-0	201 thru 202	Dec 15/77
(Cont)	208A/208B	Jul 15/68		202A/202B	Dec 15/77
	209	Jun 1/70		203	Dec 1/72
	210 thru 211	Dec 31/95		204	Jun 15/71
				205	Dec 15/77
72-31-0	201	Apr 1/67		206	Dec 31/95
	202	Dec 15/77		207	Dec 1/73
	203	Dec 30/78		208	Dec 15/77
	204	Dec 31/95		209	Sep 15/76
	205 thru 207	Dec 15/77		210	Dec 1/73
				211 thru 213	Dec 15/77
72-32-0	201 thru 202	Jun 1/84			
	203	Sep 15/75	72-43-0	201	Oct 1/89
	204	Oct 1/89		202	Dec 15/77
	205 thru 208	Sep 15/75			
	209 thru 210	Dec 31/95	72-45-0	201	Dec 15/77
	211 thru 213	Sep 15/75			
			72-46-1	201 thru 202	Apr 1/67
72-33-0	201	Sep 15/75			
	202	Jun 1/84	72-46-2	201	Apr 1/67
	203 thru 207	Sep 15/75			
			72-46-3	201	Apr 1/67
72-34-0	201	Apr 1/67			
	202	Sep 15/75	72-46-4	201	Apr 1/67
	203	Oct 1/89		202	Jun 15/71
72-40	1 thru 3	Apr 1/67	72-46-5	201	Apr 1/67
	201 thru 202	Dec 30/78	72-47-0	201 thru 202	Apr 1/67
	203	Jun 1/70			
	204	Dec 1/73	72-50	1	Jun 1/84
	204A	Dec 31/95		2	Oct 1/69
	204B	Dec 31/95		2A/2B	Jun 1/84
	204C/204D	Dec 1/73		3	Oct 1/69
	205	Sep 15/76		4	Dec 1/73
	206	Dec 15/77			
	206A/206B	Oct 1/89		201	Dec 15/77
	207	Sep 15/76		202	Sep 15/76
	208	Jul 15/68		202A/202B	Oct 1/69
	209 thru 212	May 31/98		203	Sep 15/76
				204	Jun 1/70
72-41-0	201 thru 202	Jun 15/71		204A/204B	Jun 1/70
	203	Dec 15/77		205	Apr 1/67
	204	Jun 15/71		206	Jun 1/84
				207 thru 208	Sep 15/75
				208A/208B	Sep 15/75
				209	Dec 1/72

* Asterisk indicates pages added, changed, or deleted by this revision.

CHAPTER 72 - ENGINE (Cont)

LIST OF EFFECTIVE PAGES (Cont)

* Asterisk indicates pages added, changed, or deleted by this revision.

CHAPTER 72 - ENGINE (Cont)

LIST OF EFFECTIVE PAGES (Cont)

CHAPTER/ SECTION	PAGE	DATE	CHAPTER/ SECTION	PAGE	DATE
72-71-0	203 thru 204	Oct 1/69			
(Cont)	205	Jun 1/70			
	206	Dec 31/95			
	206A thru 206B	Dec 31/95			
	207 thru 208	Dec 31/95			
	208A/208B	Dec 31/95			
	209 thru 213	Jun 1/70			
	214 thru 218	Dec 31/95			
72-72-0	201	Dec 31/95			
	202	Oct 1/89			
	202A thru 202B	Dec 31/95			
	203	Jun 1/84			
	204 thru 209	Oct 1/89			
	210	Dec 31/95			
	210A thru 210D	Oct 1/89			
	211 thru 213	Jun 1/84			
72-73-0	201	Sep 15/76			
	202	Dec 1/72			
	202A thru 202B	May 31/98			
	202C	Jun 1/84			
	202D	Dec 1/72			
	202E/202F	Dec 1/72			
	203	Oct 1/69			
	204 thru 206	Dec 31/95			
	206A/206B	Dec 31/95			
	207 thru 212	Oct 1/89			

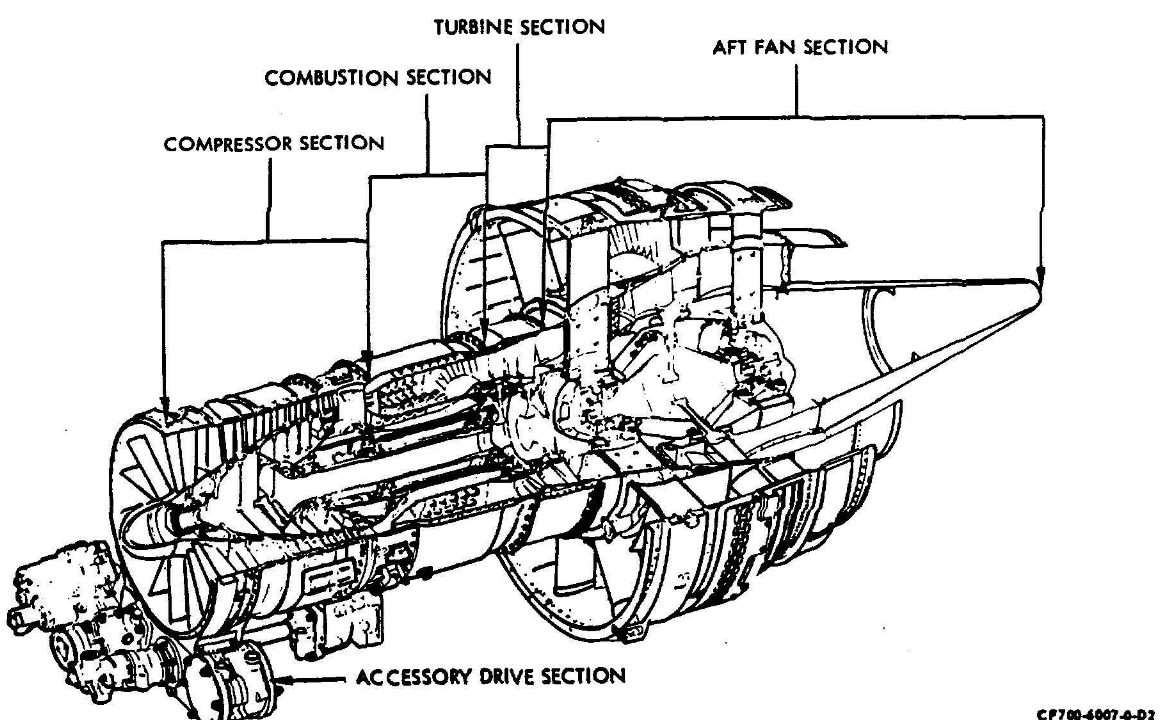
* Asterisk indicates pages added, changed, or deleted by this revision.

ENGINE DESCRIPTION AND OPERATION

1. General. The General Electric CF700-2C, CF700-2D and CF700-2D-2 engines are axial flow, turbofan engines. They are compact, high thrust, light weight engines with five main bearings supporting an eight stage axial flow compressor, a two stage turbine coupled to the compressor and a free-floating single-stage aft fan. The engine is controlled by a hydro-mechanical fuel system and a combination variable geometry-air bleed air control on the compressor.

2. Engine Data.

Engine Length - Front flange to rear flange....... 53.5 inches (approx.)
- Extreme.......................... 85.0 inches (approx.)
Engine Diameter - Maximum........................ 33.6 inches (approx.)
Engine Weight (Dry)................................. 725 lbs. (CF700-2C)
737 lbs. (CF700-2D and 2D-2)
Direction of Rotation (Rear looking forward)
- Compressor and Turbine Rotor........................... Clockwise
- Fan Rotor..................................... Counterclockwise



Engine Sections
Figure 1

3. Sections of Engine. (See figure 1.)

Basically, the engine consists of the following major sections; the compressor section, the combustion section, turbine section, an aft fan section and an accessory drive section. The description of each of these is given in the corresponding section of this chapter.

WARNING: ASBESTOS

THIS ENGINE MAY CONTAIN SMALL AMOUNTS OF ASBESTOS. WHEN WORKING WITH THIS ENGINE, THE FOLLOWING PRECAUTIONS MUST BE RIGIDLY ADHERED TO:

BEFORE ANY MAINTENANCE ACTIVITIES ARE UNDERTAKEN, REVIEW THE ILLUSTRATED PARTS BREAKDOWN/CATALOG INDEX TO DETERMINE IF THE HARDWARE TO BE WORKED ON OR USED CONTAINS ASBESTOS.

WHENEVER MECHANICAL REMOVAL OF MATERIAL, SUCH AS MACHINING, GRINDING, BUFFING, DRILLING, SANDING OR ANY TYPE OF MATERIAL BUILD-UP ON PARTS THAT CONTAIN ASBESTOS IS NECESSARY, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT MUST BE WORN, AND NATIONAL ENVIRONMENTAL CONTROLS REQUIRED FOR THE HANDLING OF ASBESTOS-CONTAINING MATERIAL MUST BE COMPLIED WITH.

BEFORE HANDLING, REPLACING, OR DISPOSING OF ASBESTOS-CONTAINING HARDWARE, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND NATIONAL ENVIRONMENTAL CONTROLS MUST BE STRICTLY ADHERED TO FOR HANDLING ASBESTOS-CONTAINING HARDWARE.

TROUBLESHOOTING

1. General. Troubleshooting is a systematic analysis of the symptoms which indicate engine malfunction; these are usually a deviation from normal operating parameters. Since the operating limits section of this manual describes normal engine indications, trouble-shooting is closely related to this information. Since it would be impractical to list all the possible malfunctions which could occur in a modern jet engine, this section will cover only the most commom malfunctions. A thorough knowledge of the engine systems, applied with logical reasoning, will solve any remaining problems which may occur.

As a guide to troubleshooting the most probable troubles have been listed and analyzed. (See Table 101.) Possible solutions have been listed, in most cases, in the order of their probability. The only deviation from the probability sequence occurs when checking of the least probable is much easier than checking the more probable. For instance, changing the fuel control is an extensive operation, hence the fuel control is not removed and replaced until all other areas of malfunction are eliminated.

As a further guide to troubleshooting, the most probable troubles have also been listed in flow chart form (see figure 101).

TABLE 101

TROUBLESHOOTING GUIDE

Problem	Probable Cause	Investigation/Corrective Action
STARTING PROBLEMS		
WARNING: WHEN ROTATING COMPRESSOR ROTOR BY HAND, TAKE PRECAUTIONS TO PREVENT HAND FROM BEING CAUGHT BETWEEN ROTATING AND STATIONARY PARTS.		
1. Engine Fails to Rotate When Starter is Energized.		
A. Starter Inoperative.	(1) Rotate compressor rotor by hand.	(a) Check for simultaneous rotation of the starter armature. If the armature rotates, refer to the aircraft electrical system manual for troubleshooting of a possible electrical system malfunction.
		(b) If armature does not rotate, remove starter and check starter shaft shear section for failure.
		(c) Check for rotation of drive spline at accessory gearbox pad. If drive spline does not rotate, investigation into the accessory drive section will be necessary. This work should only be performed by a proper maintenance agency.
B. Compressor or Turbine Rotor Seized.	(1) Attempt hand rotation of compressed rotor.	(a) If the engine rotor will not rotate and visual inspection of the compressor and turbine reveals no damage, allow engine to cool at least one hour. During cool down, attempt hand rotation of rotor.
		1. After cool period - four hours if necessary - if rotor is still frozen, pull forward on compres-

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		sor rotor in an attempt to shift rotor forward. If rotor frees, turn by hand and listen for unusual noises. If none are heard, motor engine with starter and listen for unusual noises. If none are heard, continue normal operation of engine. If unusual noises are noted, determine and correct cause before proceeding.
		2. If engine rotor does not become free after cool period, remove lube filter and magnetic drain plug and check for metal contamination per section 79-00, Maintenance Practices, before proceeding. If metallic contamination is found, the source must be determined and corrective action taken by a qualified maintenance agency. If no metal contamination is found, loosen all bolts in forward flange of turbine casing and attempt to rotate rotor. If rotor is free, retighten bolts per section 72-01-3, figures 2 and 3. If rotor will rock but turbine casing is frozen to the rotor, the turbine stator casing must be removed and inspected. If rotor is still frozen in position, the turbine rotor must be removed and the turbine outer labyrinth and interstage

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		seals inspected for interference. Maintenance facility should have Hot Section capability if they are to proceed.

NOTE: Engine will have to be removed from aircraft if all turbine casing flange bolts cannot be loosened in order to complete this check.

Problem	Probable Cause	Investigation/Corrective Action
C. Accessory Drive Section Seized.	(1) Attempt hand rotation of compressor rotor.	(a) If the rotor will rock, the seizure is probably in the accessories and accessory drive section and will require individual removal and inspection of each accessory beginning with the starter.

2. Motoring Speed on Starter is Low.

NOTE: The most common cause for low motoring speed is low battery voltage. Check this by using a ground power unit with capability of 27.5-28.5 volts dc, 1000 amps to motor engine. A good system either battery or ground power unit, should have capability of motoring engine to at least 12 percent engine speed (N_g) in 12 seconds for ambient temperature conditions of 0°F (-18°C) or higher.

Problem	Probable Cause	Investigation/Corrective Action
A. Compressor Rotor Dragging.	(1) Turn rotor by hand and check for excessive drag.	(a) When excessive drag is noted, remove the aircraft hydraulic pump and the starter-generator and again check for excessive drag. If excessive drag is still noted, troubleshoot the engine per preceding paragraph 1.

WARNING: WHEN ROTATING COMPRESSOR ROTOR BY HAND, TAKE PRECAUTIONS TO PREVENT HAND FROM BEING CAUGHT BETWEEN ROTATING AND STATIONARY PARTS.

Problem	Probable Cause	Investigation/Corrective Action
B. Electrical Input to Starter.	(1) Check motoring speed of opposite engine, noting max attainable rpm, then recheck engine in question.	(a) If neither engine will motor to proper speed, refer to aircraft electrical system manual for troubleshooting of a possible electrical system malfunction.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		(b) If there is a substantial difference in indicated RPM's, switch RPM indicators to check for indicator malfunction.
		(c) If indication remains the same, switch starter from good side to bad side or replace starter with known good unit and recheck motoring speed. If this corrects problem reject faulty starter.
		(d) If after installation of known good starter and the RPM remains low, consult applicable aircraft electrical manual.

3. Failure of Engine to Light-Off During Attempted Start.

NOTE: If motoring speed of 12 percent in 12 seconds for ambient temperature conditions of 0°F (-18°C) or higher can be achieved, and fuel mist is coming from tailpipe with throttle in idle detent and no continuous fuel drainage from engine drains, proceed on the assumption that the problem is in the ignition system.

Problem	Probable Cause	Investigation/Corrective Action
A. No Audible Spark from Either Igniter.	(1) Motor engine and check for proper input voltage to igniter box (minimum 19 volts).	(a) If check is insufficient voltage, check input to exciter using air-start ignition system.

WARNING: UNDER NO CIRCUMSTANCE SHOULD THE HARNESS OR IGNITER BE HELD WHILE THE IGNITION SYSTEM IS ENERGIZED.

Problem	Probable Cause	Investigation/Corrective Action
		(b) If proper voltage can only be attained using airstart system or if proper voltage cannot be attained using either system, refer to aircraft electrical system manual for troubleshooting of possible aircraft system malfunction.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		(c) If proper voltage is present, remove both igniter plugs from engine per 80-23-0 and position them where spark gap is visible. Energize ignition exciter and check both igniters for strong, blue colored, rapid firing arcs. If either or both igniters exhibit weak arcs, replace the weak igniters per section 80-23-0 and check again.
		(d) If strong arcs are observed, check for proper immersion of the igniters and assemble per section 80-23-0.
		(e) If neither igniter fires properly, replace the ignition exciter per 80-21-0 and recheck igniter plugs again.
		(f) If only one igniter produces a strong arc, switch the high tension leads at the exciter box to check the plugs for breakdown. When weak arc is consistent with switch, replace the bad plug. Should the same igniter continue to exhibit a weak arc, replace the ignition exciter per 80-21-0.

B. Faulty Fuel Nozzle

NOTE: Before proceeding with fuel system investigation, ensure there is no severe hot section distress in the form of burned metal on the fan nozzle and fan turbine blades.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(1) Motor engine with throttle in idle detent; a heavy mist should be seen coming from tailpipe. See following step (2) if no or slight mist is observed.	(a) If a heavy mist is observed and it has been previously established that ignition is satisfactory, it is recommended that the two fuel nozzles, those immediately upstream of the two igniter plugs which might interfere with the spray pattern, be removed and checked for cracks or carbon build-up per section 73-18-0. Determine if there was an increase in EGT during the previous flight.

NOTE: A rough approximation for amount of mist is that the output of all fuel nozzles together is about one quart every 30 seconds at starter motoring speed.

Problem	Probable Cause	Investigation/Corrective Action
	(2) If tailpipe is not wet after motoring engine with throttle in idle detent, the fuel system should be investigated starting with the aircraft system, then proceeding to the engine. Check aircraft fuel system by observing the aircraft instruments for positive indication of boost pressure while attempting a normal start per the aircraft flight manuals. NOTE: Check the aircraft fuel shutoff valve for proper operation.	(a) If boost pressure indication is not observed, consult applicable aircraft electrical and fuel system manuals for troubleshooting of possible aircraft system malfunction. (b) If proper boost pressure indication is observed, and continuous drainage noted from engine gang drains, during motoring with throttle in idle detent or at anytime boost pumps are operating, replace the manifold drain valve per 73-16-0. 1. Replace the fuel pump, 73-13-0, if fuel drains from the fuel pump shaft seal drain. It is important to check the fuel pump and control filters for contamination. Should the control filter show

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		signs of having bypassed, (heavily contaminated) the fuel control must be replaced per 73-21-0. In addition, the filter in the servo fuel supply line to the overspeed governor must be cleaned. 2. Replace the manifold drain valve per 73-16-0 if fuel drains from the fuel manifold drain valve at a steady flow rate while engine is being motored with throttle in idle detent. (c) Carry out start attempt - advance throttle to higher setting. If engine starts, check the following: 1. Correct throttle rigging if shaft fails to reach idle detent or fuel control lever is not at ground idle mark on control when throttle shaft is in the idle detent. 2. Deleted.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		3. Deleted.
		(d) If engine does not start when throttle is pushed forward. Carry out the following:
		1. If proper boost pressure indication is observed and the control throttle shaft is positioned properly, check for air locked pump by first disconnecting reference pressure line to pressurization valve. Turn on aircraft electrical boost pumps until at least one quart of fuel drains from line then reconnect line. If air was present in the system, perform a "Motoring Check", 72-00, Adjustment/Check Section, to prime system then attempt a start.

TABLE 101

TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Correction Action
		2. If air was not present, and engine will not start, check fuel pump and fuel control filters for contamination. If either filter contains sufficient contamination to have bypassed, that component must be replaced.
		3. Excessive internal leakage in the overspeed governor, check by disconnecting the line from the overspeed governor "bypass" port. Cap the line but leave the overspeed governor port unplugged. Disarm ignition and motor engine. Place throttle in idle position. Leakage from port shall be less than 80 pph. If over 80 pph, the overspeed governor must be replaced per section 73-22-0.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action

4. High Exhaust Gas Temperature (EGT) During Starts.

NOTE: Ensure engine achieves 12 percent speed in 12 seconds for ambient temperature conditions of $0^{o}F$ ($-18^{o}C$) or higher. A slow acceleration to a speed below 12 percent may result in a hot start. Hot starts represent over-temperature conditions within the engine, therefore, troubleshooting should be approached with caution. Any overtemperature of the engine requires inspection checks per 72-00, Inspection/Checks. Prior to troubleshooting the engine, position aircraft facing into the wind.

Problem	Probable Cause	Investigation/Corrective Action
A. Turbine Temperature EGT (T_5) Rises Abnormally Requiring Start to be Aborted.	(1) Improper EGT indication.	(a) Ensure EGT indicating system is functioning correctly by checking aircraft/engine system with a Jetcal Analyzer, or equivalent, which actually applies heat to the thermocouple harness probes. If the aircraft/engine EGT indicating system does not check out satisfactory, check each component (thermocouple harness, engine temperature protector, aircraft wiring, aircraft indicator) for resistance and determine the malfunctioning component. NOTE: If an engine temperature (ETP) is installed on the engine, the aircraft indicating system should read $13^{o}C$ lower than the Jetcal Analyzer for every one ohm of resistance in the ETP above 1.5 ohms and $13^{o}C$ higher than the Jetcal Analyzer for every one ohm of resistance in the ETP below 1.5 ohms.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
A. (Cont)		
	(2) Improper fuel density setting (Ref. Section 73-21-0.)	(a) Check fuel density setting for the proper combination of fuel and position. If the setting is at a higher specific gravity than the specific gravity of the fuel being used, the problem will be made worse by setting it to a lower number. Therefore, only reset the adjustment if the specific gravity is at a lower number than that of the fuel being used.
	(3) Foreign object damage (FOD).	(a) Inspect compressor and turbine for signs of FOD. If excessive damage is evident, repair as necessary.
	(4) Improper starting procedure.	(a) Ensure throttle is not advanced to idle until at least 10 percent (Ng) is reached. (12 percent or higher is preferable if obtainable.)
	(5) Air in fuel control.	(a) This is likely to occur if any portion of the fuel system has been opened upstream of the fuel control. If this has occurred, make a normal (wet) start attempt without ignition for 20 seconds. Allow engine to drain, then make a normal start. But do not open stopcock until 15 seconds after initiation of start. This will blow residual fuel from the engine.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
A. (Cont)	(6) Delayed ignition.	(a) Check that engine lights off within 5 seconds of throttle advance to ground idle detent. If not, check ignition system. If this proves satisfactory, suspect fuel nozzles.
	(7) Improper overboard drainage.	(a) Motor engine with throttle in ground idle detent and ignition off. When motoring speed has stabilized, stopcock the throttle and allow engine to shut down. A minimum of 100 cc of fuel should flow from the overboard drain. If there is no or little overboard drainage replace the drain valve per 73-16-0.
	(8) Ice in fuel control P_3 sensing bellows.	(a) Apply heat to fuel control sensing bellows before attempting next start.
		(b) Remove the water from the sensing bellows and fill the bellows with diethylene glycol monobutyl ether, *antifreeze fluid* (Butyl Carbitol, manufactured by Union Carbide Corp., Box 8361, 437 MacCorkle Ave., South Charleston, West Virginia, 25303, or MCB Manufacturing Chemists, 2909 Highland Avenue, Norwood, Ohio, 45212, or equivalent) as follows:
		1. Disconnect the P_3 line from the fuel control.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
A. (Cont)		2. Deleted.
		3. Heat (evenly distributed) the control, if necessary, to 75°-135°F and stabilize the temperature.
		4. Close antifreeze valve (No. 2) and open vacuum pump valve (No. 1). Maintain a constant temperature and the correct pressure/vacuum for at least 1 hour.
		5. After the bellows has been evacuated for 1 hour at the proper temperature and pressure/vacuum, close the vacuum pump valve (No. 1) and open the antifreeze valve (No. 2) to allow complete filling of the bellows with antifreeze.
		6. Close antifreeze valve (No. 2). Reconnect the P_3 line to the fuel control.
		(c) The following procedure may be used to remove the water from the sensing bellows and to fill the bellows with antifreeze fluid.
		NOTE: This procedure is to be used only as an interim procedure and must be followed by the procedure described in paragraph (b) at the first opportunity.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
A. (Cont)		1. Disconnect the P_3 line from fuel control. 2. Allow moisture or water to drain out of P_3 fitting on fuel control. Using a syringe inserted in the P_3 fitting, suck out the bellows. 3. Pour or squirt a small amount of diethylene glycol monobutyl ether into the P_3 fitting to fill the bellows (approx. 5 cc). 4. Reconnect the P_3 line to the fuel control.

NOTE: If the foregoing does not correct problem, make more rigorous FOD inspection. If no damage, change fuel control per 73-21-0.

5. Engine Will Not Accelerate to Idle Speed in 40 Seconds

NOTE: Deleted.

Problem	Probable Cause	Investigation/Corrective Action
A. Hang-Up Occurs Below 20 Percent Engine Speed.	(1) Starting system will not accelerate engine to 12 percent speed in less than 12 seconds.	(a) Trouble shoot start system per paragraph 2. of this troubleshooting guide.
B. Hang-Up Occurs Above 20 Percent Engine Speed.	(1) Engine accelerates out of hang-up when throttle is advanced.	(a) Correct throttle rigging if throttle shaft fails to reach idle detent or fuel control lever is not at idle mark when throttle shaft is in idle detent.
	(2) Engine does not accelerate out of hang-up when throttle is advanced.	(a) Inspect P_3 line to fuel control and P_3 line to turbine for tightness and cracks. Repair is necessary. (b) Check overboard drain line for fuel flow, replace drain valve if any fuel flows from drain at hang-up condition.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
B. (Cont)		(c) Inspect for FOD in compressor and turbine sections. Repair as necessary.
		(d) Measure overspeed governor internal leakage by disconnecting the return line from the overspeed governor "bypass" port. Cap the line but leave the overspeed governor port unplugged. Disarm ignition and motor engine. Place throttle in idle position. Leakage from port should be less than 80 pph. If greater, the overspeed governor must be replaced per section 73-22-0.
		(e) Adjust fuel control density setting one click to lower number setting and try another start.
		(f) Check for leakage of pressurizing valve by opening valve reference pressure line, capping off line from main fuel pump, and cranking engine with stopcock open. If leakage occurs, change pressurizing valve.
		(g) Change fuel control per 73-21-0 if above checks do not correct problem.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
C. Air start hang-up.	(1) Improper air-start envelope.	(a) Make sure the start was attempted within the air-start envelope of the Aircraft Flight Manual.
	(2) Improper fuel type setting (Ref. section 73-21-0).	(a) Check fuel density setting for the proper combination of fuel and position.
	(3) Faulty ignition system.	(a) Check per ignition system checks, paragraph 3.A.

STALL PROBLEMS

6. Compressor Stalls.

NOTE: 1. Stalls may be divided into two types; steady state and those occurring during acceleration or deceleration. Steady state stalls are those that occur each time an engine reaches a certain speed regardless of how slowly it is accelerated. Acceleration/deceleration stalls depend on the rate of acceleration or deceleration. Stalls occur when the air flow through the compressor is disrupted.

2. If a cause for compressor stalls is not identified by any of the following probable causes and the engine is to be disassembled as during overhaul, the compressor shall be rebuilt to meet the fits and clearances of the engines modified according to Service Bulletin (CF700) 72-115.

Problem	Probable Cause	Investigation/Corrective Action
A. All types of stalls (steady state, acceleration and deceleration).	(1) Loss of compressor stall margin and turbine efficiency.	(a) Check compressor and fan turbine sections for FOD.
		(b) Check compressor (through inlet and bleed valves) for cleanliness or corrosion. A contaminated compressor will result in loss of stall margin. Clean as necessary per 72-00, Maintenance Practices - Cleaning, paragraph 4.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
6.A. (Cont)		
	(2) Variable geometry system not working properly.	(a) Check variable geometry system by operating system by hand for: NOTE: The actuators should move smoothly but have firm resistance. 1. Excessive wear. 2. Binding linkages. 3. Actuator jamming. 4. Broken/kinked feedback cable.
	(3) Variable geometry system out of limits.	(a) Check variable geometry system per 75-00, Maintenance Practices.

NOTE: If bleed valves have closed during shutdown, turn on boost pumps and motor the engine with ignition OFF. This will open the bleed valves.

Problem	Probable Cause	Investigation/Corrective Action
	(4) Improper fuel type setting (Ref. section 73-21-0.)	(a) Check fuel density setting for the proper combination of fuel and position.
	(5) Faulty compressor inlet temperature sensing system.	(a) Check CIT sensing air hoses from inlet to aspirator for signs of chafing, collapse, and blockage.
	(6) Incorrect stator alignment.	(a) Check alignment of stator segment bleed holes with holes in compressor casing (view through customer bleed ducts).

NOTE: The above checks should eliminate steady state stall problems. Further checks for acceleration or deceleration stalls should be carried out with the engine running. Ensure aircraft is facing into the wind to perform these checks. Do not operate engine above idle with pod doors open or removed.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
6. (Cont)		
B. Engine stalls during acceleration or deceleration.	(1) Bleed valve schedule out of limits.	(a) Perform variable geometry check per 72-00, Adjustment/Test. If schedule cannot be adjusted within limits, replace fuel control per 73-21-0.
		(b) Perform fast acceleration followed by fast deceleration. If engine does not stall, return engine to service.
	(2) Stall occurs in 50 to 70 percent speed range.	(a) Check fuel density setting on fuel control for correct setting per 73-21-0.
	(3) Stall occurs above 70 percent speed range.	(a) Either FOD or basic engine problem. If stall occurs above 90 percent, remove compressor top half and inspect for FOD. or stator vane sector reversal.
		(b) If fuel density setting is correct, increase it one setting and perform Acceleration Check per 72-00, Adjustment/Test. If this corrects problem perform Maximum Speed Setting procedure per 72-00, Adjustment/Test. If problem still exists, replace fuel control per 73-21-0.

TABLE 101
TROUBLESHOOTING GUIDE (CONT)

Problem	Probable Cause	Investigation/Corrective Action
6. (Cont)		
C. Engine stalls during altitude acceleration or steady state conditions.		
NOTES: 1. Record inlet temperature (T2) and speed (Ng) at which stall occured.		
2. See figure 103 for troubleshooting guide and for references to overhaul inspection and repair procedures.		
3. To make sure that the stall problem has been corrected, perform an altitude acceleration check after all repairs and adjustments have been accomplished.		
	(1) Compressor or turbine FOD.	(a) Inspect and repair per overhaul manual.
	(2) VG system worn, binding or broken and feedback cable broken or kinked.	(a) Check VG system by operating by hand. The actuators should move smoothly and have firm resistance.
		(b) Inspect and repair per overhaul manual.
	(3) P3 line to MFC damaged.	(a) Inspect for damage or blockage.
	(4) Contaminated fuel filters.	(a) Inspect aircraft and engine filters for blockage per SEI-154, Sections 73-13-0, 73-14-0, 73-20-1, and 73-21-0.
	(5) Top speed in excess of 108 percent gas generator.	(a) Bench test fuel control and recalibrate topping schedule downwards per SEI-154, Section 73-20-1.
	(6) Shift in fuel control acceleration schedule.	(a) Check fuel control for proper specific gravity setting per SEI-154, Section 73-20-1.
		(b) Bench test fuel control and recalibrate topping schedule downwards per SEI-154, Section 73-20-1.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
6. C. (Cont)		
	(7) Engine/aircraft system problem.	(a) Check inlet duct for damage or misalignment.
		(b) Check nacelle area for air leakage or exhaust recirculation.
		(c) Check aircraft for engine throttle rigging fault.
		(d) Inspect T2 sensor hose for damage or cracking.
		(e) Check sample of fuel for contamination (debris or water).
		(f) Check aircraft for boost pumps failure.
		(g) Check bleed duct for misalignment.
		(h) Check tail pipe area. Use average of 12 ID measurements.
	(8) Low compressor operating line.	(a) Inspect turbine for FOD, tip rubs, and blade damage repair per overhaul manual.
		(b) Inspect turbine shroud for excessive clearance and repair per overhaul manual.
		(c) Inspect for undersize turbine nozzle flow areas and repair per overhaul manual.
		(d) Inspect for undersize fan nozzle flow area and repair per overhaul manual.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
6. C. (Cont)		
		(e) Inspect compressor for excessive corrosion and for tip rubs per overhaul manual.
		(f) Inspect compressor for excessive FOD rework per overhaul manual.
		(g) Inspect compressor for excessive blade and vane tip clearance and repair per overhaul manual.
		(h) Inspect for clogged fuel passages and/or clogged cooler, repair per overhaul manual.
		(i) Inspect for compressor blade leading edge quality (factory check) and replace if necessary.
		(j) Inspect for compressor vane orientation angle (factory check) and replace if necessary.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
ACCELERATION PROBLEMS		
7. Slow Engine Acceleration from Idle to Takeoff Power.		
A. Acceleration Time from Idle rpm to Stabilized Takeoff EPR is Greater than 15 Seconds (or what was previously "normal" for the particular engine).	(1) Compressor and/or fan turbine area damage.	(a) Inspect the compressor blades for nonserviceable damage through the engine inlet and bleed valve ports. Check for non-serviceable damage to the fan turbine section by looking up the tailpipe.
	(2) Low idle rpm.	(a) Check idle rpm and correct, since the slowest acceleration is in the range below 65 percent rpm a low idle rpm will extend the acceleration time.
	(3) Aircraft bleed air system.	(a) Check the bleed air system for leakage by making accelerations with customer bleed air on and off. Check for large increase in acceleration time with customer bleed air on. If this occurs, consult applicable aircraft manual for troubleshooting of bleed air system. Check engine anti-ice system for proper operation. If valve has failed, replace the valve, 75-11-0, and recheck acceleration time.
	(4) Compressor discharge pressure (P_3) sensing line.	(a) Check compressor discharge pressure sensing line to the fuel control for leaks, especially at the gasket on the engine mainframe. Remove and replace the gasket if a leak is found and repeat the acceleration test.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(5) Low fuel flow from fuel control.	(a) Check fuel control fuel density setting. If setting is high, set for type of fuel being used and check acceleration. If this does not correct problem, decrease density setting one setting and accelerate from idle to takeoff. If this corrects the problem, perform Acceleration Check and Maximum Speed Setting procedure per 72-00 Adjustment/Test. If problem still exists, replace fuel control per 73-21-0.

LOW ENGINE SPEED

8. Low RPM - Engine Unable to Reach Selected Speed.

NOTE: Deleted.

Problem	Probable Cause	Investigation/Corrective Action
A. Engine Fails to Attain Selected Engine Speed.	(1) Turbine section damage.	(a) Visually inspect fan turbine for non-serviceable damage.
	(2) Fuel control shaft position.	(a) Check fuel control shaft travel by positioning aircraft throttle against takeoff stop and check control shaft for proper position and rig aircraft throttle system per aircraft manual, if required.
	(3) Compressor discharge pressure (P_3) sensing line.	(a) Check for ruptured gasket at the mainframe end of the compressor discharge pressure sensing line, also loose fitting at fuel control.
	(4) Aircraft bleed air system.	(a) Inspect aircraft bleed air system for evidence of leaks and correct per aircraft manual.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
8.A. (Cont)		
	(5) Perform engine run. NOTE: Do not operate engine above idle with pod doors open or removed.	(a) Check the indicating system by replacing the low reading indicator with a known good item or by switching indication from opposite engine.
		(b) Check Maximum Speed Setting per 72-00 Adjustment/Test. Adjust maximum speed setting higher; if necessary.
		(c) Check for overspeed governor malfunction by making an overspeed governor check. If test speed on overspeed governor is not within limits, replace the governor per 73-22-0.
		(d) Check for defective fuel pump by inspecting the fuel pump and fuel control filters. Check boost element by removing inlet line to pump and attempt rotation of boost element through the inlet.
		(e) Check for defective fuel control by making bleed valve schedule check per 72-00, Adjustment/Test. If there is a large shift in the downward direction (bleed valves close much sooner than they are supposed to, i.e., 1-2 percent or more under schedule) replace the fuel control per 73-21-0.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
8.B. Engine speed decreases approx 2%.	(1) Failed engine fuel pump impeller shaft.	(a) Disconnect fuel pump inlet hose. Carefully rotate engine while attempting to hold impeller with a nylon rod. If impeller does not rotate, replace fuel pump.

WARNING: WHEN ROTATING COMPRESSOR ROTOR BY HAND, TAKE PRECAUTIONS TO PREVENT HAND FROM BEING CAUGHT BERWEEN ROTATING AND STATIONARY PARTS.

PERFORMANCE PROBLEMS

NOTES: 1. Before troubleshooting any performance problem, calibrate instrumentation for the following parameters:

Fan speed (Nf)
Gas generator speed (Ng)
EGT (T5). See paragraph 4.A.(1)(a).
Fuel flow (Wf)
Engine Pressure Ratio (EPR) (aircraft instrumentation)

2. On CF700-2D-2 engines, pressure probes are calibrated to a specific engine. Make certain that the part number of the probe being used is the same as the one recorded in the engine log book.

9. Insufficient performance margin. (See figure 104.)

Problem	Probable Cause	Investigation/Corrective Action
A. Aircraft engine instrument(s) over limits.	(1) Aircraft instrument(s) out of calibration.	(a) Recalibrate aircraft instruments as noted.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. A. (Cont)		
NOTE: Aircraft problem possibilities should be eliminated before rejecting newly installed engines. Refer to figure 104 for troubleshooting guide.		(b) Using Engine Analyzer Model 1300, R-L Instruments, Columbia Station, Ohio 44028 (or equivalent), check each parameter through the entire engine operating range. Advise operator to replace or repair defective instruments.
	(2) Bleed air loss.	(a) Test engine with the mainframe customer bleed ports blanked off; if engine performance is sufficient, troubleshoot aircraft for losses.
B. EGT limited at takeoff (or maximum cruise) EPR condition.	(1) EPR error.	(a) Check probes for cracks and carbon build-up covering sensing holes. Remove carbon or replace probe per 77-11-0.
		(b) Check lines for cracks and leaks. Replace defective parts.
		(c) Check variable geometry system for integrity and freedom of movement and rigging per 75-00.
	(2) CIT sensing error.	(a) Check CIT inlet aspirator hoses for signs of collapse, blockage, and damage.
	(3) Compressor FOD, erosion, or excessively dirty.	(a) Check compressor blades and vanes and check bleed valves for FOD, cleanliness and corrosion. Repair as necessary per 72-32-0 and 72-33-0.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. B. (Cont)		
		(b) Check 8th-stage seal clearances per overhaul manual.
	(4) Faulty air bleed system or IGV's incorrectly rigged.	(a) Turn off bleed air system and check for increase in EPR. If EPR, fuel flow, and EGT return to normal, inspect bleed air system. Check the engine variable geometry schedule per 75-00 and check the IGV static rigging. With IGV's in the full-open position, the scribe mark on the actuating ring must line up with the zero mark (longest line of the five lines on front frame). Adjust per 75-00.
	(5) Faulty fuel nozzles, indicated by torching.	(a) With engine running, station an observer in a safe position where he can see into the engine tailpipe. Instruct the observer to look for a continuous visible flame and to note its position. Proceed as follows:

CAUTION: DURING A NORMAL START THERE CAN BE NO VISIBLE FLAME OR TORCHING FROM THE TAILPIPE WHILE THE ENGINE ACCELERATES TO IDLE. THE ENGINE START SYSTEM SHOULD BE CAPABLE OF MOTORING THE ENGINE TO AT LEAST 12 PERCENT ENGINE SPEED (Ng) IN 12 SECONDS. THE THROTTLE SHOULD BE ADVANCED TO IDLE AT 10 PERCENT, MINIMUM, ENGINE SPEED (Ng). IF THESE REQUIREMENTS ARE NOT MET CONSISTENTLY, THE TORCHING MAY RESULT IN DAMAGE TO THE HOT SECTION PARTS.

1 If a continuous flame is observed at idle, terminate engine run

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. B. (5) (Cont)		immediately and remove three fuel nozzles; the one clockwise of the flame and the next two in the counterclockwise direction (aft looking forward). Inspect these nozzles, in the nozzle annulus and on front face, for carbon deposits and/or cracks which might alter the nozzle spray pattern. Replace fuel nozzles per 73-18-0. CAUTION: DO NOT EXCEED RPM OR EGT LIMITS. 2 If no torching is observed at idle, advance power slowly until either torching is observed or EGT or RPM limits power increases. 3 If torching is observed at any speed between idle and max power, terminate run and remove fuel nozzles and inspect per step 1 above.
	(6) Engine temperature protector set incorrectly.	(a) Perform cell test to check engine temperature protector per overhaul manual.
	(7) Turbine damage, erosion, or rubs.	(a) Carefully inspect for any evidence of abnormal metal erosion, FOD or other forms of damage such as missing and/or damaged nozzle partitions or rotor blades, or damage to the tailpipe exit area. Inspect and repair damaged parts per 72-50.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. B. (7) (Cont)		(b) Inspect turbine shroud for excessive clearances or rubs. Replace as necessary per 72-50.
		(c) Inspect turbine nozzles for cracks and missing metal. Repair and resize per overhaul manual.
		(d) Inspect first-stage turbine blades for bow and warp per 72-53-0.
	(8) Combustor damage.	(a) Inspect for abnormal metal burnout, erosion or missing rivets. Repair as necessary per 72-42-0.
	(9) Fan damage, erosion, or rubs.	(a) Inspect fan shroud clearances per 72-70. Inspect for excessive rubs and missing abradable coating; repair or replace as necessary.
		(b) Inspect fan transition seals for excessive clearances per 72-70. Replace if necessary per 72-71-0.
		(c) Inspect fan nozzle for cracks and missing metal. If required, repair and resize flow area per overhaul manual.
C. High fan speed at takeoff EPR.	(1) Excessive FOD of fan blades.	(a) Replace blades having major FOD per INSPECTION, 72-72-0.
	(2) Oversize turbine nozzle flow areas.	(a) Inspect and repair flow area per overhaul manual.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. C. (Cont)		
	(3) Undersize fan nozzle flow area.	(a) Inspect and repair flow area per overhaul manual.
	(4) Excessive fan transition seal clearances.	(a) Inspect seal clearance per 72-70 and, if necessary, replace per 72-71-0.
	(5) Excessive untwist of turbine or fan blades.	(a) Inspect first-stage turbine blades per 72-53-0. Inspect fan blades per overhaul manual.
	(6) Distorted fan rear frame intermediate casing (midskin).	(a) Inspect casing contour per 72-73-0.
	(7) EPR probe cracked or plugged.	(a) Inspect and repair per 77-11-0.
D. High gas generator speed at takeoff EPR.	(1) Undersize turbine nozzle flow area.	(a) Inspect and repair flow area per overhaul manual.
	(2) Oversize fan nozzle flow area.	(a) Inspect and repair flow area per overhaul manual.
	(3) Leaking interstage bleed valve.	(a) Inspect for proper rigging and operation of valves per 75-00.
	(4) Leaking anti-icing valve.	(a) Inspect for operation of valve per 72-00 or replace per 75-11-0.
	(5) Excessive compressor 8th-stage seal clearance.	(a) Inspect clearance and replace parts as necessary per overhaul manual.
	(6) Excessive turbine or fan shroud clearance.	(a) Inspect per 72-50 and 72-70. Repair or replace parts if necessary.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. D. (Cont)		
	(7) Excessive transition seal clearances.	(a) Inspect per 72-70. Repair or replace parts if necessary.
	(8) Misrigged IGV and variable geometry.	(a) Inspect and rig per 75-00.
E. High or low thrust at EPR	(1) Distorted fan rear frame intermediate casing (midskin).	(a) Inspect casing contour and repair as necessary per 72-73-1.
	(2) Excessive untwist of turbine blades.	(a) Inspect first-stage turbine blades for bow and warp per 72-53-0.
	(3) Cracked or plugged EPR probe.	(a) Inspect and repair per 77-11-0.
F. High specific fuel consumption (SFC).	(1) Excessive fan shroud clearance.	(a) Inspect per 72-70 and repair per 72-73-0.
	(2) Excessive transition seal clearances.	(a) Inspect per 72-70, repair or replace parts if necessary.
	(3) Damaged exit guide vanes.	(a) Inspect and repair per 72-73-0.
	(4) Oversize fan nozzle area.	(a) Inspect area and repair overhaul manual.
	(5) Excessive fan blade FOD	(a) Inspect and repair per 72-72-0.
	(6) Leaking anti-icing or bleed valves.	(a) Inspect and repair per 75-00.
	(7) Excessive turbine blade tip clearance.	(a) Inspect per 72-50. Repair or replace parts if necessary.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
9. F. (Cont)	(8) Excessive turbine blade untwist.	(a) Inspect first-stage turbine blades for bow and warp per 72-53-0.
	(9) Compressor FOD	(a) Inspect and repair per 72-31-0, 72-32-0 and 72-33-0.
	(10) Excessive CDP seal leakage.	(a) Inspect and replace if necessary per overhaul manual.
	(11) Turbine FOD.	(a) Inspect and repair per 72-53-0.
	(12) Oversize turbine nozzle areas.	(a) Inspect and repair per overhaul manual.

10. Apparent Excessive T_2 Cutback. (Speed and EPR low at altitude.)

NOTE: These checks must be made with throttle at Max. position. (See figure 506.)

Problem	Probable Cause	Investigation/Corrective Action
A. Speed and EPR are low at altitude when compared to figure 506, 72-00, Adjustment/Test	(1) Speed can be increased by advancing throttle.	(a) Check aircraft and engine throttle system and rigging.
	NOTE: Engine to control system tolerance stack-up may create a throttle mismatch situation which should not be interpreted as excessive T_2 cutback.	(b) Check P_3 to fuel control line for tightness, cracks or bad gasket at mainframe.
		(c) Check fuel control top speed setting during ground run up. See section 72-00, Adjustment/Test.

TABLE 101

TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(2) Slow start as well as T_2 cutback is experienced.	(a) Set fuel control density adjustment to a lower setting. Adjust idle and top speed, then perform fast idle to max. accels (if engine stalls, replace fuel control). If engine operation is satisfactory, make flight test to determine if excessive speed cutback has been eliminated.
	(3) Speed cannot be increased by advancing throttle.	(a) Check for correct functioning of aircraft boost pump. If low pressure, troubleshoot aircraft fuel system.
		(b) Inspect CIT sensing system for damage, and for collapsed or blocked hoses; inspect aspirator housing for cracks or damage.
		(c) During throttle retard to idle, engine stalled or flamed out between 80-90 percent speed (indicates T_2 bellows failure or IGV feedback cable problem). Inspect compressor and fan turbine for FOD and other damage (i.e. thermal distress). If satisfactory, start engine and check bleed valve schedule while accelerating. If the bleed valves start to close early (approx. 70 percent speed) do not continue to accel engine as speed hang-up may occur in 70-75 percent (Ng) range. Replace fuel control (T_2 bellows failure) per 73-21-0.
		(d) If engine does not stall or flame out on decel, turn on anti-icing air and observe

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		engine speed. This should be done at the flight condition at which problem occurs. If speed does not change, replace fuel control per 73-21-0.
	(4) Excessive metered flow leakage.	(a) Check overspeed governor for internal leakage per 3.B.(2)(d)3.
		(b) Check drain valve for overboard leakage with engine running. If leakage, replace valve per 73-16-0.
		(c) Check pressurizing valve for leakage through reference port by disconnecting hose at fuel pump. Cap off fuel pump connection and start engine. Fuel should not leak from the open pressurizing valve port. If it does, replace valve per 73-15-0.
11. High or Erratic EGT (T5) Readings in Flight Envelope.		
A. High EGT in Flight Envelope.	(1) EPR is low compared to EGT.	(a) Check the EGT indicating system per paragraph 4.A.(1)(a).
		(b) Check physical security of the EGT wiring harness and any other wires in its vicinity. Incorrect readings can result due to bunches of other wires coming close to the EGT wiring harness, setting up an induced current.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(2) Anti-icing air is on.	(a) Check functioning and related wiring of anti-ice valve. This is a fail safe system, and so if any part of the electrical system in the anti-ice circuit fails, then the valve opens.

ABNORMAL ENGINE NOISE

12. Excessive Engine Noise.

NOTE: There are certain normal noises associated with engine starts and shutdowns, such as "ticking", "scraping" and "rubbing" because of basic design features such as pinned No. 1 stage compressor rotor blades, backlash in the accessory gear train and variable clearances. Departures from normal noises are to be investigated. A normal engine coastdown time is usually greater than 30 seconds and a slight "kick-back" at the moment the rotor stops turning usually indicates that the rotor is free.

Problem	Probable Cause	Investigation/Corrective Action
A. Noise During Start and Shutdown.	(1) Turn rotor by hand to determine the amount of drag associated with the noise, if possible determine the approximate location of the noise, i.e., gearbox, compressor, turbine. NOTE: Scraping noises are sometimes associated with newly overhauled or repaired engines and usually associated with "wearing in" of new or relocated seals. This may be considered normal.	(a) If coastdown time is less than 20 seconds, remove the hydraulic pump from its pad, then start engine. After engine has stabilized at idle, shutdown engine and note coastdown time. (b) If time is less than 25 seconds and can be determined that the noise comes from the turbine, perform engine run as follows. Start engine and advance power until max is obtained. Hold max power for approximately four minutes then reduce RPM in increments of 5 percent holding each speed for two minutes until idle or 50 percent speed is reached. Shutdown engine and listen for noise and check coastdown time.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		1. If either or both improve, observe proper shutdown procedure after subsequent flights and monitor shutdown noise.
		2. If engine run has not corrected turbine noise, teardown of the engine hot section by a facility having this capability should be made to determine the source and correct the problem.
B. Noises Such as "Bumps", "Thumps" and "Squeaks".	Generally associated with bearings.	Using some sound amplification probe method check the starter, gearbox, and external engine adjacent to main engine bearings at starter motoring speeds and during coastdown from either start or idle RPM. If it is believed that the noise is a bearing, the engine or accessory component should be removed and replaced at a facility having proper capability.
C. Operational Noises		

NOTE: Abnormal engine operation can result from fuel or combustion system instability, vibration of the engine structures or piping and noise internal to the engine or accessories due to interference.

Problem	Probable Cause	Investigation/Corrective Action
	(1) Fuel or combustion system.	(a) Instability within either system is heard as a "rumble". The condition can be corrected by orderly removal and replacement of components within either system. However, prior to replacing components it is recommended that a General Electric Co. representative be consulted.

SEI-187

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(2) Vibrating engine structures and piping.	(a) This condition usually results from unbalance condition of an engine rotating component. Correction can be performed only at engine overhaul level facility.
	(3) Interference noise.	(a) The offending accessory can be detected by removal and replacement.
		(b) Rubbing within the engine usually occurs in the turbine section (seals and blade rubs) and can be detected by using a sound *amplification probe method*. Rubbing noises within the compressor section require detail inspection and correction at an engine overhaul facility.
12A. Engine "Rumble" in Speed Range 48-65% Ng.		
A. Fuel System Malfunction.	(1) Air in pressurizing valve reference pressure line.	(a) Turn on boost pump, open stop cock and loosen reference pressure line at pressurizing valve. Allow flow to continue until fuel is free of air bubbles. Tighten fuel line, close stop cock and switch off boost pump.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(2) Pressurizing valve instability.	(a) Change pressurizing valve.
	(3) Overspeed governor servo valve instability.	(a) Change overspeed governor.
	(4) Fuel nozzle flow divider instability.	(a) Change all fuel nozzles.
B. Improper combustion.	(1) Combustor incompatibility with other engine components.	(a) Change combustor.

NOTE: Aircraft fuel system boost pressure level can cause "rumble". Consideration should be given to changing the aircraft boost pump if difficulty is found in eliminating rumble.

LUBE SYSTEM

NOTE: Before troubleshooting Lube System problems of temperature or pressure, check the instrumentation calibration of these parameters.

13. Lube System Troubleshooting.

NOTE: The engine lube supply system basically consists of a supply tank, a positive displacement pump, a cooler, a filter, and the jets. Oil pressure is sensed before it enters the filter. If the filter becomes dirty or the flow through the jets is restricted, the indicated pressure will increase. At the present time there are two basic lube systems. The center vent (CV) and non-center vent (non-CV) systems. In troubleshooting the CV vs. the non-CV system, the most significant difference is that the internal sump and gearbox pressures in the CV engine run considerably higher than those of the non-CV engine.

CAUTION: IF THE ENGINE HAS OPERATED WITH NO OIL PRESSURE, A COMPLETE LUBE SYSTEM INSPECTION MUST BE MADE BY AN OVERHAUL FACILITY.
A SUDDEN INCREASE OR DECREASE IN OIL PRESSURE OF 10 PSI FROM THAT OIL PRESSURE CONSIDERED TO BE NORMAL FOR THE ENGINE IS CAUSE FOR INVESTIGATION.

A. High Oil Pressure	(1) Contaminated lube pump filter	(a) Remove filter and check for contamination as stated in section 79-00, Servicing.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
NOTE: Check lube filter and and perform gearbox pressure check if engine has non-CV system. If filter is clean and gearbox pressure is less than 5 lbs., engine should be removed for complete lube system inspection by an overhaul facility.	(2) Defective oil pressure transmitter or gage. Install a direct reading gage (0-200 psi scale) in the line to the aircraft transmitter. If engine is CV type install a second (0-30 psi) gage in parallel with the lube pressure reference line.	(a) Replace defective transmitter or gage. NOTE: During engine operation the direct reading gage on CV engines will indicate higher pressure than non-CV engine at same RPM. Reference (main sump) pressure must be subtracted from supply pressure when checking lube pressures of CV engines.
	(3) Defective oil cooler	(a) Thermostat or relief valve failure/ruptured oil cooler (internal). Replace oil cooler per 79-23-0.
	(4) Damaged/defective oil supply line.	(a) Remove supply line. Inspect for blockage and damage. Repair or replace supply line.
	NOTE: Do not change lube pump because it cannot cause high oil pressure.	
B. Low or No Oil Pressure	(1) Low oil in oil tank	(a) Service lubrication system per 79-00.
	(2) Defective lubrication lines and/or fittings	(a) Retorque or replace defective line and fittings.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(3) Defective pressure transmitter or gage	(a) Replace defective pressure transmitter or gage. Check using direct reading gage.
	(4) Defective or obstructed relief valve	(a) Clean/replace relief valve.
	(5) Defective oil cooler	(a) Faulty thermostat valve. Comply with engine service bulletin (ESB) No. 72-42 or replace cooler per 79-00.
	(6) Defective lube pump NOTE: If pressure remains low after lube pump replacement, reject engine to overhaul facility for inspection of internal lube system components.	(a) Disconnect No. 1 bearing lube inlet line at 10 o'clock (aft looking forward) front frame connection. Motor engine. If oil does not discharge, remove lube pump. Check lube pump inlet for clogged condition. Clean as required or replace lube pump per section 79-21-0.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
C. No Oil Pressure and Loss of Ng Indication.	(1) Defective lube pump.	(a) Determine cause of pump failure. Check lube supply filter per 79-22-0. 1. If clean, remove pump and check for failed gear and/or No. 1 element bearing seizure. Remove gearbox and pump and send to engine overhaul facility. Flush engine lube system and service with new oil. 2. If contaminated, remove engine and send to overhaul facility for inspection and repair.
D. Fluctuating Oil Pressure.	(1) Low oil in tank.	(a) Check and service lubrication system per 79-00.
NOTE: A fluctuation of ±5 PSI is cause for investigation.		
	(2) Defective pressure transmitter or gage	(a) Replace defective pressure transmitter or gage. Check using direct reading gage as stated in preceding paragraph A.(2).
	(3) Contaminated or weak check valve spring in lube pump filter	(a) Remove filter and check for contamination as stated in section 79-00, Servicing.

TABLE 101
TROUBLESHOOTING GUIDE (CONT)

Problem	Probable Cause	Investigation/Corrective Action
	(4) Defective lube pump.	(a) Check pump operation as stated in preceding paragraph B.(5).
	(5) Defective swivel pendulum pickup.	(a) Remove pump from tank per 79-21-0, and check pickup for proper movement.
E. High Oil Consumption.	(1) Oil tank filler cap loose.	(a) Replace O-ring, install and lock cap.
	(2) Defective lube pump tachometer generator drive shaft seal.	(a) Replace seal per section 79-21-0.
	(3) External lube lines and fittings for leakage.	(a) Retorque or replace defective lube lines or fittings.
	(4) Defective oil tank relief valve.	(a) Replace valve per Section 72-12-0.
	(5) Oil on compressor blades and pooling of oil droplets at 6 o'clock position inside compressor casing.	(a) If oil is present, operate the engine at IDLE speed after running for a least three minutes at approximately 100 percent and with stabilized oil temperature, check for oil mist blowing from the compressor bleed valves. Oil will be apparent inside the cowling or at the bleed valve duct exists. (Do not misconstrue compressor rotor preservation oil which blows out during start.) Replace the No. 1 carbon seal, if oil mist is noted, by a qualified maintenance facility per section 72-30.

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
	(6) Faulty carbon seals, O-rings, etc.	(a) Check No. 2 and 3 sumps as follows: 1. Disconnect Nos. 1, 4 and 5 sump vent lines. Cap off end of vent lines or fittings to prevent oil loss during engine operation. 2. Connect a vacuum-pressure gage (30 in. Hg vacuum to 30 psig) to the mainframe vent fitting for center vent (CV) or axis "B" aft fitting for non-center vent (non-CV). 3. Operate engine at take-off for 5 minutes stabilization period and then record sump pressure. Operate engine at idle for 3 minutes stabilization period and then record sump pressure. 4. Nos. 2 and 3 sump reading must be within the following limits. Readings lower than these indicate an internal leak. CV — Non-CV Idle — 0 psig — -1.0 in Hg. Take-off — 10 psig — 0 psig 5. If leakage is determined to be internal, remove the engine and return to overhaul for investiga-

TABLE 101 (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		tion (per Overhaul Manual) of No. 2 and No. 3 sump areas. This will require engine disassembly to areas required for leakage isolation. If No. 2 and 3 sumps are within limits continue troubleshooting as follows.
		(b) The engine should be removed from the aircraft for ease of troubleshooting.
		(c) Remove external hoses and lines and inspect for blockage or breaks. Clean or replace as necessary.
		(d) Check No. 1 sump area as follows:
		1. Remove bullet nose.
		2. Remove line from oil supply, scavenge and vent fittings on front frame.
		3. Cap the oil supply and scavenge line. Supply 5-10 psig of clean air to No. 1 sump through the vent line.
		4. Soap check all brazed joints outside of No. 1 sump. No leaks allowed. Leakage from the carbon seal is normal.
		5. If leakage occurs, return the engine to overhaul.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
13.E.(6) (Cont)		(e) Check No. 5 sump area as follows: 1. Remove exhaust tail cone. 2. Remove rear shield. 3. Remove line from vent, oil supply, 8th stage seal leakage and scavenge fittings on fan rear frame. 4. Cap all fittings except the vent fitting. Supply 5-10 psig of clean air to the No. 5 sump through the vent fitting. 5. Soap check all tube joints and all exposed areas. No leaks allowed. If leaks occur at tube joints, replace O-rings on tube. If leaks occur at scavenge pump, replace gasket or scavenge pump and gasket per 79-24-0. If leaks occur in the No. 5 bearing housing, the housing must be replaced. (f) Check the No. 4 sump area as follows: 1. Remove the fan package from the engine per 72-70. 2. Remove the cover and front shield from the No. 4 sump area.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
13.E.(6) (Cont)		3. Remove line from vent, oil supply, 8th stage seal leakage and scavenge fittings on fan front frame.
		4. Cap all fittings except the vent fitting. Supply 5-10 psig of clean air to the No. 4 sump through the vent fitting.
		5. Soap check all tube joints and all exposed area. No leaks allowed. If leaks occur at tube joints, replace O-rings on tube. If leaks occur at scavenge pump, the gasket or scavenge pump and gasket must be replaced. If leaks occur in the No. 4 bearing housing, the housing must be replaced.
		(g) If no leaks occur during soap check of sump areas, the fan package must be returned to overhaul.
	(7) Oil foaming in oil tank.	(a) Small amounts of silicone oil or grease in the lube system will cause oil foaming which may result in engine oil being forced out of the overboard vent. If silicone contamination is suspected, replace the engine oil per section 79-00, Paragraph 2.E.

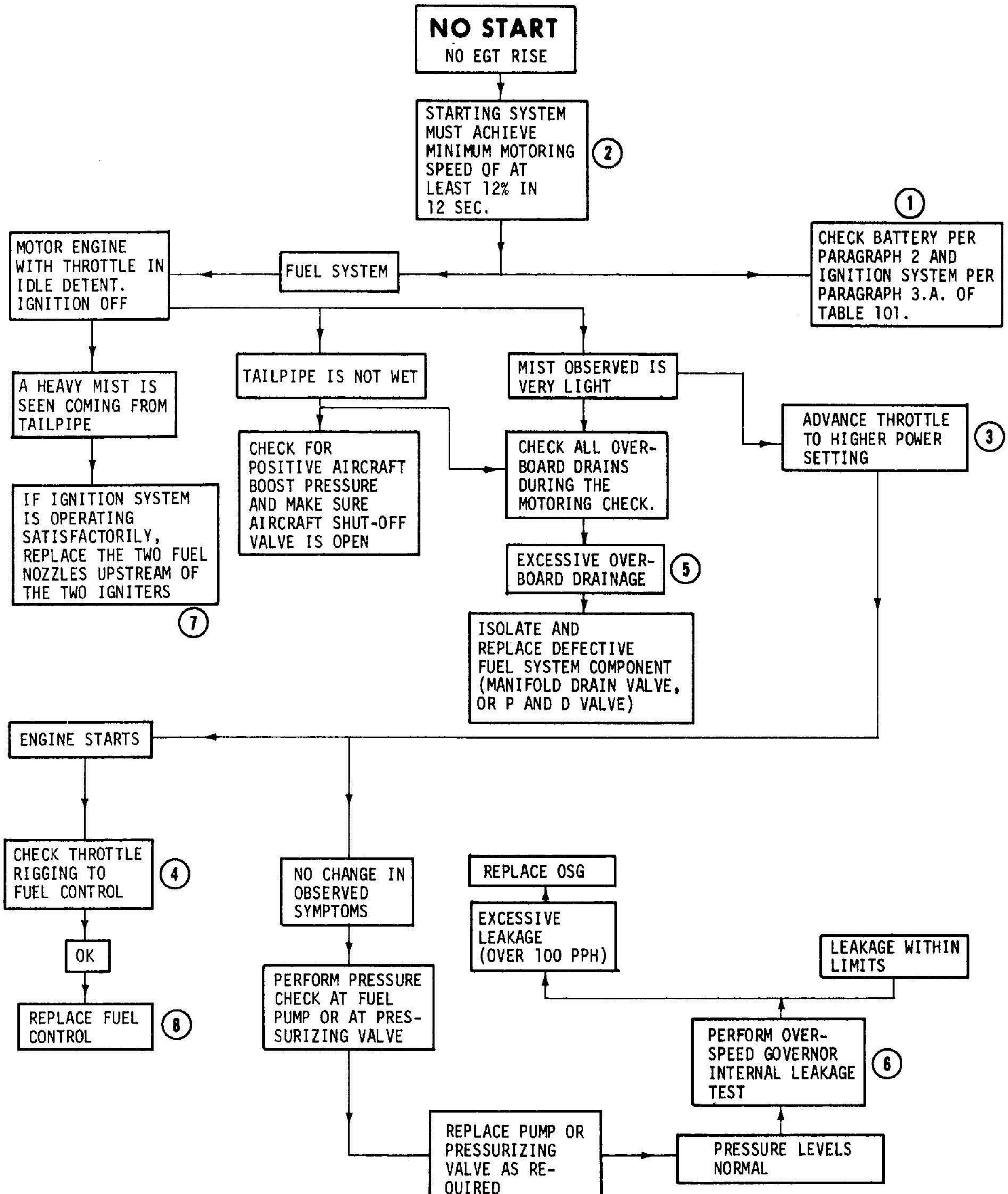
TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
13.F. Fuel Mixed with Lube Oil.	(1) Ruptured oil cooler.	(a) Watch oil tank overboard air relief valve for overflow of lube oil and/or fuel. Replace oil cooler per 79-23-0. Drain, flush, and fill lube system.
		(b) Drain oil tank; check drainings for fuel contamination by smell or by feel. Replace oil cooler per 79-23-0. Drain, flush, and fill lube system.
	(2) Fuel pump shaft seal failure.	(a) Check fuel pump overboard drain for excessive fuel drainage. Replace defective fuel pump per 73-13-0. Drain, flush, and fill lube system.
	(3) Accessory gearbox fuel pump drive gear seal failure.	(a) Check for defective seal. Replace defective seal per 72-64-0. Drain, flush, and fill lube system.
G. Oil Tank Ballooned.	(1) Oil tank relief valve.	(a) Check valve for proper operation and replace the valve if required per 79-12-0.
	(2) Fuel contamination.	(a) Refer to preceding paragraph F for procedure.
H. Lube System Contamination.	(1) Contaminated lube pump filter.	(a) If filter has less than 10% element coverage, flush system, change filter, and monitor. Refer to 79-00.

TABLE 101
TROUBLESHOOTING GUIDE (Cont)

Problem	Probable Cause	Investigation/Corrective Action
		(b) If filter has more than 10% element coverage, lube system investigation is required. Bypass of filter is possibly allowing contaminates to pass into lube jets, sumps, lube pump, oil tank, and oil cooler.
	(2) System contamination.	(a) Define by examination of the extent of contamination.
		(b) If system is contaminated beyond filter, remove engine for examination by overhaul shop. (For example, examination is required if metal particles are detected on magnetic plug of accessory gearbox.)

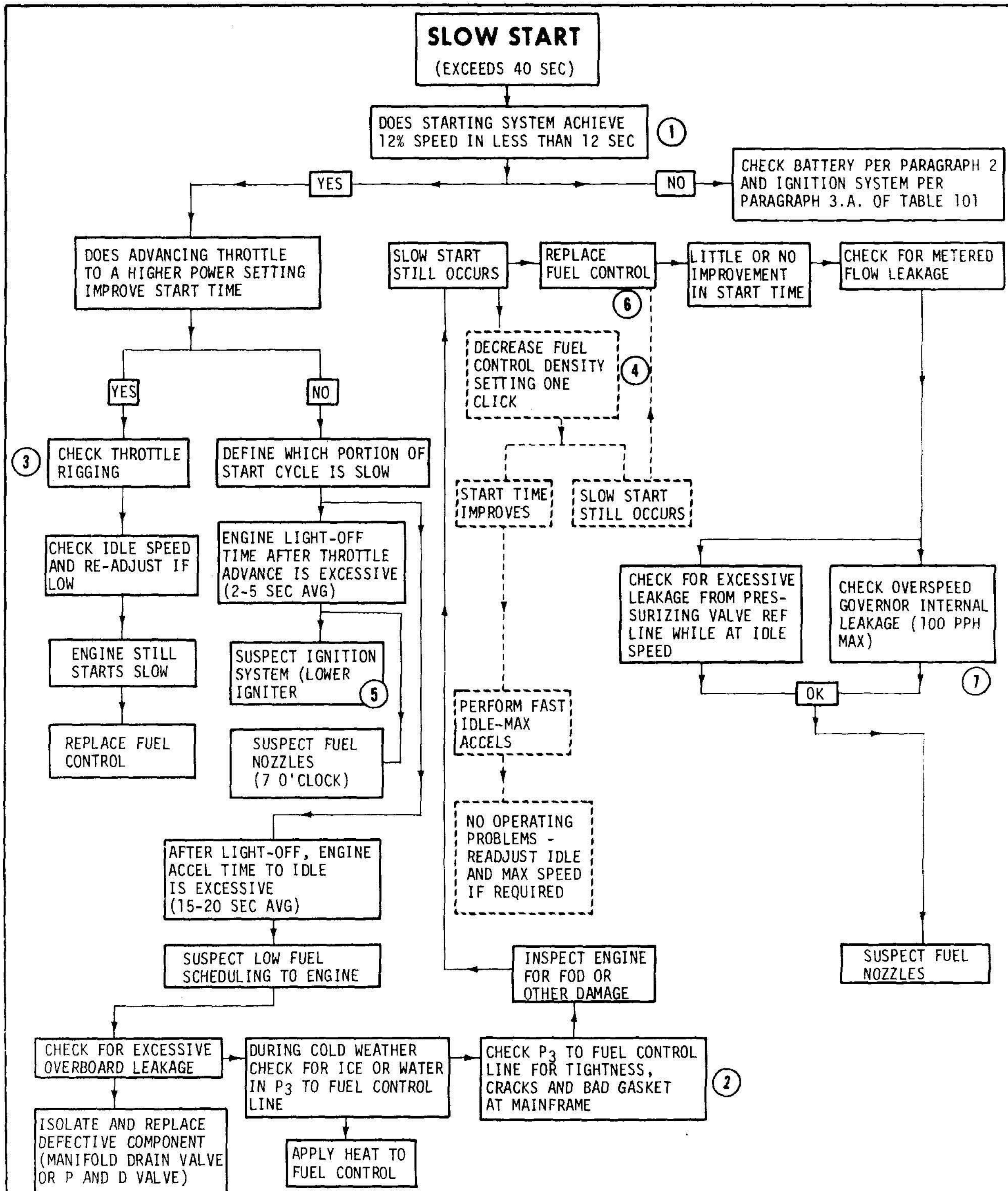
TABLE 102 Deleted.



NOTE: ANY OF THE ITEMS LISTED MAY CAUSE THE PROBLEM, THEREFORE THE ENTIRE CHART SHOULD BE READ AND UNDERSTOOD BY THE USER. HOWEVER, FIELD EXPERIENCE HAS INDICATED THAT THE MOST PROBABLE CAUSES (IN DESCENDING ORDER) ARE THOSE INDICATED BY THE NUMBERED CIRCLES. IT IS SUGGESTED THAT THEY BE FOLLOWED IN SEQUENCE.

BC-0126

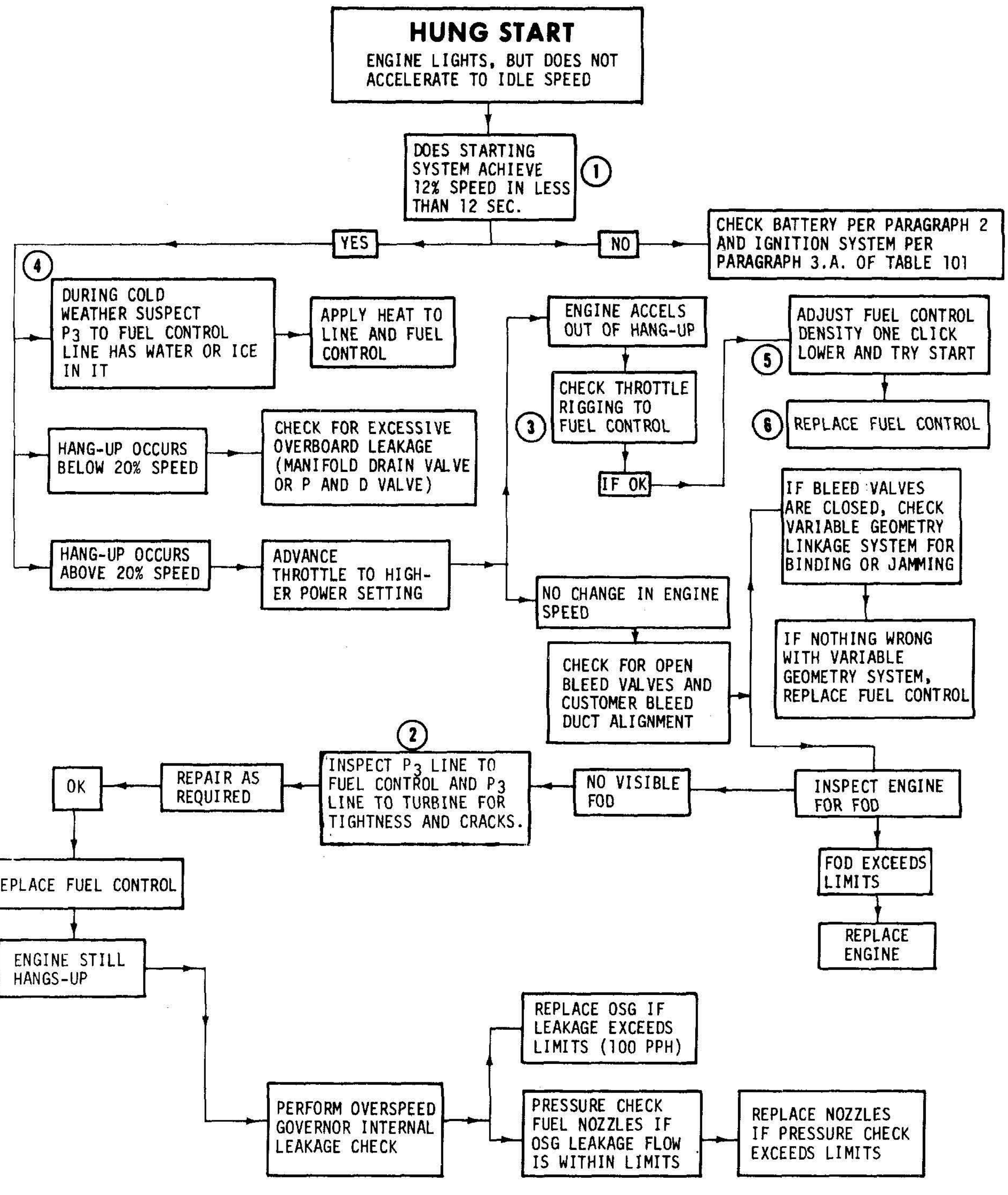
Trouble-Shooting Flow Chart
Figure 101 (Sheet 1 of 6)



NOTE: ANY OF THE ITEMS LISTED MAY CAUSE THE PROBLEM, THEREFORE THE ENTIRE CHART SHOULD BE READ AND UNDERSTOOD BY THE USER. HOWEVER, FIELD EXPERIENCE HAS INDICATED THAT THE MOST PROBABLE CAUSES (IN DESCENDING ORDER) ARE THOSE INDICATED BY THE NUMBERED CIRCLES. IT IS SUGGESTED THAT THEY BE FOLLOWED IN SEQUENCE.

F
BC-0127

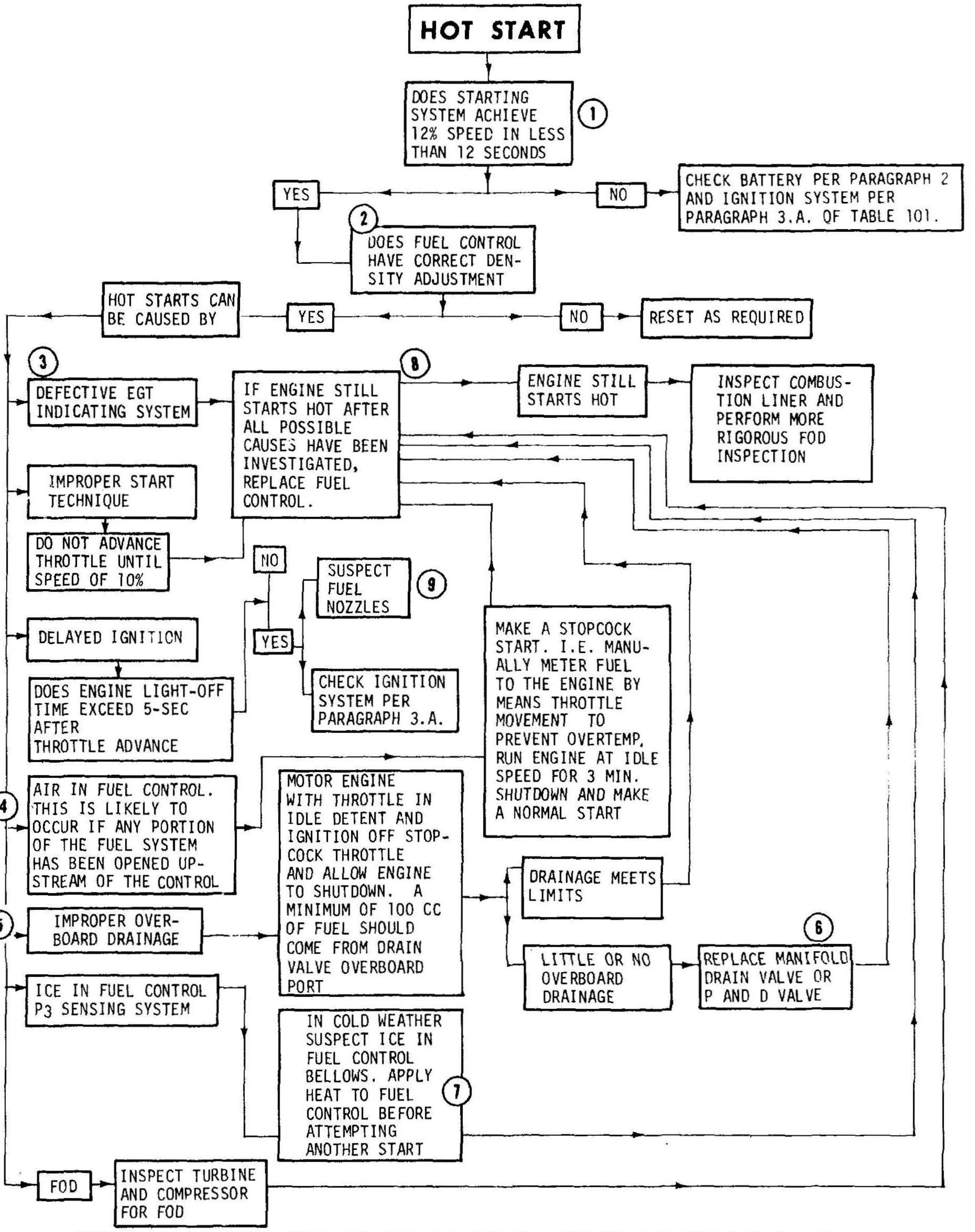
Trouble-Shooting Flow Chart
Figure 101 (Sheet 2 of 6)



NOTE: ANY OF THE ITEMS LISTED MAY CAUSE THE PROBLEM, THEREFORE THE ENTIRE CHART SHOULD BE READ AND UNDERSTOOD BY THE USER. HOWEVER, FIELD EXPERIENCE HAS INDICATED THAT THE MOST PROBABLE CAUSES (IN DESCENDING ORDER) ARE THOSE INDICATED BY THE NUMBERED CIRCLES. IT IS SUGGESTED THAT THEY BE FOLLOWED IN SEQUENCE.

F
BC-0128

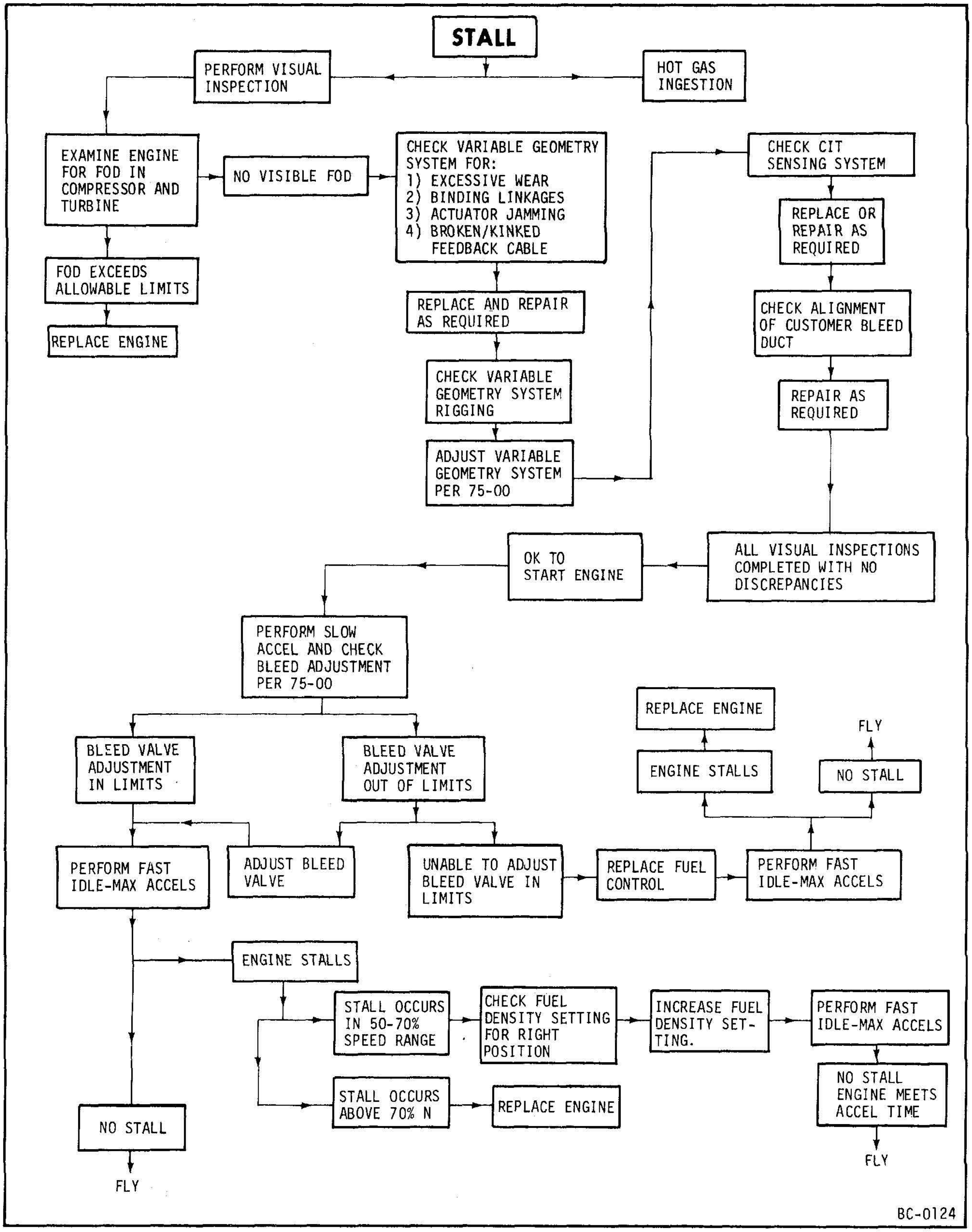
Trouble-Shooting Flow Chart
Figure 101 (Sheet 3 of 6)



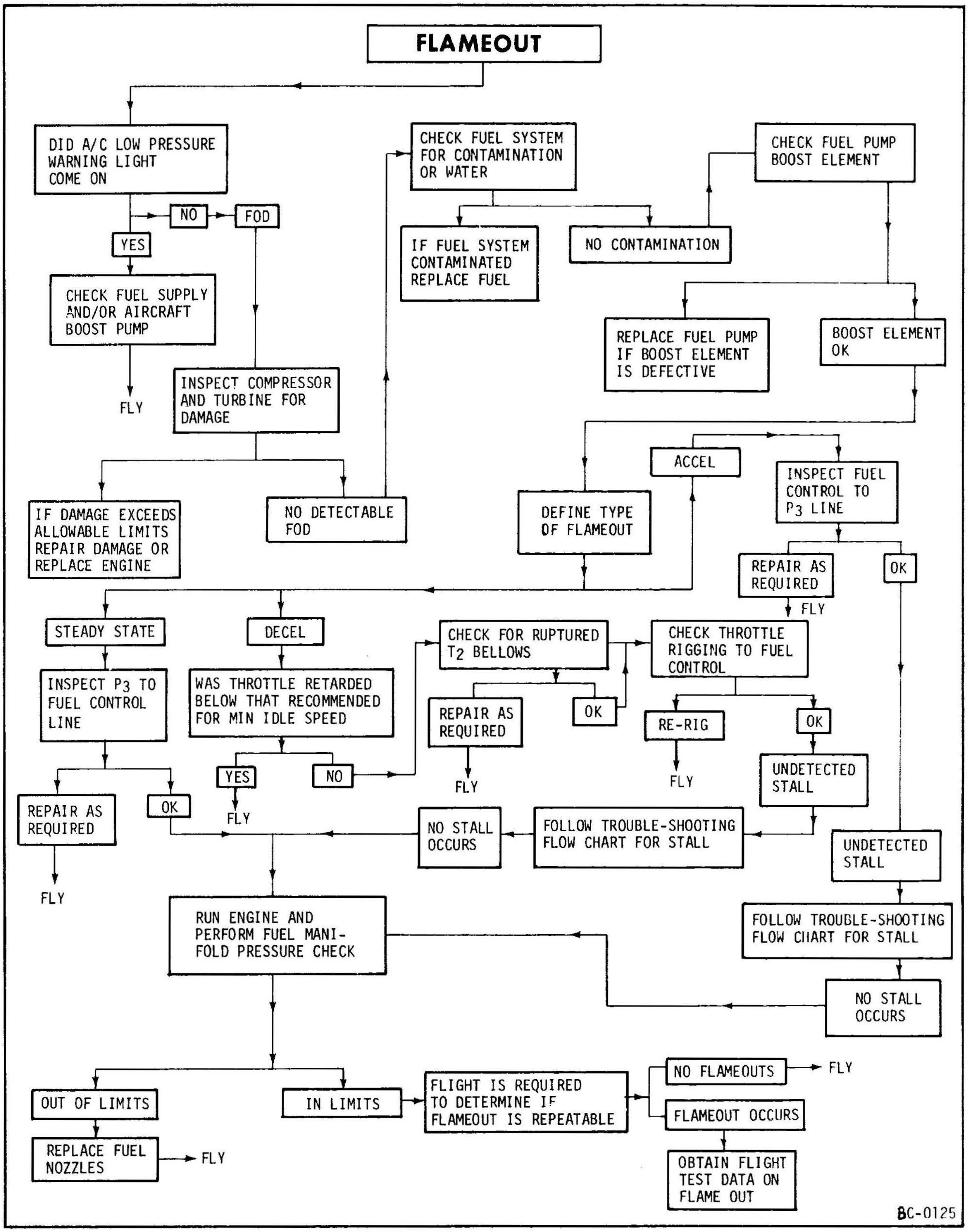
NOTE: ANY OF THE ITEMS LISTED MAY CAUSE THE PROBLEM, THEREFORE THE ENTIRE CHART SHOULD BE READ AND UNDERSTOOD BY THE USER. HOWEVER, FIELD EXPERIENCE HAS INDICATED THAT THE MOST PROBABLE CAUSES (IN DESCENDING ORDER) ARE THOSE INDICATED BY THE NUMBERED CIRCLES. IT IS SUGGESTED THAT THEY BE FOLLOWED IN SEQUENCE.

BC-0123

Trouble-Shooting Flow Chart
Figure 101 (Sheet 4 of 6)

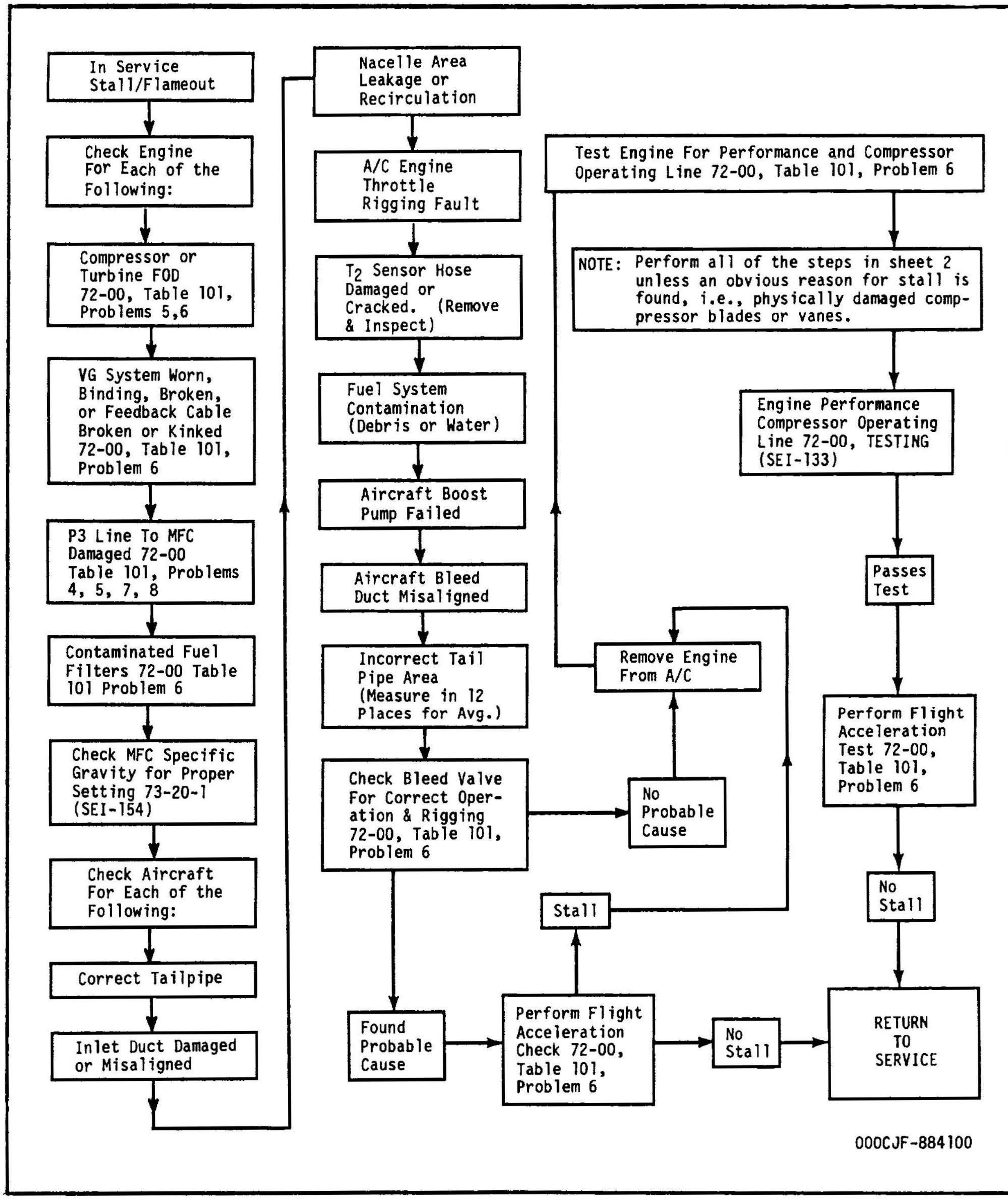


Trouble-Shooting Flow Chart
Figure 101 (Sheet 5 of 6)



Trouble-Shooting Flow Chart
Figure 101 (Sheet 6 of 6)

Figure 102 Deleted.



Altitude Stall/Flameout Troubleshooting Guide
Figure 103 (Sheet 1 of 2)

Record "as received" data and compare against manual limits.

1. Compressor

- Perform 100% shadowgraph (include spacer runouts) and EROM on compressor rotor/stator. Calculate clearances 72-33-0 (SEI-133)
- Blade tips must meet clearance limits per tables II, III & IV Section 72-33-0 (SEI-133)
- Be sure all blades and vanes are clean
- Replace all FOD blended blades and vanes
- Replace all blades with runouts in excess of 0.008 inch TIR
- Inspect for FOD (dents), corrosion (pits) and tip rubs 72-32-1, 72-32-2, 72-32-2 (SEI-133)
- Repair compressor cases which exceed 0.007 inch land runout per REI 125
- Reject all airfoils which do not meet the requirements of surface finish (max surface finish is 32 microinches for stages 1 thru 4 and 20 microinches for stages 5 thru 8) and do not meet the leading edge radius requirements shown in 72-32-0, Fig 205 and 72-33-0, Fig. 203
- Replace vanes as necessary to obtain the following:
  - •• Maximum vane runout not to exceed 0.007 inch TIR
  - •• Maximum average step between adjacent vane sectors: 0.003
  - •• Maximum scallop for each individual vane sector: 0.006
- Machine vanes to obtain the following end-gap on each half case:

Stage	End-Gap Per Half Case
3,4, & 5	0.030 to 0.055 inch
6 & 7	0.040 to 0.100 inch

  If more than 0.005 inch of metal removal is required, then machine vanes uniformly on each sector. Adjust end-gap to maximum side of tolerance
- Record clearance data. To obtain the average value, all calculations must be based on 100% of the blades and vanes
- The aluminum base intermetallic diffusion coating must be removed or the blades replaced in stages 5 thru 8 of extended life compressor per Service Bulletin 72-139(CF700) Rev. 1
- If one or more stages of blades requires replacement, use the CF700-2D-2 with "B" clearance limits listed in tables II, III, & IV in Section 72-33-0 (SEI-133)

2. Turbine Nozzles

- Stage 1 nozzle
  - •• Measure area of nozzle "as received"
  - •• Adjust to max. area for particular engine 72-51-0 (SEI-133)

  NOTE: No adjustment allowed on CF700-2D/2D2 engines
  - •• Check partitions; no reverse bends allowed
- Stage 2 nozzle to be within manual area limits; no further adjustment permitted

3. Turbine

- Measure and record "as received" clearances
- Inspect for FOD. Replace blades or shrouds as necessary to obtain tip clearance limits 72-53-0 (SEI-133)
- Measure and record FWD and AFT seal clearances for "mini-turbine" assemblies. Disassemble standard turbine wheel assemblies and measure/calculate interstage to torque ring clearances

4. MFC

- Test per 73-20-1 (SEI-154)
- Recalibrate MFC to overhaul manual limits and record data per 73-20-1 (SEI-154)

5. Fuel System

- Flow-check fuel nozzles 73-16-1 (SEI-154)

6. Engine Rigging

- Be sure IGV's are rigged to zero degrees

7. Fan Nozzle (CF 700 Only)

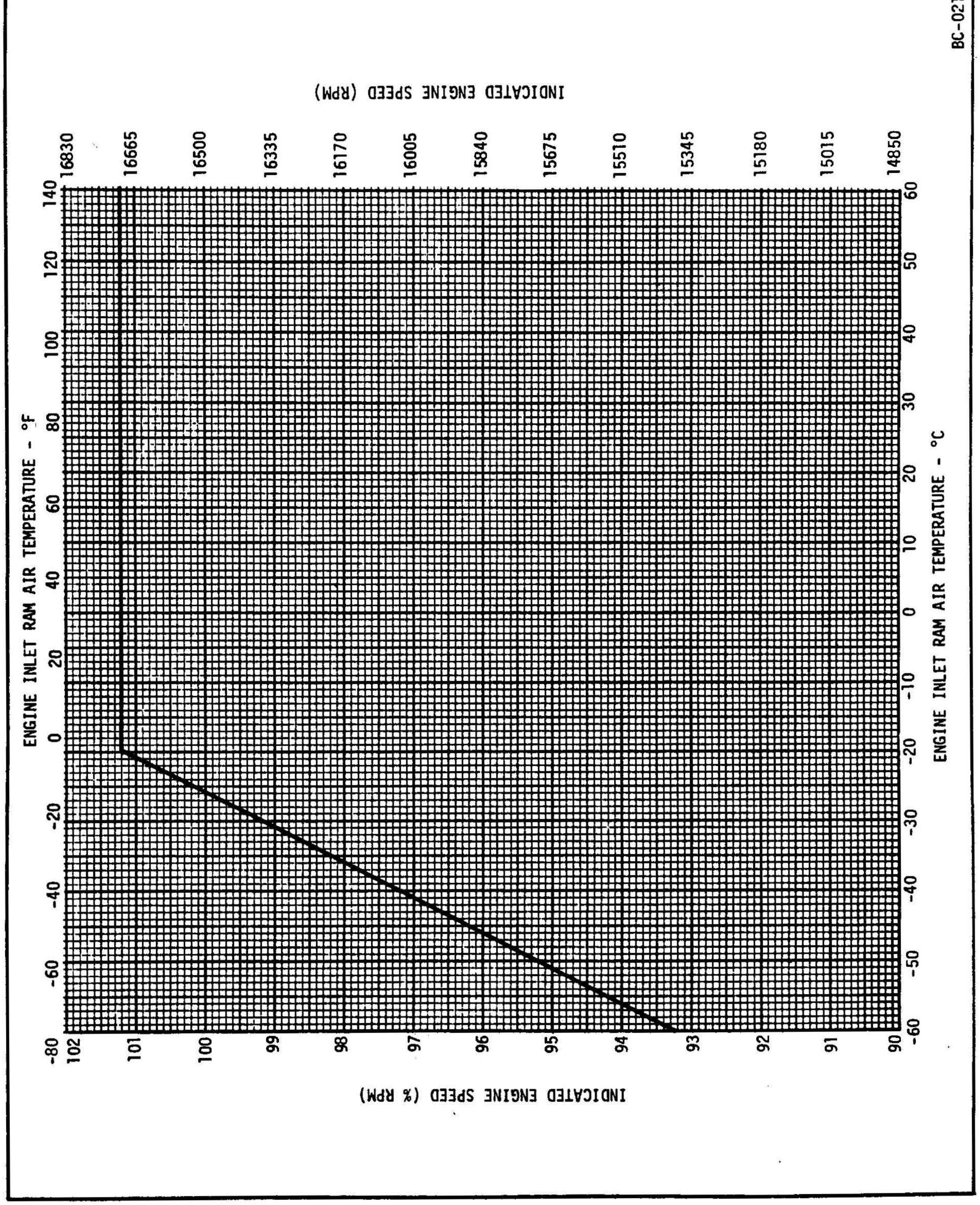
- Measure and record area of nozzle "as received"
- Correct to manual limits & record

NOTE

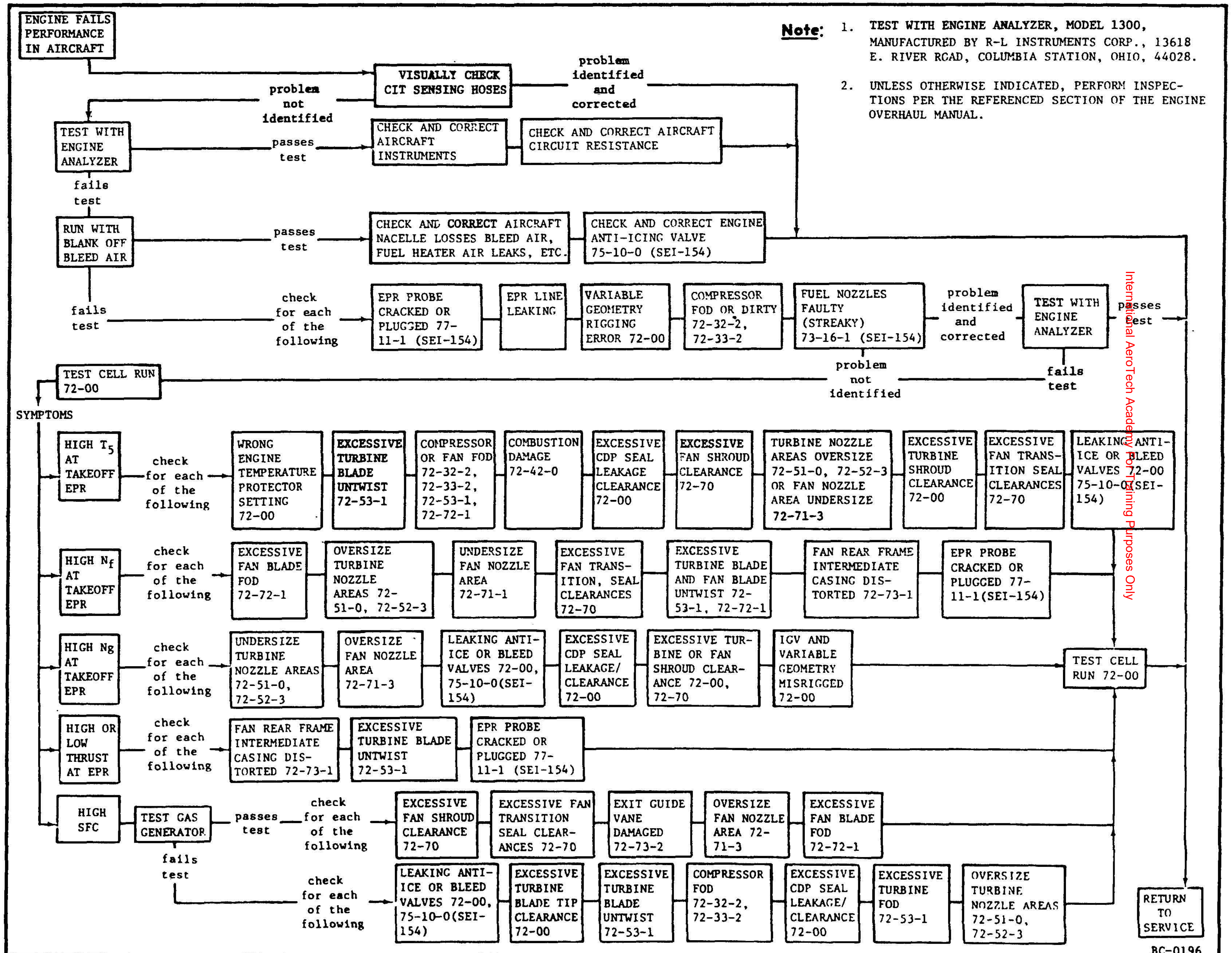
All References are to SEI-187 unless noted.

000CJF-884200

Altitude Stall/Flameout Troubleshooting Guide
Figure 103 (Sheet 2 of 2)



Maximum Engine Speed - Altitude Stall Troubleshooting
Figure 103A



Performance Troubleshooting Guide
Figure 104

ENGINE MAINTENANCE PRACTICES - SERVICING

1. General.

The items that require servicing are listed in this section along with the service to be performed. It also contains instructions for activating the engine after storage, preserving and storing the engine for specific time periods either in the airframe or the shipping container.

NOTE: Engines removed from aircraft for servicing or maintenance should be installed in a horizontal stand, such as 2C5347.

2. Lubrication System.

A. Check lube level in lube tank. (Refer to 79-00.)

B. Clean and check lube filter. (Refer to 79-22-0.)

C. Check for metallic particles. (Refer to 79-00.)

D. Procedure for changing lube oil. (Refer to 79-00.)

E. Prime the lube and scavenge pump as instructed in paragraph, this Section, titled Activating Engine After Storage Procedures if any of the following conditions exist.

(1) Engine has not been operated within the last 14 days.

(2) The engine is being tested for the first time since installation into an aircraft.

(3) The engine is being tested for the first time after having been preserved.

(4) The engine is being tested for the first time after replacement of the lube and scavenge pump.

3. Fuel System.

A. Clean and check fuel pump filter. (Refer to 73-13-0.)

B. Clean and check fuel control filter. (Refer to 73-21-0.)

C. Clean and check high-pressure fuel filter. (Refer to 73-14-0.)

4. Activating Engine After Storage Procedures.

NOTE: Preserved engines must be depreserved before operation.

A. Remove all protective covers from the engine.

B. Visually inspect the engine for damage. Insure that no foreign material is lodged in any of the engine ports such as the bleed valves, fuel inlet, etc.

C. Depreserve the lubrication system as follows:

(1) Drain any residue oil from the accessory gearbox and the transfer gearbox by removing the drain plugs.

(2) Reinstall drain plugs and torque to 60-80 lb-in.

(3) Remove the oil filter cap from the lube tank and fill the tank with oil that has been filtered through a 10-micron metallic filter (tank capacity is 4 quarts). Refer to Chapter 79-00, Maintenance Practices for the list of approved oils.

(4) Prime the number 1 scavenge element of the lube and scavenge pump with engine oil by using any of the following methods:

(a) Disconnect (see figure 301) the No. 4 and No. 5 sumps scavenge oil return line to the oil tank just forward of the firewall, add a pint of engine oil (oil must be clean, filtered through a 10 micron filter) to enter the oil tank dwell chamber and the scavenge pump discharge ports, and reconnect the No. 4 and No. 5 sump scavenge oil return line.

(b) Disconnect (see figure 301) the No. 1 sump oil supply line where it is attached at the top left hand side of the accessory gearbox (aft looking forward), add one pint of engine oil (oil must be clean, filtered through a 10 micron filter) into the hose so it will enter the No. 1 sump and drain through the No. 1 sump scavenge tube to the inlet port of the No. 1 scavenge element of the pump.

(c) Remove the bullet-nose and No. 1 sump cover from the forward side of the front frame hub and add a pint of engine oil (oil must be clean, filtered through a 10 micron filter) to enter the No. 1 sump scavenge tube to the inlet port of the No. 1 scavenge element of the pump.

NOTE: Remove and replace the bullet-nose and No. 1 sump cover as outlined in Section 72-30, Front Frame Removal/Installation.

(d) Or, any other method approved by the General Electric Company.

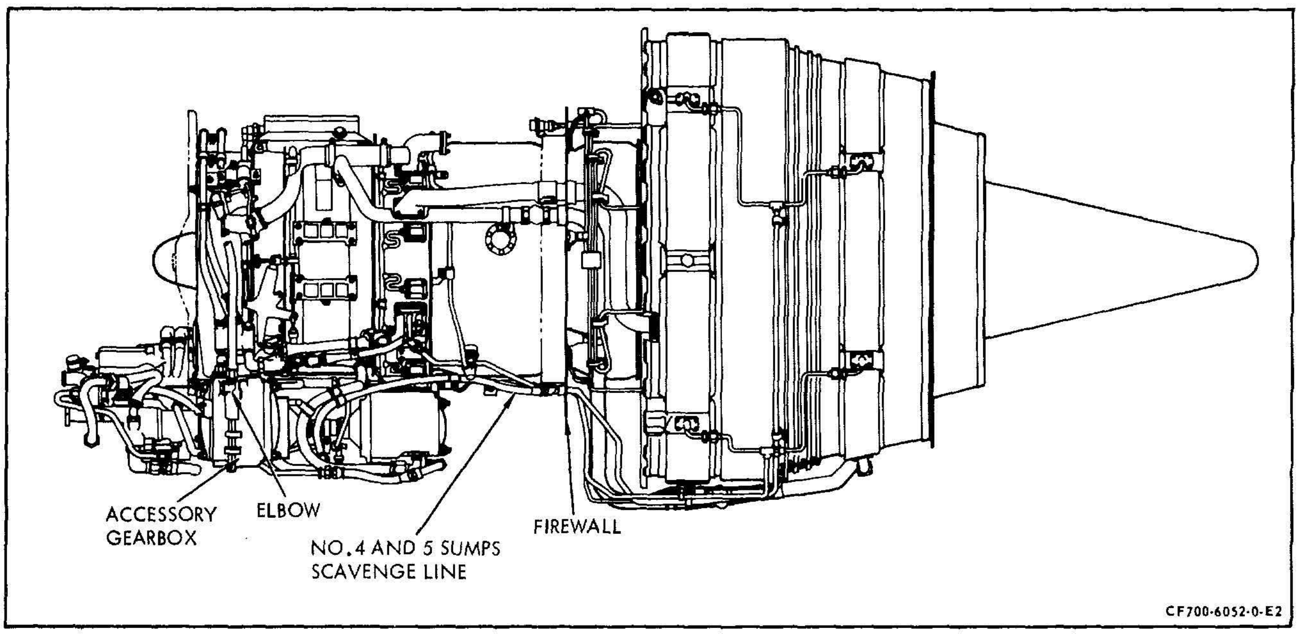
(5) Allow the added oil to settle in the lube and scavenge pump parts for at least 10 minutes to assure the No. 1 scavenge element is primed.

CAUTION: BEFORE THE ENGINE IS STARTED A PINT OF OIL MUST BE DRAINED FROM THE OIL TANK TO MAKE CERTAIN THE LUBE SYSTEM HAS NOT BEEN OVER-SERVICED.

(6) Replace the oil tank cap and lock it. Connect lines.

D. Depreservation of the compressor and exhaust sections of the engine is not required. Make sure the engine inlet and exhaust areas are free of foreign material that could damage the engine.

E. Depreservation of the variable geometry actuators is not necessary. The preservative oil and any entrapped air will mix with fuel before it is discharged through the fuel nozzles.



Lube and Scavenge Pump Priming
Figure 301

F. Depreserve the fuel system as follows:

(1) Connect a fuel supply to the fuel pump inlet adapter. The fuel should be supplied to the engine through a 10-micron filter at a pressure between 7.5 psi (above true vapor pressure) and 50 psig. Refer to Chapter 73-00, Maintenance Practices.

(2) Motor the engine, with the throttle set at 15 degrees, for 2 minutes as follows:

CAUTION: MAKE SURE THE IGNITION IS TURNED OFF. DO NOT EXCEED THE DUTY CYCLE PERIOD FOR THE STARTER. THE 2-MINUTE MOTORING PERIOD MAY BE ACCOMPLISHED IN INCREMENTS OF THE STARTER DUTY CYCLE. RETURN THE THROTTLE TO 0 DEGREES AT THE END OF EACH DUTY CYCLE.

(a) Check the tailpipe. A fine mist should be seen coming from the tailpipe during motoring.

(b) Check the engine piping for leaks. No leaks allowed.

(c) Check the combustion section drain. Fuel should drain out of the combustion drain line during motoring.

(d) Check the fuel manifold drain valve for proper operation. Fuel should drain from the valve during motoring.

(3) At the completion of the motoring period, allow the engine to drain for 3 minutes.

(4) With the throttle closed, motor the engine for 1 minute.

G. Start the engine and perform the following check per Adjustment/Test, 72-00. Adjustments should be made as required, per Adjustment/Test, 72-00.

(1) Start engine.

(2) Check engine idle. Allow the engine to remain at idle RPM for a minimum of 5 minutes operating time before advancing the throttle to higher power or speed settings.

(3) Check the variable geometry system.

(4) Perform the takeoff check.

(5) Check the overspeed governor.

(6) Check engine acceleration.

(7) Shut down engine.

5. Preservation Procedure - 1 to 30 Days.

NOTE: A preservation run is not required for oil system preservation.

A. After the last engine run, drain fuel from the bottom of the fuel tanks and check the fuel for water. If there is none, the engine has been shut down with water-free fuel in the main fuel control and there is no need to preserve the fuel system or VG actuator system.

B. If the engine is to remain inactive for more than 15 days, spray the compressor section per paragraph 6, step D. Also preserve the fuel system per step C, using fuel (filtered through 0.25 micron filter) instead of MIL-L-6081, grade 1010 oil.

C. Install the closures per paragraph 6, step "E".

D. Engine preservation does not require additional work to maintain engine preservation for the 1 to 30-day period. However, if for any reason the fuel system is drained or partially drained, the fuel system should be refilled with a fresh supply of fuel to prevent internal corrosion and drying out of rubber packing rings, etc.

E. Engine preservation for the one to 30 day period may be renewed once. Renew engine preservation by motoring the engine for 2 minutes as follows:

(1) Make sure the ignition is OFF.

(2) Make sure there is oil in the oil tank.

(3) Motor the engine for 2 minutes. While motoring the engine, provide fuel filtered through a 25-micron filter to the fuel pump inlet adapter at a pressure between 0 and 50 psig.

CAUTION: DO NOT EXCEED THE STARTER DUTY CYCLE. IF THE ENGINE IS MOTORED WITH STARTER, THE THROTTLE SHOULD BE ADVANCED TO 15 DEGREES, HELD FOR 15 SECONDS, TO 0 DEGREES RETARDED AND HELD FOR 15 SECONDS. CONTINUE WITH THIS CYCLE FOR THE DURATION OF THE MOTORING PERIOD (SEE ADJUSTMENT/TEST, 72-00).

6. Preservation Procedure - 30 to 120 Days.

NOTE: This procedure may be used for preservation of engines regardless of whether a shipping container is or is not used. If the engine will be installed in a shipping container, steps "F" and "G" of this procedure do not apply (refer to the instructions in paragraph 8).

A. Deleted.

B. Preserve the variable geometry (VG) actuators as follows:

(1) Disconnect the 2 VG actuator lines at the fuel control. Cap the fuel control fittings.

(2) Manually operate the VG actuators several times to remove all the fuel from the lines. Position the actuators in the fully extended position (bleed valves closed).

<u>NOTE</u>: Two men, one at each bell crank, are required for manual operation of the VG actuators.

(3) Remove the 2 plugs from the underside of the left-hand actuator. Allow the fuel to drain.

(4) Supply oil (Specification MIL-L-6081, grade 1010) through a 25-micron filter, to each of the actuator lines. Force the oil (under pressure) through each of the actuator lines until fuel-free oil is seen coming from the open ports on the underside of the left-hand actuator.

(5) Reinstall the plugs in the open ports of the left-hand actuator and lockwire. Install plugs in the open ends of the VG actuator lines.

(6) Wipe a light film of oil on the extended VG actuator piston rods.

C. Preserve the fuel system by introducing oil, MIL-L-6081, grade 1010, into the fuel system as follows:

(1) Make sure the caps and plugs installed in steps "B.(1)" and "B.(5)" are tight. Make sure all other plugs in the fuel system are installed and tight.

(2) Remove the cover from the fuel pump inlet adapter.

(3) Supply oil through a 25-micron filter to the engine fuel pump inlet adapter at a pressure between 0 and 50 psig. (The oil supply system must be capable of supplying oil at the rate of at least 1 gpm.)

(4) Motor the engine (see Adjustment/Test, 72-00) with the starter (within the limits of the starter duty cycle) to raise engine speed to starting RPM. Advance the throttle to 15 degrees and allow 2 gallons of oil to pass through the fuel pump.

CAUTION: MAKE SURE THE IGNITION IS OFF. BEFORE MOTORING THE ENGINE, MAKE SURE THERE IS OIL IN THE OIL TANK. IF THERE IS NO OIL ON THE OIL TANK DIPSTICK, ADD ENGINE OIL UNTIL IT CAN BE SEEN ON THE DIPSTICK.

IF THE LIMITS OF THE STARTER DUTY CYCLE WILL NOT ALLOW (IN A SINGLE PERIOD) ENOUGH TIME TO PUMP 2 GALLONS OF OIL THROUGH THE ENGINE, USE AS MANY STARTER DUTY CYCLE PERIODS AS REQUIRED, PROVIDING THE THROTTLE IS RETURNED TO 0 DEGREES AT THE END OF EACH DUTY CYCLE.

(5) Retard the throttle to 0 degrees and allow the engine to coast to a complete stop.

(6) Reconnect the VG actuator lines to the fuel control.

(7) Reinstall the cover to the fuel pump inlet adapter.

D. Preserve the compressor section as follows:

CAUTION 1: BEFORE MOTORING THE ENGINE, MAKE SURE THERE IS OIL IN THE OIL TANK.

CAUTION 2: IF THE LIMITS OF THE STARTER DUTY CYCLE WILL NOT ALLOW, IN A SINGLE PERIOD, ENOUGH TIME TO SPRAY THE ENTIRE 1/2 PINT, USE AS MANY DUTY CYCLE PERIODS AS REQUIRED TO USE UP THE ENTIRE AMOUNT.

(1) While the engine is being motored, spray 1/2 pint of oil (MIL-C-6529, Type II) into the compressor inlet. Adjust the spray gun so that it will spray a fine mist or fog. Spray the oil into the compressor section by holding the spray gun about 18 inches from the engine inlet and moving the gun radially and circumferentially to cover the entire inlet area.

NOTE: To effectively spray the compressor section, the engine motoring speed should be close to starting RPM, but not less than 10% RPM.

(2) Allow the engine to coast down and the excess preservation oil to drain off.

E. Install closures to all engine openings, namely the bleed valves, eighth-stage bleed ports, engine inlet, engine exhaust, instrumentation bosses or connectors, and accessory drive pads. The openings are sealed to prevent water and foreign material from entering the engine. If prefabricated type closures are not available, any waterproof type material can be used and fixed in place with a suitable pressure sensitive tape. Only manufacturer approved plastic caps are recommended for protection of electrical connectors.

F. If the engine is not installed into a shipping container after the engine is preserved per steps B through E, engine preservation is maintained during the 30 to 120 day inactive period as follows:

NOTE: The fuel, anti-icing and VG actuator systems do not require any additional work to maintain their preservation.

(1) At least once every 30 days, motor the engine for 2 minutes using the installed starter.

CAUTION: BEFORE MOTORING THE ENGINE, MAKE SURE THERE IS OIL IN THE OIL TANK.

DO NOT EXCEED THE DUTY CYCLE PERIOD OF THE STARTER.

WHILE MOTORING THE ENGINE, SUPPLY OIL (SPECIFICATION MIL-L-6081, GRADE 1010) FILTERED THROUGH A 25-MICRON FILTER TO THE FUEL PUMP INLET AT A PRESSURE BETWEEN 0 AND 50 PSIG.

(2) See if there is an oil film on the engine inlet. If it has deteriorated, respray per step "D".

G. If the engine is not installed in a shipping container, engine preservation must be renewed at the end of each 120-day period. There is no limit to the number of times that engine preservation may be renewed. Renew engine preservation as follows:

(1) Depreserve the engine per paragraph 4.

(2) Represerve engine per steps B through E of this paragraph.

7. Installation of Engine into Shipping Containers.

NOTE: After the engine is preserved per paragraph 6, install the engine into the shipping container.

A. Vapor-barrier bag.

(1) Remove the cover and stored hardware from the engine shipping container. Unfold the vapor-barrier bag so that the engine may be placed on the shipping container inner frame.

(2) With the engine held in a horizontal position with a sling 2C5327 (1, figure 302) and hoist, assemble the container support ring to the front frame flange.

(3) Assemble the tee-brackets and the lower angle support to the engine rear mounts located on the fan assembly. Lockwire the bolts to the tee-brackets.

(4) Lower the engine into the container until the flanges of the lower angle support rest on the container side rails. Insert bolts as guide pins.

CAUTION: BE CAREFUL NOT TO TEAR THE VAPOR-BARRIER BAG.

(5) Place the forward angle support over the front frame. Align hole in the plates with the support ring hole. Insert pin and hold in place with cotter pin. Bend over ends of cotter pin.

(6) Align the holes in the forward angle support flanges with the holes in the side rails. Insert four 7/16-20 bolts and torque the locknuts to 32-38 lb-ft.

(7) Remove the sling from the engine.

(8) Install the tee-brackets with the upper angle support to the top mounts of the fan casing.

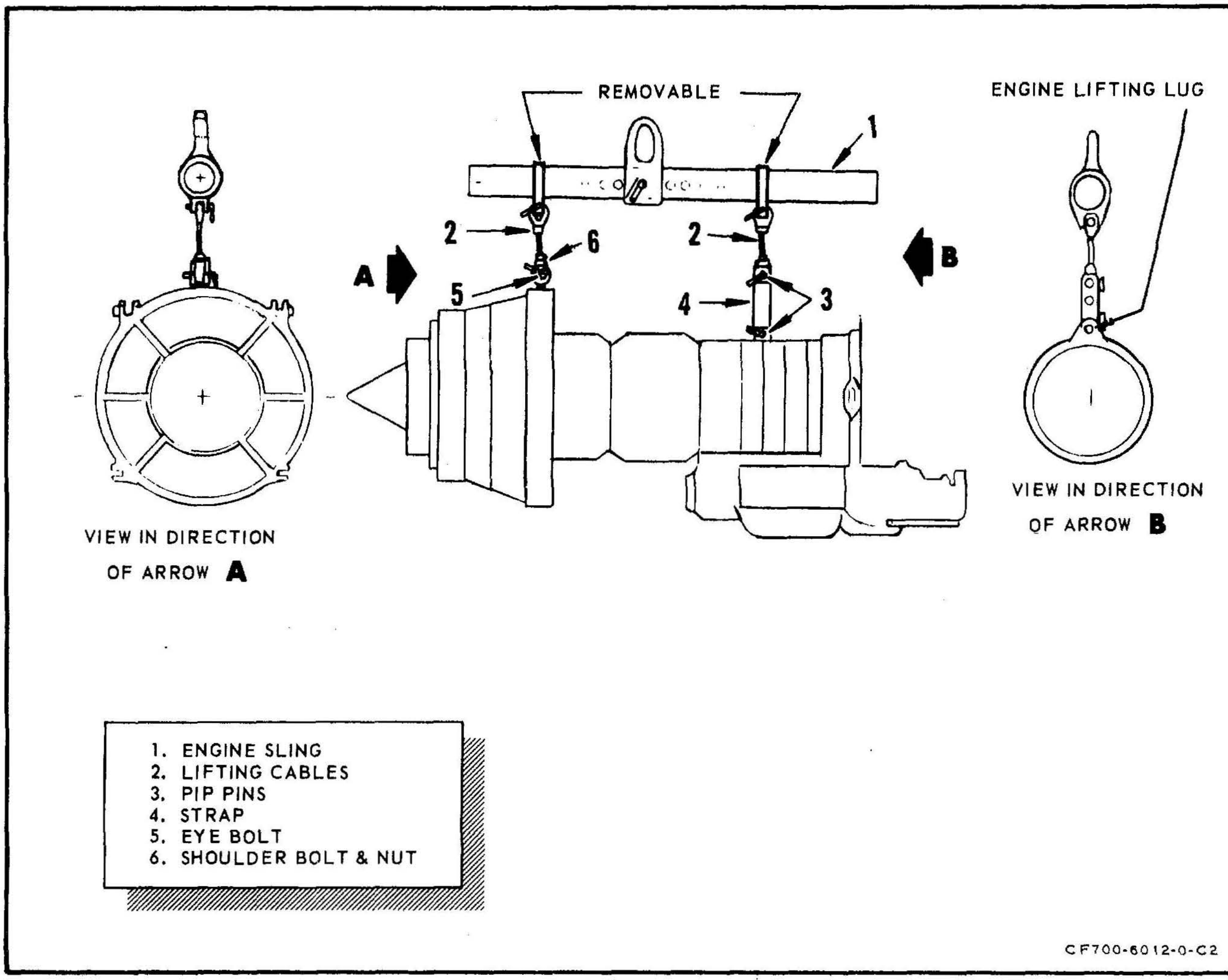
(9) Secure the upper angle support tee-brackets to the 2 top mounts on the fan casing. Lockwire the bolts to the tee-brackets.

(10) Align the holes in the rear upper and lower angle supports with the siderails. Secure the supports with 7/16-20 bolts and torque the locknuts to 32-38 lb-ft.

(11) Check all bolts on the container for torque and lockwire where required.

(12) Lockwire across the compressor inlet cover to keep it in place. Two holes are provided in mounting ring.

(13) Pad all sharp corners of the engine and inner frame to protect the vapor-barrier bag when it is folded around the engine.



Engine Lifting Sling
Figure 302

(14) Fasten 20, 8-unit bags (or equivalent) of dehydrating agent, Specification MIL-D-3464, to the container inner frame, around the engine.

(15) Fold the vapor-barrier bag around the engine and heat-seal (475° to 525°F) a seam approximately 1-inch wide. Leave about a 2-inch opening to insert nozzle of air evacuator. Do not exhaust air so as to draw the bag tightly around the engine.

(16) Fold any loose material around the engine and secure in place with cloth, glass or nylon adhesive tape.

(17) Secure the engine records (enclosed in a plastic bag) inside the container.

(18) Place the cover over the engine and secure in place with 3/8 hex-head bolts and flat washers. Band the cover with 3/4-inch bands in 3 locations.

B. Metal shipping container. (See figure 303.)

(1) Remove lid of shipping container. Place to the side.

CAUTION: USE WOOD SLATS UNDER CORNERS OF LID.

(2) Check container, including the horizontal flange gasket recess, for rust and loose paint. Remove rust, and repaint any place which needs touching up. Wipe and/or vacuum-clean the inside of the container and the gasket recess to ensure cleanliness.

(3) Remove container yoke (1) shipping support ring (2) and four tee brackets (3) and fan support (4) from container.

(4) Install two upper and two lower tee brackets (3) on engine fan mounts. Insert shoulder bolts (5).

(5) Tighten shoulder bolts to 60-90 lb-in. of torque and lockwire.

(6) Install fan support (4) in front of fan inlet to tee brackets. Insert 7/16-20 x 1 1/4 inch long bolts (6) and tighten.

(7) Install a shipping support ring (2) on the flange of the front frame. The 7/16 diameter hole in the ring must be in the 12 o'clock position. Secure with fourteen 10-32 x 1/2 inch long bolts (7) locknuts and lockwire where applicable.

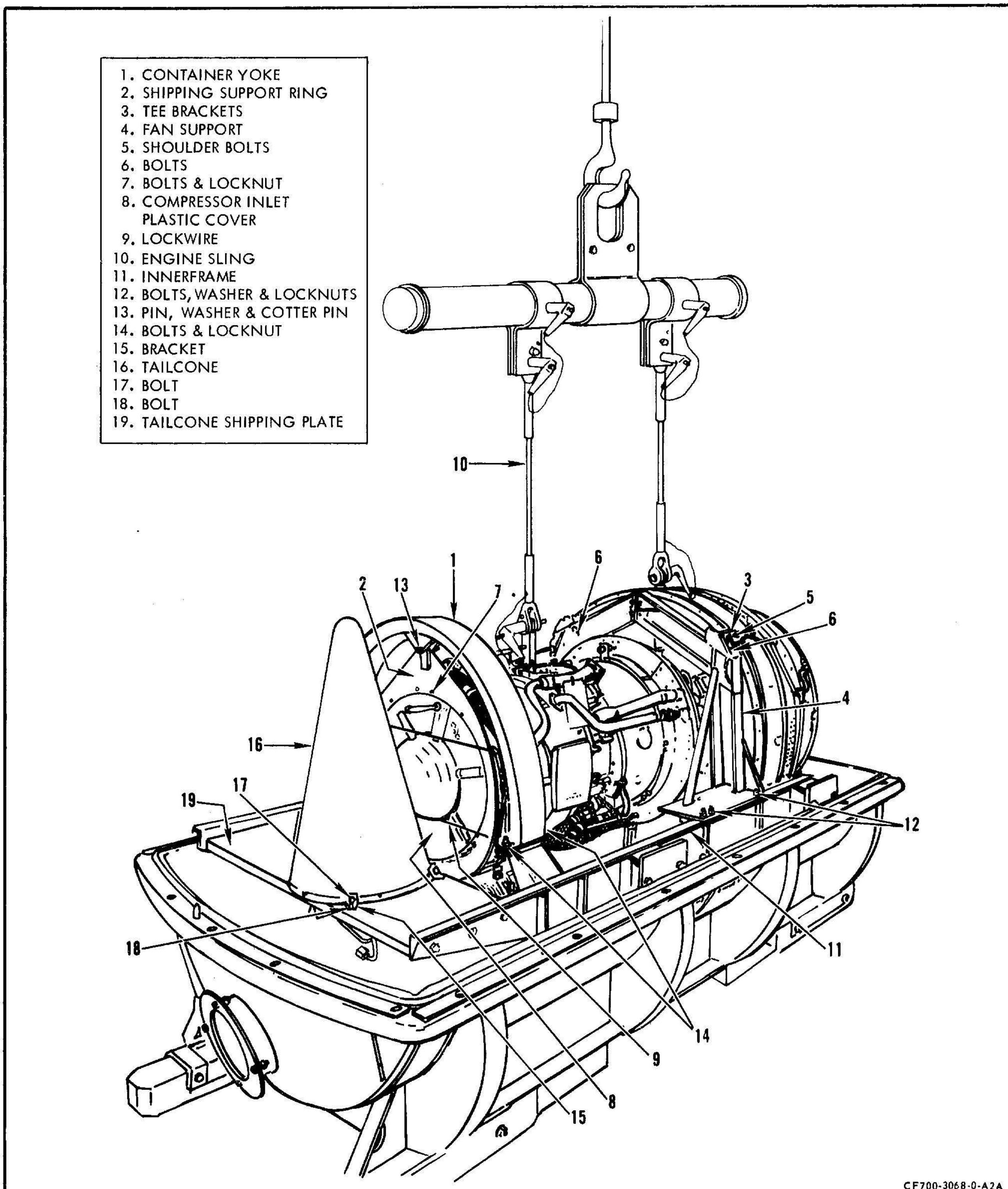
(8) Secure compressor inlet plastic cover (8) in place by criss-crossing lockwire (9) in front of cover, running wire through 1/8 inch diameter holes located on outer edge of support ring.

(9) Using sling (10) 2C5327 and hoist, position engine over the lower half of the container.

(10) Lower engine into the container until the fan support plates rest on the inner frame (11). Align the holes of the plate with the holes of the inner frame.

(11) Secure the two plates to the inner frame with 7/16-20 hex head bolts (12), washers and locknuts. Thread nuts to a snug fit. Do not torque. Threaded section must be in up position.

(12) Place the container yoke (1) over the shipping support ring (2). Insert the 7/16 inch diameter pin (13) through the yoke and shipping support ring link. Install washer and 1/8 inch diameter cotter pin. Spread cotter pin.



Metal Shipping Container
Figure 303

(13) Align holes of container yoke and inner frame. Insert 7/16-20 hex head bolts (14), threaded section of bolts must be in up position. Turn on locknuts until finger tight.

(14) Remove engine sling (10) from the engine.

(15) Tighten the bolts (14) that secure the container yoke to inner frame and bolts (12) that secure fan support to inner frame to 32-38 lb-ft of torque.

(16) Install bracket (15) to tailcone (16) with bolt (17).

(17) Attach bracket and tailcone to tailcone shipping plate (19) and secure with bolt (18).

(18) When engine is ready to be enclosed with container lid, fill wire basket located in lower half of container with 96 units (twelve 8-unit bags) of desiccant.

NOTE: If dehydrated air is not used to pressurize the container, an additional 96 units (twelve 8-unit bags) of desiccant should be taped to container inner frame around engine.

(19) Hoist cover over engine container and lower into position on lower half immediately.

CAUTION: LID MUST BE IN PLACE AND BOLTS TORQUED AS QUICKLY AS POSSIBLE AFTER PLACING DESICCANT IN CONTAINER TO AVOID CONTAMINATION OF THE DESICCANT.

(20) Install with threaded ends up, twenty-four 1/2 - 13 bolts and nuts in closure flanges.

(21) Tighten bolts 1, 4, 7, 10, 13, 16, 19 and 22 in that order, to pull cover down evenly on gasket.

(22) Starting with bolt No. 1 tighten each successive bolt to 70-75 lb-ft.

NOTE: If shipping container contains an air relief valve, omit steps (24) through (29).

(23) Remove outer cover of the desiccant port, valve cap and valve insert.

(24) Install an air-filler valve connection, and pressurize container to 5 psig.

CAUTION: USE DEHYDRATED AIR ONLY UNLESS EXTRA DESICCANT WAS PLACED INSIDE CONTAINER.

(25) Recheck with an air gage for proper pressure; then remove the filler valve connection and install the valve cap.

(26) Brush the air-filler valve and all joints, seams and flanges with a liquid soap solution. Correct the leaks that any resulting air bubbles indicate.

(27) At the end of a 60 minute period, recheck for proper pressure.

(28) Bolt the outer cover of the desiccant port in place.

(29) Coat the exposed surfaces of flange-bolts and nuts with a corrosion preventative compound conforming to MIL-C-16173, Grade I.

(30) Place engine records and shipping papers in plastic bag or envelope. Place in record receptacle. Tighten bolts securely.

8. Storage of Engines Installed in Shipping Containers.

A. Vapor-barrier bag.

(1) Engines may be stored in their shipping container for the period specified on the outside of the shipping container.

(2) The humidity indicators should be checked every 90 days to make sure the moisture content within the plastic bag has not exceeded the maximum acceptable limit.

(3) The engine must be represerved if any of the humidity indicators have changed to a pink color.

B. Metal shipping containers (air relief-valve type).

(1) Engines may be stored in their shipping containers indefinitely provided periodic inspection indicates that humidity condition in the container is satisfactory.

(2) The humidity indicators should be checked every 30 days to make sure the moisture content within the container has not exceeded the maximum acceptable limit.

(3) The engine must be represerved if any of the humidity indicators have changed to a pink color.

C. Metal shipping containers (pressurized type).

NOTE: When an engine has been preserved and packed according to the preceding instructions, it is considered to be preserved indefinitely provided periodic inspection indicates that pressure and humidity conditions in the container are satisfactory. The following Periodic Inspection must be made at least once every 180 days.

(1) Observe and record pressure and humidity in the shipping container within 7 days and at least once every 180 days thereafter.

(2) If inspection reveals that internal pressure is more than 1 psig and humidity indicator is blue, no action is required.

(3) If inspection reveals that internal pressure is less than 1 psig and that in an initial inspection, the humidity indicator is blue, re-pressurize the container to 5 (± 1) psig with clean, dry air. Check the pressure again after 7 days. If pressure has not been maintained, remove the engine and represerve it in another container.

(4) If inspection reveals that humidity indicator is pink (a corrosive condition) remove the engine from the container and inspect it for indication of rust or corrosion.

(a) If the engine is serviceable, represerve it in another container.

(b) If inspection shows evidence of rust or corrosion, re-install the shipping cover, replace the desiccant, re-pressurize the container to 5 (± 1) psig and return the engine to overhaul for inspection and repair.

9. Removal of Engine from the Shipping Container.

A. Vapor-barrier bag. (See figure 302.)

(1) Place the shipping container under a hoist.

(2) Cut and remove the wire bands (if installed) that secure the cover to the container.

(3) Remove the bolts that attach the cover to the container. Remove the cover.

(4) Remove and check the engine historical records. (Note any deficiencies.) Record any damage to the shipping container; record damage of any consequence to the engine.

(5) Carefully remove the tape that is used to hold the corners of the moisture-barrier bag close to the engine. Cut off the sealed seam on the top of the bag.

CAUTION: DO NOT TEAR THE MOISTURE-BARRIER BAG. CUT THE BAG CAREFULLY SO THAT IT CAN BE REUSED.

(6) Unfold the bag carefully so as to expose the engine for removal.

(7) Remove the inner protecting wrap and dispose of the desiccant.

(8) Remove the 4 bolts securing the upper and lower angle supports to the side rails.

(9) Remove the shoulder bolts at the 11 and 1 o'clock positions at the fan main mounts.

(10) Loosen the bolts that secure the tee-brackets to the upper angle support. Do not remove the nuts and bolts.

(11) Remove the tee-brackets and upper angle support from the engine.

NOTE: The engine is adequately supported at the 5 and 7 o'clock positions by the lower angle support and tee-brackets.

(12) Assemble the lifting sling (2C5327, figure 302) to the engine by attaching to the rear lifting boss at the 12 o'clock position on the fan casing and to the engine forward lifting lug located at the compressor casing - mainframe flanges.

(13) Attach crane to the lifting sling and take up slack.

(14) Remove the shoulder bolts from the lower main mounts of the aft fan.

(15) Remove the tee-brackets and the lower angle support frame from the engine.

(16) Remove the 4 bolts that secure the forward angle support to the side rails.

(17) Remove the cotter pin and pin from the forward angle support assembly.

(18) Remove the forward angle support from the engine.

(19) Hoist the engine from the container.

(20) If the engine is equipped with a container mounting ring, remove and return it and all other hardware, etc., to the container.

(21) Store all container hardware in the shipping container for reuse.

NOTE: If the engine requires maintenance and will not be operated before being torn down, no depreservation is required.

B. Metal shipping container. (See figure 303.)

(1) Release air pressure from the shipping container by removing the desiccant port cover and unscrewing the core of the air filler valve. The container is pressurized to approximately 5 psig. After pressure has been released, reinstall core.

NOTE: Step (1) is not necessary for shipping containers that contain air relief valve as they are not pressurized.

(2) Remove the bolts which fasten the top half of the container to the bottom half.

(3) Attach a sling to the cover. Lift the cover carefully.

CAUTION: BE CAREFUL NOT TO STRIKE THE ENGINE WHEN LIFTING THE COVER.

(4) Remove bolts (18) securing bracket (15) and tailcone (16) to tailcone shipping plate (19).

(5) Remove tailcone and brackets from shipping container. Remove bolts (17) and bracket (15) from tailcone.

(6) Assemble the engine sling (8) tool No. 2C5327 to the engine by attaching to the rear lifting boss at the 12 o'clock position on the fan casing and to the engine forward lifting lug located at the compressor casing - mainframe flanges.

(7) Attach crane to the engine sling and take up slack in the lifting cables of the sling.

(8) Remove the nuts and bolts (14), (12) that attach the container yoke (1) and fan support (4) to the inner frame (11) of the shipping container.

(9) Remove pin, washer and cotter pin (13) from container yoke and remove the yoke.

(10) Carefully raise the engine free of the container.

CAUTION: BE CAREFUL NOT TO STRIKE THE ENGINE AGAINST THE CONTAINER.

(11) Remove bolts (6) that attaches fan support (4) to tee brackets. Remove fan support.

(12) Remove shoulder bolts (5) that secures tee brackets to engine fan mounts. Remove tee brackets.

(13) Remove lockwire (9) and compressor inlet plastic cover (8) from inlet of engine.

(14) Remove bolts (7) that secure the shipping support ring (2) to the front frame flange. Remove shipping support ring.

(15) Return container yoke, shipping support ring, tee brackets, fan support, compressor inlet plastic cover, bolts, washers and locknuts to the shipping container for reuse.

NOTE: If the engine requires maintenance and if it will not be operated before being torn down, no depreservation is required.

10. Preservation of Accessories.

NOTE: If an accessory is removed from the engine and placed in spare parts stock, it must be properly prepared for storage. By observing normal practices of proper packaging and performing the following preservation procedures, all engine accessories can be stored without detrimental effects.

A. Fuel System Components.

(1) If component has been subjected to commercial kerosene, as in engine operation, it can be stored for periods up to 30 days by draining excess fluid, installing protective covers over drive shafts and control shafts, and capping all openings.

(2) To store components for periods in excess of 30 days, the component should be flushed with MIL-L-6081, grade 1010 oil. Drain excess fluid, install protective covers over drive shafts and control shafts, and cap all openings.

B. Lubrication System Components.

(1) Pour a sufficient amount of engine oil, listed in approved oils, chapter 79, into the component to coat the internal parts. Rotate the drive shaft of engine driven components to assure a thorough coating of oil.

(2) Drain excess fluid.

(3) Cap all openings.

(4) Install protective covers over drive shafts.

C. Electrical Components. To store electrical components, install protective covers on amphenol connectors and drives.

D. Air System Components. To store air system components, install caps on all openings.

ENGINE MAINTENANCE PRACTICES - REMOVAL AND INSTALLATION

1. General.

   A. The detailed removal and installation information is covered in the Airframe Maintenance Manual.

   B. Whenever the engine is removed from the aircraft, it should be preserved in accordance with Engine Maintenance Practices - Servicing, 72-00.

   C. Install engine in maintenance stand, 2C5347, when engine is removed from aircraft for maintenance.

MAINTENANCE PRACTICES - ADJUSTMENT/TEST

1. General.

To operate properly, an engine must be correctly adjusted. The checks for proper adjustment, and the adjustments themselves, can best be made during operation of the engine; therefore, a functional run-up procedure is outlined in this section. This is followed by adjustment procedures and operating limits. The pre-start check is to ensure that the engine inlet and area around the engine area are clean, no fuel or oil leaks are evident, fuel and oil supply is adequate and the gas generator rotor turns freely. The functional test run takes the engine through a full running cycle. This procedure should be followed for a newly installed engine, and for troubleshooting an engine with a malfunction. The functional run has been divided into a number of different categories called checks. Each check has been selected to evaluate one particular phase of engine operation. Generally, only one or two of these checks need to be made on an engine, depending on the extent of the maintenance the engine has undergone. A record of engine instrument readings at T.O. and cruise including air speed, RAT, and altitude every 10-15 hours is very useful for troubleshooting.

2. Safety Precautions.

A. Observe routine safety precautions while operating the engine.

(1) Be sure that personnel are standing clear of the exhaust area. (Refer to figures 501 and 502.)

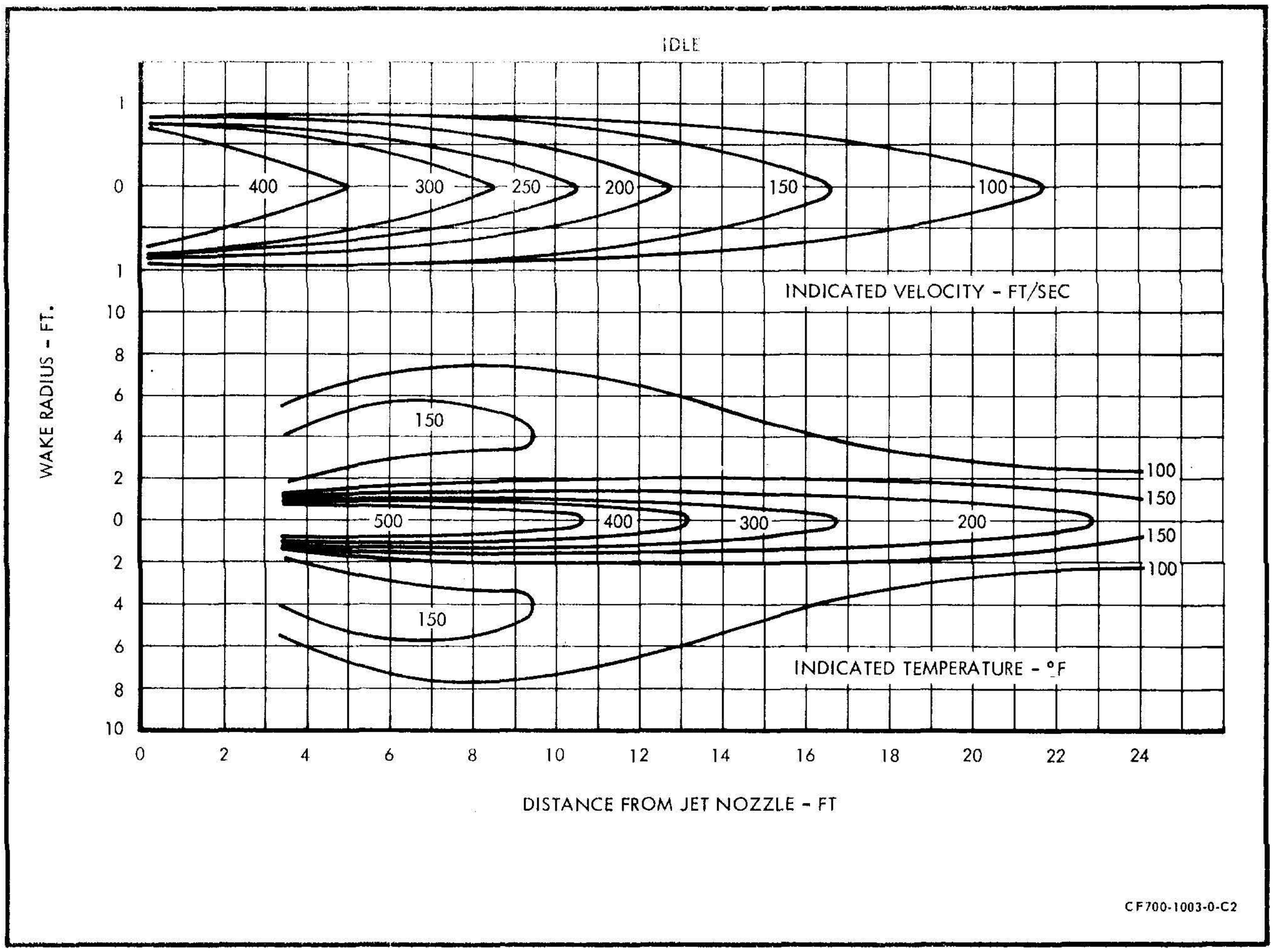
(2) Be sure that personnel are standing clear of the engine inlet and compressor bleed valves.

(3) Be sure that fuel drainage does not present a fire hazard.

(4) Be sure the ground beneath the engine is clean and free of loose debris which might possibly be picked up and ingested by the engine.

B. Do not exceed the exhaust gas temperature or engine speed limits during starting or subsequent engine operation.

3. Functional Test Run. The functional test run is intended to give an engine a thorough test for mechanical soundness and for correct indications of engine operating parameters. The functional test has been divided into categories called "checks"; these are defined in figure 503. After some types of maintenance, it will be necessary to perform all of the checks listed. Figure 503 can be used as a guide to decide what checks are necessary after certain types of maintenance. The checks may be performed with the engine



Jet Wake Temperature and Velocity Profile at Idle
Figure 501

installed in a test cell, test stand or in the aircraft. If the engine is in a test facility, a bellmouth and tailpipe which conforms to the General Electric Company specifications must be used. If the engine is installed in an aircraft the inlet portion of the nacelle and the tailpipe must be attached. Face engine into the wind, if possible, so that the exhaust gases are not ingested by the engine.

NOTE: Refer to 72-00, SERVICING, Lubrication System to determine if the lube and scavenge pump requires priming before starting the engine.

CAUTION: TO AVOID OVERSTRESS OF FAN BLADES DO NOT OPERATE ENGINE ABOVE IDLE SPEED WITH NACELLE DOORS OPEN OR REMOVED.

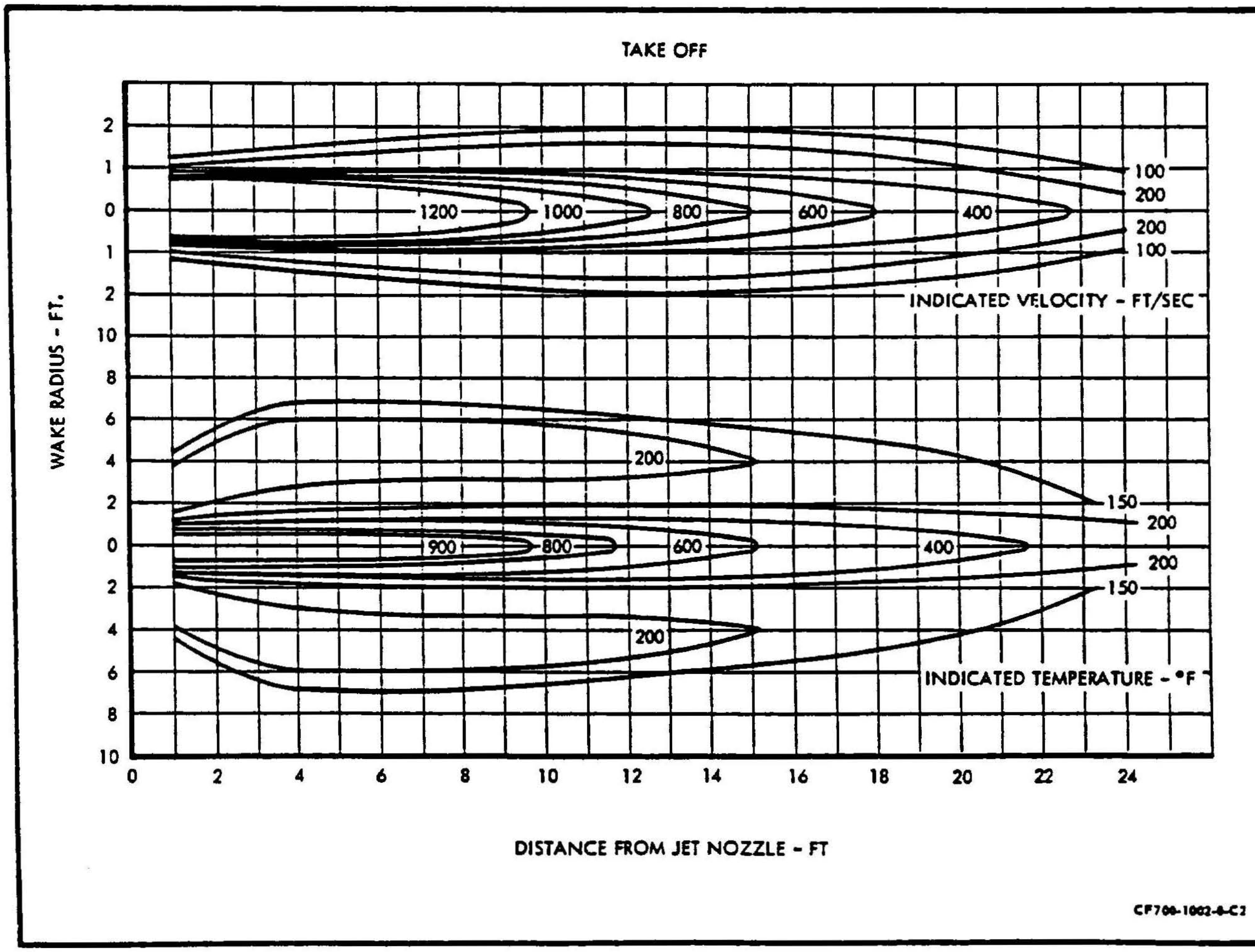
A. Prestart Check.

(1) Check the oil level indicated on the oil tank dipstick. If the dipstick indicates that additional oil is required, use the following steps to prevent overservicing the oil tank.

NOTE: When the engine is shut down, oil seeps from the oil tank to the accessory and transfer gearboxes. Fan wind-milling will also result in lowering the oil level. Use duct and tail pipe covers whenever possible.

(a) Motor the engine with the starter for a period not to exceed the starter duty cycle. (Motoring scavenges the oil back to the oil tank.)

(b) Drain the accessory and transfer gearbox sumps. Replace the plugs.



Jet Wake Temperature and Velocity Profile at Takeoff
Figure 502

MAINTENANCE WORK DONE ON ENGINE	PRESTART CHECK	MOTORING CHECK	ENGINE START	IDLE CHECK	VARIABLE GEOMETRY CHECK	TAKE-OFF POWER CHECK	MAX-SPEED CHECK	ANTI-ICING CHECK	OVERSPEED GOVERNOR CHECK	ACCELERATION CHECK	EGT CHECK	ALTITUDE ACCEL. CHECK	ENGINE SHUTDOWN
1. INITIAL ENGINE INSTALLATION, OVERHAUL, OR MAJOR REPAIR	x	x	x	x	x	x	x	x	x	x	x	x	x
2. PERIODIC INSPECTION (REFER TO SECTION 5-21-2, TABLE 1, ITEM N)	x	x	x	x	x	x	x	x	x	x			x
3. HOT SECTION INSPECTION	x	x	x	x	x	x	x	x	x	x	x		x
4. FUEL CONTROL CHANGED	x	x	x	x	x	x	x		x	x			x
5. VARIABLE GEOMETRY SYSTEM ADJUSTED			x		x	x	x			x			x
6. IGNITER PLUG CHANGED	x		x										x
7. LUBE PUMP CHANGED		x	x	x		x	x						x
8. LUBE TANK CHANGED		x	x	x		x	x						x
9. OVERSPEED GOVERNOR CHANGED		x	x	x		x	x		x				x
10. ANY LUBE SYSTEM CONNECTION DISRUPTION		x		x									
11. ANY FUEL SYSTEM CONNECTION DISRUPTION		x		x									
12. ANY AIR SYSTEM CONNECTION DISRUPTION		x		x									

Function Check Guide
Figure 503

(c) If the dipstick still indicates that oil is required, add oil that has been filtered through a 10-micron metallic filter to bring the oil level up to the FULL mark on the oil tank dipstick.

(d) Replace the oil tank filler cap. Turn the locking tab clockwise to seat the cap.

(2) Check the power lever actuator rigging at the IDLE position. If adjustment is necessary, do the following:

(a) Set the fuel control input shaft at the IDLE position. Insert the rigging pin, 2C5320, through the input shaft rigging hole and into the slot in the fuel control casing.

(b) Connect the power lever clamp and linkage to the fuel control input shaft.

NOTE: The input shaft has a missing serration which can be used for alignment purposes.

(c) Exert a slight pressure on the input shaft toward the OFF direction, and adjust the linkage so that the power lever is set at the IDLE position.

(d) Remove the rigging pin and check the input shaft travel. The travel should be 93-94 degrees.

(3) Inspect the engine and engine installation.

(a) Check the engine mounts, and the fuel and electrical connections.

(b) Check all engine fuel, air, and lube lines. Check the engine accessories for proper installation and security of mounting.

(c) Check the compressor rotor for free rotation.

(d) Check to determine that the density knob on the fuel control is set at the correct location for the particular type fuel being used.

B. Motoring Check.

(1) The motoring check is required only after inspection or maintenance and it ensures that the engine rotates freely, that the instrumentation functions properly, that the fuel and lube systems are leak-free, and that starter operation meets the speed requirements for successful starts. Motoring primes the fuel and lube systems when maintenance has required replacement of fuel or lube system components.

(2) Position the engine controls as follows:

(a) Fuel Boost.................................... ON

(b) Anti-Icing.................................... OFF

(c) Power Lever.................................... OFF

(d) Ignition.. OFF

(e) Starter... OFF

(f) Customer Air Bleed System....................... OFF

CAUTION: THE FUEL PUMP AND FUEL CONTROL ARE FUEL-LUBRICATED. DO NOT MOTOR, START, OR OPERATE THE ENGINE UNLESS A POSITIVE FUEL INLET PRESSURE IS INDICATED.

(3) Turn the starter ON. Advance the power lever to IDLE and hold only as long as necessary (20 seconds max.) to check the instruments for positive indications of engine speed, oil pressure, and fuel flow.

(a) The starter must be capable of turning the engine rotor to, at least 12 percent within 12 seconds for ambient temperature conditions of 0°F (-18°C) or higher to achieve normal starts. If these conditions cannot be met, refer to the Troubleshooting Guide.

(b) Normal oil pressure indication is 1 to 10 psig. However, initially there may be no indication if any of the lube system components have been replaced, or if the oil has been changed during maintenance.

(4) Retard the power lever to OFF and continue motoring (20 seconds min.) for the time remaining within the starter-usage limit to purge the combustion and exhaust sections of fuels and vapors.

NOTE: If the fuel flow does not drop to zero when the power lever is returned to OFF, check the rigging of the power lever.

(5) De-energize the starter. During engine coastdown, make the following checks:

(a) Listen for unusual noise from the rotating components. Check the engine front frame, mainframe, and turbine areas for unusual roughness.

NOTE: Normal rotational noise consists of clicking compressor and turbine blades, gear noise, and rubs at the second-stage turbine shroud and turbine torque ring.

(b) Inspect the fuel and lube system lines and their fittings for leakage.

(c) Check the combustor and fuel manifold drain valve for proper drainage operation.

(6) After rotation ceases, turn the fuel boost OFF. Shut off the power and supply systems to the engine.

(7) Refer to Troubleshooting, 72-00, for the correction of any discrepancies found during the motoring check.

(8) Retorque or replace fittings as necessary, to correct fuel or lube leaks.

(9) Check the oil tank oil level. If necessary, add oil per procedure specified in Prestart Check.

(10) Allow a 2 minute (min.) period for fuel to drain from the engine before attempting to start the engine after the motoring check.

C. Engine Start.

(1) Position the engine controls and switches as follows:

(a) Fuel Boost.................................... ON

(b) Anti-Icing.....................................OFF

(c) Power Lever....................................OFF

(d) Ignition.......................................OFF

(e) Starter..OFF

(f) Customer Air Bleed System.....................OFF

CAUTION: THE FUEL PUMP AND FUEL CONTROL ARE FUEL-LUBRICATED. DO NOT MOTOR, START, OR OPERATE THE ENGINE UNLESS A POSITIVE FUEL INLET PRESSURE IS INDICATED.

(2) Turn the starter and ignition ON, and advance the power lever to IDLE at 10 percent rpm.

(a) Be prepared to retard the power lever slightly, or if necessary, to chop completely OFF should the starting fuel flow exceed 350 pounds per hour. Chop power lever to OFF if EGT indication does not occur within 10 seconds.

CAUTION: FUEL FLOW IN EXCESS OF 350 POUNDS PER HOUR WILL CAUSE HOT STARTS. DO NOT ALLOW THE STARTING FUEL FLOW TO EXCEED 350 POUNDS PER HOUR BEFORE COMBUSTION OCCURS.

(3) Observe the exhaust gas temperature (EGT), fuel flow, and oil pressure instrument readings.

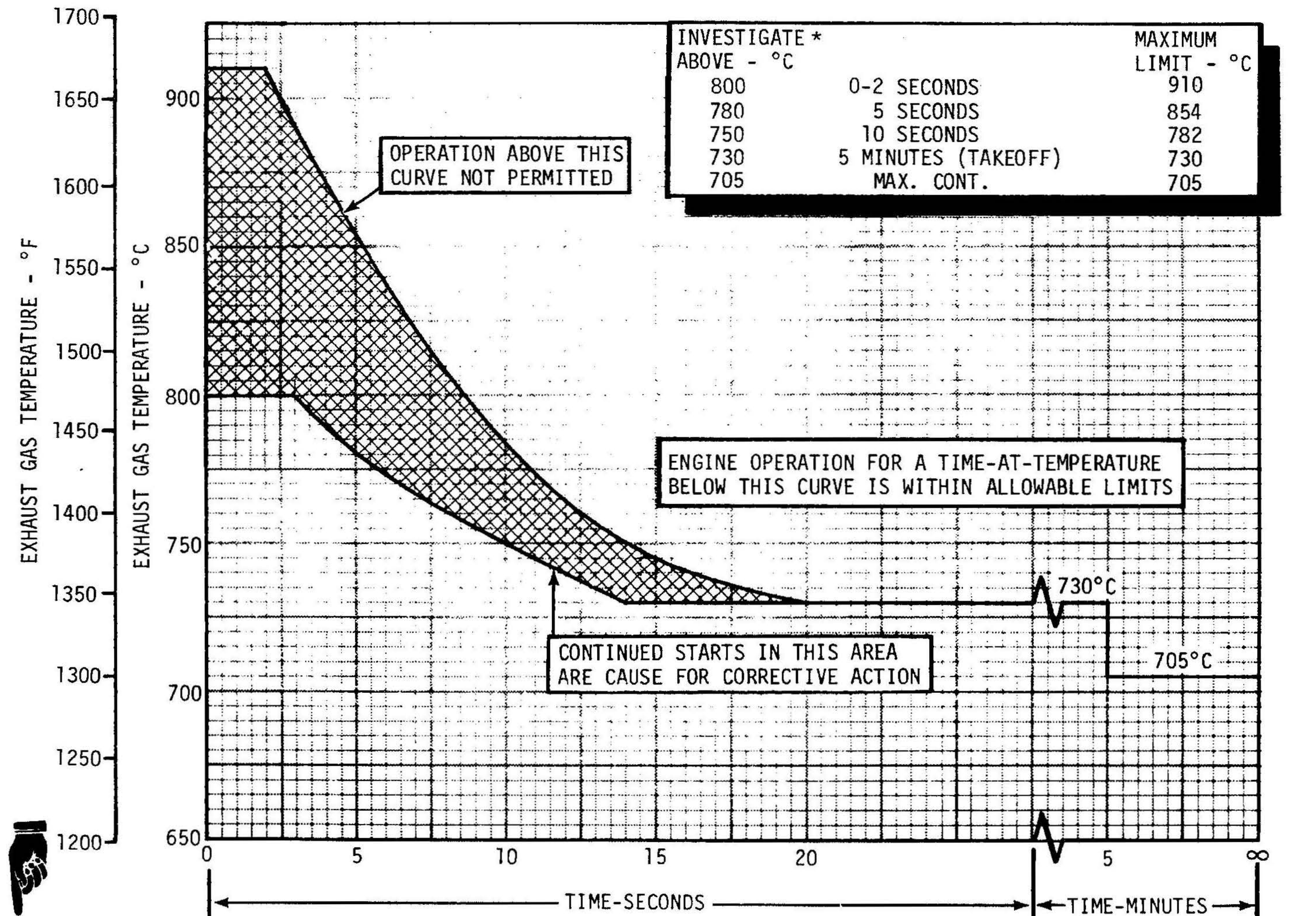
(a) If EGT reaches 750°C (1382°F) and is rising rapidly during an attempted start, chop the power lever to OFF, and continue operating the starter to maintain EGT within the starting temperature limits.

CAUTION: DO NOT ALLOW EGT TO EXCEED THE TEMPERATURE, OR TIME-AT-TEMPERATURE LIMITS IN FIGURE 504, 504A, 504B, OR 504C.

(4) Turn the starter and ignition OFF when the engine speed exceeds 40% (6600 rpm approx.).

(5) Allow the engine to stabilize at IDLE. Check the engine instrumentation readings for values within the operating limits.

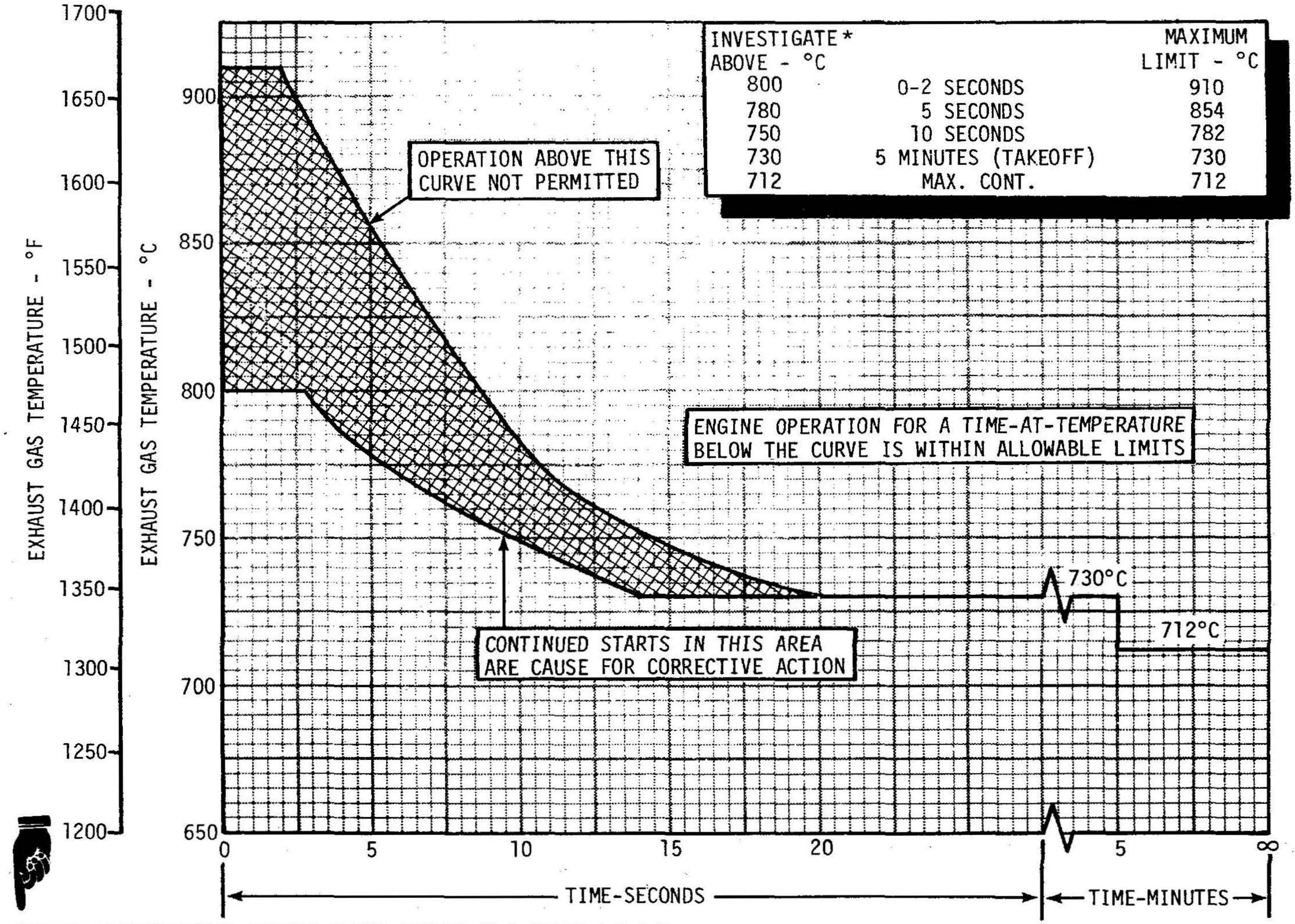
CAUTION: TO AVOID OVERSTRESS OF FAN BLADES DO NOT OPERATE ENGINE ABOVE IDLE SPEED WITH NACELLE DOORS OPEN OR REMOVED.



*START TEMPERATURES SHOULD NEVER EXCEED THE SOLID LINE TIME--TEMPERATURE CURVE. AT AMBIENT TEMPERATURES OF APPROXIMATELY 30°C AND ABOVE, NORMAL START TEMPERATURES MAY EXCEED 800°C BUT SHOULD BE LESS THAN 820°C.

F
BC-0081-1

Exhaust Gas Temperature Limits CF700-2C (Aspirating Harness)
Figure 504

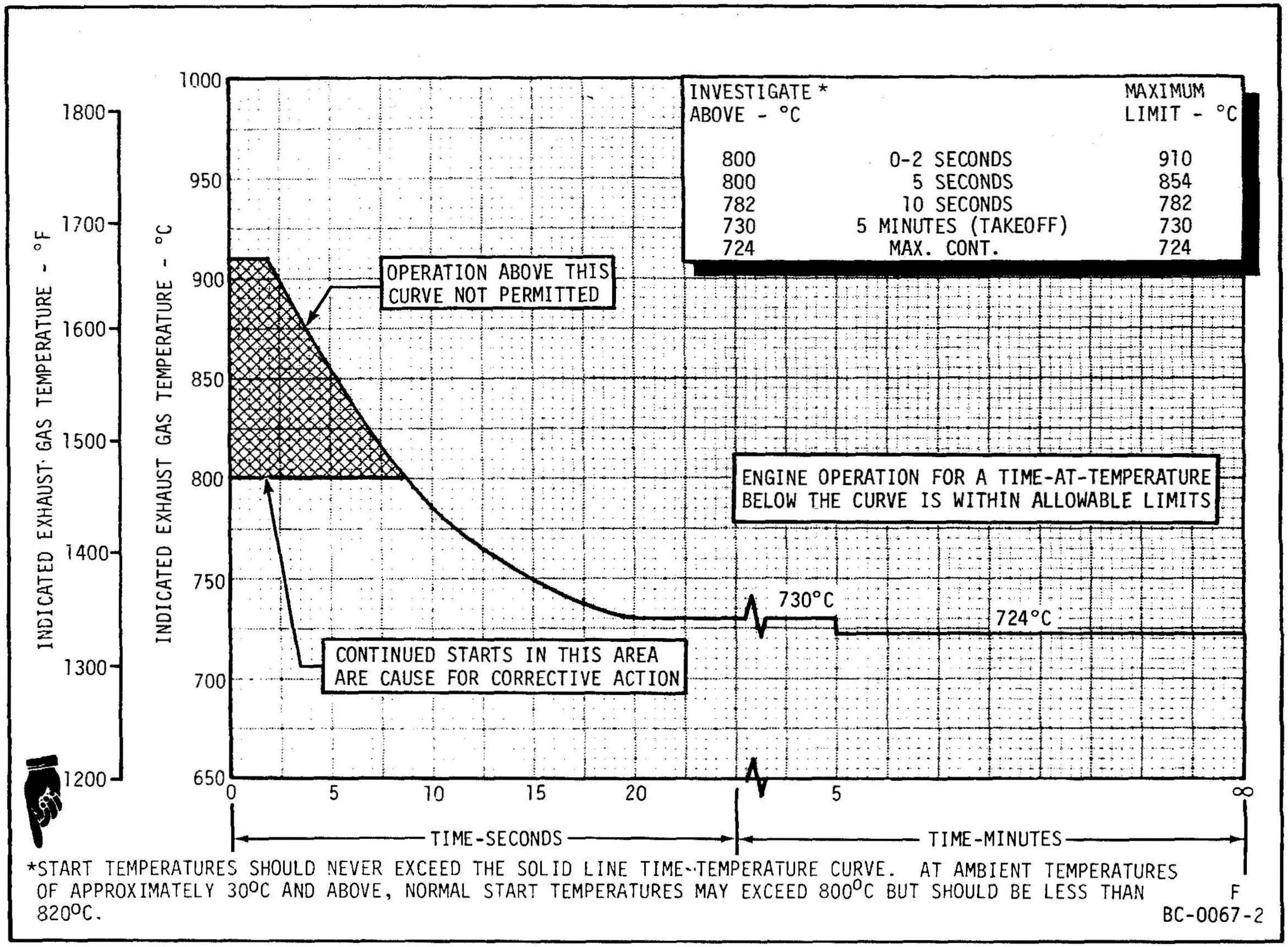


INVESTIGATE* ABOVE - °C		MAXIMUM LIMIT - °C
800	0-2 SECONDS	910
780	5 SECONDS	854
750	10 SECONDS	782
730	5 MINUTES (TAKEOFF)	730
712	MAX. CONT.	712

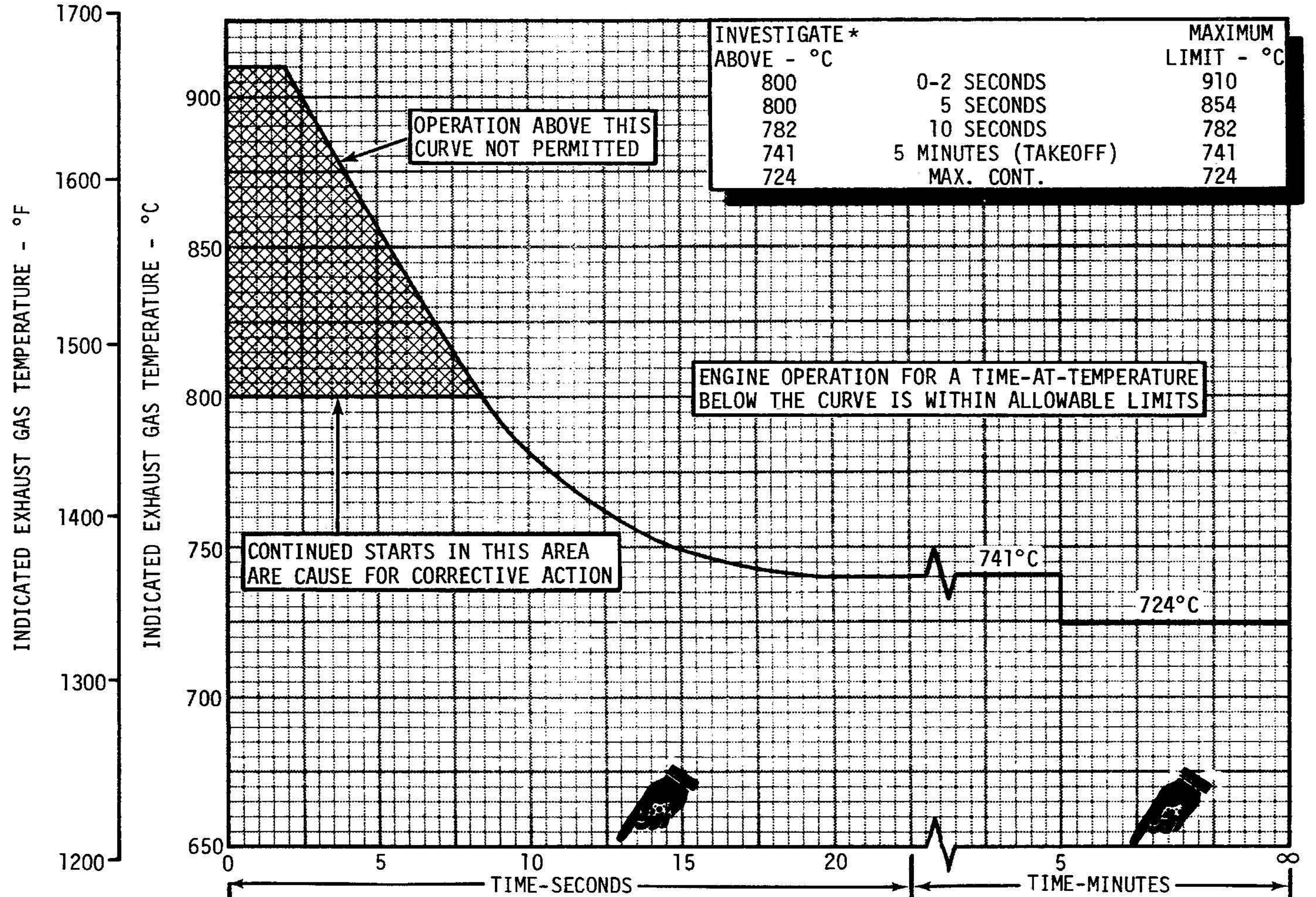
*START TEMPERATURES SHOULD NEVER EXCEED THE SOLID LINE TIME TEMPERATURE CURVE. AT AMBIENT TEMPERATURES OF APPROXIMATELY 30°C AND ABOVE, NORMAL START TEMPERATURES MAY EXCEED 800°C BUT SHOULD BE LESS THAN 820°C.

F
BC-0082-1

Exhaust Gas Temperature Limits CF700-2D (Aspirating Harness)
Figure 504A



Exhaust Gas Temperature CF700-2C (Alternate Immersion Harness)
Figure 504B



*START TEMPERATURES SHOULD NEVER EXCEED THE SOLID LINE TIME-TEMPERATURE CURVE. AT AMBIENT TEMPERATURES OF APPROXIMATELY 30°C AND ABOVE, NORMAL START TEMPERATURES MAY EXCEED 800°C BUT SHOULD BE LESS THAN 820°C.

F
BC-0083-2

Exhaust Gas Temperature CF700-2D and -2D2 (Alternate Immersion Harness)
Figure 504C

D. Idle Check.

(1) The idle check consists of checking for proper engine operation as evidenced by leak-free connections, normal operating noise, and proper indications of all engine-related instruments, controls, and switches. While the engine is running, a malfunction is indicated by abnormal readings of the instruments.

(2) After the engine has stabilized at IDLE, check the following instruments:

NOTE: Deleted.

(a) Engine Speed .... 46 (± 1.0)% (7425-7755 rpm)

(b) Aft Fan Speed .... Positive Indication

(c) Oil Pressure .... 5.0-25.0 psig with oil tank temperature stabilized above 176°F (80°C). Operate engine at maximum continuous for 5 minutes to warm up oil just prior to taking reading.

(d) Exhaust Gas Temperature .. See figures 504, 504A, 504B, or 504C

(e) Fuel Inlet Pressure ...... 50 psig (max.)

NOTE: Do not adjust the IDLE speed adjustment until after the MAXIMUM speed adjustment has been made.

(3) If the fan does not show a speed indication; determine if fan is rotating. If not, shut the engine down immediately. If the fan is rotating, troubleshoot the fan speed-sensing circuit.

(4) Inspect the engine and accessories as follows:

(a) Check for leakage at the horizontal (split-line) and vertical flanges of the compressor and turbine casings.

(b) Check all engine accessories, lines, and fittings for fuel, air, or oil leakage.

NOTE: Little or no fuel drainage from the combustion casing or fuel manifold drain valve should be evident after several minutes of operation.

(c) Check each gearbox-mounted accessory at the mounting pads for oil leakage. Disregard normal oil leakage from the provided drains. (See Table 504 for limits.)

(5) Before proceeding with the operational check, retorque any leaking fittings or lines, and replace defective instruments. If necessary, shut the engine down to make repairs. All instrument indications should be within limits and the fuel or oil leaks corrected before running the engine at TAKEOFF power.

CAUTION: TO AVOID OVERSTRESS OF FAN BLADES DO NOT OPERATE ENGINE ABOVE IDLE SPEED WITH NACELLE DOORS OPEN OR REMOVED.

E. Variable Geometry Check.

(1) The variable geometry operating schedule, which is a function of compressor inlet temperature (CIT) and engine speed (RPM), is regulated by the main fuel control. The fuel control closes the inlet guide vanes and opens the compressor bleed valves at lower engine speeds. At higher engine speeds the inlet guide vanes are fully opened, and the compressor bleed valves are closed to allow maximum air flow through the engine.

(2) Check the variable geometry operating schedule as follows:

NOTE: A calibrated tachometer accurate within ± 0.25 percent, or equivalent Jetcal analyzer, is recommended when checking engine speed. However, aircraft instrumentation may be used for a rough check. Use observed ambient temperature in the engine inlet for CIT. To determine compressor bleed valve position when engine is installed in aircraft, use tool 2C5425.

(a) While observing the compressor bleed valves, slowly advance the power lever until the valves begin to close. Record the CIT and RPM at this point.

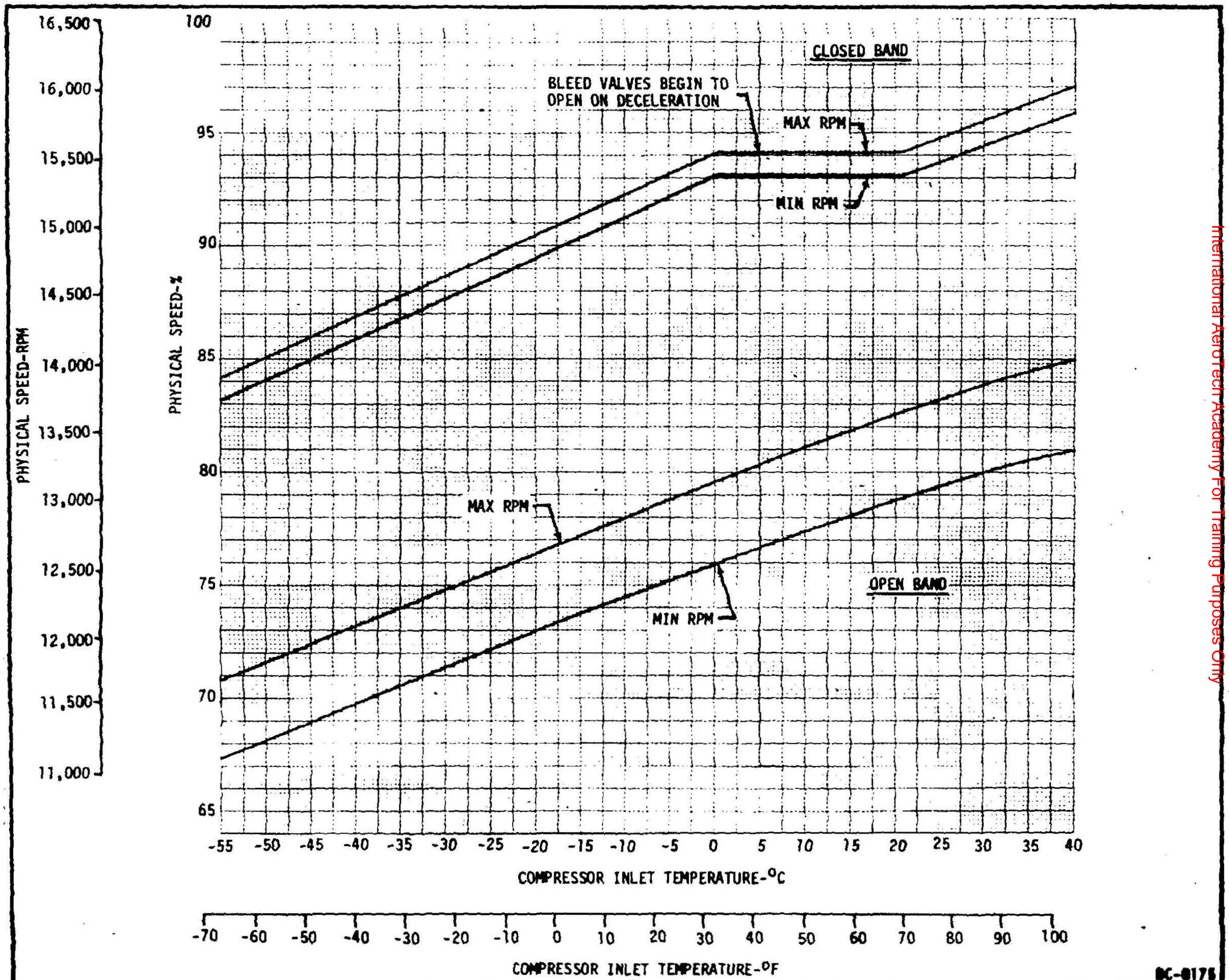
1 Plot the observed point on figure 505.

2 If the point falls within the maximum - minimum limits at the initial closing band, this portion at the variable geometry check is complete and no adjustment is necessary.

3 If the point falls outside the limit, adjust the variable geometry system per Maintenance Practices, 75-00.

(b) Increase engine speed until the bleed valves are fully closed. Slowly decrease engine speed until bleed valves just begin to open. Record this speed (RPM) and the compressor inlet temperature (CIT). Tool 2C5425 reads 0.5% high due to pressure and mechanical lag. Correct for lag by subtracting 0.5% from RPM (observed) prior to plotting the point.

1 Plot the observed point on figure 505.



Engine Bleed Valve Operating Schedule
Figure 505

2 If the point falls within the maximum-minimum limits of the full closed band, the variable geometry check is complete and no adjustments are necessary.

3 If the point falls outside the limit, adjust the variable geometry system per Maintenance Practices, 75-00.

(c) Deleted.

F. Takeoff Power Check. Takeoff power is attained when the required engine pressure ratio (EPR) for the existing compressor inlet temperature is attained without exceeding engine speed pr exhaust gas temperature limits.

CAUTION: TO AVOID OVERSTRESS OF FAN BLADES DO NOT OPERATE ENGINE ABOVE IDLE SPEED WITH NACELLE DOORS OPEN OR REMOVED.

(1) The takeoff power check determines the capability of the engine to meet the minimum power requirements for optimum takeoff performance using the Engine Pressure Ratio (EPR) system. However, the data is applicable only if the following conditions exist:

NOTE: On CF700-2D-2 engines, pressure probes are calibrated to a specific engine. Make certain that the part number of the probe being used is the same as the one recorded in the engine log book.

(a) Inlet duct recovery equal to 100%. Compressor total inlet pressure equal to barometric pressure.

(b) An engine tailpipe (exhaust nozzle) which conforms to the General Electric Company specifications. On CF700-2D-2 engines, the tailpipe (exhaust nozzle) that is an integral part of the engine should be used.

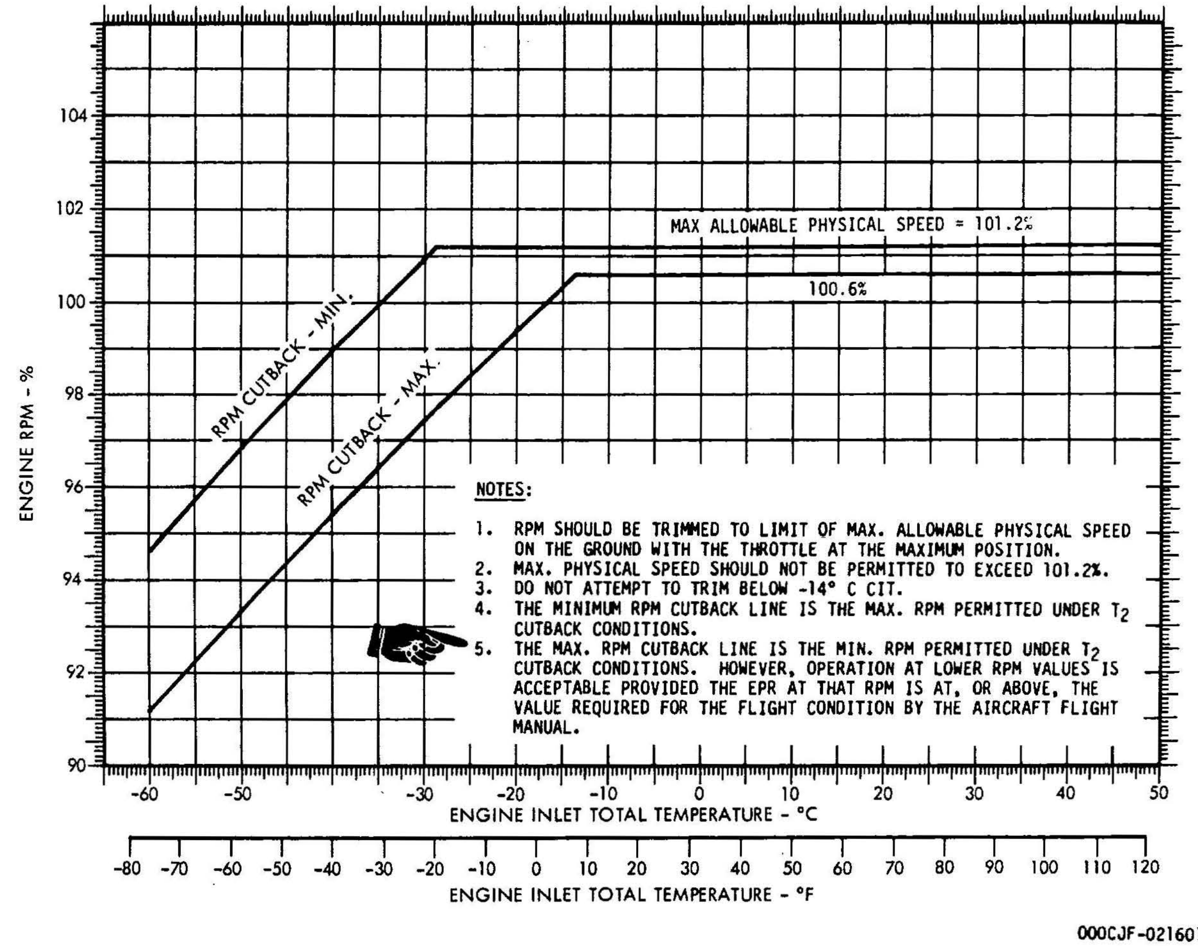
(c) No anti-icing airflow.

(d) No customer bleed or power extraction.

(e) Instrumentation as follows:

Parameter	Gage Range
RPM	0-110%
Exhaust Gas Temp.	0-1000^{o}C
Exhaust Gas Pressure	0.50 in. Hg.

NOTE: If the takeoff check is conducted with the engine in the aircraft with the aircraft inlet ducting and tailpipe, the operator must use the AIRCRAFT EPR takeoff power curve.



NOTES:

1. RPM SHOULD BE TRIMMED TO LIMIT OF MAX. ALLOWABLE PHYSICAL SPEED ON THE GROUND WITH THE THROTTLE AT THE MAXIMUM POSITION.
2. MAX. PHYSICAL SPEED SHOULD NOT BE PERMITTED TO EXCEED 101.2%.
3. DO NOT ATTEMPT TO TRIM BELOW -14° C CIT.
4. THE MINIMUM RPM CUTBACK LINE IS THE MAX. RPM PERMITTED UNDER T_2 CUTBACK CONDITIONS.
5. THE MAX. RPM CUTBACK LINE IS THE MIN. RPM PERMITTED UNDER T_2 CUTBACK CONDITIONS. HOWEVER, OPERATION AT LOWER RPM VALUES IS ACCEPTABLE PROVIDED THE EPR AT THAT RPM IS AT, OR ABOVE, THE VALUE REQUIRED FOR THE FLIGHT CONDITION BY THE AIRCRAFT FLIGHT MANUAL.

Engine Speed at Maximum Throttle
Figure 506

(2) Conduct the takeoff power check with the engine facing into the wind so that the exhaust gases are not ingested by the engine.

(3) If exhaust gas pressure (EGP) is to be read directly instead of Engine Pressure Ratio (EPR), convert EPR to EGP before operating the engine by using the following formula:

EGP (gage) = (EPR x barometric pressure) - barometric pressure.

(4) Determine accurately and record compressor inlet temperature (ambient) and barometric pressure.

Figure 507. Deleted.

Table 501. Deleted.

(5) Determine the following for the particular compressor inlet temperature that was recorded;

(a) Engine speed limit. (Figure 506)

NOTE: The curve in figure 506 represents limits only when the throttle is at maximum setting. At other throttle settings, some degree of T_2 cut-back will be experienced. This effect diminishes to zero at the IDLE throttle position.

(b) Exhaust gas temperature limit (figure 504. 504A, 504B, or 504C).

(c) Engine pressure ratio (EPR) required at takeoff. Refer to the Aircraft Operating Manual.

(d) Aft fan speed limit (figure 508).

(6) Perform maximum speed adjustment check per paragraph F1. If EPR determined in step (5)(c) is achieved with RPM and EGT within limits, the engine has demonstrated satisfactory takeoff performance. If EPR requirement is not met due to:

(a) Maximum speed adjustment is too low, the maximum speed will have to be raised per paragraph F1. and another EPR check made.

(b) Speed limit, EGT limit or fan speed limit, other maintenance action is required. Refer to Troubleshooting.

F1. Maximum Speed Setting. This procedure is used for ambient temperatures above $0^{o}F$ for G10 and lower controls and minus $10^{o}F$ for G11 and above controls.

NOTE: Perform a maximum speed check (MSC) prior to making any adjustments.

(1) Slowly advance the power lever to maximum unless an engine operational limit is exceeded (refer to Table 504). If the engine is speed or temperature limited, stabilize the engine at the highest limiting factor and record engine speed. EGT, and EPR. Retard power lever to idle position.

(2) Compare the readings to Table 502 to determine which of the two procedures (direct or indirect) is to be used to make the maximum speed adjustment (MSA).

TABLE 502

MAXIMUM SPEED SETTING PROCEDURES

Case	Operating Parameters	Result	Procedure
1.	Power lever Engine speed (N_g) EGT (T_5) Fan speed (N_f)	Maximum (92° or more) Equal to 100.7 to 101.2 percent Equal to or less than limiting Equal to or less than limiting	None Required. Adjustment is correct.
2.	Power lever Engine speed EGT Fan speed	Less than maximum Equal to 101.2 percent Equal to or less than limiting Equal to or less than limiting	Direct. See step (3) for procedure. (MSA is too high.)
3.	Power lever Engine speed EGT and/or Fan speed	Equal to or less than maximum Less than 100.7 percent Equal to limiting	Indirect. See step (4) for procedure. (MSA not directly determinable.)
4.	Power lever Engine speed EGT Fan speed	Equal to maximum Less than 100.7 percent Less than limiting Less than limiting	As the MSA is too low, an estimate should be made to determine the result on T_5 and N_f when increasing the MSA. This estimate will determine which procedure is to be used so an additional cycle will not be required. See step (5) for procedure.

NOTE: In the region of 97 percent corrected engine speed, EGT increases at the rate of approximately 20°C per percent N_g and N_f increases at the rate of approximately 1.5 percent per percent N_g. By multiplying this rate times the difference between 100.7 percent (N_g) and observed speed, an approximation of the increase in either parameter can be determined. Adding this approximation to the observed speed and comparing the sum to limits in Table 504 will determine if the engine will be limited when engine speed is increased to 100.7 percent. If the estimate is not limiting, use the direct method; if the estimate is limiting, use the indirect method.

(3) Direct procedure. (Power lever less than maximum, engine speed of 101.2 percent is obtainable and EGT and fan speed are within limits of Table 504.)

(a) Set maximum speed in accordance with Maintenance Practices, 73-21-0.

(b) Slowly advance the power lever to maximum and observe that speed is within limits of figure 506.

(c) Return power lever to idle. Adjust idle speed per Maintenance Practices, 73-21-0, if required.

(4) Indirect procedure. (Power lever equal to less than maximum, engine speed less than 100.7 percent, EGT and/or fan speed equal to limiting.)

(a) Determine the number of clicks required to set maximum speed to desired limit by the following:

1 Subtract recorded engine speed from 101.2 percent.

2 Divide result of step 1 by 0.2 percent per click. Round off any fraction to next highest number. This is the number of counterclockwise (CCW) clicks required to set maximum speed approximately 1 to 1-1/2 percent below EGT or fan speed limiting speed.

3 *Add 5 clicks to results of step 2 to ensure that MSA is lowered sufficiently.*

(b) Adjust the MSA with the number of CCW clicks determined in step 3 per Maintenance Practices, 73-21-0. Adjust at idle or with engine shutdown.

(c) Repeat maximum speed check. Conditions of case 4, Table 502, must be met. If not, repeat steps (a) and (b) until these conditions are met. Record engine speed. Retard power lever to idle. Label this, "speed reading number one".

(d) Adjust maximum speed 10 clicks CCW per Maintenance Practices, 73-21-0 and run another check. Record engine speed. Retard power lever to idle. Label this, "speed reading number two".

(e) Determine the gain of the adjustment by the following:

1 Subtract "speed reading number two" from "speed reading number one".

2 Divide result of step 1 by ten (the number of CCW clicks in step (d)).

(f) Determine number of clicks required for adjustment by the following:

1 Subtract "speed reading number two", step (d) from 101.2 percent.

2 Divide the result of step 1 by the gain (found in step (e)2. Round off to the next lowest whole number.

(g) Change the maximum speed adjustment by the number of clicks determined in step (f)2 and adjust per Maintenance Practices, 73-21-0.

(h) Check idle speed and adjust per Maintenance Practices, 73-21-0, if required.

(5) Estimating procedure. (Power lever at maximum, engine speed less than 100.7 percent, EGT and fan speed are less than limiting.)

(a) Determine if EGT is limiting by the following:

1 Subtract the recorded engine speed from 100.7 percent.

2 Multiply result of step 1 by 20°C. (Change per percent N_g.)

3 Add result of step 2 to recorded EGT. Compare sum with limits in Table 504.

4 If the sum of step 3 is equal to or less than maximum operating limit, engine will not be temperature limited and the direct procedure is used to adjust maximum speed.

5 If the sum of step 3 is more than maximum operating limit, engine will be temperature limited. Determine the amount the temperature exceeds limit by subtracting the maximum operating limit from this.

6 Divide the result of step 5 by 20°C (change per percent N_g).

7 Subtract the result of step 6 from 100.7 percent. Label this estimated engine speed "N_{go}". With this estimated N_{go}, use the indirect procedure for adjusting the maximum speed.

NOTE: The estimated engine speed (N_{go}) will be used in place of the recorded engine speed (in the indirect procedure).

(b) Determine if fan speed (N_f) is limiting by the following:

1 Subtract the recorded engine speed from 100.7 percent.

2 Multiply result of step 1 by 1.5 percent. (Change per percent N_g.)

3 Add result of step 2 to recorded fan speed. Compare sum with limits in Table 504.

4 If the sum of step 3 is equal to or less than maximum operating limit, engine will not be limited by fan speed and the direct procedure is used to adjust maximum speed.

5 If the sum of step 3 is more than maximum operating limit, engine will be limited by fan speed. Determine the amount the fan speed exceeds limit by subtracting the maximum operating limit from this.

6 Divide the result of step 5 by 1.5 percent. (Change per percent N_g.)

7 Subtract the result of step 6 from 100.7 percent. Label this estimated engine speed "N_{go}". With this estimated N_{go}, use the indirect procedure for adjusting the maximum speed.

NOTE: The estimated engine speed (N_{go}) will be used in place of the recorded engine speed (in the indirect procedure).

G. Anti-Icing Check.

(1) Set the engine to operate at approximately 90% speed (14,850 rpm).

(2) Turn the anti-icing system ON. (When the anti-icing system is turned ON, the exhaust gas temperature increases.) Check for an increase in exhaust gas temperature. (When a gage is installed, check the anti-icing gage for pressure indication.) Turn the anti-icing system OFF.

(3) Retard the power lever to IDLE.

H. Overspeed Governor (OSG) Check. Check the operation of the OSG using one of the two following procedures.

(1) If the overspeed governor has a knurled-knob on the control arm, and with the engine shutdown or at IDLE, proceed as follows:

(a) Grasp the knurled knob on the governor control arm and push up approximately 1/8 inch to free it from its locked position.

(b) Rotate the knob clockwise 1/8 turn.

(c) Pull the knob downward so that the square part of the arm is below the bracket.

(d) Rotate the knob 1/8 turn counterclockwise so that the square part of the arm snaps into the locked position.

(e) With the engine operating at IDLE, advance the power lever to the TAKEOFF position. Engine speed should be limited to 90.5 (±1.5)% (14,708-15,156 rpm) for satisfactory governor operation. If not, replace the overspeed governor per 73-22-0.

(f) Retard the power lever to IDLE (and shutdown the engine if desired).

(g) Return the governor control arm to the normal (up) position as follows:

1. Grasp the knurled knob on the governor control arm and pull down approximately 1/8 inch to free it from its locked position.

2. Rotate the knob clockwise 1/8 turn.

3. Push the knob upward so that the square part of the arm is above the bracket.

4. Rotate the knob 1/8 turn counterclockwise so that the square part of the arm snaps into the locked position.

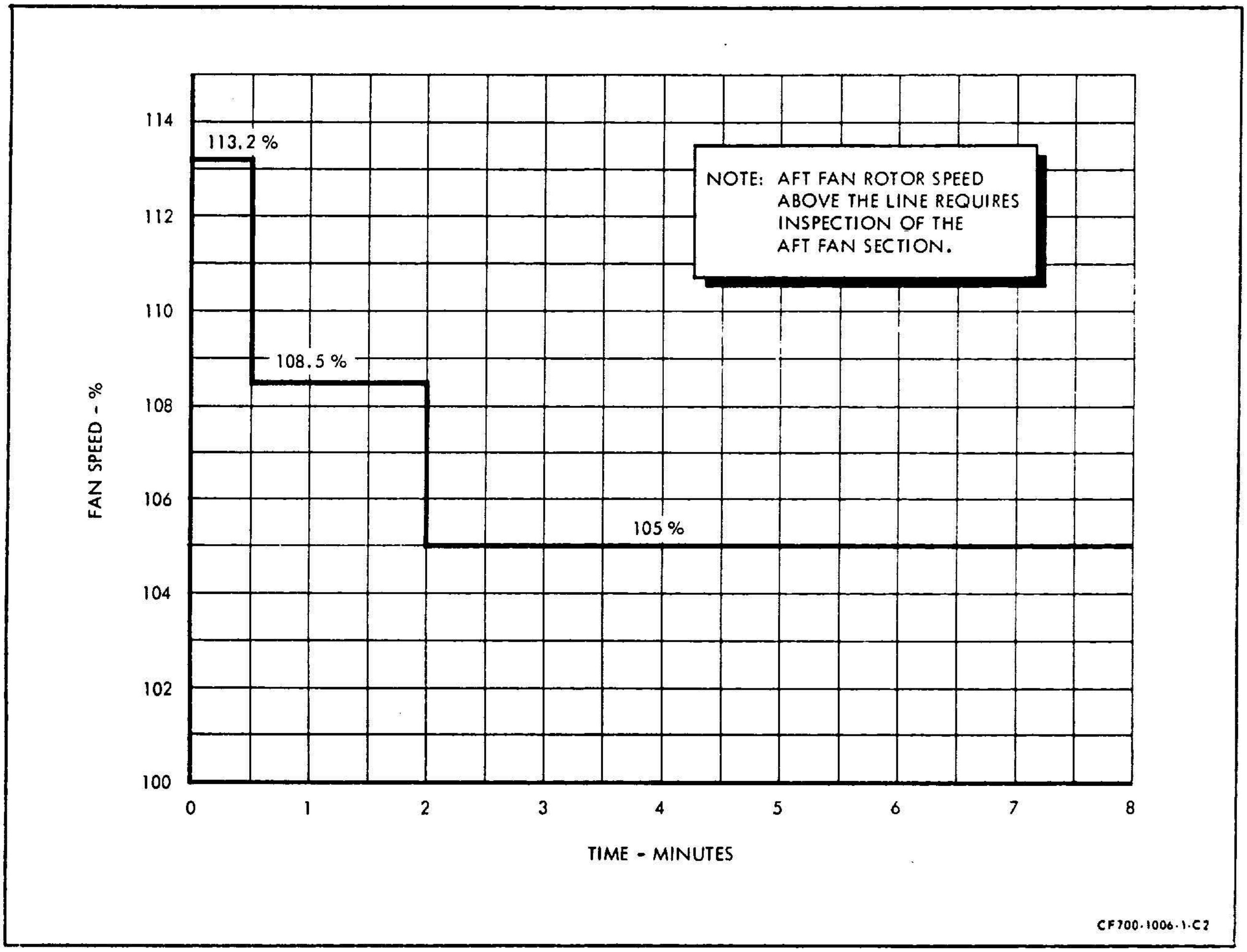
(2) If the overspeed governor has a lever-type control arm and with the engine shutdown or at IDLE proceed as follows:

(a) Push the control arm aft until the rocker arm firmly seats against the stop.

(b) With engine operating at IDLE, advance the aircraft power lever to the TAKEOFF position. Engine should be limited to 90.5 (±1)% for satisfactory governor operation. If not, replace the overspeed governor per 73-22-0.

(c) Retard the power lever to IDLE (and shutdown the engine if desired).

(d) Complete the overspeed governor check by returning the control arm to the forward position.



Aft Fan Transient Overspeed Limits
Figure 508

I. Acceleration Check.

NOTE: Make throttle movements in a smooth and normal manner. Quick throttle retard followed by immediate advance (Bodie burst) will make the check invalid.

(1) The acceleration check determines engine capability for reaching TAKEOFF power output in a specified time and indirectly checks compressor performance, fuel scheduling, variable geometry operation, and governor speed control.

(2) Advance the power lever from IDLE to TAKEOFF setting in 1 second or less. The engine should attain takeoff power stabilization within 6-8 seconds.

NOTE: During power-burst acceleration, EGT and RPM may overshoot the steady-state operating limits momentarily. See figures 504, 504A, 504B, 504C, 508, and 509 for the allowable transient overtemperature and overspeed limits.

(3) Retard the power lever to IDLE.

I_1. Maximum Altitude Acceleration Check for Saberliner and Falcon Aircraft.

(1) This check is required on all engines at initial installation, after overhaul, and also after major repair if in the judgment of the overhaul shop or operator, the altitude performance or operation has been affected.

(2) This check is to be done at the maximum certified altitude of the aircraft or at the maximum altitude permissible in countries where the civil air regulations do not permit operation at the maximum certified altitude. Refer to the applicable aircraft flight manual for the maximum certified altitude. If an individual operator elects (with responsible civil aviation authority concurrence) to restrict his aircraft to some altitude less than the certified altitude, the acceleration check should be made at that altitude.

(3) The purpose of this check is to demonstrate that engine operation will be satisfactory at all conditions up to the limiting altitude specified.

CAUTION: THE MAXIMUM ALTITUDE CHECK DESCRIBED IN THESE INSTRUCTIONS MAY CAUSE SUDDEN LOSS OF ENGINE POWER. BE PREPARED FOR SINGLE-ENGINE OPERATION AND AIR START.

(4) Perform the acceleration check as follows:

NOTES: 1. Before making this check, check the aircraft/engine dual ignition system for satisfactory operation in accordance with Section 72-00, Table 101, problem 3 of this manual.

2. Throttle movements should be made in a smooth and normal manner. A quick throttle retard followed by immediate advance (bodie burst) will make check invalid.

3. While performing this check, it is permissible to exceed Max Continuous T5 up to the levels and time specified in EGT Curves, figures 504, 504A, 504B, and 504C. The throttle should be reset at or below Max Continuous power as soon as practical.

(a) Proceed to the test altitude to perform the following check.

NOTE: While checking one engine, check speed of the other engine. It should be at least 2 percent below maximum Ng.

(b) Establish an airspeed of 195 to 200 KIAS by adjusting the opposite engine while leaving the throttle of the test engine at the climb power setting. Record Ng, Nf, RAT, EGT, EPR, Fuel Flow, and airspeed.

(c) Slowly set the test engine to 2 percent below the observed gas generator RPM and increase to the maximum RPM by making a rapid throttle movement. Record the maximum RPM and RAT.

(d) If engine accelerates to maximum RPM with no evidence of a stall or flameout, the acceleration check has been satisfactorily completed and the engine is acceptable.

(e) If the engine stalls or flames out during the acceleration check, it is not acceptable and requires further action.

Options available include the following:

1 Troubleshoot the engine per figure 104, Section 72-00.

2 Contact an authorized overhaul shop for assistance.

3 Repeat the acceleration check at a lower altitude and if successful, restrict aircraft operation to that altitude with the concurrence of the responsible civil aviation authority for a temporary period until corrective action can be taken.

I_2. Exhaust Gas Temperature (EGT) Check.

NOTES: 1. The objective of this check is to assure that takeoff EPR is available within the certified EGT limit at all values of CIT. It should be done after specific maintenance work (see figure 503), and can be used as a general engine performance health check at any time.

2. Because altitude affects engine performance, do not do this check at altitudes above 2,000 feet.

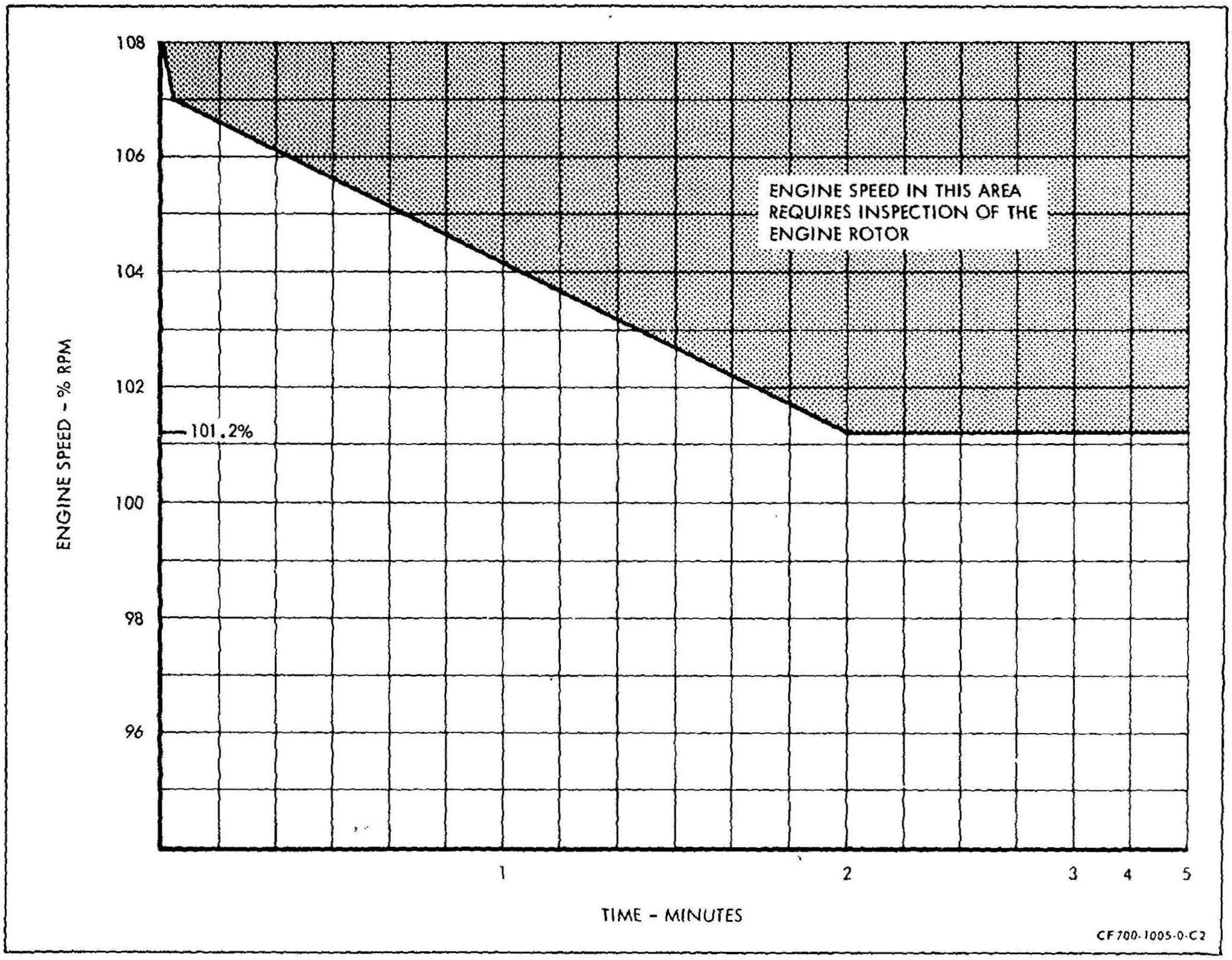
3. If specific maintenance work (see figure 503) is done at altitudes above 2,000 feet, the engine should be operated in accordance with the applicable Aircraft Flight Manual.

(1) Set the engine pressure ratio (EPR) for the model engine installed per the applicable figure 509A through figure 509F.

(2) Read the indicated EGT.

(3) If the EGT is at or below the temperature line, shown on the applicable figure 509A through 509F, takeoff EPR is available within the certified EGT limit at all values of CIT.

(4) If the EGT is above the temperature line by 68°F (20°C) or more, troubleshooting and corrective action per Section 72-00, Table 101, paragraphs 4, 9, and 11 is recommended before you operate the aircraft. If EGT is above the value determined in step (2) by less than 68°F (20°C), troubleshooting and corrective action should be taken at the earliest practical time. Operation of the aircraft prior to corrective action is acceptable only for CIT values that produce EGT within the certified limit.



Engine Transient Overspeed Limits
Figure 509

J. Shutdown Procedure.

(1) Prior to a normal shutdown, operate the engine at IDLE for 2 minutes to dissipate heat and stabilize operating temperatures. In an emergency, such as an overtemperature, flameout, or loss of oil pressure, shut the engine down immediately.

(2) Normal Shutdown.

(a) Set the power lever at IDLE for 2 minutes to stabilize operating temperature.

(b) While observing EGT and fuel flow, retard the power lever to OFF (0°). EGT and RPM should decrease, and fuel flow should immediately drop to zero.

CAUTION: IF EGT REMAINS ABNORMALLY HIGH, MOTOR THE ENGINE WITH THE STARTER TO ELIMINATE ANY FUEL IN THE HOT SECTION OF THE ENGINE.

(c) During coastdown, listen for any unusual rotational noises. Check for an abrupt or binding stop.

(d) Inspect the engine and repair any fuel or lube oil leaks. Observe the amount of fuel drainage from the engine drain lines.

(3) Abnormal Shutdown.

(a) Chop the power lever to OFF (0°). Shut off the engine fuel supply. If a post-shutdown fire occurs, motor the engine to the limits of the starter.

NOTE: A post-shutdown fire is evidenced by black smoke from the engine inlet or exhaust sections.

(b) If a post-shutdown fire is still evident, motor the engine with the starter and apply a CO_2 fire extinguisher to the engine inlet section.

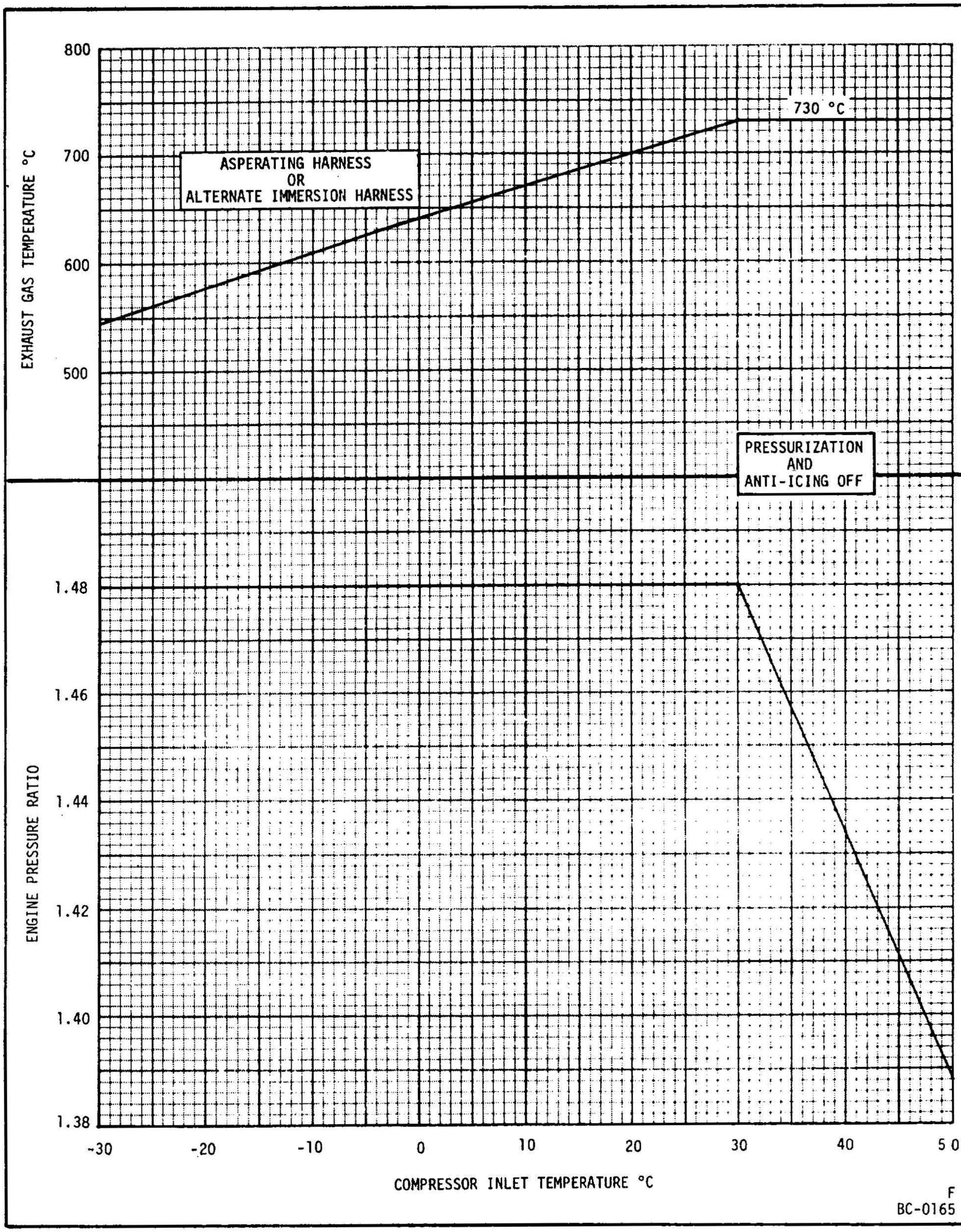
NOTE: Exercise judgment in the use of the starter when applying a fire extinguisher to control a post-shutdown fire. Motor the engine only if the coastdown is reasonably smooth; otherwise, additional damage to the engine may occur.

(c) During coastdown, listen for any unusual rotational noises.

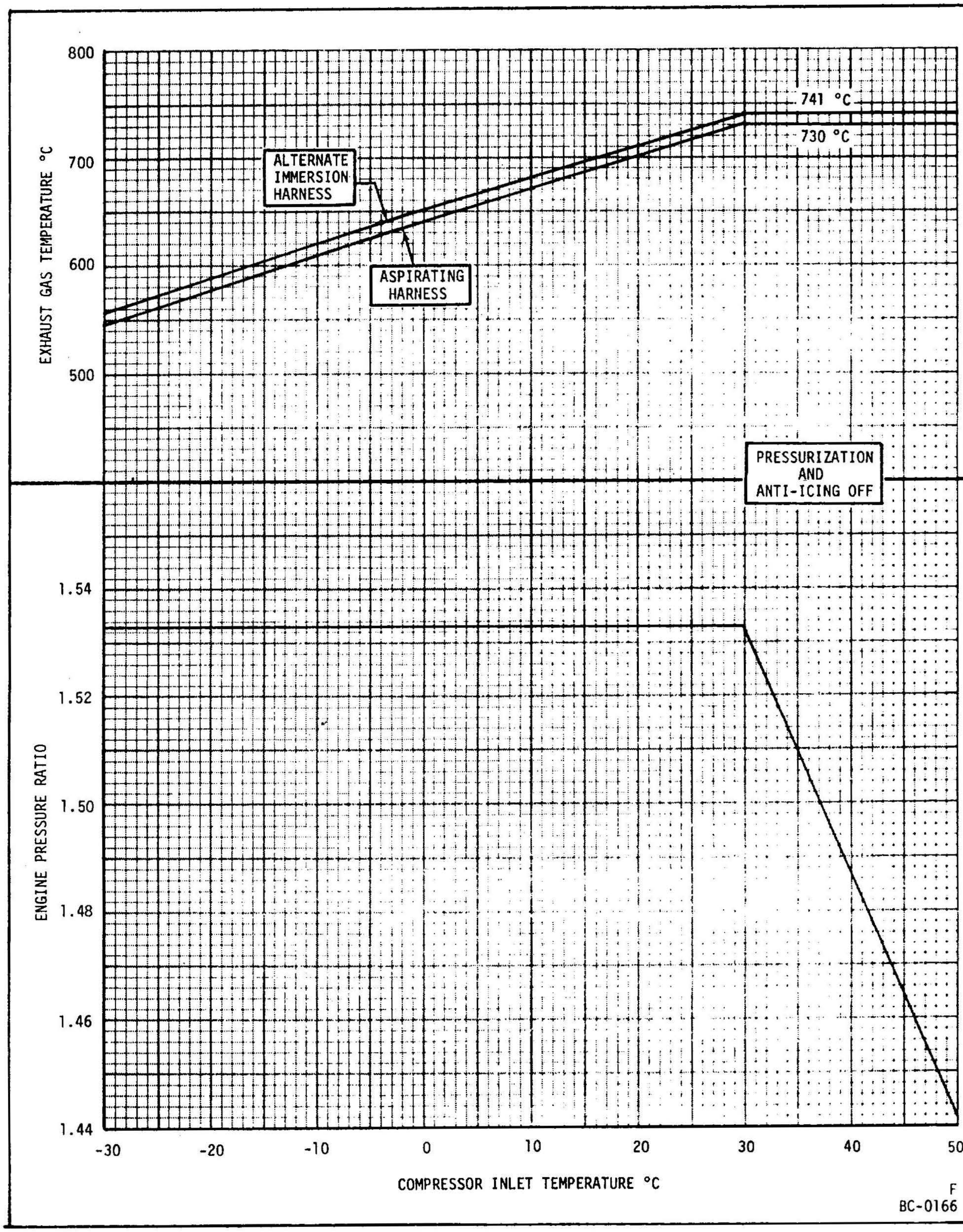
(d) Inspect the compressor through the inlet section and through the bleed valve ports for rubs or damage. Inspect the turbine through the exhaust section for burned or damaged parts. If damage is evident, visually inspect all compressor rotor blades and stator vanes and perform a Hot Section inspection.

4. Abnormal Operation.

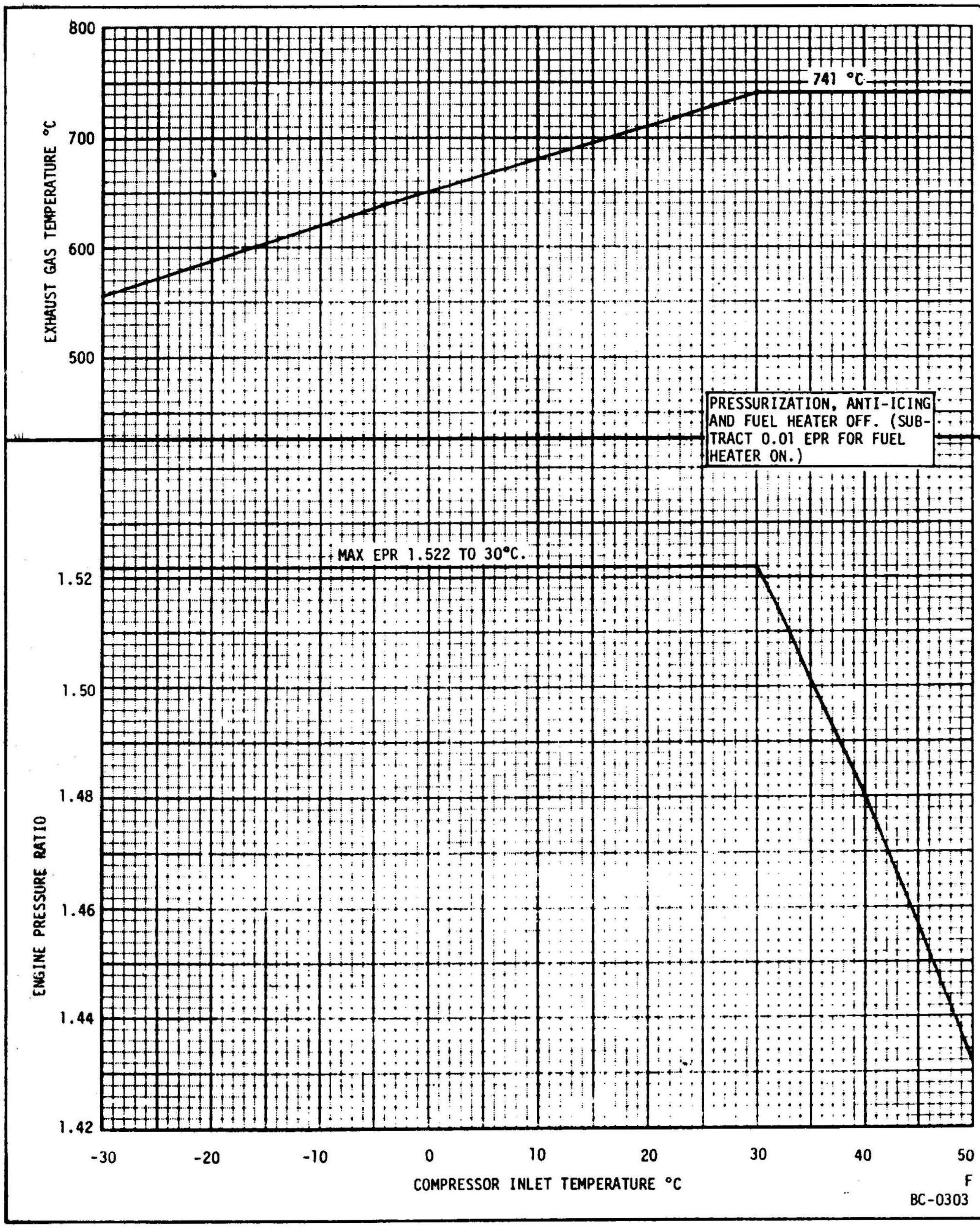
A. Emergency Procedures. The following paragraphs describe abnormal conditions which may be encountered during engine operation and the emergency action to be taken to correct the condition.



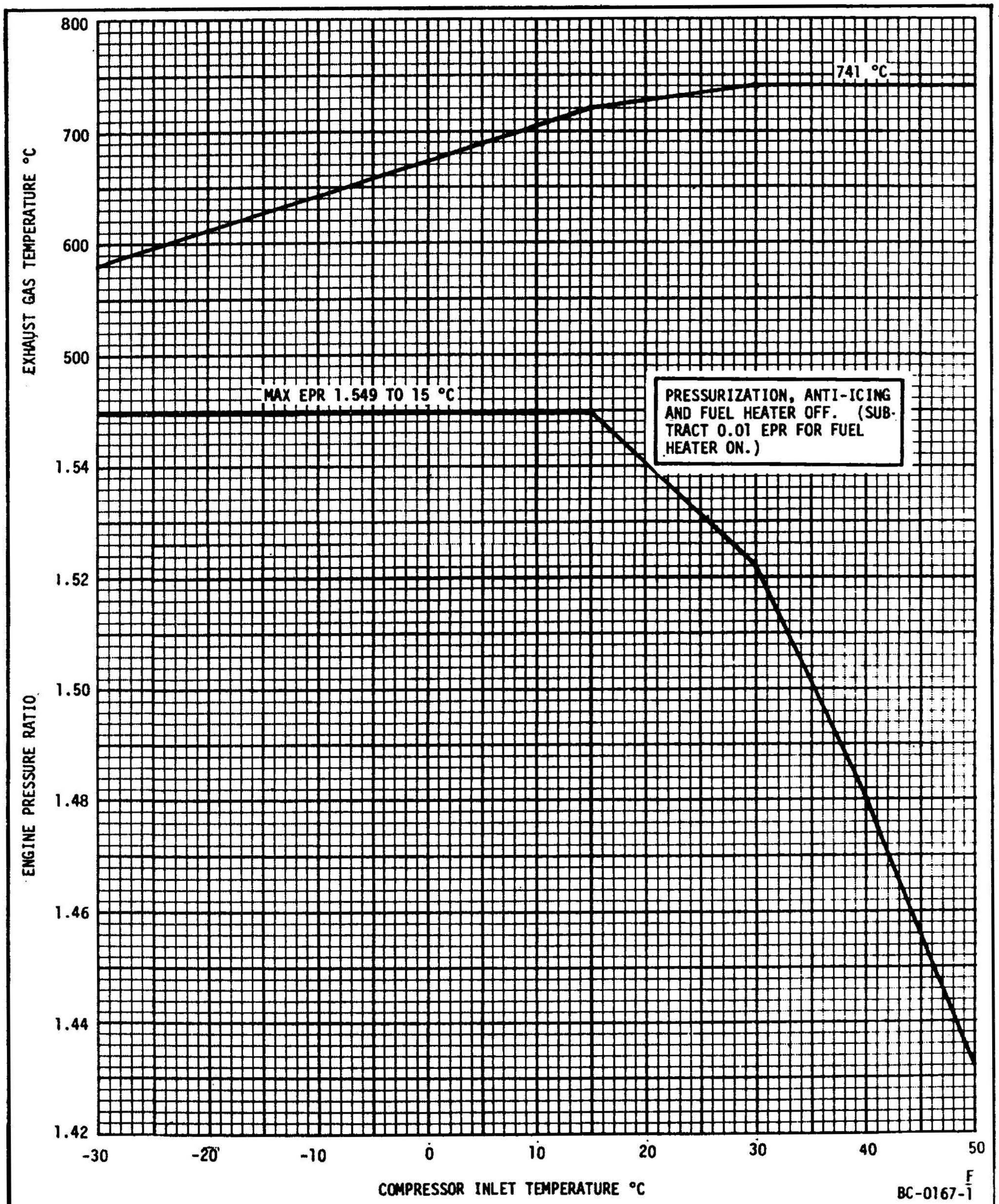
Power Assurance Check for CF700-2C Engines
Installed in Falcon 20C Aircraft
Figure 509A



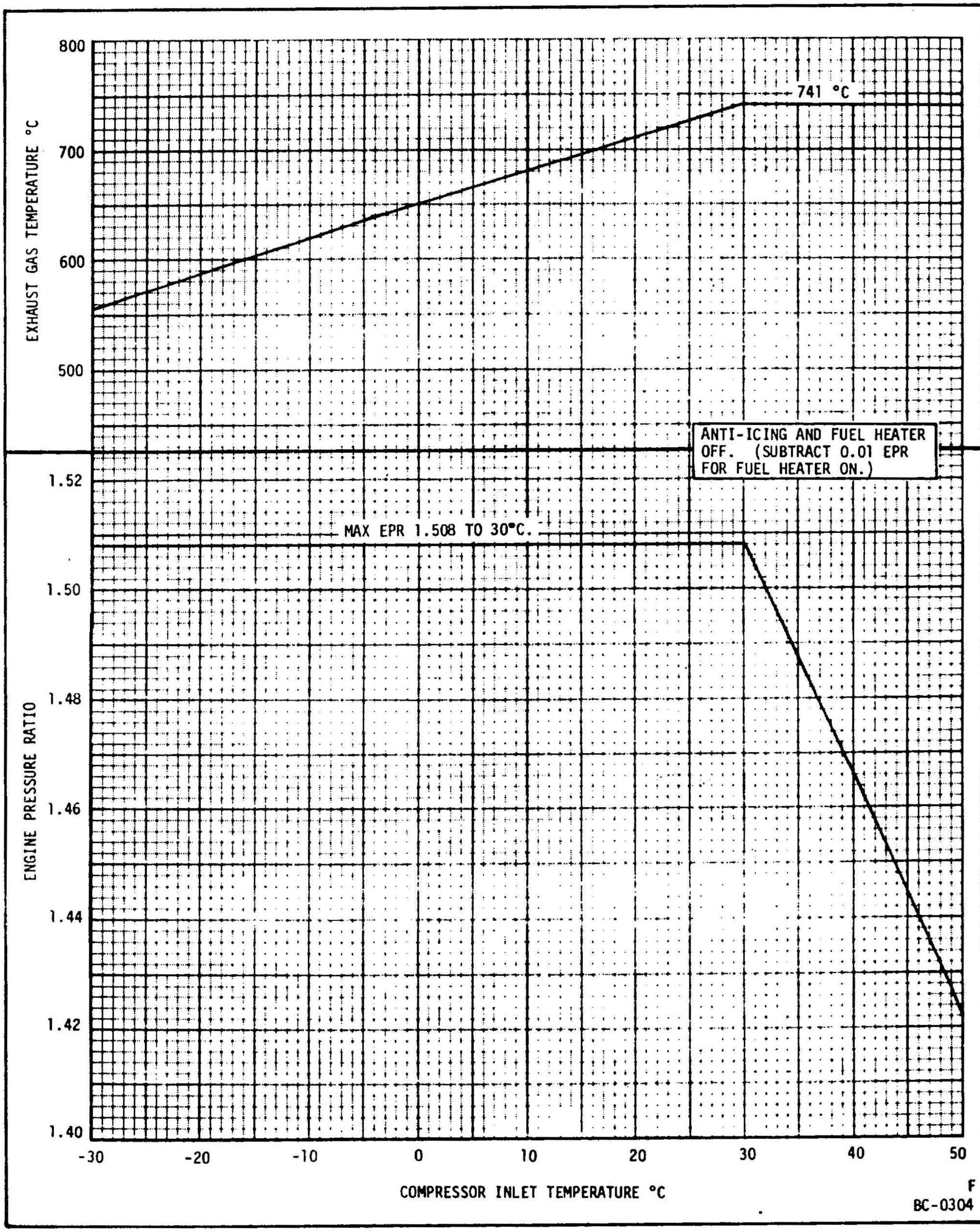
Power Assurance Check for CF700-2D Engines
Installed in Falcon 20D Aircraft
Figure 509B



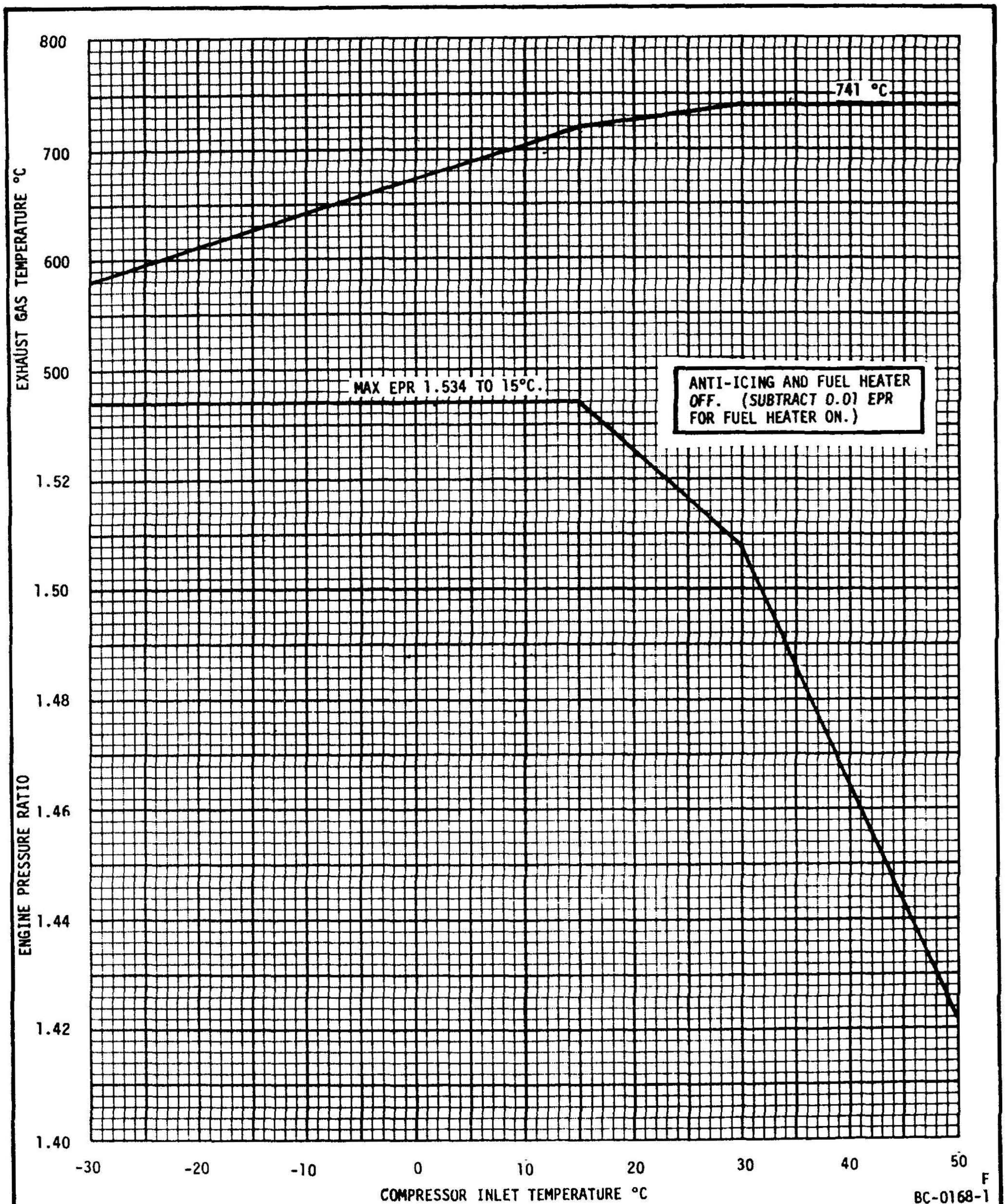
Power Assurance Check for CF700-2D-2 Engines
Installed in Falcon Models 20E and 20F Aircraft
(Engines NOT MODIFIED per Service Bulletin 72-128)
Figure 509C



Power Assurance Check for CF700-2D-2 Engines
Installed in Falcon Models 20E and 20F Aircraft
(Engine Serial No.s 304325 and up, or Engines
MODIFIED per Service Bulletin 72-128)
Figure 509D



Power Assurance Check for CF700-2D-2 Engines
Installed in Sabreliner 75A Aircraft (Engines NOT
MODIFIED per Service Bulletin 72-128)
Figure 509E



Power Assurance Check for CF700-2D-2 Engines Installed in Sabreliner 75A Aircraft (Engine Serial No.s 304325 and up, or Engines MODIFIED per Service Bulletin 72-128)
Figure 509F

B. No Start. If the engine does not light off within the prescribed time/temperature (see figures 504 through 504C), the cause is usually a malfunctioning fuel or ignition system. If the engine fails to start, refer to Troubleshooting, 72-00.

C. Hot Start. During a hot start the exhaust gas temperature increases very rapidly and will exceed the limits if the start is not discontinued in time. This is usually caused by an excessively rich mixture in the combustion section or by low motoring speed. By keeping a close check of starting speed and exhaust gas temperature, the operator should be able to anticipate a hot start and discontinue it before the temperature limits are exceeded. If temperature limits are exceeded, refer to Inspection, 72-00, for engine disposition. If EGT reaches 750°C (1382°F) and is rising rapidly, chop power lever to OFF.

D. False Start. The engine lights off normally during a false start; but the engine, instead of increasing to idle speed (45 to 47 percent, 7425 to 7755 rpm), remains at some lower value. The start should be discontinued as soon as this condition is recognized by chopping the power lever to OFF. If a second attempt produces the same results refer to Troubleshooting, 72-00.

E. Compressor Stall.

(1) Compressor stall is recognized by overtemperature, speed "hang-up", and a rapid audible change in the characteristic sound of normal engine operation. The stall usually occurs during throttle-burst accelerations and may result from improper adjustment or malfunctioning components in the variable geometry system.

<u>NOTE</u>: The objective of the technique for handling the power lever during a stall condition is to recover from the stall and return the engine to IDLE speed for a cooling stabilization period before shutting the engine down.

<u>CAUTION</u>: IF EGT INCREASES TOO RAPIDLY TO ATTEMPT RECOVERY AFTER A STALL HAS OCCURRED, CHOP THE POWER LEVER TO OFF.

(2) As soon as a stall is recognized, or the stall occurs, immediately retard the power lever toward IDLE. Use care to ensure that the engine does not flameout because of too rapid or great movement of the power lever (below the IDLE position); however, the movement must be rapid and great enough to prevent overtemperature and subsequent damage to the engine.

<u>NOTE</u>: Successful recovery from a stall depends on how far the condition has progressed. Early recognition will increase the possibility of a quick recovery and lessen the chance of damage from overtemperature.

(3) If the stall condition is corrected after the initial movement of the power lever toward IDLE, advance the power lever slightly to prevent flameout; but not so far as to cause re-entry into stall.

(4) After regaining control of the engine, retard the power lever to IDLE. Allow the engine to stabilize for 2 minutes, then shut it down.

(5) During the coastdown, listen for any unusual rubbing, clicking or grinding noises. Inspect the engine for any damaged, loose or missing parts. Give special attention to the variable geometry system linkage. Inspect the compressor rotor interior for damaged blading or dirty condition by looking through the ports of both bleed valves and through the compressor inlet section. Take all possible measures to eliminate the cause of stall before restarting the engine.

(6) Refer to Inspection/checks for deceleration stalls.

F. Aft Fan Stall. Aft fan stall may be indicated by rapid and violent fluctuations in thrust, fan speed, or vibrations. This may occur when the engine exit area has been reduced excessively, thereby raising the fan operating line above its aerodynamic stall line. In such cases, immediately operate the engine at a reduced power setting to bring the fan out of the stall. Then shut the engine down and correct the stall-inducing conditions.

G. Overtemperature.

(1) Whenever the exhaust gas temperature (EGT) exceeds the established limits, first retard the power lever to bring EGT within operating limits. If it still appears that EGT will exceed limits, chop the power lever to OFF. Do not allow EGT to exceed the limits before taking corrective action.

(2) Record the magnitude (degree F or C) and duration (seconds) of the overtemperature, then determine engine serviceability per figures 504, 504A, 504B or 504C. Refer to Inspection, 72-00, for engine disposition if the limits have been exceeded.

H. Engine Overspeed.

(1) If the MAXIMUM engine speed stabilizes at 103.5 (± 0.5)% (16996-17160 rpm), and cannot be reduced by retarding the power lever to IDLE, engine speed is being controlled by the overspeed governor. Retard the power lever to OFF (0-degrees).

<u>CAUTION:</u> DO NOT ATTEMPT TO RESTART ENGINE UNTIL CAUSE OF OVERSPEED IS DETERMINED AND CORRECTED.

(2) Remove the fuel pump, fuel control and fuel filters and check for contamination.

NOTE: If the fuel control fails, the overspeed governor limits engine speed to 103.5% RPM (NOMINALLY).

(a) Replace fuel control.

(b) Inspect the high pressure fuel filter, OSG servo filter and the fuel control filters. If metal contamination is found, replace fuel pump.

(c) If other contamination is observed, which is abnormal for operating period and conditions, determine the source and correct the situation.

(d) Clean and examine the pump fuel filter, OSG servo filter and fuel control filter in accordance with the applicable sections of this manual. Especially determine that the screening elements are physically intact (not ruptured or torn).

(e) Install serviceable units, replace others.

(3) If the engine exceeds a sustained speed of 101.2% (16,700 rpm) or a transient speed of 108% (17820 rpm), determine engine serviceability per figure 509.

NOTE: Engine operation above 17,820 rpm requires an engine inspection as defined in Inspection, 72-00.

(4) Shut the engine down. Refer to the Troubleshooting, 72-00, and correct the cause of the overspeed.

I. Aft Fan Overspeed. An aft fan overspeed may occur if the fan blades become unloaded due to a blockage of the fan inlet. If an overspeed occurs (see figure 508), immediately chop the power lever to IDLE, shut the engine down normally, and investigate the fan inlet for blockage. Do not operate the engine if the fan is in an overspeed condition.

J. Flameout. A flameout is usually caused by an imbalance in the fuel-air ratio in the engine combustion section. The flameout is accompanied by a decreasing EGT, RPM, aft fan speed and EPR along with a change in the pitch of a normal engine sound. If an engine flameout occurs, do the following:

(1) Chop the throttle to OFF and motor the engine with the starter to purge the engine of residue fuel.

(2) Check for any unusual noise from the rotating components during engine coastdown.

K. Oil Leakage Due to Engine Windmill Operation. Oil leakage may occur, due to inefficient sump scavenging, when the engine is allowed to windmill at low speeds. Windmilling of the engine during flight may cause some increase in oil consumption above the engine normal usage rate depending on time, conditions and engine speeds. Regardless of oil loss during windmilling operation, it is not cause for rejecting the engine. After a *windmilling condition, oil consumption should be confirmed during normal* engine operation. Oil level must be checked before engine operation. Use duct and tailpipe covers to stop engine fan windmilling while aircraft is on the ground.

5. Engine Adjustments.

A. The following adjustments are allowable on the fuel system components. Refer to Maintenance Practices, 73-21-0.

(1) Idle speed adjustment.

(2) Maximum speed adjustment.

(3) Fuel density adjustment.

B. Adjustment of the variable geometry system. Refer to Maintenance Practices, 75-00.

TABLE 503 DELETED.

6. Operating Limits.

TABLE 504

OPERATING LIMITS

Item	Requirements	Remarks
A. Exhaust Gas Temperature.		
(1) Starting.		Refer to figures 504, 504A, 504B or 504C for allowed starting temperatures.
(2) Idle.		Refer to figures 504, 504A, 504B or 504C for allowed starting and transient over-temperature limits.
(3) Take-off.	Maximum values are shown on figures 504, 504A, 504B and 504C for the several engine models and two EGT harnesses.	Refer to figures 504, 504A, 504B or 504C for allowed overtemperature limits.
(4) Oscillation at take-off.	Peak to peak oscillation: 10°C or 18°F not exceeding maximum.	Provided steady state limits are not exceeded.
B. Speed RPM.		
(1) Starting.		
(a) Engine.	See paragraph 3.C. for starting instructions.	Starting system must be capable of turning the engine rotor to at least 12 percent speed in 12 seconds at ambient temperature conditions of 0°F (-18°C) or higher to achieve normal starts.
(2) Idle.		
(a) Engine.	45-48% (7425 - 7920 rpm).	When adjusting IDLE speed.
(b) Aft fan.	Positive indication.	Engine must not be operated if the fan is not rotating.

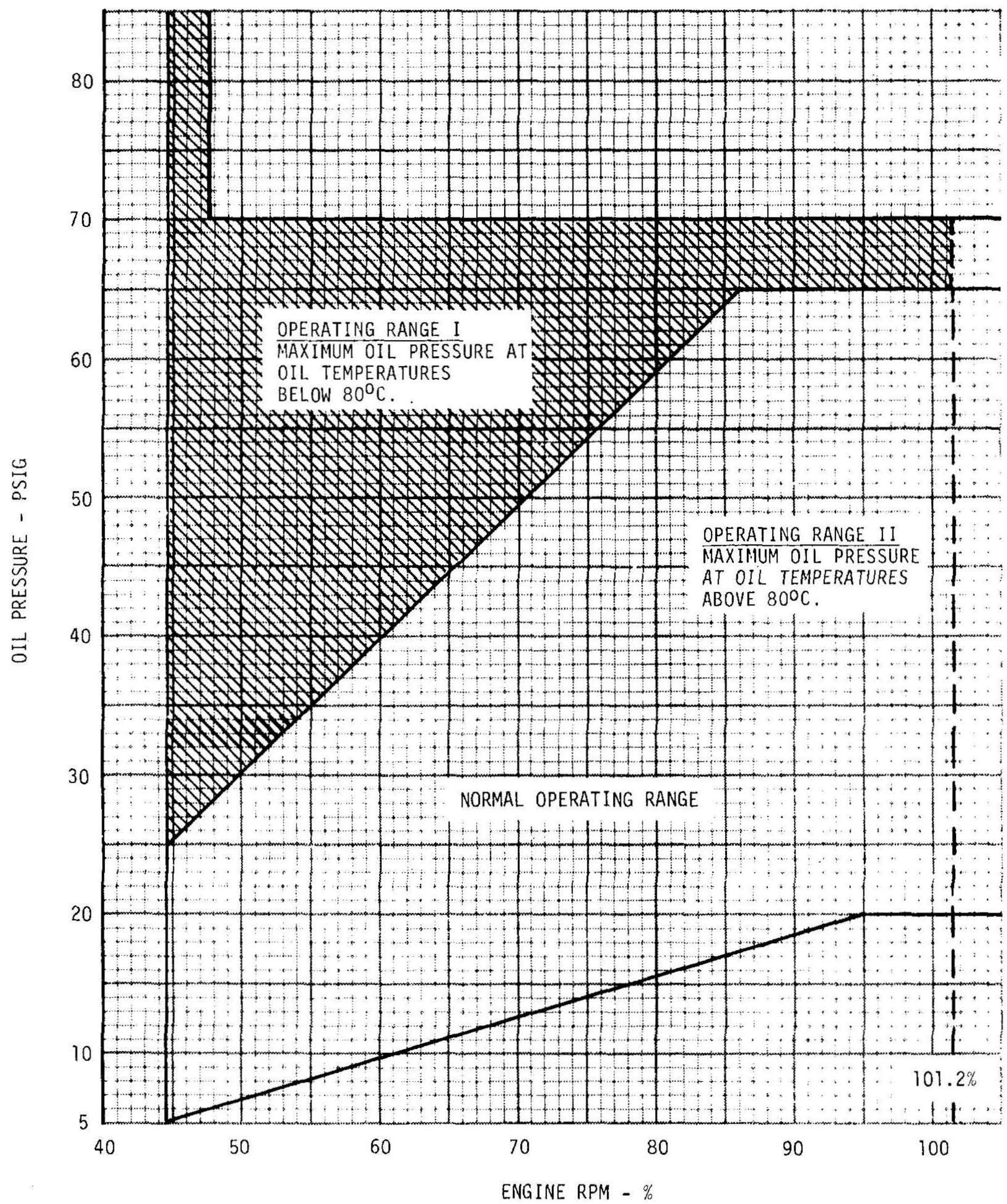
TABLE 504 (Cont)

Item	Requirements	Remarks
(3) Takeoff (5 minute rating)		
(a) Engine.	101.2 percent (16,700 rpm) maximum.	Refer to figure 509 for allowed transient over-speed limit. See figure 506 for cold day limits.
(b) Aft fan.	105% (9000 rpm).	Refer to figure 508 for allowed transient over-speed limits.
(4) Time to reach idle.	Approximately 40 seconds.	Measured from starter energizing to stabilizing IDLE speed.
(5) Deleted.		
(6) Oscillation.		
(a) Idle.	3 percent (495 rpm).	Within idle speed range.
(b) Takeoff.	2 percent not exceeding 101.2 percent.	

TABLE 504 (Cont)

Item	Requirements	Remarks
C. Oil System. Stabilized oil pressure will vary between engines from 20 psig to 65 psig in the cruise to take-off power range. Determine what the engine's normal operating oil pressure should be by referring to the engine test and operation records. Investigate any deviation of more than $\pm$10 psig from the normal under the same operating conditions. See figure 510 for operating range. It is possible for an engine's normal operating limits to shift after lube system parts have been replaced or after a change over to Type 2 oil. There may be a slight delay in oil pressure indication after changing or servicing oil. Extremely low ambient temperatures during the first few seconds of start may cause abnormally high oil pressure. Wait until oil pressure stabilizes below 70 psig before operating the engine above IDLE (with oil tank temperature below 176°F (80°C)). Operate engine at maximum continuous for 5 minutes to stabilize oil temperature just prior to reading idle oil pressure.		
(1) Engine Oil Pressure.		
(a) Starting.	Positive indication.	May peak to 175 psig under extremely cold conditions.
(b) Idle.	5-25 psig (with oil tank temperature above 176°F (80°C). Operate engine at maximum continuous for 5 minutes to stabilize oil temperature just prior to reading idle oil pressure.	Lube oil pressure on center vent engines is measured as differential between filter inlet and main sump vent.
*(c) All other conditions.		Refer to figure 510.
*(d) Drop across engine.	10 psig max.	
(2) Oil pressure fluctuations.	$\pm$2 psig.	
(3) Oil consumption.	0.60 pints per hour (max.).	

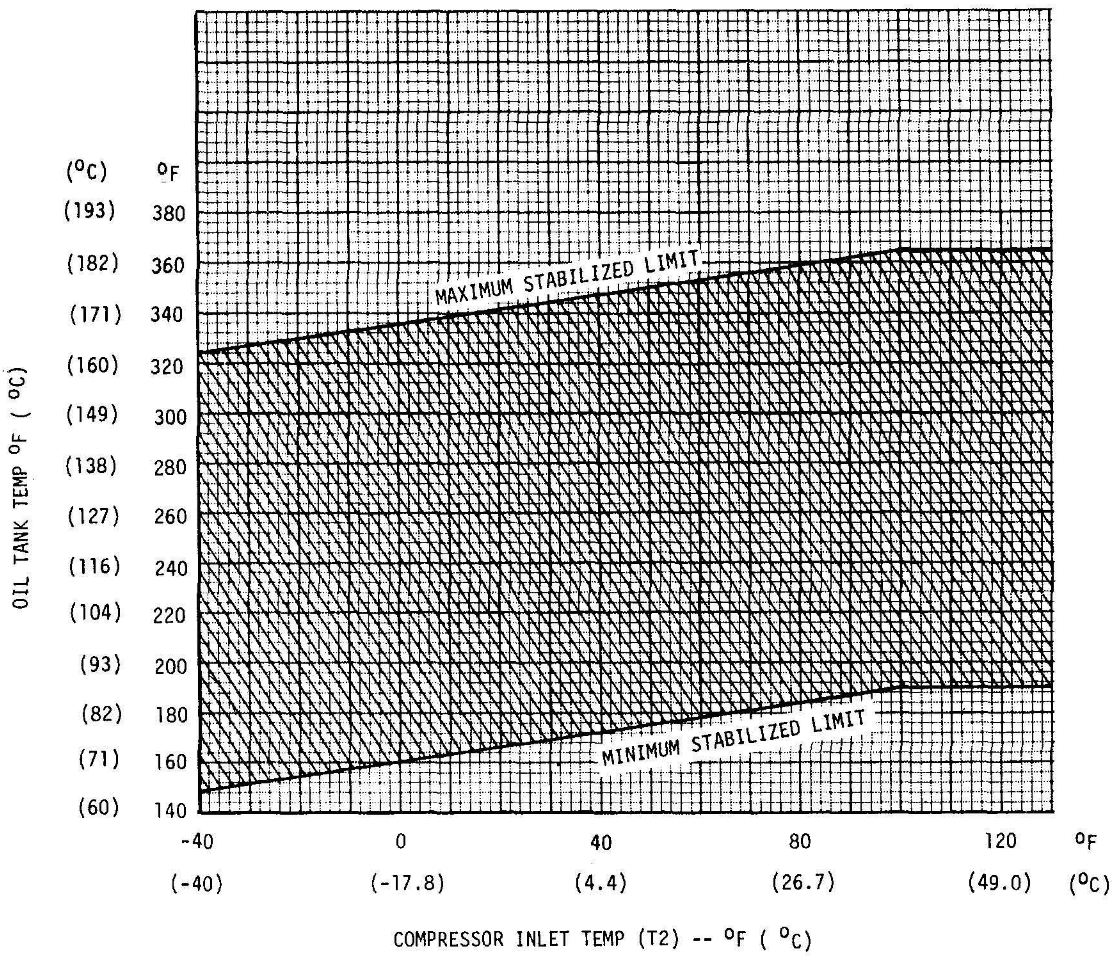
*NOTE: Trend conditions are best observed and recorded in flight under steady state conditions, such as 15 to 30 minutes of cruise operation, by the pilot.



Oil Pressure Limits
Figure 510

TABLE 504
OPERATING LIMITS (Cont)

Item	Requirements	Remarks
(4) Oil temperature.		
(a) Oil in tank.	365° (185°C). 380° (193°C).	Max. steady-state. Max. transient (3 minutes). See figure 510A.
(b) No. 2 bearing scavenge.	380°F (193°C).	Max. steady-state.
(c) No. 3 bearing scavenge.	380°F (193°C).	Max. steady-state.
(5) Oil leakage.		
(a) Oil tank vent relief valve.	10 cc per hour.	
NOTE: Approximately 18 drops of oil equal 1 cc.		
(b) Accessory drive gearbox seals.	3 drops in 5 minutes at each mounting pad.	During engine operation.
(c) Oil blowing from bleed valves.	None allowed.	Check at idle.
(d) Front frame oil accumulation (after shutdown).		None allowed up to 10 minutes after normal shutdown.
(e) Front frame No. 1 bearing seal drain line.	10 cc per hour.	Check at Hot Section Inspection and whenever there are indications of excessive leakage.



NOTES:

1. TEMPERATURE RANGE BASED ON STEADY-STATE RPM OF 95 to 102%.
2. MAX STABILIZED LIMIT MAY BE EXCEEDED UP TO THE TRANSIENT LIMIT OF 380°F (193°C) FOR 3 MINUTES PROVIDED TEMPERATURE RETURNS TO BELOW THE MAX LIMIT CURVE WITHIN 6 MINUTES.
3. ON COLD DAYS OR INITIAL RUNUPS, TEMPERATURES MAY BE BELOW MIN STABILIZED LIMITS PROVIDED THEY STABILIZE ABOVE THE MIN LIMIT CURVE WITHIN 5 MINUTES AT TAKEOFF POWER AND 7 MINUTES IN MAX CLIMB OR BELOW.

BC-0149

Oil Tank Temperature Limits in Aircraft
Figure 510A

TABLE 504 (Cont)

Item	Requirements	Remarks
D. Fuel System.		
(1) Fuel pump inlet pressure.	Positive indication (min) to 50 psig (max).	
(2) Starting fuel flow.	200-350 pounds per hour.	
(3) Fuel pump inlet temperature.		
(a) JP-5.	-20°F (min) estimated to 110°F (max).	
(b) JP-4.	-65°F (min) to 110°F (max).	
(c) Jet A, Jet A1, JP-8.	-45°F (min) estimated to 110°F (max).	
(d) Aviation gasoline.	-65°F (min) to 110°F (max).	Emergency use only. 25 hours within any one overhaul period when mixture contains more than 50 percent aviation gasoline by volume.
(4) Fuel drainage.		
(a) Fuel pump.	30 cc per hour.	
(b) Fuel control.	3 cc per hour.	
(c) Drain valve.	5 cc per hour.	Other than starting or shutdown.
(d) Overspeed governor.	6 cc per hour.	
(e) IGV actuator.	90 cc per hour.	Drain port leakage, static or dynamic.

NOTE: Approximately 21 drops of fuel equal 1 cc.

TABLE 504 (Cont)

Item	Requirements	Remarks
E. Starting and Ignition System.		
(1) Starting duty cycle.		Refer to starter manual.
(2) Ignition Exciter.	(a) 2 minutes ON, 3 minutes OFF.	(a) First start.
	(b) 2 minutes ON, 23 minutes OFF.	
	(c) Alternate: 5 minutes ON, 25 minutes OFF.	
	(d) Extended duty-during landings and takeoffs, adverse weather and possible bird strikes; use as required.	

F. Vibrations.

Vibration standards are established for test cell operation and these standards are acceptable for all CF700 engine/aircraft installations. Pilot reports of change of or excessive vibration attributed to the engine can be confirmed by running the engine in the test cell and performing a vibration check in accordance with overhaul manual test requirements.

When observing the engine operation in the aircraft, evidence of "blurry" fuel, oil hard lines, cracked standoff brackets, cracked air tubing, foreign object damage or a rattling noise in the compressor during coast down are usually signs of excessive engine vibration. Do not run engine with cowl doors open above idle.

If these symptoms are not evident, careful checks of engine mounts for tightness, aircraft doors, nacelle cowling, flap fit, or antennae fit in accordance with the airframe maintenance instructions should be undertaken prior to removing engine for vibration testing.

TABLE X TEMPERATURE CONVERSIONS

−459.4 to −220			−210 to 0			1 to 25		
C	C or F	F	C	C or F	F	C	C or F	F
−273	**−459.4**		−134	**−210**	−346	−17.2	**1**	33.8
−268	**−450**		−129	**−200**	−328	−16.7	**2**	35.6
−262	**−440**		−123	**−190**	−310	−16.1	**3**	37.4
−257	**−430**		−118	**−180**	−292	−15.6	**4**	39.2
−251	**−420**		−112	**−170**	−274	−15.0	**5**	41.0
−246	**−410**		−107	**−160**	−256	−14.4	**6**	42.8
−240	**−400**		−101	**−150**	−238	−13.9	**7**	44:6
−234	**−390**		−95.6	**−140**	−220	−13.3	**8**	46.4
−229	**−380**		−90.0	**−130**	−202	−12.8	**9**	48.2
−223	**−370**		−84.4	**−120**	−184	−12.2	**10**	50.0
−218	**−360**		−78.9	**−110**	−166	−11.7	**11**	51.8
−212	**−350**		−73.3	**−100**	−148	−11.1	**12**	53.6
−207	**−340**		−67.8	**−90**	−130	−10.6	**13**	55.4
−201	**−330**		−62.2	**−80**	−112	−10.0	**14**	57.2
−196	**−320**		−56.7	**−70**	−94	−9.44	**15**	59.0
−190	**−310**		−51.1	**−60**	−76	−8.89	**16**	60.8
−184	**−300**		−45.6	**−50**	−58	−8.33	**17**	62.6
−179	**−290**		−40.0	**−40**	−40	−7.78	**18**	64.4
−173	**−280**		−34.4	**−30**	−22	−7.22	**19**	66.2
−169	**−273**	−459.4	−28.9	**−20**	−4	−6.67	**20**	68.0
−168	**−270**	−454	−23.3	**−10**	14	−6.11	**21**	69.8
−162	**−260**	−436	−17.8	**0**	32	−5.56	**22**	71.6
−157	**−250**	−418				−5.00	**23**	73.4
−151	**−240**	−400				−4.44	**24**	75.2
−146	**−230**	−382				−3.89	**25**	77.0
−140	**−220**	−364						

26 to 50			51 to 75			76 to 100		
C	C or F	F	C	C or F	F	C	C or F	F
−3.33	**26**	78.8	10.6	**51**	123.8	24.4	**76**	168.8
−2.78	**27**	80.6	11.1	**52**	125.6	25.0	**77**	170.6
−2.22	**28**	82.4	11.7	**53**	127.4	25.6	**78**	172.4
−1.67	**29**	84.2	12.2	**54**	129.2	26.1	**79**	174.2
−1.11	**30**	86.0	12.8	**55**	131.0	26.7	**80**	176.0
−0.56	**31**	87.8	13.3	**56**	132.8	27.2	**81**	177.8
0	**32**	89.6	13.9	**57**	134.6	27.8	**82**	179.6
0.56	**33**	91.4	14.4	**58**	136.4	28.3	**83**	181.4
1.11	**34**	93.2	15.0	**59**	138.2	28.9	**84**	183.2
1.67	**35**	95.0	15.6	**60**	140.0	29.4	**85**	185.0
2.22	**36**	96.8	16.1	**61**	141.8	30.0	**86**	186.8
2.78	**37**	98.6	16.7	**62**	143.6	30.6	**87**	188.6
3.33	**38**	100.4	17.2	**63**	145.4	31.1	**88**	190.4
3.39	**39**	102.2	17.8	**64**	147.2	31.7	**89**	192.2
4.44	**40**	104.0	18.3	**65**	149.0	32.2	**90**	194.0
5.00	**41**	105.8	18.9	**66**	150.8	32.8	**91**	195.8
5.56	**42**	107.6	19.4	**67**	152.6	33.3	**92**	197.6
6.11	**43**	109.4	20.0	**68**	154.4	33.9	**93**	199.4
6.67	**44**	111.2	20.6	**69**	156.2	34.4	**94**	201.2
7.22	**45**	113.0	21.1	**70**	158.0	35.0	**95**	203.0
7.78	**46**	114.8	21.7	**71**	159.8	35.6	**96**	204.8
8.33	**47**	116.6	22.2	**72**	161.6	36.1	**97**	206.6
8.89	**48**	118.4	22.8	**73**	163.4	36.7	**98**	208.4
9.44	**49**	120.2	23.3	**74**	165.2	37.2	**99**	210.2
10.0	**50**	122.0	23.9	**75**	167.0	37.8	**100**	212.0

101 to 340			341 to 490			491 to 750		
C	C or F	F	C	C or F	F	C	C or F	F
43	**110**	230	177	**350**	662	260	**500**	932
49	**120**	248	182	**360**	680	266	**510**	950
54	**130**	266	188	**370**	698	271	**520**	968
60	**140**	284	193	**380**	716	277	**530**	986
66	**150**	302	199	**390**	734	282	**540**	1004
71	**160**	320	204	**400**	752	288	**550**	1022
77	**170**	338	210	**410**	770	293	**560**	1040
82	**180**	356	216	**420**	788	299	**570**	1058
88	**190**	374	221	**430**	806	304	**580**	1076
93	**200**	392	227	**440**	824	310	**590**	1094
99	**210**	410	232	**450**	842	316	**600**	1112
100	**212**	413	238	**460**	860	321	**610**	1130
104	**220**	428	243	**470**	878	327	**620**	1148
110	**230**	446	249	**480**	896	332	**630**	1166
116	**240**	464	254	**490**	914	338	**640**	1184
121	**250**	482				343	**650**	1202
127	**260**	500				349	**660**	1220
132	**270**	518				354	**670**	1238
138	**280**	536				360	**680**	1256
143	**290**	554				366	**690**	1274
149	**300**	572				371	**700**	1292
154	**310**	590				377	**710**	1310
160	**320**	608				382	**720**	1328
166	**330**	626				388	**730**	1346
171	**340**	644				393	**740**	1364
						399	**750**	1382

751 to 1000			1001 to 1250			1251 to 1490		
C	C or F	F	C	C or F	F	C	C or F	F
404	**760**	1400	543	**1010**	1850	682	**1260**	2300
410	**770**	1418	549	**1020**	1868	688	**1270**	2318
416	**780**	1436	554	**1030**	1886	693	**1280**	2336
421	**790**	1454	560	**1040**	1904	699	**1290**	2354
427	**800**	1472	566	**1050**	1922	704	**1300**	2372
432	**810**	1490	571	**1060**	1940	710	**1310**	2390
438	**820**	1508	577	**1070**	1958	716	**1320**	2408
443	**830**	1526	582	**1080**	1976	721	**1330**	2426
449	**840**	1544	588	**1090**	1994	727	**1340**	2444
454	**850**	1562	593	**1100**	2012	732	**1350**	2462
460	**860**	1580	599	**1110**	2030	738	**1360**	2480
466	**870**	1598	604	**1120**	2048	743	**1370**	2498
471	**880**	1616	610	**1130**	2066	749	**1380**	2516
477	**890**	1634	616	**1140**	2084	754	**1390**	2534
482	**900**	1652	621	**1150**	2102	760	**1400**	2552
488	**910**	1670	627	**1160**	2120	766	**1410**	2570
493	**920**	1688	632	**1170**	2138	771	**1420**	2588
499	**930**	1706	638	**1180**	2156	777	**1430**	2606
504	**940**	1724	643	**1190**	2174	782	**1440**	2624
510	**950**	1742	649	**1200**	2192	788	**1450**	2642
516	**960**	1760	654	**1210**	2210	793	**1460**	2660
521	**970**	1778	660	**1220**	2228	799	**1470**	2678
527	**980**	1796	666	**1230**	2246	804	**1480**	2696
532	**990**	1814	671	**1240**	2264	810	**1490**	2714
538	**1000**	1832	677	**1250**	2282			

1491 to 1750			1751 to 2000			2001 to 2250		
C	C or F	F	C	C or F	F	C	C or F	F
816	**1500**	2732	960	**1760**	3200	1099	**2010**	3650
821	**1510**	2750	966	**1770**	3218	1104	**2020**	3668
827	**1520**	2768	971	**1780**	3236	1110	**2030**	3686
832	**1530**	2786	977	**1790**	3254	1116	**2040**	3704
838	**1540**	2804	982	**1800**	3272	1121	**2050**	3722
843	**1550**	2822	988	**1810**	3290	1127	**2060**	3740
849	**1560**	2840	993	**1820**	3308	1132	**2070**	3758
854	**1570**	2858	999	**1830**	3326	1138	**2080**	3776
860	**1580**	2876	1004	**1840**	3344	1143	**2090**	3794
866	**1590**	2894	1010	**1850**	3362	1149	**2100**	3812
871	**1600**	2912	1016	**1860**	3380	1154	**2110**	3830
877	**1610**	2930	1021	**1870**	3398	1160	**2120**	3848
882	**1620**	2948	1027	**1880**	3416	1166	**2130**	3866
888	**1630**	2966	1032	**1890**	3434	1171	**2140**	3884
893	**1640**	2984	1038	**1900**	3452	1177	**2150**	3902
899	**1650**	3002	1043	**1910**	3470	1182	**2160**	3920
904	**1660**	3020	1049	**1920**	3488	1188	**2170**	3938
910	**1670**	3038	1054	**1930**	3506	1193	**2180**	3956
916	**1680**	3056	1060	**1940**	3524	1199	**2190**	3974
921	**1690**	3074	1066	**1950**	3542	1204	**2200**	3992
927	**1700**	3092	1071	**1960**	3560	1210	**2210**	4010
932	**1710**	3110	1077	**1970**	3578	1216	**2220**	4028
938	**1720**	3128	1082	**1980**	3596	1221	**2230**	4046
943	**1730**	3146	1088	**1990**	3614	1227	**2240**	4064
949	**1740**	3164	1093	**2000**	3632	1232	**2250**	4082
954	**1750**	3182						

2251 to 2490			2491 to 2750			2751 to 3000		
C	C or F	F	C	C or F	F	C	C or F	F
1238	**2260**	4100	1371	**2500**	4532	1516	**2760**	5000
1243	**2270**	4118	1377	**2510**	4550	1521	**2770**	5018
1249	**2280**	4136	1382	**2520**	4568	1527	**2780**	5036
1254	**2290**	4154	1388	**2530**	4586	1532	**2790**	5054
1260	**2300**	4172	1393	**2540**	4604	1538	**2800**	5072
1266	**2310**	4190	1399	**2550**	4622	1543	**2810**	5090
1271	**2320**	4208	1404	**2560**	4640	1549	**2820**	5108
1277	**2330**	4226	1410	**2570**	4658	1554	**2830**	5126
1282	**2340**	4244	1416	**2580**	4676	1560	**2840**	5144
1288	**2350**	4262	1421	**2590**	4694	1566	**2850**	5162
1293	**2360**	4280	1427	**2600**	4712	1571	**2860**	5180
1299	**2370**	4298	1432	**2610**	4730	1577	**2870**	5198
1304	**2380**	4316	1438	**2620**	4748	1582	**2880**	5216
1310	**2390**	4334	1443	**2630**	4766	1588	**2890**	5234
1316	**2400**	4352	1449	**2640**	4784	1593	**2900**	5252
1321	**2410**	4370	1454	**2650**	4802	1599	**2910**	5270
1327	**2420**	4388	1460	**2660**	4820	1604	**2920**	5288
1332	**2430**	4406	1466	**2670**	4838	1610	**2930**	5306
1338	**2440**	4424	1471	**2680**	4856	1616	**2940**	5324
1343	**2450**	4442	1477	**2690**	4874	1621	**2950**	5342
1349	**2460**	4460	1482	**2700**	4892	1627	**2960**	5360
1354	**2470**	4478	1488	**2710**	4910	1632	**2970**	5378
1360	**2480**	4496	1493	**2720**	4928	1638	**2980**	5396
1366	**2490**	4514	1499	**2730**	4946	1643	**2990**	5414
			1504	**2740**	4964	1649	**3000**	5432
			1510	**2750**	4982			

NOTE—The numbers in bold face type refer to the temperature either in degrees Centigrade or Fahrenheit which it is desired to convert into the other scale. If converting from Fahrenheit degrees to Centigrade degrees the equivalent temperature will be found in the left column, while if converting from degrees Centigrade to degrees Fahrenheit, the answer will be found in the column on the right.

$$°F = \frac{9}{5}(°C) + 32$$

$$°C = \frac{5}{9}(°F - 32)$$

INTERPOLATION FACTORS

C		F	C		F
0.56	**1**	1.8	3.33	**6**	10.8
1.11	**2**	3.6	3.89	**7**	12.6
1.67	**3**	5.4	4.44	**8**	14.4
2.22	**4**	7.2	5.00	**9**	16.2
2.78	**5**	9.0	5.56	**10**	18.0

CJ610-6117-0-A2A

Temperature Conversion Chart
Figure 511

ORIGINAL
As Received By
ATP

Deleted Section

Maintenance Practices - Inspection/Checks

(See Sections 5-11 and 5-21)

MAINTENANCE PRACTICES - CLEANING AND PRESERVATION

1. General. The following procedures are practices applicable to the basic engine. The cleaning procedures applicable to a system component are fully covered within its respective chapter. Refer to table 701 for cleaning or preservation of compressors.

NOTE 1: A coated compressor is one that meets the following conditions:

All stages 1 through 8, or stages 1 through 4 rotor blades, and all stages 1 and 2 vane sectors must be coated with aluminum-base intermetallic diffusion coating A-12 or HI51.

All stages 3 through 8 vane sectors must be made of Inconel 718 material.

The compressor casing must be coated with magnesium-base intermetallic diffusion coating TSM-3 or SermeTel 725.

NOTE 2: An uncoated compressor is any compressor not completely conforming to the coated configuration (see note 1). That is, if one blade, one stator vane segment, or the compressor stator does not conform to the coated configuration, the compressor is considered uncoated.

TABLE 701
MAINTENANCE PROCEDURES FOR
COATED AND UNCOATED COMPRESSORS

The following definitions are associated with coated and uncoated compressors:

- Water-Wash - Use to remove salt and other light deposits from compressor airfoils.
- Cleaning - Use to remove heavy industrial grime and smog deposits, using an approved solvent and water.
- Preservation - Use to inhibit corrosion on uncoated compressor parts, using a corrosion preventive fluid.

CAUTION: IF USED EXCESSIVELY, OILS IN PRESERVATION SOLUTIONS WILL CAUSE INTERMETALLIC DIFFUSION COATINGS TO DETERIORATE.

TABLE 701
MAINTENANCE PROCEDURES FOR COATED AND UNCOATED COMPRESSORS (Cont)

Configuration	Water-Wash	Cleaning	Preservation
Coated Compressor Stator Cases Coated Blades Stg 1-8 or Coated Blades Stg 1-4. (Refer to Service Bulletin (CF700) 72-139 and 72-139, Revision 1.)	Not required.	When compressor is visibly dirty, engine performance has deteriorated, or loss of stall margin is noted.	Not required.
Uncoated Compressor Rotor/Stator Cases.	Every 60 days or 100 hours whichever occurs first. Every 30 days or 50 hours whichever occurs first, when operated in or near salt-laden air or high-humidity conditions (see Note).	When compressor is visibly dirty, engine performance has deteriorated, or loss of stall margin is noted.	Every 60 days or 100 hours whichever occurs first. Every 30 days or 50 hours, whichever occurs first, when operated in salt-laden air (see Note).

NOTE 1: Salt-laden air can be expected as far as 100-150 miles inland.

NOTE 2: The above recommendations are for normal aircraft operation; aircraft operating under extreme conditions should be water-washed/cleaned as required to maintain engine integrity.

A. Cleaning and preservation as described herein is required only on compressors having a part(s) that is not protected by intermetallic diffusion coating (a protective coating is never used in inconel vanes). If all of the compressor parts are protected, only pure water should be used.

The compressor section should be cleaned and preserved if there is:

(1) Visible indications of dirt or salt deposits on airfoils.

(2) General deterioration of engine performance as indicated by the cockpit instruments or by the performance trend monitor log.

(3) Loss of engine stall margin.

CAUTION: OILS IN CLEANING AND PRESERVATIVE SOLUTIONS WILL CAUSE INTERMETALLIC DIFFUSION COATINGS TO DETERIORATE.

B. Since compressor corrosion damage may result before the above indications are noted, periodic cleaning (and preservation for engines not having compressor parts protected by diffusion coatings) is recommended for all operators. Application of a corrosion preventative compound should be at least once but preferably twice a week. Apply preservative according to instructions in paragraph 2.E.

C. The compressor should be cleaned, using water wash procedures, every 60 days or 100 flight hours, whichever occurs first. For aircraft operated in or near salt laden air it is recommended that the compressor be washed with clear water on a 30 day interval and (except for compressors protected by diffusion coatings) washed with a cleaner on a 60 day interval.

2. Removal of Compressor Contaminants. This procedure is recommended for cleaning the compressor of an engine subjected to the deteriorating effects of industrial grime or smog and the exposure to salt laden or warm humid atmospheres. Industrial grime or smog may be detected by a dark film on compressor airfoil surfaces. The film will be much more noticeable on the rear or high pressure side of the compressor blades. Salt deposits are evidenced by white deposits on vanes and blades. All compressor contaminants must be promptly removed if corrosion is to be controlled.

NOTE: Engine compressors not protected by diffusion coatings should always be water-washed with a cleaner prior to instituting a preservation program. Do not put preservative in a dirty compressor.

A. Equipment and Material Required.

(1) Engine Inlet Cover, 2C5505, used to block the airflow through the engine inlet.

(2) Power Spray, "Dobbins" Power Sprayer Cart, No. 14125-G, or equivalent. Used to supply water for washing. This pump type sprayer is a 30 gallon tank unit on wheels with a 3 HP gasoline engine. The adjustable pressure regulator set at 300-400 psi will deliver the required 5.5-6.0 GPM through the number 9 disc (orifice). The 25 foot hose and the 4 foot wand allow insertion of the spray nozzle into the engine inlet. (Fimco, Inc. 1st and Court Streets, Sioux City, Iowa, 51101.)

NOTE: The water used for this process will be more effective if it is hot (140°-160°F) and demineralized (softened) to prevent mineral deposits on the blades and vanes. However, ordinary tap water may be used for water washing.

(3) Corrosive Preventative and Cleaning Compound Applicator, 2C5503. An ordinary lawn and garden pump type sprayer modified with a 4 foot wand to allow insertion of the spray nozzle into the engine inlet.

(4) Mixer. Used to externally mix cleaner and water at the desired proportion so that only water need be put into the power sprayer cart. Mixer may be obtained from B & B Chemical Co., Miami, Florida.

(5) The following, or other GE approved preservatives can be used to preserve the compressor.

Name	Manufacturer
WD-40	WD-40 Co. 5390 Napa Street San Diego, Calif. 92110
Diversey MP71	Diversey Chemical Co. 212 West Monroe Street Chicago, Illinois 60606
Rust-Lick No. 606	Rust-Lick Inc. 92 Taylor Street Danbury, Conn. 06810

(6) All engines can be cleaned using plain water; however, the following cleaning solutions, or other solutions, can be used to clean compressors that are not protected by diffusion coatings:

Name	Manufacturer	Solution
B & B 3100 Gas Path Cleaner	B & B Chemical Co. General Offices and Main Plant Miami, Florida 33166	4 parts water to 1 part B & B 3100 Gas Path Cleaner
Harco 141	Harley Chemical Co. 17th and Federal Streets Camden, New Jersey 08105	Mix per manufacturer's recommendation.
Rust-Lick No. 606	Rust-Lick, Inc. 92 Taylor Street Danbury, Conn. 06810	Use full strength: allow to soak 6 to 8 hour period followed by water wash.
Ardrox 9PR4L	Ardrox Limited Commerce Road Brentford, England	Mix per manufacturer's instructions.

(7) The following preservative can be used to preserve compressor parts that are not protected by diffusion coatings:

Name	Manufacturer
WD-40	WD-40 Co. 5390 Napa Street San Diego, Calif. 92110
Diversey MP71	Diversey Chemical Co. 212 West Monroe Street Chicago, Illinois 60606
Rust-Lick No. 606	Rust-Lick, Inc. 92 Taylor Street Danbury, Conn. 06810

B. Preparation of Aircraft for Cleaning:

WARNING: TRICHLOROETHANE, O-T-620

DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON VERY HOT SURFACES. DO NOT SMOKE WHEN USING IT. HEAT AND FLAMES CAN CAUSE THE FORMATION OF PHOSGENE GAS WHICH IS INJURIOUS TO THE LUNGS.

REPEATED OR PROLONGED CONTACT WITH LIQUID OR INHALATION OF VAPOR CAN CAUSE SKIN AND EYE IRRITATION, DERMATITIS, NARCOTIC EFFECTS, AND HEART DAMAGE.

AFTER PROLONGED SKIN CONTACT, WASH CONTACTED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. IF VAPORS CAUSE IRRITATION, GO TO FRESH AIR. GET MEDICAL ATTENTION FOR OVEREXPOSURE OF SKIN AND EYES.

WHEN HANDLING LIQUID IN VAPOR-DEGREASING TANK WITH HINGED COVER AND AIR EXHAUST, OR AT AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GLOVES AND GOGGLES.

WHEN HANDLING LIQUID AT OPEN, UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

DISPOSE OF LIQUID-SOAKED RAGS IN APPROVED METAL CONTAINER.

(1) Wipe all dirt deposits from the engine inlet, IGV's, front frame and both sides of the stage 1 compressor blades using a suitable solvent, such as trichloroethane.

(2) Check to be sure the cabin air conditioning and anti-icing air valves are in the OFF position.

(3) Face the aircraft into the wind to carry the exhaust discharge away from the aircraft.

(4) Allow the engine to cool until EGT is less than 100°C before applying the cleaning agent.

NOTE: High "soak back" temperatures after shutdown will cause cleaners and contaminants to bake onto the blades, resulting in a loss of performance and stall margin.

(5) Install the engine inlet cover 2C5505 wedged into the engine inlet against the front frame struts with the application holes located between struts near 12 o'clock. Install cover with the attached red flag dangling outside the aircraft inlet duct.

(6) If engine has not complied with Service Bulletin (CJ610) 73-38 or 73-41 disconnect the P3 (CDP) line at the fuel control and plug the line.

(7) If engine is used on aircraft equipped with thrust reversers: in order to prevent damage to thrust reverser solenoids resulting from soap residue or water mixture, proceed as follows:

(a) Locate 1-1/4 inch diameter line that leads from engine bleed airpad to union. (Union is located at 9 o'clock position on right hand engines, and at 3 o'clock position on left hand engines.)

(b) Disconnect the 3/4 inch diameter line at the union that leads from the union to the thrust reverser pneumatic actuator assembly. Cap the line that leads from engine bleed air pad.

C. Cleaning and water-washing shall be accomplished as follows:

- Every 60 days or 100 hours, whichever occurs first.
- Every 30 days or 50 hours, whichever occurs first, when operated in or near salt-laden air or high-humidity conditions.

CAUTION: 1. DO NOT TURN IGNITION ON DURING THIS PROCEDURE.

2. OILS IN CLEANING AND PRESERVATIVE SOLUTIONS WILL CAUSE INTERMETALLIC DIFFUSION COATING TO DETERIORATE.

(1) Mix the approved cleaners per the manufacturer's recommendations and put in power sprayer cart 14125-G, or equivalent.

NOTE: If a mixer is used, only water need be put into the power sprayer cart.

(2) Assemble equipment and adjust nozzle of power sprayer cart 14125-G, or equivalent, to provide a delivery of 2.5 gallons of solution at the rate of 5.5 - 6.0 GPM. Determine proper flow by first spraying into a container for 30 seconds.

NOTE: 1. Use of a ground power unit (GPU) during motoring cycles will eliminate discharge of aircraft battery. Ensure that GPU volt age is set 0.5 to 1.0 volt below aircraft system voltage.

2. Refer to aircraft manuals for starter duty limitations for water-washing.

(3) Motor the engine to maximum starter speed (about 10 to 13 percent gas generator speed).

CAUTION: 1. BEFORE STARTING TO SPRAY WATER, ALLOW ENGINE TO REACH MAXIMUM MOTORING SPEED. THIS WILL BUILD UP PRESSURE IN THE COMPRESSOR DISCHARGE AIR BLEED TUBES TO PREVENT SPRAY FROM ENTERING THE TUBES.

2. A SOLID STREAM OF WATER WILL DAMAGE THE ROTATING COMPRESSOR BLADES. A FINE SPRAY MUST BE USED.

(4) With the engine rotating, spray approximately 2.5 gallons of the mixed solution, at the rate of 5.5-6.0 GPM, or 4 ounces of Rust-Lick No. 606, at full strength, through the opening of inlet cover 2C5505. On completion of spraying, discontinue motoring and allow to coast down to static conditions.

(5) Maintain the engine in a static condition for a period of 10 to 15 minutes for the mixed solution or several hours (overnight) for Rust-Lick 606 to permit the cleaner to soften contamination deposits. Install aircraft exhaust cover during period of inactivity.

NOTE: Do not start engine(s) until after washing compressor with fresh water. If this is not done, the deposits are likely to be baked onto the blade airfoils, and result in loss of stall margin or performance.

(6) Remove exhaust cover.

(7) Motor the engine to maximum starter speed (about 10 to 13 percent gas generator speed).

(8) With the engine rotating, spray approximately 2.5 gallons of water, at the rate of 5.5-6.0 GPM through the opening of inlet cover 2C5505. On completion of spraying, discontinue motoring and allow engine to coast down to static conditions.

D. Dry-out Cycle Procedure. Immediately after water washing, dry out engine as follows:

(1) If used, remove plug from P3 (CDP) line at fuel control. Blow through P3 line to force trapped fluids back into engine. Connect and tighten P3 line onto fuel control.

(2) Remove inlet cover 2C5505.

CAUTION: ENGINE WILL BE DAMAGED IF THE INLET COVER IS NOT REMOVED.

(3) Start engine and stabilize at idle speed.

(4) Turn ON aircraft anti-icing and cabin air conditioning valves to purge these lines of fluids that may have collected.

NOTE: Refer to aircraft manuals for anti-icing and cabin air conditioning ground operation limitations.

(5) Operate for 5 minutes, then turn OFF aircraft anti-icing and cabin air conditioning valves and shut-down engine.

(6) On engines used on aircraft with thrust reversers, remove cap from line that leads from engine bleed air pad and connect the thrust reverser pneumatic actuator assembly line removed in paragraph 2.B.(7).

E. Preserve engines having compressor parts that are not protected by diffusion coatings as follows (Weekly):

(1) Allow engine to cool so that EGT is below 100°C.

NOTE: Engine cooling period is required to permit the liquid preservative to deposit on the compressor rear stages. These stages are hot enough at engine shutdown to vaporize the liquid preservative compound, which will bake onto the blades, resulting in a loss of performance and stall margin.

(2) Install engine inlet cover 2C5505 wedged into the engine inlet against the front frame struts with the application hole between struts near 12 o'clock. Install the cover with the attached red flag left dangling outside the aircraft inlet duct.

(3) Use applicator 2C5503 to spray approximately 4 ounces of the preservative into the inlet cover application hole during coastdown from maximum motoring speed. Refer to paragraph 2.A.(6).

CAUTION: DO NOT TURN IGNITION ON DURING THIS PROCESS.

(4) Remove inlet cover 2C5505.

(5) Install aircraft inlet and exhaust covers during periods of inactivity.

F. Inspection of the cloth filters (coalescer bags) in the cabin air conditioning system may be required with repeated application of the preservative compound. Although liquid preservative compounds are non-toxic, the accumulation of preservative in the filters may cause a disagreeable odor in the cockpit until the excess material is dissipated.

3. Removal of Salt Deposits - Washing and Preserving. Engines operated over or near *(within 150 miles from sea coast) large bodies of salt water*, or in warm humid climates are particularly susceptible to corrosive attack. This procedure is recommended for those aircraft encountering the above types of atmosphere either in operation or storage. The following procedure is recommended every 30 days or 50 flying hours, with applications of the preservative compound once a week.

   A. Equipment and Material Required.

      (1) Same as paragraph 2.A. except the mixer will not be required since only water is used for this wash procedure.

   B. Preparation of Aircraft for Cleaning.

      (1) Prepare aircraft and engine according to instructions in paragraph 2.B.

   C. Cleaning and water-washing shall be accomplished as follows:

      . Every 60 days or 100 hours, whichever occurs first.
      . Every 30 days or 50 hours, whichever occurs first, when operated in or near salt-laden air or high-humidity conditions.

      (1) Assemble equipment and adjust nozzle of power sprayer cart 14125-G, or equivalent, to provide a delivery of 2.5 gallons of water at the rate of 5.5-6.0 GPM.

         CAUTION: DO NOT ENERGIZE IGNITION DURING THIS PROCEDURE.

         NOTE: 1. Use of a ground power unit (GPU) during motoring cycles will eliminate discharge of aircraft battery. Ensure that GPU voltage is set 0.5 to 1.0 volt below aircraft system voltage.

         2. Refer to aircraft manuals for starter duty limitations for water-washing.

      (2) Motor the engine to maximum starter speed (about 10 to 13 percent gas generator speed).

         CAUTION: 1. BEFORE STARTING TO SPRAY WATER, ALLOW ENGINE TO REACH MAXIMUM MOTORING SPEED. THIS WILL BUILD UP PRESSURE IN THE COMPRESSOR DISCHARGE AIR BLEED TUBES TO PREVENT SPRAY FROM ENTERING THE TUBES.

         2. A SOLID STREAM OF WATER WILL DAMAGE THE ROTATING COMPRESSOR BLADES. A FINE SPRAY MUST BE USED.

(3) With the engine rotating, spray approximately 2.5 gallons of water, at the rate of 5.5-6.0 GPM through the opening of inlet cover 2C5505. On completion of spraying, discontinue motoring and allow engine to coast down to static conditions.

D. Dry-out Cycle Procedure.

(1) Immediately after water washing, dry out engine according to instructions in paragraph 2.D.

E. Apply Preservative (weekly) to applicable engines according to instructions in paragraph 2.E.

F. Inspection of the cloth filters (coalescer bags) in the cabin air conditioning system may be required with repeated applications of the preservative compound. Although liquid preservative compounds are non-toxic, the accumulation of preservative in the filters may cause a disagreeable odor in the cockpit until the excess material is dissipated.

4. Abrasive Cleaning-Compressor Section (Shellblast). This procedure is recommended in instances where a considerable loss of stall margin or engine performance is experienced and the condition is suspected to be the result of compressor contamination or corrosion. This procedure is most useful in removing hard or baked-on deposits from compressor airfoils which cannot be removed by the recommended liquid cleaning compounds. Such deposits may result from washing the compressor with cold hard water or from repeated compressor preservation without the benefit of the compressor water washing cycle, or preservation of a hot engine. This type of compressor contamination generally occurs in the latter stages of the compressor where higher operating temperatures promote rapid evaporation of preservative and baking of contaminant residues. Compressor internal inspection through the stage 5 bleed valve ports, is helpful in detecting hard, baked on airfoil deposits.

CAUTION: DO NOT SHELLBLAST ENGINES HAVING COMPRESSOR PARTS THAT ARE INTERMETALLIC DIFFUSION COATED. ABRASIVE CLEANING (SHELLBLAST) WILL DAMAGE THE COATING.

A. Equipment and Material Required.

(1) Shop air supply (50-120 psig with a 8 CFM continuous duty).

(2) Air pressure regulator capable of 25 psig setting at outlet when connected to shop air supply.

(3) Walnut shell shellblast, size AD-9B, mesh 40/100, (Manufactured by Agra Shell Inc., 4500 East 26th Street, Los Angeles, California) or equivalent.

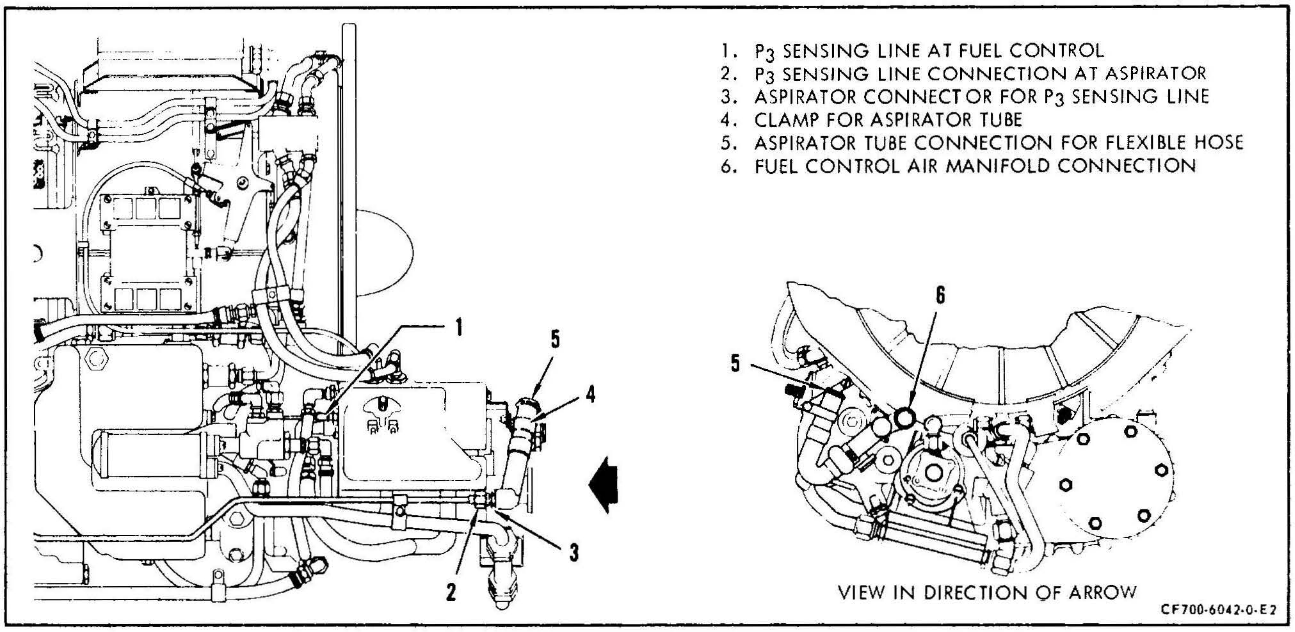
NOTE: Do not use mesh size other than that recommended.

(4) Kit-Shellblast-Engine Compressor Cleaning, 2C5373G1.

B. Preparation for Cleaning.

(1) Orient the aircraft into the wind to carry away the shellblast material from the aircraft. In addition, protect or remove the EPR probes to prevent the probe holes from becoming plugged by shellblast.

(2) Disconnect the P3 sensing line at fuel control (1, figure 701). Install plug assembly, 2C5373P6, in sensing line.



Dynamic Compressor Cleaning Cap Off Point - Fuel Control
Figure 701

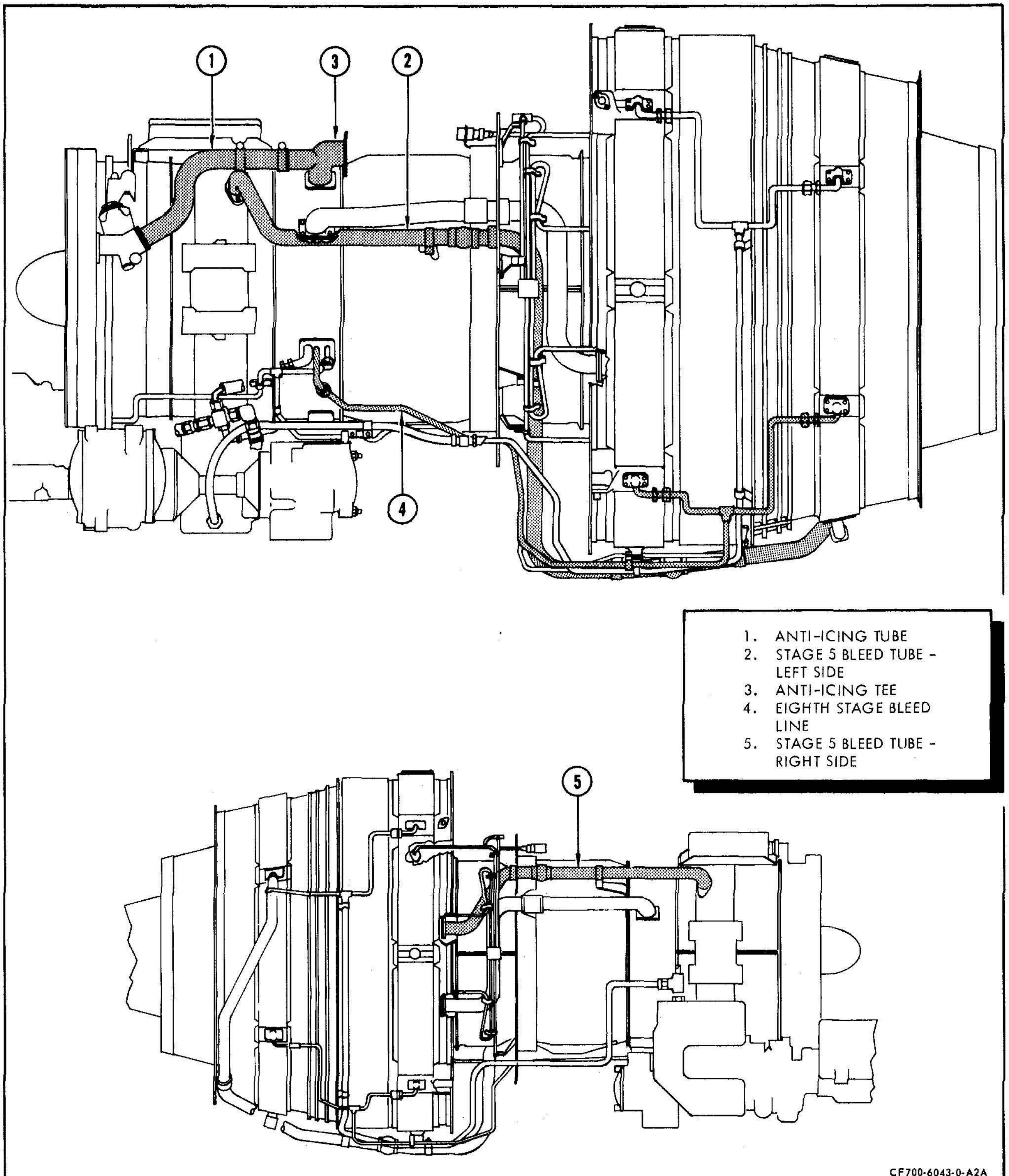
(3) Disconnect P3 line at aspirator (2, figure 701). Connect aspirator P3 line (2, figure 701) to filter inlet, 2C5373P5. Connect filter discharge hose to P3 fitting on fuel control (1, figure 701). Install cap assembly, 2C5373P7, on fitting (3, figure 701).

(4) Loosen clamp (not shown, but located above 4, figure 701) hose to aspirator tube (5, figure 701). Cap off tube using the 2C5373P8 rubber cap assembly.

(5) Loosen clamp (not shown) securing flexible hose to fuel control air manifold (6, figure 701). Cap off inlet to manifold using a second rubber cap assembly, 2C5373P8.

(6) Remove the anti-ice tube (1, figure 702), disconnect at tee on mainframe and the anti-ice valve on the front frame. Slip on and clamp a suitable length of rubber hose (1-1/8" ID) or equivalent, to the tee (3, figure 702) to discharge blast material overboard. Install blank-off plate, 2C5373P9, on the anti-ice valve.

(7) Remove two bolts that retain the stage 5 bleed air tube assembly, (5, figure 702) on the right side of the engine to the compressor case and discard the gasket. Install cover plate, 2C5373P13, on compressor casing pad and re-install bolts.



Dynamic Compressor Cleaning Cap Off Points - Anti-Ice and No's. 4 & 5 Sumps
Figure 702

(8) Repeat step (7) for the stage 5 bleed tube on the left side of the engine (2, figure 702).

(9) Disconnect the air tube assembly (4, figure 702) (eighth stage air to carbon seals in Nos. 4 and 5 sumps) at the mainframe fitting and install cap assembly, 2C5373P7, on the fitting.

(10) De-couple Wiggin couplings on airframe air tubes for wing de-icing and cabin pressurization in the engine to fuselage pylon area and slip on and clamp suitable lengths of hose (1-1/4 inch ID) or equivalent to engine end of tubes to discharge blast material below the engine. Refer to airframe manual for location of connections.

(11) De-couple the Wiggin coupling aft of the control valve on the cowl de-ice air tube, located on left side of engine. Install cap, 2C5373P14, on the engine end of the air tube and clamp in position using a 1-1/4 inch clamp, 2C5373P22. Position cap to discharge blast material away from engine and cowl de-icing air inlet. Refer to airframe manual for location of connection.

(12) De-couple the Wiggin coupling on the fuel heater air tube in the area of the overboard drain unit (mast) and slip on and clamp a suitable length of hose (5/8 inch ID) or equivalent, to engine end of tube to discharge blast material below the engine. Refer to airframe manual for location of connection.

(13) Connect the hose assembly, 2C5373P12 (less blow gun 2C5373P12-1) to quick-disconnect on blast gun, 2C5373P11.

(14) Remove the blast gun cannister and fill with 8 pounds of shellblast (AD-9B). Reassemble cannister to blast gun.

NOTE: Make sure cannister is clean prior to filling.

C. Cleaning Procedure.

(1) Adjust the air pressure to give a flow rate of shellblast of approximately 1/2 pound per minute. (Approximately 25-30 psig to blast gun.)

(2) Install the six foot tube extension (2 pieces), 2C5373P18 and P26 on the blast gun and clamp in place. Use clamps, 2C5373P19 and P20.

(3) Start engine and set engine speed at IDLE.

(4) Direct shellblast into engine inlet, with engine running at IDLE speed, at a flow rate of 1/2 pound per minute. Direct discharge around entire engine inlet to obtain complete coverage until 8 pounds of blast material is discharged into engine.

(5) Continue running engine at IDLE for five minutes after blasting is complete to purge the air lines and shut down engine.

WARNING: TRICHLOROETHANE, O-T-620

DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON VERY HOT SURFACES. DO NOT SMOKE WHEN USING IT. HEAT AND FLAMES CAN CAUSE THE FORMATION OF PHOSGENE GAS WHICH IS INJURIOUS TO THE LUNGS.

REPEATED OR PROLONGED CONTACT WITH LIQUID OR INHALATION OF VAPOR CAN CAUSE SKIN AND EYE IRRITATION, DERMATITIS, NARCOTIC EFFECTS, AND HEART DAMAGE.

AFTER PROLONGED SKIN CONTACT, WASH CONTACTED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. IF VAPORS CAUSE IRRITATION, GO TO FRESH AIR. GET MEDICAL ATTENTION FOR OVEREXPOSURE OF SKIN AND EYES.

WHEN HANDLING LIQUID IN VAPOR-DEGREASING TANK WITH HINGED COVER AND AIR EXHAUST, OR AT AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GLOVES AND GOGGLES.

WHEN HANDLING LIQUID AT OPEN, UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

DISPOSE OF LIQUID-SOAKED RAGS IN APPROVED METAL CONTAINER.

(6) Clean the accessible areas in the compressor inlet by hand using a clean cloth and suitable solvent, such as trichloroethane or equivalent. (Areas to be cleaned are the inlet duct, bullet nose, front frame struts and ID, IGV's and both sides of the first stage blades.)

D. Restore engine to operating condition.

(1) Remove cleaning hardware with exception of aspirator caps, 2C5373P8.

(2) Remove blast gun from air supply and install blow gun, 2C5373P12-1, and use blow gun to reverse purge the eighth stage air supply line to carbon seals in No's. 4 and 5 sumps. Reconnect line (4, figure 702).

(3) Reverse purge the P3 lines (1 and 2, figure 701) to the fuel control and aspirator and reconnect. Blow off aspirator adapter to front frame and any area where shells may have accumulated.

(4) Remove aspirator caps, 2C5373P8, and restore engine to normal operating configuration.

MAINTENANCE PRACTICES - SPECIAL TOOLS

1. General. The special tools numerically listed below are the recommended tools for engine maintenance. The Recommended Tool No. column lists the recommended or preferred tool part number; the Alt Tool No. column lists, but not in numerical order, an alternate tool part number which may be substituted, if necessary, for the recommended tool; the Nomenclature column lists the identifying name of the tool; and the Topic/Sect./Para. No. column lists the area of the text where the tool is referenced.

   A. Tool List.

Recommended Tool No.	Alt Tool No.	Nomenclature	Text Ref. Topic/Sect./Para. No.
2C5300	21C506	Pusher, Hydraulic - Turbine Rotor Assembly	Removal-Install./ 72/50/2
2C5301G02	None	Tab Bender - Stage 2, Turbine Rotor	Repair/72-53-0/4
2C5302G02	None	Tab Bender - Stage 1, Turbine Rotor	Repair/72-53-0/4
2C5303	21C518	Stand - Turbine Rotor Assembly	Removal-Install./ 72-50/2 Repair/72-53-0/4
2C5304	21C531	Wrench, Spanner - No. 3 Bearing Locknut	Repair/72-53-0/4
2C5305	21C532	Puller, Hydraulic - Turbine Rotor Assembly	Removal-Install./ 72-50-2
2C5306	21C533	Puller, No. 3 Bearing Inner Race & Seal Runner	Repair/72-53-0/4
2C5308	21C565	Gage, Runout - No. 3 Bearing Area	Removal-Install./ 72-40/5
2C5309	21C641	Pusher - No. 3 Bearing Outer Race	Removal-Install./ 72-40/5
2C5310	21C665	Pusher - No. 1 Bearing Inner Race & Seal Runner	Removal-Install./ 72-30/3
2C5311	21C666	Puller - No. 1 Bearing Inner Race & Seal Runner	Removal-Install./ 72-30/3
2C5312	21C669	Pusher - No. 1 Bearing Outer Race	Removal-Install./ 72-30/3
2C5313	21C2663	Puller - No. 1 Bearing Outer Race	Removal-Install./ 72-30/3
2C5315	21C822	Wrench, Combination - Special, Accessory Gearbox	Removal-Install./ 72-64-0/2

A. Tool List. (Cont)

Recommended Tool No.	Alt Tool No.	Nomenclature	Text Ref. Topic/Sect./Para. No.
2C5316	21C823	Wrench, Half-Moon - Special, Accessory Gearbox	Removal-Install./ 72-64-0/2
2C5317	21C862	Wrench, Spanner & Torque - Turbine Rotor Locknut	Removal-Install./ 72-50/2
2C5318	21C863	Gage, Depth - Igniter Plug	Removal-Install./ 80-23-0/1
2C5319	21C866	Pliers, Seating - Pin Retainer, 1st Stage Compressor Blade	Removal-Install./ 72-30/6
2C5320	21C868	Pin, Rigging - Fuel Control	Adj.-Test/72-00/3
2C5321	21C2615	Wrench, Spanner, Runup - Turbine Rotor Locknut	Removal-Install./ 72-50/2
2C5322	21C2640	Wrench, Socket, Extension Anti-Icing Valve, Air Leakage Duct & Fuel Nozzle	Removal-Install./ 73-18-0/2 Removal-Install./ 75-11-0/2
2C5323	21C2900	Fixture, Alignment - Gearbox Brackets	Removal-Install./ 72-30/7
2C5324	None	Gage, Alignment - Accessory & Transfer Gearbox Splined Shafts	Install. 72-64-0/2
2C5325	None	Pliers, Special - Gearbox Snap Ring	Removal-Install./ 72-63-0/2
2C5326	None	Guide, Pilot - Front Frame	Removal-Install./ 72-30/2 & 3
2C5327	21C2997	Sling, Universal - Aircraft Maintenance	Servicing/72-00/7&9 Disassy-Assy/72-70/3
2C5328	21C2967	Adapter, Lifting - Fan Assembly	Disassy-Assy/72-70/3
2C5331	21C3029	Tool Kit - Replacement, Lube Pump Shaft Seal	Repair/79-21-0/4
2C5332	21C2951	Stand - Aft Fan	Removal-Install./ 72-70/2 Disassy-Assy/72-70/2
2C5333	21C2901	Kit, Puller - Accessory & Transfer Gearbox Seal Housing	Repair/72-62-0/4 Repair/72-64-0/4
2C5334	21C2619	Kit, Replacement - Carbon Seal, Accessory & Transfer Gearbox	Repair/72-62-0/4 Repair/72-64-0/4
2C5335	21C2636	Inserter - Mating Ring & Packing Accessory & Transfer Gearbox	Repair/72-62-0/4 Repair/72-64-0/5
2C5336	21C631	Kit, Guide - Mating Ring & Packing Installation, Accessory & Transfer Gearbox	Repair/72-64-0/4
2C5337	None	Kit - Hydraulic Actuating	Removal-Install./ 72-50/2

A. Tool List. (Cont)

Recommended Tool No.	Alt Tool No.	Nomenclature	Text Ref. Topic/Sect./Para. No.
2C5344	21C2987	Bracket, Lifting & Indexing - Fan Assembly	Removal-Install./ 72-70/2 Disassy-Assy/72-70/3
2C5345	None	Lift Sling - Aft Fan Assembly	Removal-Install./ 72-70/2
2C5346	None	Stand, Storage - Aft Fan Assembly	Removal-Install./ 72-70/2
2C5347	None	Stand, CF700 Maintenance - Horizontal	Servicing/72-00/1 Removal-Install./ 72-00/1
2C5351	None	Puller - Oil Seal, No. 4 & No. 5 Bearing	Disassy-Assy/ 72-71-0/2 Disassy-Assy/ 72-73-0/2
2C5356	21C630	Gage, Alignment - IGV Actuator Ring	Adj.-Test/75-00/2
2C5358	21C2960	Puller, Gear - No. 4 & No. 5 Scavenge Pump	Removal-Install./ 79-24-0/2
2C5359	None	Wrench, Spanner - No. 1 Bearing Locknut	Removal-Install./ 72-30/2 & 3
2C5360	None	Adapter, Locking - Gearbox Axis "B" Aft	Removal-Install./ 72-30/2 & 3
2C5371	21C661 & 21C2664	Tool Set - Removal & Installation of Stator Segments	Removal-Install./ 72-30/10
2C5373G1	21C3041	Kit, Shellblast - Engine Compressor Cleaning	Clean.-Pres./72-00/4
2C5374	21C3097	Clamp, Alignment - Inlet Guide Vane	Adj.-Test/75-00/2
2C5377	None	Holding Fixture, Tip Grinding - Turbine Blades (CF700-2D, -2D2)	Repair/72-53-0/4
2C5379	None	Puller Set - Fan Rotor Bearings & Seal Runners	Disassy-Assy/72-70/3
2C5388	21C863	Gage, Immersion Depth - Ignitor Plug	Removal-Install./ 80-23-0/1
2C5425	None	Indicator, Position - Actuator, Bleed Valve	Adj.-Test/72-00/3
2C5436	None	Kit, Installation & Removal - Aft Seal, Lube & Scavenge Pump	Repair/79-21-0/4
2C5442	None	Applicator, Grease - Stator Case Tracks	Removal-Install./ 72-30/10
2C5450	21C3067	Spreader - Louvers, Swirl Cup, Combustion Liner	Repair/72-42-0/4

A. Tool List. (Cont)

Referenced Tool No.	Alt Tool No.	Nomenclature	Text Ref. Topic/Sect./Para. No.
2C5451	21C3077	Closing Tool - Louvers, Swirl Cup, Combustion Liner	Repair/72-42-0/4
2C5452	21C3068	Gage, Go-No-Go - Louvers, Swirl Cup, Combustion Liner	Repair/72-42-0/4
2C5453	21C2681	Kit, Maintenance - Louvers, Combustion Liners	Repair/72-42-0/4
2C5458	21C2955	Pusher - No. 4 Bearing Inner Race (Fwd. Half)	Disassy-Assy/72-70/3
2C5462	21C2961	Wrench, Spanner - Gear Locknut No. 4 & 5 Bearing	Disassy-Assy/72-70/3
2C5464	21C2964	Fixture, Assembly - Frames To Rotor, Fan Assembly	Disassy-Assy/72-70/3
2C5465	21C2978	Stand, Bench - Fan Rotor Assembly	Disassy-Assy/72-70/3
2C5466	21C2981	Arbors, Guide - Front & Rear	Disassy-Assy/72-70/3 Housings, Fan Assembly
2C5468	21C2986	Sling, Lifting - Fan Frames	Disassy-Assy/72-70/3
2C5469	21C2993	Eye, Lifting - Fan Rotor Assembly, Vertical	Disassy-Assy/72-70/3
2C5482	21C3065	Spreader - Louvers, Dome, Combustion Liner	Repair/72-42-0/4
2C5483	21C3066	Gage, Go-No-Go - Louvers, Dome, Combustion Liner	Repair/72-42-0/4
2C5484	None	Puller - Mating Ring, Main Lube Pump	Repair/79-21-0/4
2C5501	21C2639 or equivalent	Gage, Plug, Alignment - Bleed Air Ports	Removal-Install/ 72-30/5
2C5503	None	Applicator, Preservative - Engine	Clean.-Pres./72-00/ 2 & 3
2C5505	None	Plug, Engine - Inlet Duct	Clean.-Pres./72-00/ 2 & 3
21C6198P01	None	Gage, Thickness - Stage 2 Nozzle	Repair/72-52-0/3A
21C6277	None	Set, Cutter and Bushing	Repair/72-02-1/9

LUBRICANTS, PRESERVATIVES, AND ANTI-SEIZE COMPOUNDS

1. General. The following table contains the lubricants, preservatives, and anti-seize compounds used on various parts of the engine.

Specification Number	Name	Typical Uses
A.1. VV-P-236	Petrolatum.	Hold and lubricate O-rings.
A.2. G.E. Spec. A50TF92	Mobil RT403C.	Hold and lubricate O-rings.
B. G.E. Spec. D50TF1	Engine oil (See 79-00, Servicing, for list of approved oils).	(a) Threads of all fittings (except fuel). (b) All gears and splines in lubrication system. (c) Preservation of engine bearings.
C. Deleted.		
D. MIL-L-6081, grade 1005 or 1010.	Lubricating oil.	(a) Threads of fuel fittings. (b) Preservation of VG actuator, fuel system and compressor 1-30 days.
E. MIL-C-6529 Type III	Corrosion Preventive, Aircraft Engine.	Preservation of compressor 30-120 days.
F. Deleted. (Combined with paragraph 1.B.)		

Specification Number	Name	Typical Uses
G. GE Aircraft Engine Specifications A50TF18.	Plastilube Moly No. 3 (Thiem Automotive Div. 5151 Denison Ave. Cleveland, OH 44102) or Moly Lube 503 Grease (Bel-Ray Co., Inc. P.O. Box 526 Farmingdale, NJ 07727) or approved equivalent.	(a) Fuel pump shaft spline. (b) O/S governor shaft spline. (c) Starter pad spline. (d) Hydraulic pump pad spline. (e) Tachometer pad spline. (f) Customer PTO pad spline.
MIL-G-81322 (alternate).	Mobil Grease 28 (Mobil Oil Corp.) or Royco 22S (Royal Lubricants) or Aeroshell 22 (Shell Oil Co.).	
MIL-L-3545 (alternate).	Aeroshell 5 (Shell Oil Co.).	
H. MIL-L-23398.	Solid film, air drying lubricant.	Bleed valves.
I. MIL-A-907.	Anti-seize compound or Molykote M-77. (Dow Corning Corp. 50 Commerce Drive Trumbull, CT 06601).	Turbine rotor locknut threads.
J. No known specification.	Milk of magnesia (unflavored).	(a) Thermocouple bosses. (b) Igniter plugs.
K. No known specification.	Crane Compound No. 425 (Crane Co., 48 West First St., Boston, Mass.) or approved equivalent.	Pressure probe threads.

Specification Number	Name	Typical Uses
L. No known specification.	G-392 versilube, Graphite Silicone Grease (General Electric Co., Waterford, N.Y.)	(a) Alternate for Ease-Off 990. (b) Mainframe tube assemblies. (c) Mainframe pad bolts.
M. No known specification.	Ease-off 990, (Texacone Co., Box 4236, Dallas, Texas.)	(a) Alternate for G-392 (Versilube. (b) Bolt threads.

LOCKING PROCEDURE

1. General. This section covers lockwiring practices and cotterpin practices which are used many times on many different parts of the engine.

2. Lockwiring Practices. Lockwiring is the securing together of two or more parts with a wire which shall be installed in such a manner that any tendency for a part to loosen will be counteracted by an additional tightening of the wire. It is NOT a means of obtaining or maintaining torque, but rather a safety device used to prevent the disengagement of the lockwired parts. (See figure 1.)

   A. Observe the following general rules for lockwiring unless specific instructions to the contrary are given in the text.

      (1) The method of installing lockwire shall consist of two strands of wire twisted together (so called double-twist method), where one twist is defined as being produced by twisting the wires through an arc of 180 degrees and is equivalent to half a complete turn. Use the single strand method (3) only when specified as follows:

         (a) Mainframe customer bleed ports.

         (b) Anti-ice valve - forward and aft end.

         (c) Stage 8 leakage valve and elbow duct.

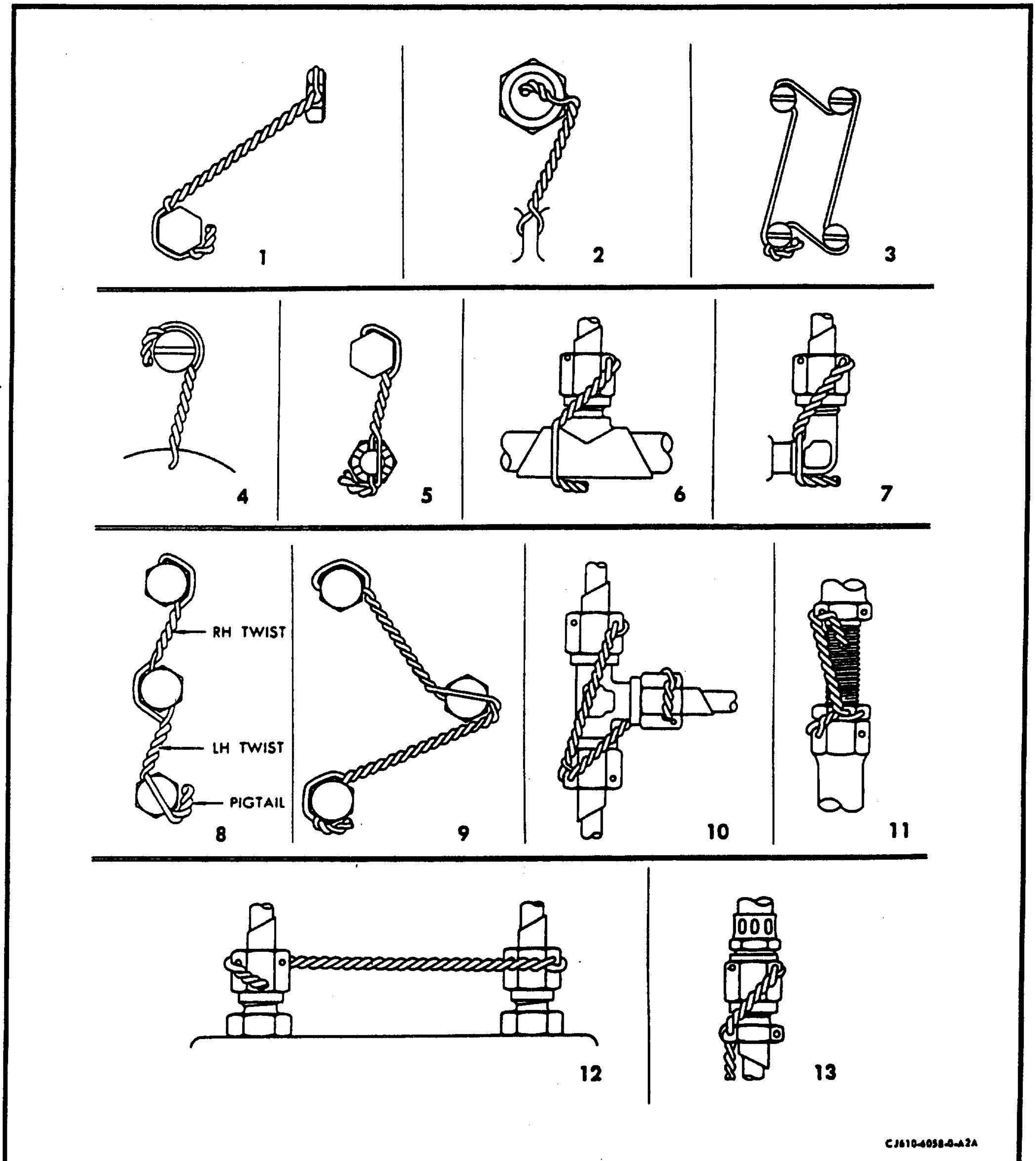
         (d) Outer combustion case viewport covers.

         (e) Aft fan assembly, forward and aft shield - P/N 3003T22/3005T19.

      (2) Lockwire shall not be installed in such a manner as to cause the wire to be subjected to chafing, fatigue through vibration, or additional tension other than the tension imposed on the wire to prevent loosening.

      (3) In all cases wiring must be done through the holes provided. In the event that no wire hole is provided, wiring shall be to a neighboring part (6, 7) in a manner so as not to interfere with the function of the parts, and in accordance with the basic principles described herein.

      (4) The maximum span of lockwire between tension points shall be six inches unless otherwise specified. Where multiple groups are lock-wired by either the double-twist or the single strand method, the maximum number in a series shall be determined by the number of units that can be lockwired by a twenty-four inch length of wire. When lockwiring widely spaced multiple groups using the double-twist method, three units shall be the maximum number in a series (8, 9).



Lockwiring Practices
Figure 1

(5) Both 0.020 inch and 0.032 inch lockwire are used throughout the engine. The application is determined by the size hole in the unit to be lockwired. Generally, whenever possible, use the 0.032 inch size lockwire.

NOTE: Only new lockwire shall be used upon each application.

(6) The lockwire shall be pulled taut while being twisted, and shall have approximately 9-12 twists per inch for 0.020 inch wire and 7-10 twists per inch for 0.032 inch wire.

(7) Hose and electrical coupling nuts shall be lockwired in the same manner as the tube coupling nuts (6, 7, 10, 11, 12, 13).

(8) Caution must be exercised during the twisting operation to keep the wire tight without overstressing, or allowing it to become nicked, kinked or otherwise mutilated.

B. The following lockwiring procedures are to be used throughout the engine during assembly.

(1) Check the lockwire holes of the parts to be lockwired for proper alignment. If a part has been properly torqued but is improperly aligned, replace it with another part.

NOTE: Proper alignment means that the lockwire holes are aligned in such a way that the installed lockwire will prevent loosening of the lockwired part.

Do NOT attempt to either over-torque or under-torque a part to align the lockwire hole.

(2) Insert the lockwire through the first part and bend the upper end either over the head of the part or around it. If bent around it, the direction of wrap and twist of the strands shall be such that the loop around the part comes under the strand protruding from the hole. Done this way, the loop will stay down and will not tend to slip up and leave a slack loop (8, 9).

(3) Twist the strands while taut until the twisted part is just short of a hole in the next part. The twisted portion should be within one-eighth inch of the hole in either part.

(4) If the free strand is to be bent around the head of the second part, insert the uppermost strand through the hole in this part, then repeat step "B, (2)". If the free strand is to be bent over the unit, the directions of twist is unimportant. If there are more than two units in the series, repeat the preceding steps.

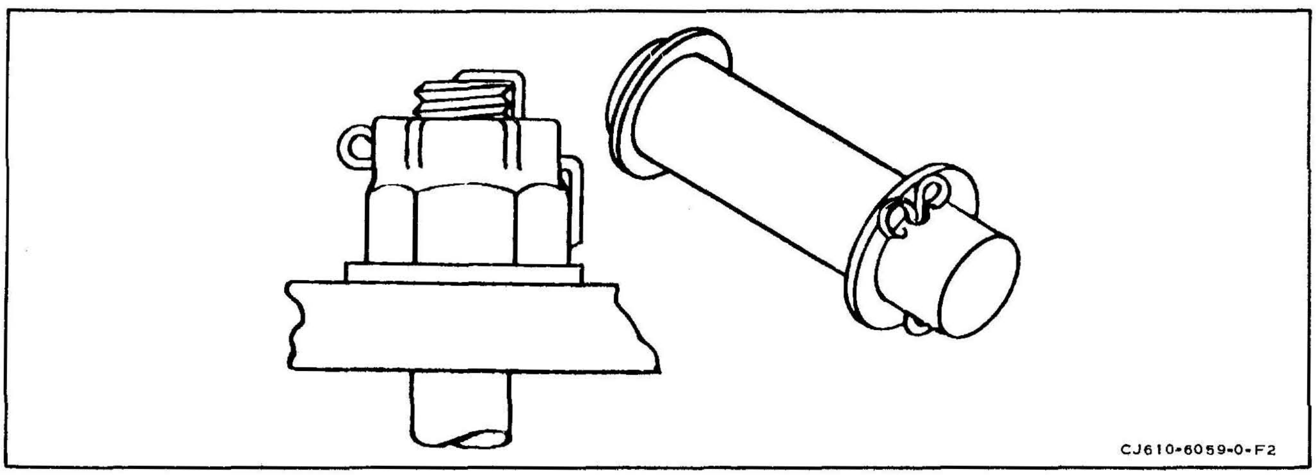
(5) After wiring the last part, continue twisting the wires to form a pigtail of 3 to 6 twists (one-quarter to one-half inch long) and cut off the excess wire. Bend the pigtail in toward the part in such a manner as to prevent it from becoming a snag.

NOTE: Although every possible combination of lockwiring is not shown in the illustration, all lockwiring must generally correspond to the examples shown.

C. If, after lockwiring per the preceding instructions, the lockwire is not taut, use the following limits to determine its acceptability.

NOTE: Use light finger pressure, applied to the mid point of the lockwire span, and flex in both directions.

Length of lockwire between parts (inches)	Total flexing at center (inches)
1/2	1/8
1	1/4
2	3/8
3	1/2
4	3/4
5	3/4
6	3/4



Cotterpin Practices
Figure 2

3. Cotterpin Practices. (Refer to figure 2 for installation of cotterpins.)

NOTE: Cotterpins are not to be bent into position more than once.

TORQUE VALUES - TIGHTENING PRACTICES

1. Torque Tightening Practices.

A. General. Torque is expressed as lb-in. (pound-inches) or lb-ft. (pound-feet). One pound-inch (or one pound-foot) is the twisting stress of one pound applied to a twist-type fastener (such as a bolt or nut) with one inch (or one foot) of leverage. This twisting stress is applied to the fastener to secure the components. Unless otherwise specified, all torque values prescribed within this manual shall be obtained with lubricated threads.

B. Torque Tightening Procedures.

(1) Tighten at a uniformly increasing rate until the desired torque is obtained. In some cases, where gaskets or other parts cause a slow permanent set, be sure to hold the torque at the desired value until the material is seated.

(2) Apply a uniform, average torque to a series of bolts of varying cross-sectional area on one flange or in one area. This prevents the tighter bolts from shearing or snapping loose because of force concentrations.

(3) It is not desirable to tighten to the final torque value during the first drawdown; uneven tension can cause distortion or overstressing of parts. Seat and torque mating parts by drawing down the bolts or nuts gradually until the parts are firmly seated, then loosen each one separately and apply final tightening. Tightening in a diametrically opposite (staggered) sequence is desirable in most cases. Do not exceed listed maximum torque values.

CAUTION: WHEN CHILLING OR HEATING ENGINE PARTS DURING ASSEMBLY, DO NOT TORQUE LOCKNUTS OR RETAINING BOLTS UNTIL THE PART RETURNS TO ROOM TEMPERATURE. IF THE PART HAS BEEN HEATED, THE FASTENER MAY LOOSEN AS THE PART COOLS. IF THE PART HAS BEEN CHILLED, THE FASTENER MAY BE OVERSTRESSED AS THE PART EXPANDS.

C. Suggested Torque Wrench Sizes. The torque wrenches listed below are recommended for use within the indicated ranges. Larger wrenches have too great a tolerance, and use of these wrenches can result in inaccuracies.

Torque Between	Torque Wrench	Tolerance
0-25 lb-in.	30 lb-in.	±1 lb-in.
25-140 lb-in.	150 lb-in.	±5 lb-in.
140-550 lb-in.	600 lb-in.	±20 lb-in.
30-140 lb-ft.	150 lb-ft.	±5 lb-ft.
140-240 lb-ft.	250 lb-ft.	±10 lb-ft.
240-1000 lb-ft.	1000 lb-ft.	±20 lb-ft.

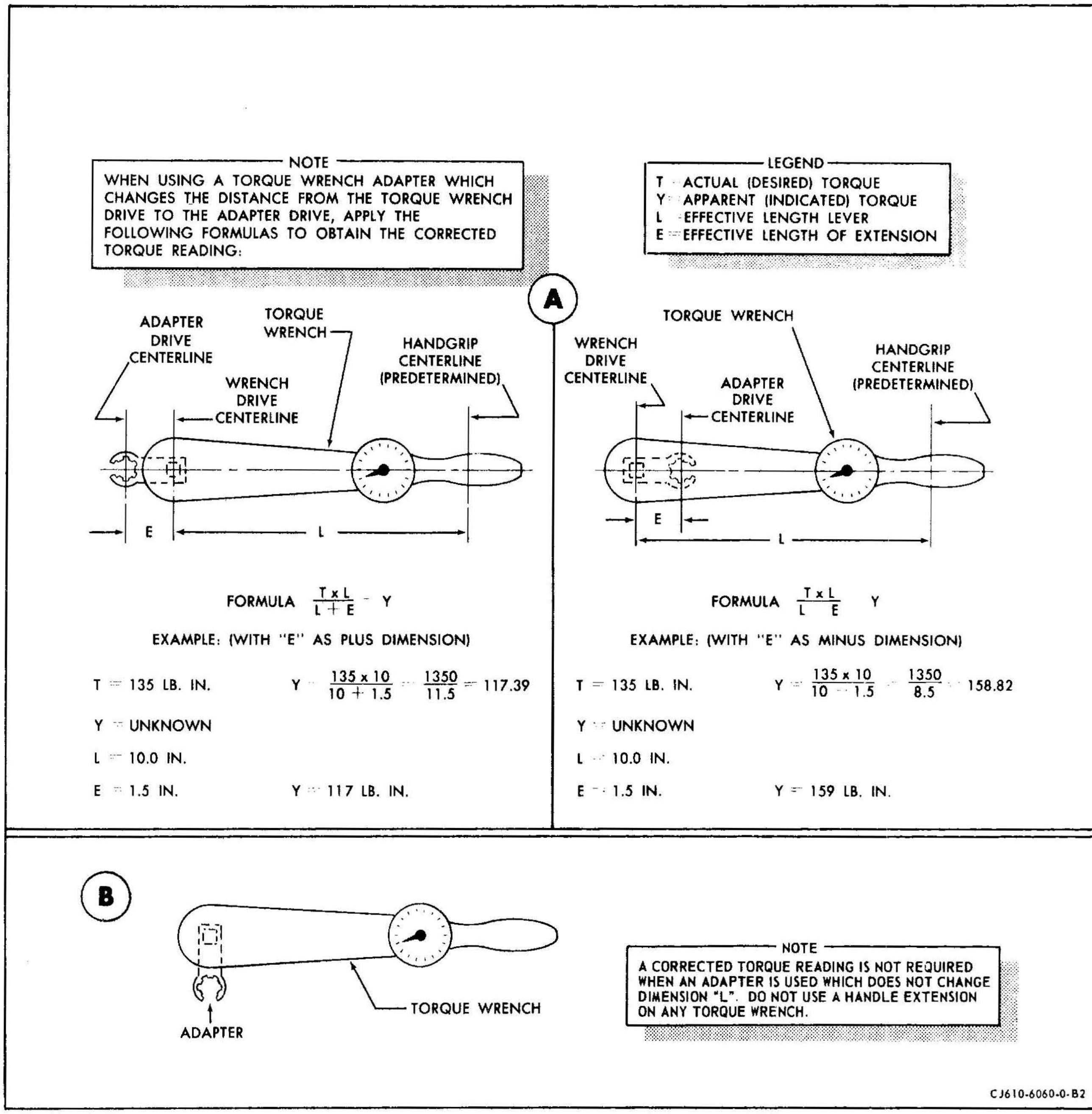
D. Use of Offset Extension Wrench (Crowfoot). When a crowfoot extension wrench is used with a torque wrench, the effective length of the torque wrench is changed. The torque wrench is so calibrated that when an extension wrench is used, the indicated torque (torque which appears on a dial or gage on the torque wrench) may be different from the actual torque that is applied to the nut or bolt. Therefore, when a crowfoot extension is used, the torque wrench shall be preset to compensate for the increase or decrease in actual torque as compared to indicated torque. Refer to paragraphs E. and F. for the proper method of computing the adjustment.

E. Measuring Effective Length of Offset Extension Wrench (Crowfoot). (See figure 1.) The addition or subtraction of the effective length of the crowfoot extension wrench (e) is determined by the position of the extension wrench on the torque wrench. When the extension wrench is pointed in the same direction as the torque wrench add the effective length of the extension wrench to the effective length of the torque wrench (L + E). When the extension wrench is pointed back toward the handle of the torque wrench, subtract the effective length of the extension wrench from the effective length of the torque wrench (L - E). When the extension is pointed at right angles to the torque wrench, the actual value does not change. The effective length of the torque wrench is a variable and a different figure will be used for each type of torque wrench. The effective length of the crowfoot extension wrench is determined by measuring from the center of the drive opening to the center of the extension wrench opening (E).

F. Determination of Gage Reading When Using Offset Extension Wrench (Crowfoot). (See figure 1.)

(1) The object is to find the gage reading which indicates the required torque.

(2) Determine the effective length of the torque wrench (which is designated as "L" in the following example) and the effective length of the crowfoot wrench (E).



Computing Effective Length of Extension Wrench (Crowfoot)
Figure 1

(3) Multiply the required torque by the effective length of the torque wrench (L).

(4) Divide this result by (L + E), or (L - E), as determined from figure 1. This answer is the gage reading which indicates the required torque.

For example: Required torque = 265 lb-in. Effective length of torque wrench = 8.4 in. Effective length of crow-foot = 1.5 in.
Therefore, (L + E) = 9.9 in.

$$265 \times 8.4 = 2226.0$$

$$2226.0 \div 9.9 = 224.8 \text{ lb-in.}$$

Thus, a gage reading of 225 lb-in. indicates a required torque of 265 lb-in.

2. Standard Torque Values for Steel Nuts and Bolts.

A. General. The torque values for standard steel nuts (including self-locking) and bolts are shown in the following table.

	UNC and 8 Series		UNF and 12 Series	
Size	Threads Per Inch	Torque	Threads Per Inch	Torque
0.112	40	3-5 lb-in.		
0.138	32	6-8 lb-in.		
0.164	32	13-16 lb-in.	36	16-19 lb-in.
0.190	24	20-23 lb-in.	32	24-27 lb-in.
0.250	20	40-60 lb-in.	28	55-70 lb-in.
0.3125	18	70-110 lb-in.	24	100-130 lb-in.
0.375	16	160-210 lb-in.	24	190-230 lb-in.
0.4375	14	250-320 lb-in.	20	300-360 lb-in.
0.500	13	420-510 lb-in.	20	480-570 lb-in.

B. Exceptions. Use one-half of the values given in the above table for following applications.

(1) Thin steel hex nuts, these nuts having a height of less than 0.6 pitch diameter for plain nuts and less than 0.8 pitch diameter for self-locking nuts.

(2) Nuts and bolts of non-ferrous alloys.

(3) All bolts threaded directly into aluminum, magnesium or non-ferrous alloys.

3. Standard Torque Values for Stud Bolts and Stepped Studs in Aluminum or Magnesium.

A. General. The following torque values are for stud bolts and stepped studs, installed in aluminum or magnesium, that are held in position by only the locking action of the interference fit between mating parts.

NOTE: These torque values are not applicable to "Lok-Thread" studs.

Bolt Size	Torque (Pound Inches)
.190 -24	35-40
.250 -20	75-80
.3125 -18	135-145
.375 -16	240-250
.4375 -14	370-380
.500 -13	580-600

B. Exceptions. Studs which have different thread sizes on opposite ends shall be torqued to the smaller size regardless of which end is fitted into the installation.

4. Standard Torque Values for Flared Tubing and Hose Fittings. The following table contains the dimensions of flared tubing and hose fittings and their standard torque values:

Tube OD	Thread Size	All Aluminum Parts	Steel Tube-Aluminum or Steel Nuts	Torque Units
.125	.3125 -24	-------	35-40	lb-in.
.1875	.375 -24	30-50	90-100	lb-in.
.250	.4375 -20	40-65	135-150	lb-in.
.3125	.500 -20	60-80	180-200	lb-in.
.375	.5625 -18	75-125	270-300	lb-in.
.500	.750 -16	150-250	450-550	lb-in.
.625	.875 -14	200-350	650-770	lb-in.
.750	1.0625 -12	35-41	75-91	lb-ft.
1.000	1.3125 -12	41-58	100-128	lb-ft.
1.250	1.625 -12	50-75	125-150	lb-ft.
1.500	1.875 -12	50-75	158-183	lb-ft.

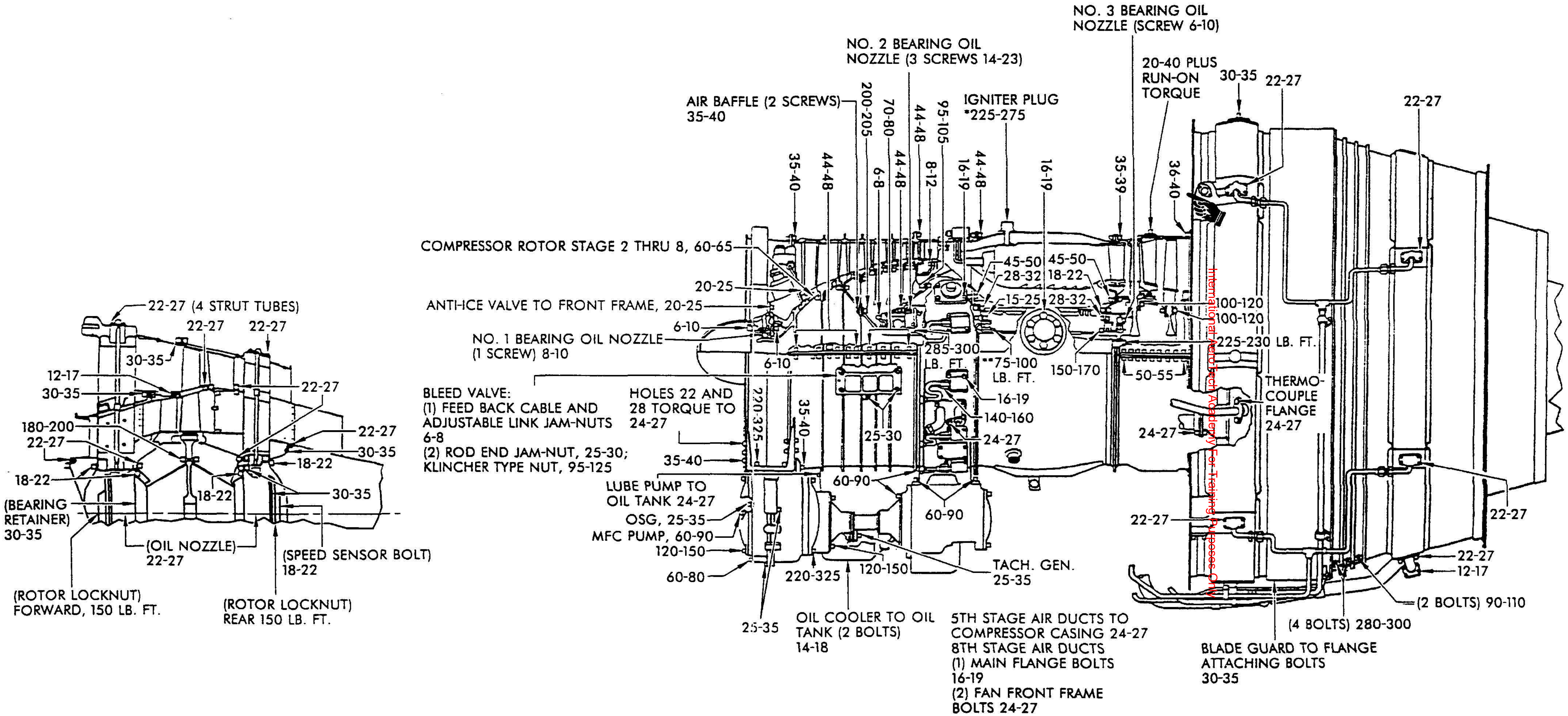
5. Standard Torque Values for Fittings with Gaskets. The following table contains the dimensions of the fittings with gaskets and their standard torque values:

Tube OD	Thread Size	Nut (AN924) Union (AN815)	Plug (AN814)	Nut (AN6289)	Torque Units
.125	.3125 -24	25-35	10-16	25-35	lb-in.
.1875	.375 -24	50-75	30-40	50-75	lb-in.
.250	.4375 -20	55-80	40-65	75-100	lb-in.
.3125	.500 -20	75-100	60-80	90-120	lb-in.
.375	.5625 -18	100-150	80-120	150-200	lb-in.
.500	.750 -16	180-230	150-200	200-250	lb-in.
.625	.875 -14	250-350	200-350	275-400	lb-in.
.750	1.0625 -12	420-600	300-500	450-650	lb-in.
1.000	1.3125 -12	50-70	38-50	55-75	lb-ft.
1.250	1.625 -12	60-80	50-60	65-85	lb-ft.
1.500	1.875 -12	70-90	50-70	75-90	lb-ft.

6. Standard Torque Values for Jam Nuts of Fittings Without Gaskets. The following table contains the dimensions of fittings and their standard torque values:

Tube OD	Thread Size	Aluminum	Steel	Torque Units
.125	.3125 -24	35-50	-----	lb-in.
.1875	.375 -24	65-80	70-90	lb-in.
.250	.4375 -20	90-105	110-130	lb-in.
.3125	.500 -20	105-125	140-160	lb-in.
.375	.5625 -18	125-145	225-275	lb-in.
.500	.750 -16	240-280	400-450	lb-in.
.625	.875 -14	330-370	550-650	lb-in.
.750	1.0625 -12	45-55	70-80	lb-ft.
1.000	1.3125 -12	70-80	85-100	lb-ft.
1.250	1.625 -12	80-100	-----	lb-ft.
1.500	1.875 -12	100-120	-----	lb-ft.

7. Special Torque Values. (See figure 2.)



NOTES:

1. LUBRICATE THREADS OF ALL BOLTS, NUTS AND STUDS WITH ENGINE OIL UNLESS OTHERWISE SPECIFIED
2. *LUBRICATE WITH UNFLAVORED MILK OF MAGNESIA (MAGNESIUM OXIDE, MGO)
3. **TORQUE, LOOSEN; RETORQUE
4. TORQUE ALL DRAIN PLUGS TO 60-80
5. TORQUE VALUES ARE GIVEN IN LB.-IN.

000BC-022201

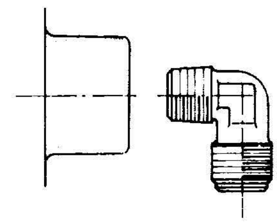
Engine Torque Chart
Figure 2

PROCEDURE FOR THE INSTALLATION OF THE POSITIONING-TYPE UNIVERSAL FITTING

1. General. These instructions apply to the positioning-type universal fittings. See figure 1.

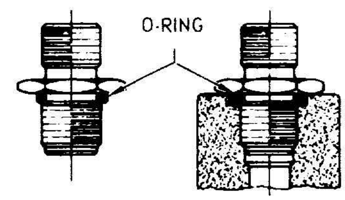
PIPE FITTING

1. INSPECT VISUALLY.
2. CLEAN IF NECESSARY.
3. LUBRICATE FITTINGS.
4. ASSEMBLE FITTING, SCREWING DOWN TO WITHIN ONE-HALF TURN OF FINAL POSITION.
5. REMOVE, CLEAN, AND INSPECT MALE THREAD.
6. RELUBRICATE.
7. REASSEMBLE AND SCREW DOWN TO FINAL POSITION.



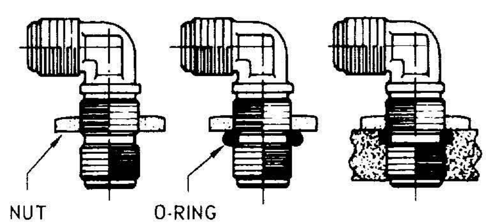
UNION

1. LUBRICATE THE O-RING AND ASSEMBLE THE O-RING TO THE GROOVE ON THE UNION.
2. SCREW THE UNION INTO THE BOSS UNTIL CONTACT IS MADE WITH THE SURFACE OF THE BOSS.
3. TIGHTEN THE UNION TO THE PROPER TORQUE VALUE.



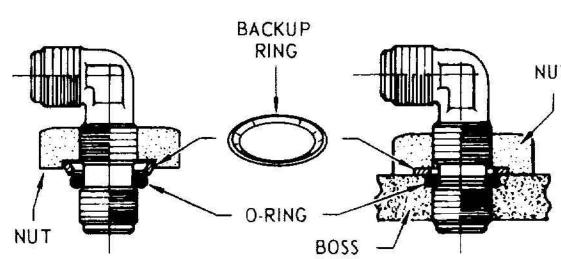
BULKHEAD FITTING

1. LUBRICATE THE FITTING END. ASSEMBLE THE NUT TO THE FITTING UNTIL THE WASHER FACE OF THE NUT LINES UP WITH THE UPPER CORNER OF THE SEAL GROOVE.
2. LUBRICATE THE O-RING AND ASSEMBLE THE O-RING TO THE GROOVE ON THE FITTING SO THAT IT CONTACTS THE NUT.
3. SCREW THE FITTING AND NUT SIMULTANEOUSLY INTO THE BOSS UNTIL THE SEAL CONTACTS THE CHAMFER AT THE FACE OF THE BOSS AND UNTIL THE NUT CONTACTS THE BOX
4. POSITION THE FITTING BY EITHER TURNING IN AS MUCH AS 3 4 TURN (·270 DEGREES) OR TURNING OUT AS MUCH AS 1 4 TURN (-90 DEGREES). ASSEMBLE THE LINE TO THE FITTING TO CHECK THE ALIGNMENT OF THE FITTING. TIGHTEN THE NUT TO THE PROPER TORQUE.



FITTINGS WITH BACKUP RINGS

1. LUBRICATE MALE THREADS OF FITTING, BACKUP RING AND O-RING.
2. ASSEMBLE THE NUT TO THE FITTING WITH THE COUNTERBORE SIDE FACING THE FITTING END.
3. ASSEMBLE THE BACKUP RING TO THE FITTING AND SEAT IT IN THE COUNTERBORE OF THE NUT WITH ITS CONVEX SIDE FACING THE FITTING END.
4. ASSEMBLE THE O-RING TO THE GROOVE ON THE FITTING.
5. ADJUST THE NUT SO THAT THE BACKUP RING FORCES THE O-RING FIRMLY AGAINST THE LOWER THREADED PORTION OF THE FITTING.
6. SCREW THE FITTING AND NUT SIMULTANEOUSLY INTO THE BOSS UNTIL THE O-RING CONTACTS THE CHAMFER AT THE FACE OF THE BOSS.
7. HOLD THE NUT AND TURN THE FITTING INTO THE BOSS 1-1 2 TURNS. THE FITTING MAY BE POSITIONED FURTHER BY ONE ADDITIONAL TURN.
8. ASSEMBLE THE LINE TO THE FITTING TO CHECK THE ALIGNMENT OF THE FITTING.
9. HOLD THE FITTING AND TIGHTEN THE NUT TO THE PROPER TORQUE.



CT58-3171-0-B2

Assembly Procedures - Hose and Tube Fittings
Figure 1

CONVERSION TABLES

1. General. The limits (dimensional) or values (torque) etc. are expressed in the English system of measurement. A table for converting English to Metric is added in this section for customers using the Metric system.

TABLE I

CONVERSION OF ENGLISH TO METRIC SYSTEM

METRIC AND DECIMAL EQUIVALENTS FOR FRACTIONS OF AN INCH AND FOOT
1 IN. = 25.4 MM 1 MM = 0.03937 IN.

FRACTIONS OF AN INCH		FRACTIONS OF AN INCH		FRACTIONS OF AN INCH		FRACTIONS OF A FOOT	
IN. DECIMALS	MM	IN. DECIMALS	MM	IN. DECIMALS	MM	IN. DECIMALS	MM
1/64 =0.016	0.4	11/32 =0.344	8.7	43/64 =0.672	17.1	1 =0.0833	25.4
1/32 =0.031	0.8	23/64 =0.359	9.1	11/16 =0.688	17.5		
3/64 =0.047	1.2	3/8 =0.375	9.5	45/64 =0.703	17.9	2 =0.1667	50.8
1/16 =0.063	1.6	25/64 =0.391	9.9	23/32 =0.719	18.3		
5/64 =0.078	2.0	13/32 =0.406	10.3	47/64 =0.734	18.7	3 =0.2500	76.2
3/32 =0.094	2.4	27/64 =0.422	10.7	3/4 =0.750	19.1		
7/64 =0.109	2.8	7/16 =0.438	11.1	49/64 =0.766	19.4	4 =0.3333	101.6
1/8 =0.125	3.2	29/64 =0.453	11.5	25/32 =0.781	19.8		
9/64 =0.141	3.6	15/32 =0.469	11.9	51/64 =0.797	20.2	5 =0.4167	127.0
5/32 =0.156	4.0	31/64 =0.484	12.3	13/16 =0.813	20.6		
11/64 =0.172	4.4	1/2 =0.500	12.7	53/64 =0.828	21.0	6 =0.5000	152.4
3/16 =0.188	4.8	33/64 =0.516	13.1	27/32 =0.844	21.4		
13/64 =0.203	5.2	17/32 =0.531	13.5	55/64 =0.859	21.8	7 =0.5833	177.8
7/32 =0.219	5.6	35/64 =0.547	13.9	7/8 =0.875	22.2		
15/64 =0.234	6.0	9/16 =0.563	14.3	57/64 =0.891	22.6	8 =0.6667	203.2
1/4 =0.250	6.4	37/64 =0.578	14.7	29/32 =0.906	23.0		
17/64 =0.266	6.7	19/32 =0.594	15.1	59/64 =0.922	23.4	9 =0.7500	228.6
9/32 =0.281	7.1	39/64 =0.609	15.5	15/16 =0.938	23.8		
19/64 =0.297	7.5	5/8 =0.625	15.9	61/64 =0.953	24.2	10 =0.8333	254.0
5/16 =0.313	7.9	41/64 =0.641	16.3	31/32 =0.969	24.6		
21/64 =0.328	8.3	21/32 =0.656	16.7	63/64 =0.984	25.0	11 0.9167	279.4

CT58-3591-(2)-0-D2

TABLE I (Cont)

CONVERSION OF ENGLISH TO METRIC SYSTEM

INCHES TO MILLIMETERS

IN.	MM	IN.	MM	IN.	MM	IN.	MM	IN.	MM
0.001	0.0254	0.01	0.254	0.1	2.54	1	25.4	10	254
0.002	0.0508	0.02	0.508	0.2	5.08	2	50.8	20	508
0.003	0.0762	0.03	0.762	0.3	7.62	3	76.2	30	762
0.004	0.1016	0.04	1.016	0.4	10.16	4	101.6	40	1016
0.005	0.1270	0.05	1.270	0.5	12.70	5	127.0	50	1270
0.006	0.1524	0.06	1.524	0.6	15.24	6	152.4	60	1524
0.007	0.1778	0.07	1.778	0.7	17.78	7	177.8	70	1778
0.008	0.2032	0.08	2.032	0.8	20.32	8	203.2	80	2032
0.009	0.2286	0.09	2.286	0.9	22.86	9	228.6	90	2286
								100	2540

FEET EQUIVALENTS OF METERS
(1 METER=3.2808 FEET)

METERS:	0	1	2	3	4	5	6	7	8	9
M					FEET					
0	—	3.28	6.56	9.84	13.12	16.40	19.69	22.97	26.25	29.53
10	32.81	36.09	39.37	42.65	45.93	49.21	52.49	55.77	59.06	62.34
20	65.62	68.90	72.18	75.46	78.74	82.02	85.30	88.58	91.86	95.14
30	98.43	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.88	177.17	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.41	206.69	209.97	213.26	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.06	249.34	252.63	255.91	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.99
90	295.27	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80

SQUARE INCHES AND SQUARE CENTIMETERS EQUIVALENTS
(1 SQ IN. = 6.452 SQ CM 1 SQ CM = 0.155 SQ. IN.)

SQ IN.	SQ CM	SQ IN.	SQ CM	SQ IN.	SQ CM	SQ IN.	SQ CM	SQ IN.	SQ CM	SQ IN.	SQ CM
1	6.45	18	116.13	35	225.81	52	335.48	69	445.16	86	554.84
2	12.90	19	122.58	36	232.26	53	341.93	70	451.61	87	561.29
3	19.36	20	129.03	37	238.71	54	348.39	71	458.06	88	567.74
4	25.81	21	135.48	38	245.16	55	354.84	72	464.51	89	574.19
5	32.26	22	141.93	39	251.61	56	361.29	73	470.97	90	580.64
6	38.71	23	148.39	40	258.06	57	367.74	74	477.42	91	587.10
7	45.16	24	154.84	41	264.52	58	374.19	75	483.87	92	593.55
8	51.61	25	161.29	42	270.97	59	380.64	76	490.32	93	600.00
9	58.06	26	167.74	43	277.42	60	387.09	77	496.77	94	606.45
10	64.52	27	174.19	44	283.87	61	393.55	78	503.22	95	612.90
11	70.97	28	180.64	45	290.32	62	400.00	79	509.68	96	619.35
12	77.42	29	187.10	46	296.77	63	406.45	80	516.13	97	625.80
13	83.87	30	193.55	47	303.22	64	412.90	81	522.58	98	632.26
14	90.32	31	200.00	48	309.68	65	419.35	82	529.03	99	638.71
15	96.77	32	206.45	49	316.13	66	425.81	83	535.48	100	645.16
16	103.23	33	212.90	50	322.58	67	432.26	84	541.93	—	—
17	109.68	34	219.35	51	329.03	68	438.71	85	548.39	—	—

WEIGHT: 1 LB = 0.454 KG
1 KG = 2.205 LBS.

PRESSURE: 1 PSI = 0.0703 KG PER CM^2
1 PSF = 4.88 KG PER M^2

VOLUME: 1 CU FT = 0.02832 CU M
1 CU M= 35.31 CU FT.

TORQUE: LB-IN. X 1.15=KG-CM.
LB-FT. X 13.84=KG-CM.

LENGTH: 1 INCH = 25.4 MM.
1 MM = 0.03937 INCH
1 FT = 30.48 CM
1 M = 3.2808 FT

CT58-3591-(1)-0-A2A

MARKING OF ENGINE PARTS

1. General. When it is necessary to mark an engine part only approved marking method shall be used.

2. Temporary marking of engine parts. In general, lead and sulphur containing materials are unacceptable for marking. All marking materials listed are equally recommended for all parts.

   CAUTION: GREASE PENCILS MUST NOT BE USED TO MARK ENGINE PARTS.

   A. Chalk
   B. Dykem - red, yellow, black
   C. Ink - Justrite Slink, black; Marco S-1141, black; Marsh Stencil Ink
   D. Soapstone

HOSE, TUBE AND CLAMP - INSPECTION AND REPAIR

1. General. The following are general limits and repair and will apply unless specific part information is given.

WARNING: ASBESTOS

THIS ENGINE MAY CONTAIN SMALL AMOUNTS OF ASBESTOS. WHEN WORKING WITH THIS ENGINE, THE FOLLOWING PRECAUTIONS MUST BE RIGIDLY ADHERED TO:

BEFORE ANY MAINTENANCE ACTIVITIES ARE UNDERTAKEN, REVIEW THE ILLUSTRATED PARTS BREAKDOWN/CATALOG INDEX TO DETERMINE IF THE HARDWARE TO BE WORKED ON OR USED CONTAINS ASBESTOS.

WHENEVER MECHANICAL REMOVAL OF MATERIAL, SUCH AS MACHINING, GRINDING, BUFFING, DRILLING, SANDING OR ANY TYPE OF MATERIAL BUILD-UP ON PARTS THAT CONTAIN ASBESTOS IS NECESSARY, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT MUST BE WORN, AND NATIONAL ENVIRONMENTAL CONTROLS REQUIRED FOR THE HANDLING OF ASBESTOS-CONTAINING MATERIAL MUST BE COMPLIED WITH.

BEFORE HANDLING, REPLACING, OR DISPOSING OF ASBESTOS-CONTAINING HARDWARE, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND NATIONAL ENVIRONMENTAL CONTROLS MUST BE STRICTLY ADHERED TO FOR HANDLING ASBESTOS-CONTAINING HARDWARE.

2. Fire Sleeve Inspection and Repair.

A. Inspection of Fire Sleeve.

(1) Tears, scratches and cuts may be treated as chafing (below) provided none of them are completely through the sleeve; if through sleeve, the sleeve must be replaced per paragraph B.(1).

(2) Chafing and wear is serviceable in any amount provided it is not deeper than 0.06 inch; if deeper repair per paragraph B.(2).

(3) Broken clamps must be replaced.

B. Repair of Fire Sleeve.

<u>WARNING</u>: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(1) Replacement of fire sleeve.

NOTE: Lines requiring only replacement of fire sleeve may be repaired without teardown by replacing with an oversized fire sleeve, per paragraph (b) below or by installing a split fire sleeve and stapling it in place, per paragraph (c) below.

(a) Remove old fire sleeve by removing the wire clamps, then cutting the sleeve material from the line with a sharp knife or razor blade.

(b) If replacing old fire sleeve with an oversize fire sleeve, (which applies only to straight and standard elbow hose line), select a fire sleeve from Table I. Cut the sleeve to proper length by using the measurement taken between nipple hexes on the end fitting of the hose. Install fire sleeve and secure with several turns of safety wire (MS9226 or equivalent) over the socket or select wire clamps to fit from Table II.

NOTE: These fire sleeve sizes are optional with the operator and may be used if a bulkier fire sleeve installation is not objectionable.

TABLE I

AEROQUIP 624 FIRE SLEEVE SIZES REQUIRED TO SLIP OVER SWIVEL NUT STYLE HOSE FITTINGS

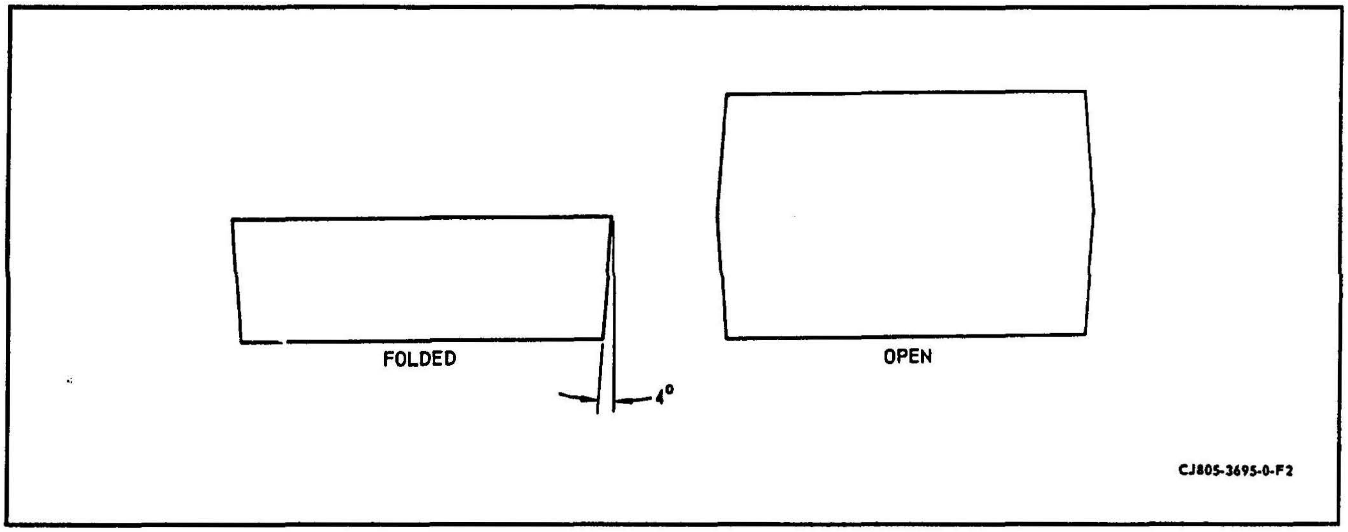
Hose Dash No.	Fire Sleeve P/N
-3	624-11
-4	-11
-5	-14
-6	-14
-8	-18
-10	-20
-12	-24
-16	-28
-20	-42

NOTE: Fire sleeve installation will be easier if the sleeve is bunched and pushed on so as to increase sleeve diameter.

TABLE II

FIRE SLEEVE CLAMP SIZES

OD Range (in.)		
From	To	Aeroquip Part No.
1/2	9/16	900976-8
19/32	11/16	-10
3/4	7/8	-14
15/16	1-1/8	-18
1-3/16	1-3/8	-22
1-7/16	1-5/8	-26
1-11/16	1-7/8	-30
1-15/16	2-1/8	-34
2-3/16	2-3/8	-38
2-7/17	2-5/8	-42
2-11/16	3	-48



Fire Sleeve Trim Cut
Figure 1

(c) If replacing old fire sleeve with a split fire sleeve (624A), proceed with the following instructions:

1 Select proper sleeve width from Table III and cut to proper length as measured between nipple hexes. Add "Y" dimensions to length per Table IV, before cutting.

2 Open crease and fold fire sleeve to a double thickness (widthwise).

3 Trim ends on a 4 degree angle, cutting from the center fold to the sleeve edges to form a trapezoid. Refere to figure 1.

4 Coat each end of fire sleeve by dipping into synthetic sealer, Table V, a minimum of 1/2 inch, and allow to dry. The sleeve can be assembled with ends "tacky" if these ends are powdered with talc or powdered soap stone.

5 Adjust Stapling Fixture Stop to "X" dimensions as referenced in figure 2 and Table III. (Use Aeroquip Corp. Stapling Fixture No. S1067, or equivalent.) Dimension "X" can vary according to desired tightness of sleeve application; however, dimension "X" must be considereed a minimum for recommended practice.

6 Wrap fire sleeve around hose, aligning cut end edges, and clinch first staple approximately 8 inches from one end or, in the case of a short hose assembly, at the mid-point of the assembly. (Use Aeroquip staples, part number 900122-1 or equivalent.)

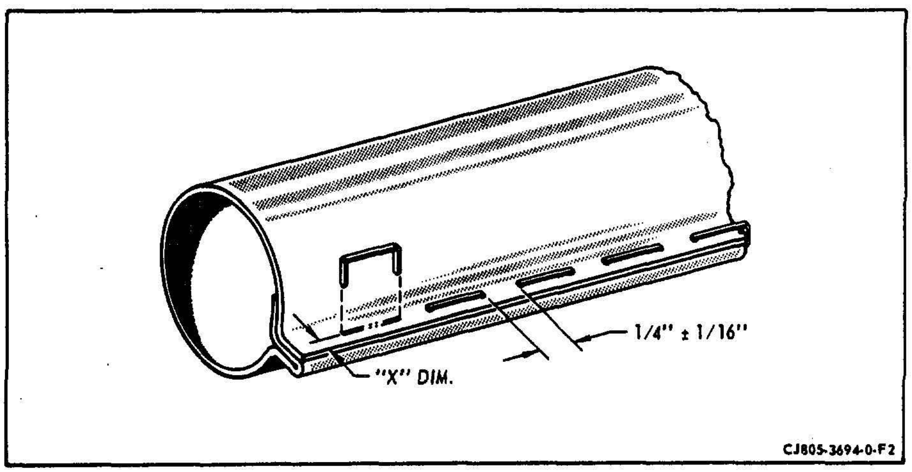
TABLE III

Hose Dash No.	624A-No.	Wire Clamp	"X" Dimension
-4	-1	900591A-14C	5/32
-5	-2	-14C	5/32
-6	-3	-16C	5/32
-8	-4	-18C	3/16
-10	-5	-22C	7/32
-12	-6	-24C	7/32
-16	-7	-32C	1/4
-20	-8	-36C	9/32
-24	-9	-42C	9/32

7 Complete the stapling of the first section (working from the center to the end), placing staples approximately 1/4 inch apart per figure 2 until the sleeve is closed to within 2 inches of the socket.

8 Complete the stapling on opposite end in a like manner.

9 Flip the stop down on the Stapling Fixture and continue stapling each end as close as possible to the socket. As this is being done, there will be a gradual opening of the flap. Continue to staple as far as possible by stapling through the flap as close as possible to the socket.



Fire Sleeve Staple Spacing
Figure 2

10 Select proper wire clamp for the assembly from Table III and assemble onto the hose. The two wire strands should straddle the hex on the hex socket and in the relatively same position on the round and two (2) flat socket designs.

11 Place wires in snubber (Aeroquip No. S1072, or equivalent), and turn clamp to hold wires.

12 Turn crank. This will tighten the wires around the sleeve. Roll the hose assembly in a direction that will start a bend in the wire strands in a direction over the loop. This is a slight bend and is intended to be enough of a bend to hold the tightness when the wire's ends are cut off. (See figure 3.)

13 Lift the wire cut-off handle. This will part the hose assembly-sleeve-wire clamp assembly from the snubber.

14 Fold the cut wire ends back against the sleeve tightly and the assembly is complete.

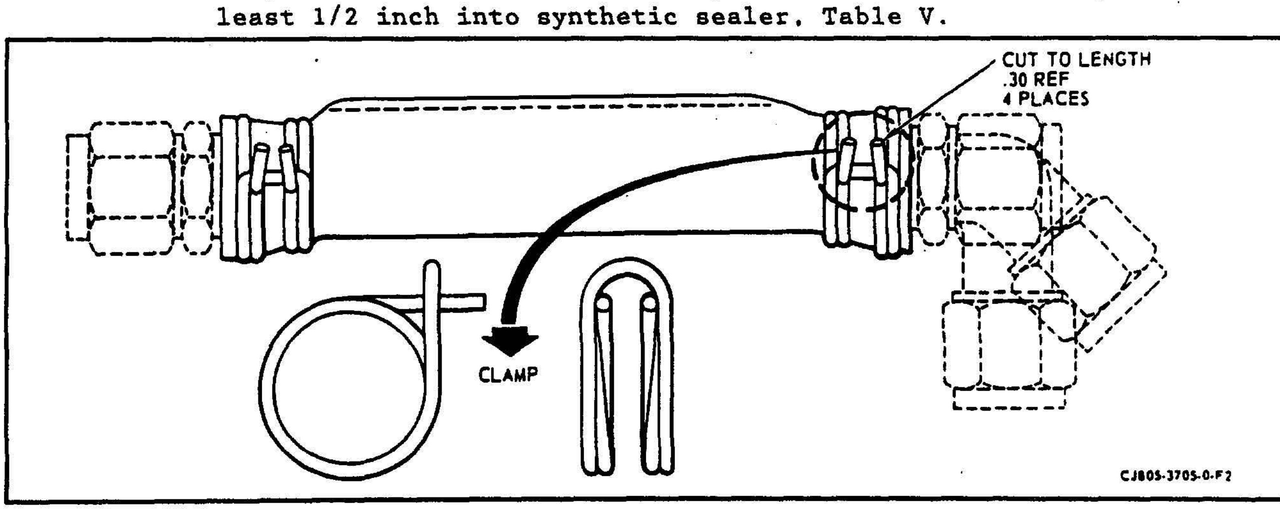
(2) Repairing fire sleeve.

WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(a) Abrasions and scuffs. Cover with brush application of synthetic sealer, Table V, if minor. If damaged beyond minor abrasions and scuffs, wrap with fireproof tape for three thicknesses then coat with fireproof sleeve sealer, Table V.

(b) Frayed ends. Trim loose or frayed ends and brush or dip ends at least 1/2 inch into synthetic sealer, Table V.



Clamping of Fire Sleeve
Figure 3

TABLE IV

624A No.	1	2	3	4	5	6	7	8	9
"Y"	.158	.175	.193	.231	.263	.291	.385	.463	.532

TABLE V

FIRE SLEEVE SEALER

Trade Name	Manufacturer
Pliobond	Goodyear Rubber Company

3. Metal Braid.

A. Inspect metal braid for frayed or broken strands. Hose is serviceable if no more than 9 strands in any 1/2 x 1/2 inch square is damaged. If more than 9 but less than 15 strands are damaged in any 1/2 x 1/2 inch square the hose must be repaired in accordance with paragraph B.

B. Repair frayed or broken strands as follows:

(1) Carefully bend back each broken strand so it does not stick into the teflon.

(2) Cut and fold a piece of 100 mesh, 0.004 inch diameter, stainless steel cloth (Buffalo Wire Works, Buffalo, N.Y. or equivalent) in accordance with figure 4.

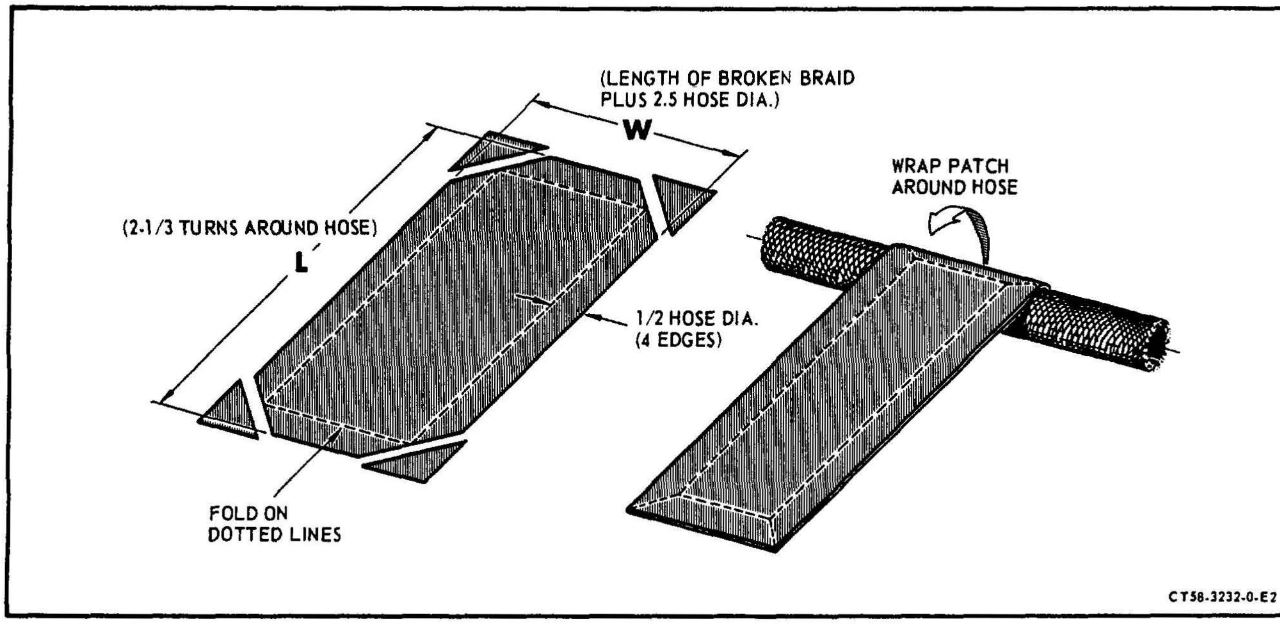
(3) Wrap the patch around the damaged section of the hose with the folds against the hose and the smooth side facing out.

(4) Secure the patch in place with 0.032 inch stainless steel lockwire formed into a knot as shown in figure 5. Knots should be placed along the length of the patch so they are no more than one hose diameter apart. The knot is formed as follows:

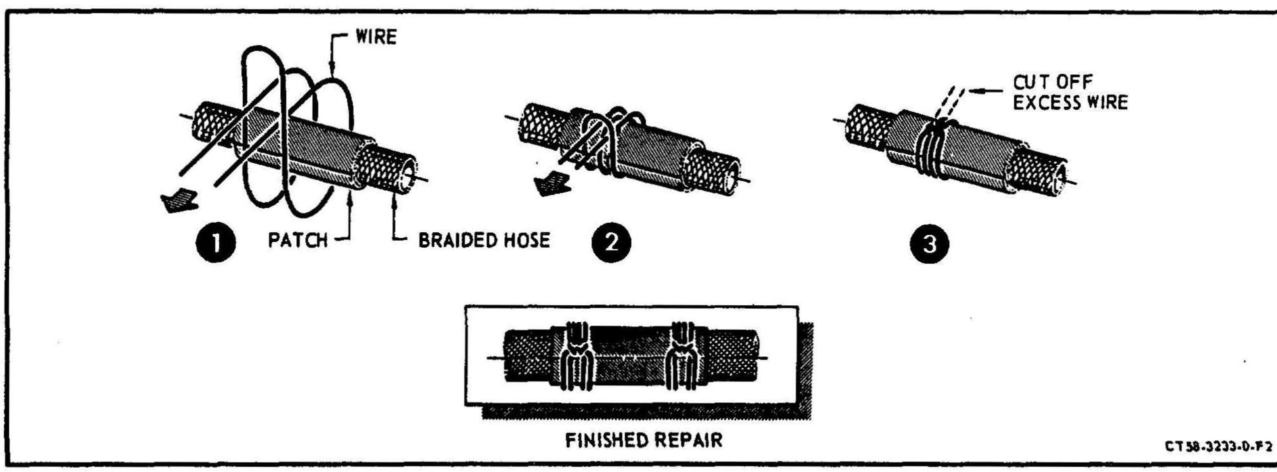
(a) Make a loop of the lockwire and wrap around the hose.

(b) Feed the ends of the wire through the loop, around the house and back through the loop.

(c) Use needle nose pliers on the free ends to tighten the knot. When tight, bend the ends back and cut off.



Metal Braid Repair - Wire Cloth Patch
Figure 4



Metal Braid Repair - Knot Construction
Figure 5

WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

4. Hose Clamps.

Visually inspect clamps and cushion material for serviceability if damage is suspected. Replace clamps with notches formed in the tangs by bolt heads, nuts or brackets, or those that have suffered other mechanical damage. Replace clamps whose cushion material is torn (damaged), have swollen due to the effects of fuel and oil or have been compressed so that the clamp will not securely hold a tube or hose.

5. Chafing Shield.

A. Inspect hose and tubing shafting shield for chafing and wear. Any amount of chafing or wear is serviceable provided shield is not cut through.

B. Replacement of Chafing Shield.

(1) Measure length of damaged chafing shield; note location on hose or tubing and remove.

(2) Cut Teflon spiral wrap to length, choosing SWT 3/8 or 1/2 as the hose or tubing diameter requires. (Manufactured by Illumitronic Engineering Corporation, 680 East Taylor Avenue, Sunnyvale, Calif.)

(3) Clean hose and wire braid with trichloroethylene (MIL-T-7003).

(4) Assemble spriral wrap to hose or tube. Wrap tightly, keeping space between each successive spiral to a minimum.

NOTE: Hold Hose straight while wrapping.

(5) Tape one end of spiral wrap to hose or tube starting approximately 1/2 inch from end of wrap. (Use 1/2 inch Mystic Tape #7010, or as an alternate, use Minnesota Mining and Mfg. Co., St. Paul 6, Minn.) Use approximately 3 to 4 wraps of tape to secure this end and pull tape tight during wrapping.

(6) Re-adjust and tighten spiral wrap each 5 to 6 inch interval using 3 to 4 turns of electrical tape pulled tightly each time to secure the spiral wrap. Continue this procedure, finishing off with a tape wrap approximately 1/2 inch from the end.

6. Tubing and Fittings Inspection. When serviceable limits are exceeded the parts may be repaired in accordance with the Overhaul Manual.

Inspect	Maximum Serviceable Limits	Remarks
A. Tubine for:		
(1) Splits or cracks.	None allowed.	
(2) Nicks, scratches, gouges, wear or chafing except chafing due to tubing clamps.	Not serviceable if of measurable depth.	
(3) Chafing caused by tubing clamps.	0.003 inch below adjacent non-defective surface with no high metal.	
(4) Dents.	Depth of defect no more than 1/5 of the tube OD if there are no sharp corners and the defect is not on the heel of a sharp bend (radius of bend is less than twice the tube OD).	
(5) Flattened cross-section.	Tube is acceptable if the OD is not reduced more than 25%.	
B. The bolt flanges on tubes for:		
(1) Flatness of the mating surface.	Flat within 0.005 inch.	
(2) Cracks.	None allowed.	
C. Teflon lined flex hoses for:		
(1) Kinks.	None allowed.	
(2) Frayed or broken wire braid.	Nine strands in any 1/2 inch x 1/2 inch square.	
D. Combination flex (hose) and rigid (tube) assemblies for:		
(1) Tubing defects.	Refer to step A.	
(2) Frayed or broken braid in the flex section.	Refer to step C.	

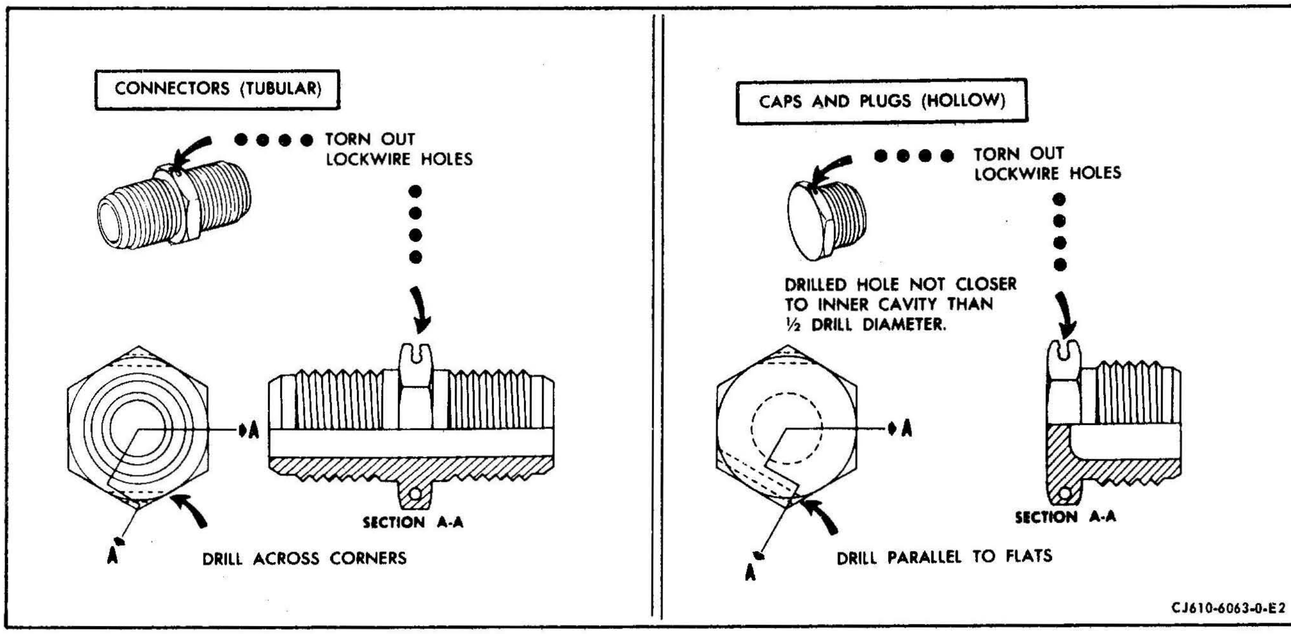
Inspect	Maximum Serviceable Limits	Remarks
E. Hex coupling nuts for:		
(1) Damaged corners on wrenching flats.	Any amount with no high metal if at least 2 opposite corners are not rounded making it impossible to use a wrench.	
(2) Cracks.	None allowed.	
(3) Nicks and burrs.	Any amount with no high metal.	
(4) Distortion.	None allowed.	
(5) Stripped threads.	1/2 of the entrance thread missing with no high metal if nut can be used without cross threading, and the rest of the threads are not damaged.	
(6) Damaged threads (nicks, burrs, high metal).	Cumulative length of defects no more than 1/2 of one thread length with no high metal.	
(7) Torn lockwire holes (applicable only if nut is normally lockwired).	At least one hole not torn out.	Drill a lockwire hole in a corner not already drilled, per paragraph 7.
F. Tube fittings.		
(1) The male fittings for:		
(a) Nicks, scratches, ridges, dents, and pits on sealing surfaces.	Any number of circumferential defects no rougher than a 63 microinch finish if fitting passes the pressure check per paragraph 8. Any number of superficial axial defects, with no high metal, on aft half (nearest the fitting threads) of the sealing surface if the fitting passes the check per paragraph 8. 4 superficial nicks, dents or pits with no high metal on the aft half of the sealing surface.	Reface the sealing surface, per paragraph 9, if the cutting edge of the refacing tool does not touch the fittings threads.

Inspect	Maximum Serviceable Limits	Remarks
	if the fitting passes the pressure check per paragraph 8.	
(b) Shiny, burnished surfaces on sealing surfaces due to normal assembly.	Any amount if the fitting passes the pressure check per paragraph 8.	
(c) Nicks, scratches, dents, gouges and burrs on threads.	Cumulative length of defects not more than 1/2 of one thread length, with no high metal.	
(d) Nicks, scratches, dents, and gouges on remaining surfaces of fitting.	Any number, 0.005 inch deep with no high metal.	
(e) Stripped threads.	1/2 of entrance thread missing with no high metal if fitting can be used without cross threading.	
(f) Cracks.	None allowed.	
(g) Torn lockwire holes (applicable only if fitting is normally lockwired).	At least one hole not torn out.	Drill a lockwire hole in a corner not already drilled, per paragraph 7.
(2) The female fittings (includes tubing flares) for:		
(a) Nicks, scratches, ridges, dents and pits on sealing surfaces.	Any number of circumferential defects no rougher than a 32 microinch finish if the fitting passes the pressure check per paragraph 8. Any number of superficial axial defects with no high metal, on the leading half (nearest assembly extremity) of the sealing surface if the fitting passes the pressure check per paragraph 8. 4 super-	

Inspect	Maximum Serviceable Limits	Remarks
	ficial nicks, dents or pits with no high metal on the leading half of the sealing surface if the fitting passes the pressure check per paragraph 8.	
(b) Shiny, burnished surfaces on sealing surfaces due to normal assembly.	Any amount if the fitting passes the pressure check per paragraph 8.	
(c) Nicks and gouges on the end of flares.	Any number, 1/32 inch deep with no high metal if the fitting passes the pressure check per paragraph 8.	
(d) Dirt on OD of flare.	None allowed.	Remove with trichloroethylene or an equivalent solvent and a clean shop rag.
(3) Hose sockets for:		
(a) Cracks and distortion.	None allowed.	
(b) Nicks and scratches.	Any amount with no high metal.	
(4) Tube flare sleeves for:		
(a) Cracks.	None allowed.	
(b) Shiny, burnished surfaces due to normal assembly.	Any amount.	
(c) Adhesion to flare nuts.	Any amount if nut and sleeve are free to slide on tube.	

7. Torn Lockwire Hole Repair. (See figure 6.)

A. Choose same drill size for new lockwire holes.



Torn Lockwire Hole Repair
Figure 6

B. Blind hole fittings (caps, plugs, etc.) shall be redrilled for lockwire not closer than 1/2 the drill diameter and parallel to the wrenching flat. Locate hole midway along flat.

C. Through-hole fittings (unions, connectors, etc.) shall be redrilled for lockwire across the hexagon corners. Locate hole to provide at least one drill diameter wall thickness to corner and position midway along flat.

D. Deburr holes to remove sharp edges.

CAUTION: REDRILLED LOCKWIRE HOLES MUST NOT PASS ANY CLOSER TO AN INNER CAVITY THAN 1/2 OF THE DRILL DIAMETER.

8. Pressure Checking Hose and Tube Assemblies.

Pressure checking hose and tube assemblies requires two separate tests. They are a high pressure hydraulic test in which a fluid under high pressure is introduced into the assembly and a low pressure test in which air under low pressure is introduced into the assembly and the entire assembly submerged in tap water or a transparent liquid. The high pressure test is used to determine the mechanical integrity of the assembly and the low pressure test is used to determine minute leaks. In both tests cap off all openings of the assembly except the one through which the pressure will be introduced.

Use suitable MS or AN caps which are known to be serviceable. On openings which require gaskets, be sure the proper gasket is used under the cap. Perform the pressure tests in the sequence shown as follows:

A. Low Pressure Check.

(1) Connect the assembly to a 90 to 110 psi source of clean dry air.

(2) Check all caps and fittings to be sure all are secure.

(3) Immerse the manifold in a tank of clean tap water or some available transparent liquid.

(4) Pressurize the assembly to 90-110 psi.

(5) After the assembly has been pressurized for approximately 3 minutes, check all sections of the assembly for escaping air bubbles. Leaks anywhere on the assembly are cause for rejection unless otherwise stated.

(6) After completing the check, dry off the assembly and subject it to the high pressure check.

B. High Pressure Check.

(1) Connect the assembly to a 2500 psi source of oil or water.

NOTE: Connect metal-bellows (Pneumatic) hoses to a 475-525 psi source of dry air or nitrogen and check for leaks per the low pressure check.

(2) Check all caps and fittings to be sure all are secure.

(3) Pressurize the assembly to 2450 to 2550 psi.

(4) After the assembly has been pressurized for 30 seconds, check all sections for weepage, leaks or ruptures. All are cause for rejection.

(5) After completing the test, pressure flush the assembly with trichloroethylene solvent in both directions. Cap all inlets and outlets with plastic caps after flushing.

WARNING: TRICHLOROETHYLENE IS TOXIC AND SHOULD BE USED WITH ADEQUATE VENTILATION. AVOID PROLONGED BREATHING OF VAPORS. REPEATED OR PROLONGED CONTACT WITH THE SKIN WILL REMOVE SKIN OILS AND CAUSE SEVERE DERMATITIS.

9. <u>Procedure to Reface Sealing Surfaces of Male Fitting Flare Connector End</u>.

A. Use this procedure to reface the sealing surfaces of standard tube end connectors (MS33656 and R494 series). The sets of cutters and bushings found in 21C6277 cover most of the fitting sizes found in the engine.

(1) Determine the style and size of the fitting being refaced. Refer to Table VI to see if the fitting is listed there. If it is, obtain cutter and bushing set 21C6277. Table IV indicates group number to be used for the various sizes.

(2) Select the desired group number cutter/bushing from the set.

(3) Note that there is a shoulder in the bushing bore. Screw the bushing down onto the threads of the defective fitting until it bottoms against the fitting hex or shoulder. If neither a hex nor a shoulder exists, screw the bushing in until the lead thread is just above the bushing shoulder.

(4) A drill press or equivalent can be used if the spindle can be hand fed. Install the cutter in the machine's chuck.

(5) Set up the part with the defective fitting in a suitable clamping arrangement secured to the machine table so the fitting is in line with the machine spindle. Position the part so the cutter in the machine spindle will slide freely in and out of the bushing on the defective fitting. Secure the part in this position.

(6) Move the cutter into the bushing, with the machine off, until it contacts the fitting. Set the machine stop so the cutter will move no further than 0.005 inch beyond the point of contact.

<u>NOTE</u>: The cutter may have a tendency to chatter; therefore, a slow spindle speed (200-500 RPM) and the use of cutting oil is recommended when refacing a fitting.

(7) Slowly and carefully run the cutter onto the fitting just enough to remove the defects. Do not remove any more material from the fitting than is necessary to clean it up. Most defects will clean up with 0.002 inch spindle movement. Total cumulative metal removal is limited up to the point where the cutter runs into the lead thread of the fittings. Do not run the cutter into the bushing shoulder.

(8) Remove the part and the cutter from the machine and the bushing from the fitting. Return the cutter and bushing set to its storage case.

WARNING: DRY CLEANING SOLVENT (STODDARD SOLVENT) P-D-680

COMBUSTIBLE - DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.

PROLONGED CONTACT OF SKIN WITH LIQUID CAN CAUSE DERMATITIS. REPEATED INHALATION OF VAPOR CAN IRRITATE NOSE AND THROAT AND CAN CAUSE DIZZINESS.

IF ANY LIQUID CONTACTS SKIN OR EYES, IMMEDIATELY FLUSH AFFECTED AREA THOROUGHLY WITH WATER. REMOVE SOLVENT-SATURATED CLOTHING. IF VAPORS CAUSE DIZZINESS, GO TO FRESH AIR.

WHEN HANDLING LIQUID OR WHEN APPLYING IT IN AN AIR-EXHAUSTED, PARTIALLY COVERED TANK, WEAR APPROVED GLOVES AND GOGGLES.

WHEN HANDLING LIQUID OR WHEN APPLYING IT AT UNEXHAUSTED, UNCOVERED TANK OR WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

NOTE: Protective caps are to be installed onto all fitting ends once they have been cleaned.

(9) Wash all chips and oil from the repair area paying particular attention to assure that the internal passage is free of all foreign material. Use dry cleaning solvent, P-D-680, or an equivalent solvent.

(10) Inspect the repaired fitting end to its serviceable limits and check it for leaks per the pressure check specified for the component on which the fitting is used. No leaks allowed.

21C6277 CUTTER/BUSHING SETS FOR REFACING STANDARD TUBE CONNECTION ENDS

Table VI

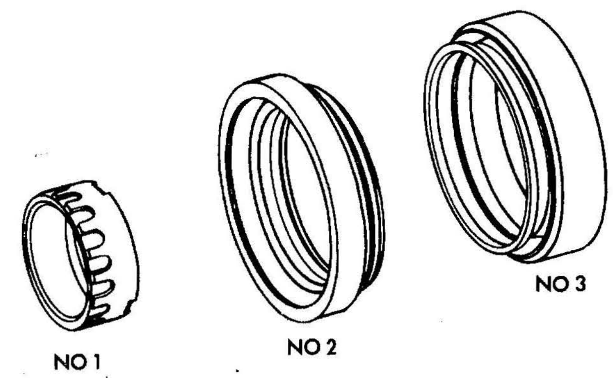
R494 SPHERICAL STYLE

21C6277 GROUP NO.	TUBE SIZE (INCH)	R494 PART NO.
G01	0.1875 (3/16)	P03
G02	0.250 (1/4)	P04
G03	0.3125 (5/16)	P05
G04	0.375 (3/8)	P06
G05	0.500 (1/2)	P08

MS33656 CONICAL 37° STYLE

21C6277 GROUP NO.	TUBE SIZE (INCH)	MS33656 DASH NO.
G06	0.125 (1/8)	-2
G07	0.1875 (3/16)	-3
G08	0.250 (1/4)	-4
G09	0.3125 (5/16)	-5
G10	0.375 (3/8)	-6
G11	0.500 (1/2)	-8
G12	0.625 (5/8)	-10
G13	0.750 (3/4)	-12

CARBON SEAL AND RUNNER - INSPECTION AND REPAIR



Carbon Rubbing Seal Runners
Figure 1

1. General. The following instructions apply to the inspection of carbon seals and runners.

2. Carbon Rubbing Seal Runner Inspection. (See figure 1.) When serviceable limits are exceeded the parts may be repaired in accordance with the Overhaul Manual.

Inspect	Maximum Serviceable Limits	Remarks
A. Seal runners for:		
(1) Cracks.	None allowed.	
(2) Dents, nicks, scratches on sealing surfaces.	None allowed.	
NOTE: Sealing surface is the area which contacts the carbon seal, plus a 1/16 inch beyond on each side. On No. 1 seal runner, the sealing surface is the area between the end of the axial slots and the front edge of the pulling slots.		
(3) Dents, nicks and scratches on surfaces other than sealing surfaces.	Any amount, 0.015 inch deep with no high metal.	

Inspect	Maximum Serviceable Limits	Remarks
(4) Chipping or chrome plating.	None allowed.	
(5) Circumferential grooves.	Any amount that cannot be felt with a pointed scribe.	
(6) Chatter marks.	Chatter marks allowed.	
(7) Heat discoloration.	Discoloration of bluing with no apparent change in surface finish is allowed. Obvious burns are not allowed.	
(8) Foreign material deposits.	Any amount no higher than base surface. Carbon crazing and fine pits normal.	Clean with solvent. A 600 grit polishing paper or crocus cloth may be used on non-sealing surfaces.

NOTE: Carbon deposits that remain after cleaning may be removed by buffing the lathe-spun carbon seal runner with a soft, cotton buffing wheel.

Inspect	Maximum Serviceable Limits	Remarks
(9) Crazing of chrome plate (superficial honeycomb cracks).	Any amount that cannot be felt with a pointed scribe.	

CAUTION: USE EXTREME CARE DURING BUFFING PROCESS TO ASSURE REQUIRED FINISH ON MATING SURFACE IS MAINTAINED.

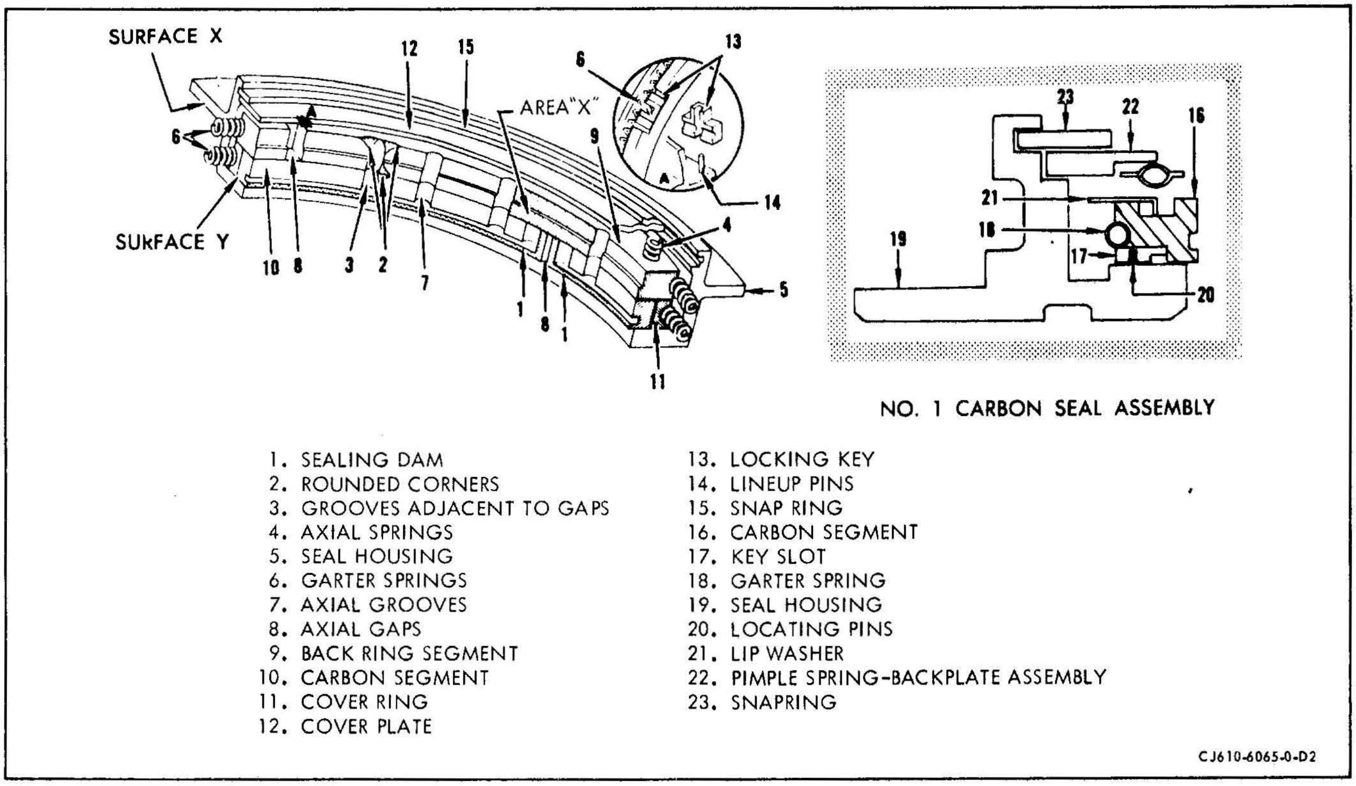
3. Carbon Seal Assembly Inspection. (See figure 2.) Inspect the No. 1 and No. 3 carbon seals in the assembled condition. If a seal does not meet inspection limits, or the carbon segments appear sticky when actuated gently with the fingers, replace the seal.

Inspect	Maximum Serviceable Limits	Remarks

CAUTION: THE RUNNING SURFACES OF THE CARBON OIL SEALS ARE EXTREMELY BRITTLE AND EASILY DAMAGED. BE CAREFUL WHEN HANDLING THEM. DO NOT ATTEMPT TO REPAIR THE CARBON SURFACES OF THE SEAL. REWORK SURFACE DEFECTS ON THE SEAL HOUSING AND RETAINING PLATE. REPLACE THE OIL-SEAL ASSEMBLY IF THERE ARE CRACKS IN THE HOUSING OR PLATE.

A. Assembled carbon seals for:

Inspect	Maximum Serviceable Limits	Remarks
(1) Chipped sealing dam (1).	None allowed.	



Carbon Seal Assembly
Figure 2

Inspect	Maximum Serviceable Limits	Remarks
(2) Cracks in carbon segments.	None allowed.	
(3) Foreign material imbedded in carbon segments.	None allowed.	
(4) Any chips (other than in sealing dams or at axial gaps).	Chips not exceeding 0.020 inch.	
(5) Excessive wear of carbon segments.	Surface wear allowed up to a maximum of 50% depth of grooves adjacent to gaps (3). (Measure by comparing to a new seal).	

Inspect	Maximum Serviceable Limits	Remarks
(6) Coked axial springs (4). (Carbon seal segments sticky and binding when checked by depressing gently with the fingers).	None allowed.	
(7) Buildup of coked oil or hard material in axial grooves (7).	Coked oil or hard material buildup allowed to maximum of 25% of the original depth of the grooves.	
(8) Buildup of coked oil or hard material in axial gaps (8).	None allowed.	
B. Assembled carbon seal housings, cover plate and snap ring for:		
(1) Nicks, dents, burrs, carbon and varnish deposits.	Any number, 0.005 inch with no high metal.	Remove high metal using a fine file or stone, wash part in trichloroethylene MIL-T-7003.

ANTI-FRICTION BEARING - INSPECTION

CAUTION: 1. THE NO. 2 AND NO. 4 BEARINGS ARE PHYSICALLY INTERCHANGEABLE, BUT ONE OF THE ALTERNATE NO. 4 BEARINGS IS NOT AUTHORIZED FOR USE IN THE NO. 2 POSITION. REFER TO SEI-137 FOR THE PROPER NO. 2 BEARING PART NUMBER PRIOR TO ASSEBMLY.

CAUTION: 2. BEARING COMPONENTS ARE MATCHED ASSEMBLIES. IF ANY PART OF A BEARING DOES NOT MEET THE INSPECTION REQUIREMENTS SPECIFIED AND IS REJECTED, THE ENTIRE BEARING MUST BE REJECTED.

CAUTION: 3. MATCHED DUPLEX BEARINGS MUST HAVE THE SAME SERIAL NUMBER AND THE SAME PART NUMBER.

1. General.

A. If any of the mainshaft bearings require replacement during hot section inspection or repair, the bearing must be replaced with a new or serviceable bearing with enough residual life to reach the next scheduled engine overhaul or bearing exposure. In any event, all mainshaft bearings must be replaced with new bearings at engine overhaul. Cumulative life limits on serviceable bearings are given in Inspection/Checks, 5-11-4.

B. Any of these bearings that have residual life remaining must meet serviceability limits of this section before reassembly to the engine. To control bearing reuse, the "TIME SINCE NEW" must be vibropeened on all serviceable bearings. Location of time marking on all bearings (except mainshaft bearings) shall be on the outer race on the side opposite the part identification number. See figure 1 for location of the time marking on mainshaft bearings.

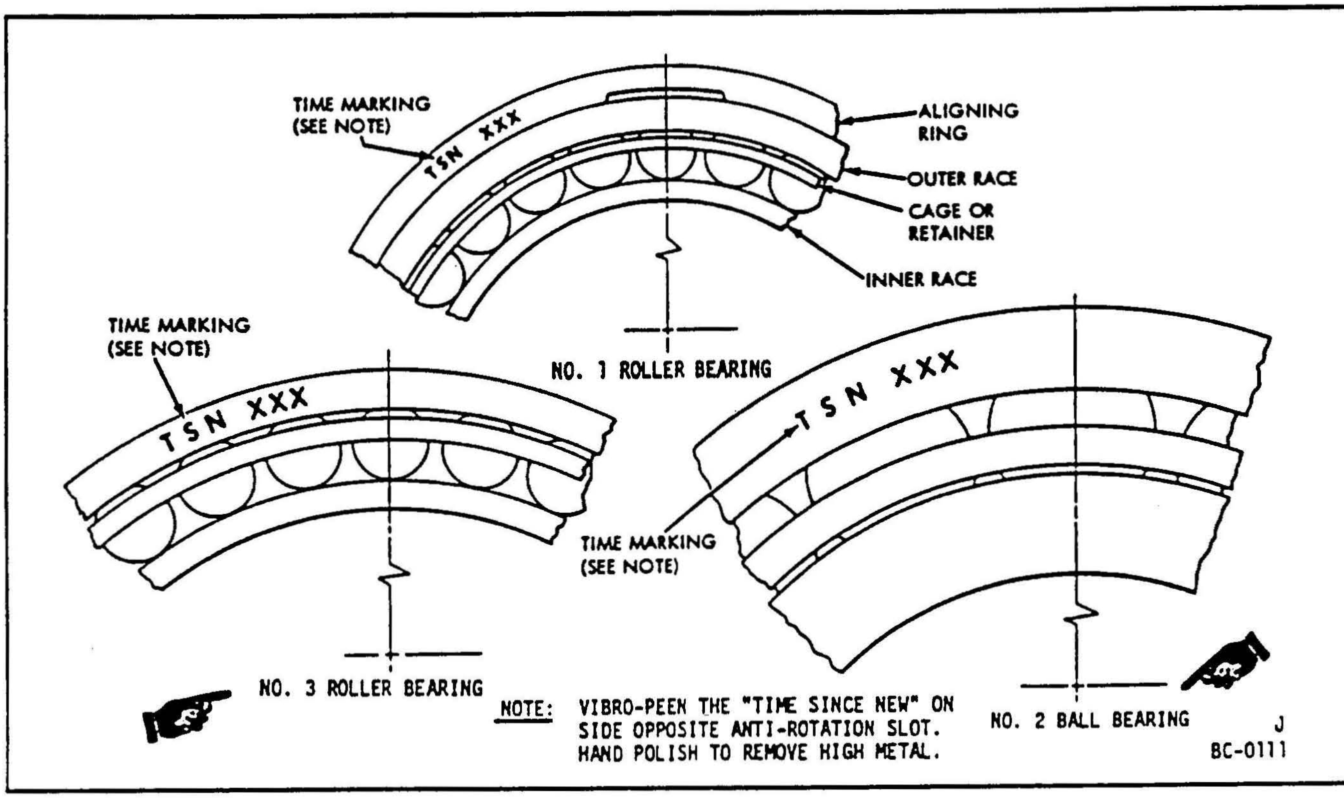
2. Bearing Cleaning Procedure.

A. Bearings may become magnetized and attract small foreign particles to the balls, rollers, or races. The attraction can be so strong that the particles will not come off during the soaking and washing operations. Therefore, completely demagnetize each bearing before cleaning.

B. Demagnetize non-separable bearings as an assembly, but demagnetize the component parts of separable bearings individually; be extremely careful not to mix the parts of one bearing with those of another.

CAUTION: HOLD TIGHTLY TOGETHER THE INNER AND OUTER RACE OF NON-SEPARABLE BEARINGS TO PREVENT THE BALLS OR ROLLERS FROM VIBRATING.

C. Turn the bearing races slowly as you pass them through the demagnetizer; turn the inner and outer races of non-separable bearings in opposite directions. Pass the bearings or bearing components through the demagnetizer at a rate not to exceed 12 feet per minute. Remove the bearings from the demagnetizing field before you de-energize the magnet.



Time-Marking of Engine Bearings
Figure 1

D. After the demagnetization, use a Gaussmeter (RFL Model 1890 or equivalent) to test the bearings or component parts for residual magnetism. If the reading exceeds 5 Gauss at any point, the demagnetization is incomplete.

CAUTION: DO NOT INTERMIX COMPONENTS OF ONE BEARING WITH ANOTHER. DO NOT ALLOW THE COMPONENTS OR BEARINGS TO BUMP AGAINST EACH OTHER DURING THE CLEANING PROCESS. NEVER SPIN OR ROTATE BEARING PRIOR TO CLEANING.

E. Separable bearings should be assembled before cleaning. All components of one bearing should be kept together during the cleaning process.

F. Allow the bearings to reach the temperature of the cleaning solvent before cleaning in order to prevent corrosion due to condensation.

WARNING: COMPRESSED AIR

WHEN USING COMPRESSED AIR FOR ANY COOLING, CLEANING, OR DRYING OPERATION, DO NOT EXCEED 30 PSIG AT THE NOZZLE.

EYES CAN BE PERMANENTLY DAMAGED BY CONTACT WITH LIQUID OR LARGE PARTICLES PROPELLED BY COMPRESSED AIR. INHALATION OF AIR-BLOWN PARTICLES OR SOLVENT VAPOR CAN DAMAGE LUNGS.

WHEN USING AIR FOR CLEANING AT AN AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GOGGLES OR FACE SHIELD.

WHEN USING AIR FOR CLEANING AT AN UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR AND GOGGLES.

WARNING: DRY CLEANING SOLVENT (STODDARD SOLVENT) P-D-680

COMBUSTIBLE - DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.

PROLONGED CONTACT OF SKIN WITH LIQUID CAN CAUSE DERMATITIS. REPEATED INHALATION OF VAPOR CAN IRRITATE NOSE AND THROAT AND CAN CAUSE DIZZINESS.

IF ANY LIQUID CONTACTS SKIN OR EYES, IMMEDIATELY FLUSH AFFECTED AREA THOROUGHLY WITH WATER. REMOVE SOLVENT-SATURATED CLOTHING. IF VAPORS CAUSE DIZZINESS, GO TO FRESH AIR.

WHEN HANDLING LIQUID OR WHEN APPLYING IT IN AN AIR-EXHAUSTED, PARTIALLY COVERED TANK, WEAR APPROVED GLOVES AND GOGGLES.

WHEN HANDLING LIQUID OR WHEN APPLYING IT AT UNEXHAUSTED, UNCOVERED TANK OR WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

G. Pressure flush each bearing component with a clean solvent-air spray. Do not allow bearing to spin during flushing. Dry cleaning (Stoddard) solvent, P-D-680 (Van Waters and Rogers, Colonial Rd., Salem, MA., 01970), is recommended. Solution should be 130°F. Use cleaning tank equipped with pump, 20-micron filtration, and stand pipes. Immerse bearings for 5 to 10 minutes and dip several times to give a thorough rinsing action before removal.

WARNING: CARBON REMOVAL COMPOUND, MIL-C-25107

COMBUSTIBLE - DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.

CONTACT WITH DRY MATERIAL OR LIQUID WILL CAUSE SEVERE EYE AND SKIN IRRITATION, AND BURNS. INHALATION OF VAPOR CAN CAUSE DROWSINESS AND PERMANENT LIVER, LUNG, AND KIDNEY DAMAGE.

IF ANY SOLUTION OR POWDER CONTACTS SKIN OR EYES, FLUSH AFFECTED AREA THOROUGHLY WITH WATER. IMMEDIATELY GET MEDICAL HELP. IMMEDIATELY REMOVE SOLVENT-SATURATED CLOTHING. IF VAPORS CAUSE DROWSINESS, GO TO FRESH AIR.

WHEN MIXING OR HANDLING SOLUTION AT AIR-EXHAUSTED, PARTIALLY COVERED TANK OR WORKBENCH, WEAR APPROVED GLOVES AND APRON, AND WEAR FACE SHIELD OR GOGGLES.

WHEN MIXING OR HANDLING SOLUTION AT UNEXHAUSTED, UNCOVERED TANK OR WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES AND APRON, AND WEAR FACE SHIELD OR GOGGLES.

CAUTION: FILTER AND SOLUTION MUST BE CHANGED REGULARLY TO MINIMIZE CONTAMINATION.

H. If carbon deposits, varnish, or other foreign materials remain on the bearing surfaces, soak the part for 5 minutes in an ultrasonic cleaning tank using a carbon remover. Turco 2538 (MIL-C-25107) may be used (Turco Products, Inc., P.O. Box 195, Marion, OH 43302, U.S.A.). Reflush per paragraph G. Do not allow the carbon remover to contaminate the Stoddard Solvent Tank.

WARNING: DRY CLEANING SOLVENT P-D-680 OBSERVE WARNING IN STEP G.

I. Rinse bearings in a solution of dry cleaning solvent, P-D-680, at room temperature in a tank equipped with a pump and 10-micron filtration. Dip bearings (handle with tongs, gloves, or a metal rack) in the solution at least five times and drain for 1 minute. Filter and solution must be changed regularly.

WARNING: ENGINE OIL

IF OIL IS DECOMPOSED BY HEAT, TOXIC GASES ARE RELEASED.

PROLONGED CONTACT WITH LIQUID OR MIST MAY CAUSE DERMATITIS AND IRRITATION.

IF THERE IS ANY PROLONGED CONTACT WITH SKIN, WASH AREA WITH SOAP AND WATER. IF SOLUTION CONTACTS EYES, FLUSH EYES WITH WATER IMMEDIATELY. REMOVE SATURATED CLOTHING.

IF OIL IS SWALLOWED, DO NOT TRY TO VOMIT, GET IMMEDIATE MEDICAL ATTENTION.

WHEN HANDLING LIQUID, WEAR RUBBER GLOVES. IF PROLONGED CONTACT WITH MIST IS LIKELY, WEAR APPROVED RESPIRATOR.

J. After rinsing, dip the bearing in an engine oil conforming to GE Aircraft Engines Specification D50TF1 (see 79-00, Servicing for listing of approved oils) and rotate one race slowly, relative to the other, to ensure that all surfaces are covered with oil.

(1) Bearings to be used for immediate requirements are to be wrapped and placed in their individual containers.

(2) Bearings to be stored for an unknown time duration are to be wrapped in grease-proof wrapping paper and placed in covered containers.

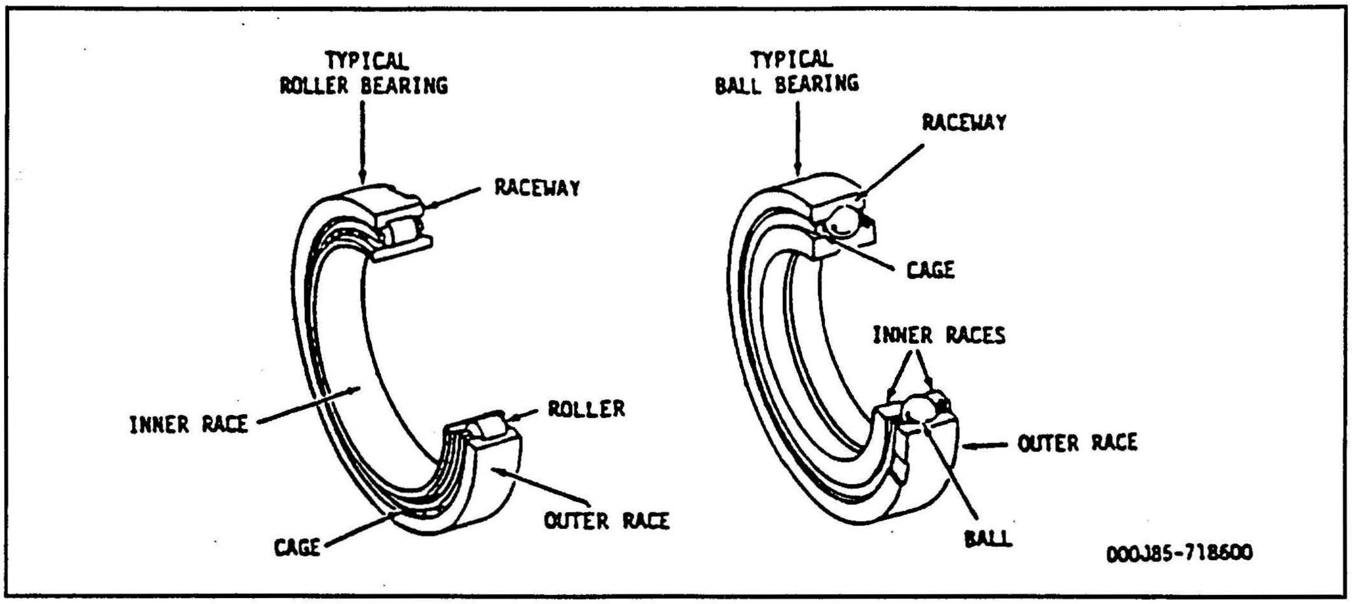
3. Handling Of Bearings.

A. Keep handling of bearings to a minimum. When inspecting, wear clean synthetic rubber gloves so that bare hands do not contact the bearing balls, rollers, or race active surfaces at any time. See figure 2 for identification of bearing components.

B. Do not allow components of one bearing to mix with those of another.

C. If for any reason, one unit of a bearing is rejected, always reject the complete bearing.

D. Do not inspect bearings (or components) by the magnetic-particle inspection method. (This precaution is taken to prevent burning of the parts during magnetization.) If a bearing component is assembled to a part which is to be magnetic-particle inspected, the bearing component shall be removed from the part.



Engine Bearings - Typical
Figure 2

4. List of Terms.

A. Nicks. Sharp indentation.

B. Scratch. Long narrow impression.

C. Dents. Smooth surface cavity.

D. Pitting. A shallow, irregular sharp-edged hole with a rough bottom and no material displacement. Pitting is caused by corrosion or spalling on the bearing active surfaces.

E. Skidding. Skid marks appear as a frosted film on the otherwise highly polished surface. Microscopic examination will show that the film is a transfer of metal.

F. Groove. Continuous channel having no sharp edges.

G. Scoring. Circumferential polished groove on either the race or rollers. Scoring is caused by foreign material trapped in the bearing and being pushed by the rollers.

H. Active Surface. Surface which comes in contact with roller or ball during engine operation.

I. Inactive Surface. Surface which is not active.

J. Wear. Removal of parent material.

K. Discoloration. Bearing in service usually has a brownish color, caused by varnish deposits left by oil. Bluing or black carbon buildup on bearing is a sign of overheating and is cause for rejecting bearing.

L. Spalling. A sharply roughened area caused by cracking off, or flaking off of small particles of metal.

M. Fretting. Loss of metal caused by rubbing against another metal.

N. Distortion. Twisting or bending out of a normal, natural, or original shape.

5. Preliminary Instructions. (See figure 2.) Inspect ball and roller bearings as instructed in paragraph 6. The inspection limits for main engine bearings in paragraph 6 take precedence over all other technical references for bearing inspection.

A. Bearings shall be inspected when:

(1) Bearings are removed from the engine during engine disassembly.

(2) Bearing housings containing assembled bearings are removed from the engine (remove bearings from housing and inspect).

(3) Chip detector inspection indicates contaminants in the lube system.

(4) Turbine or compressor rotor are removed because vibration limits have been exceeded.

B. Bearing surface defects shall be located and identified using 0.030-inch-radius tip scriber.

C. Visually inspect all bearing surfaces for heat discoloration as instructed in paragraph 6. Bearing steels that have been subjected to high temperatures will vary in color from light straw, to brown, to purple, to blue, to black.

D. Visually inspect bearings for surface defects (pits, grooves, scratches, dents, fretting, etc.) as instructed in paragraph 6.

E. Using a 0.030-inch-radius tip scriber, inspect any defects that are found during visual inspection as follows:

(1) Position scriber at right angles to surface having defects.

(2) Apply light pressure to scriber and move tip transversely across defect.

NOTE: Defects shall be disregarded if they can be seen but not felt when using a 0.030-inch-radius tip scriber.

(3) Disregard defect if it cannot be felt when scriber tip is moved across it.

6. Inspect the Following Areas. (See figure 2.) This inspection is limited to those surfaces exposed during normal engine maintenance or repair. Do not remove rollers from their retainers to inspect the inner or outer race.

Inspect	Maximum Serviceable Limits	Remarks
CAUTION: 1. BEARING COMPONENTS ARE MATCHED ASSEMBLIES. IF ANY PART OF A BEARING DOES NOT MEET INSPECTION REQUIREMENTS AND IS REJECTED, THE ENTIRE BEARING MUST BE REJECTED.		
CAUTION: 2. BE SURE THAT ANTIROTATION PIN OF NO. 1 BEARING IS FLUSH TO 0.005 INCH BELOW SURFACE AT OD.		
A. Engine Main and Accessory Bearings.		
NOTE: Inspection of bearings for heat discoloration is done only after cleaning operation has removed all oil stains and deposits.		
(1) All bearings for:		
(a) Heat discoloration and stains on balls, rollers, and raceways.	Straw or light brown color is acceptable. Purple, blue, or black color is not acceptable.	Replace bearing.
(b) Correct material.	Attracted to a magnet.	Replace bearing.
(2) Cage for:		
(a) Scratches, pits, and nicks on inactive surfaces.	Any number allowed.	Not applicable.
(b) Dents.	Visible dents are not allowed.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
(c) Distortion.	Visible distortion is not allowed.	Replace bearing.

CAUTION: IF WEAR IS FOUND ON SILVER PLATE, A HIGH VIBRATION CONDITION MAY EXIST. REFER TO OPERATING LIMITS.

Inspect	Maximum Serviceable Limits	Remarks
(d) Worn silver plate (determined visually):		
1 Polished appearance.	Any amount allowed.	Not applicable.
2 Feathering (overlap) of silver plate into roller or ball socket.	None allowed.	Replace bearing.
3 Wear thru silver plate on ID or on No. 2 ball socket.	Base material exposure limited to ± 10 degrees to a radial plane passing circumferentially thru the ball socket.	Replace bearing.
4 Wear thru silver plate on No. 1 and 3 roller pocket.	Base material exposure in a line of width that does not exceed 0.060 inch is acceptable.	Replace bearing.
(e) Dents, nicks, and scratches on active and/or inactive surfaces.	None allowed.	Replace bearing.
(f) Cracks.	None allowed.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks

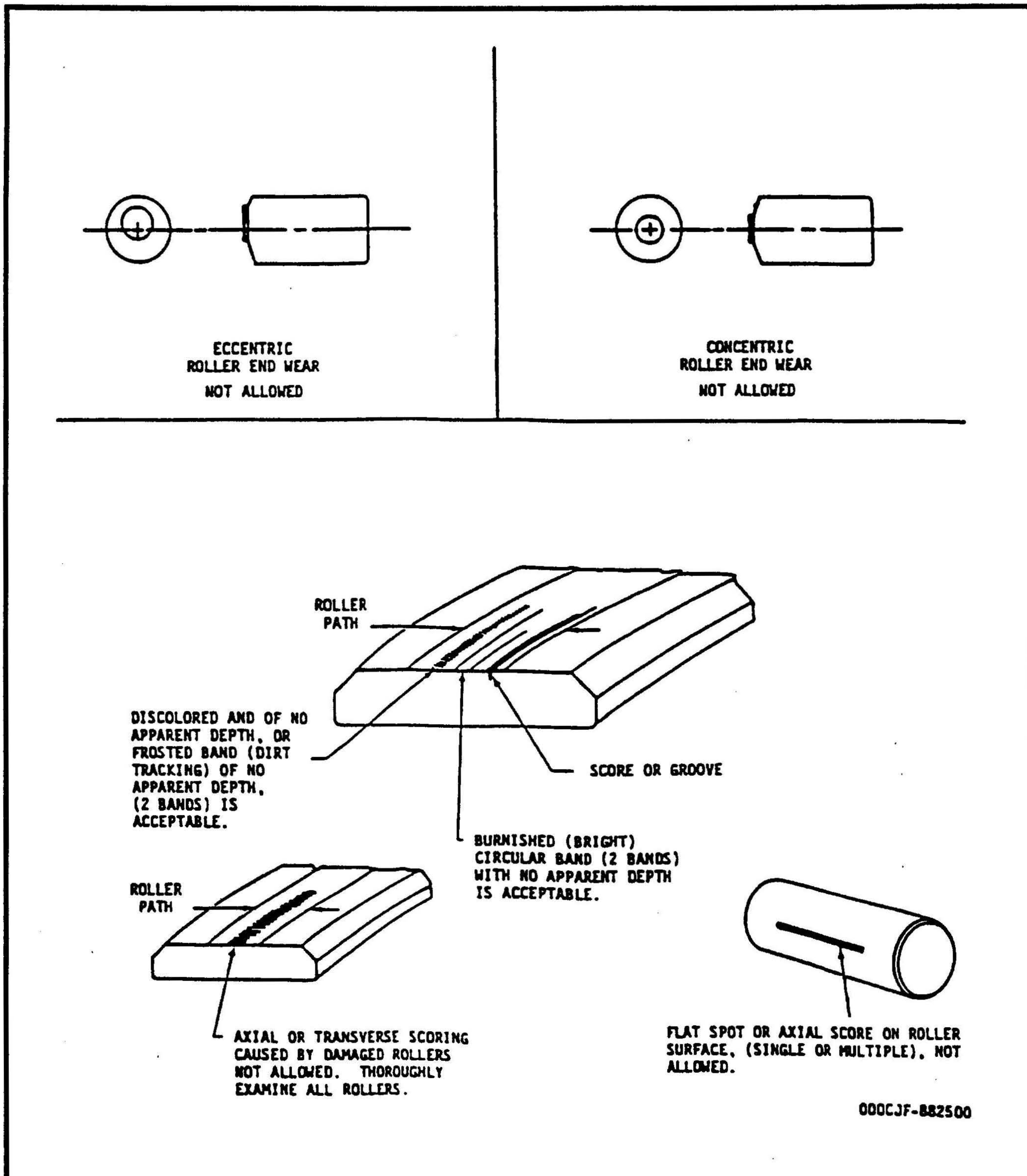
CAUTION: BE SURE THAT ANTIROTATION PIN OF NO. 1 BEARING IS FLUSH TO 0.005 INCH BELOW SURFACE AT OD.

(3) No. 1 and 3 roller bearings for:

NOTE: Roller bearing visual inspection is limited to those surfaces visible after removal from engine.

Inspect	Maximum Serviceable Limits	Remarks
(a) Circumferential grooves or scores on rollers.	Three per roller on 50 percent of rollers, with none wider than 0.010 inch;or none that can be felt with a 0.030-inch-radius tip scriber.	Replace bearing.
(b) Scratches on rollers.	(1) Scratches that exceed 0.010 inch width are not allowed.	Replace bearing.
	(2) Crossed scratches are not allowed.	Replace bearing.
	(3) One scratch per roller allowed up to half the circumference, provided width is within limits.	Replace bearing.
	(4) Three scratches per roller allowed, up to 25 percent of the circumference, provided width is within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
	(5) Any number less than 0.1 inch in length, provided width is within limits.	Replace bearing.
(c) Pits on rollers.	None allowed.	Replace bearing.
(d) Concentric wear on roller ends. (See figure 3.)	Any roller having end wear with a detectable step is not usable.	Replace bearing.
(e) Eccentric wear. (See figure 3.)	None allowed.	Replace bearing.
(f) Cracks on rollers.	None allowed.	Replace bearing.
(g) Nicks and smooth dents on rollers.	(1) Nicks or dents that exceed 0.015 inch in greatest dimension are not allowed.	Replace bearing.
	(2) Three nicks or dents per roller within a 0.25 inch diameter circle if greatest dimension of defect is within limits.	Replace bearing.



Race Way and Roller - Imperfections
Figure 3

Inspect	Maximum Serviceable Limits	Remarks
(h) Flat spots on rollers.	None allowed.	Replace bearing.
(4) Roller bearing raceway active surfaces for:		
(a) Scratches on roller path.	(1) Scratches that exceed 0.010 inch in width are not allowed.	Replace bearing.
	(2) No crossed scratches allowed.	Replace bearing.
	(3) One circum-ferential scratch allowed per raceway up to 0.50 inch in length, pro-vided width is within limits.	Replace bearing.
	(4) Three scratches allowed per raceway up to 50 percent across raceway, pro-vided width is within limits.	Replace bearing.
	(5) Any number less than 0.1 inch in length, provided width is within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
(b) Pits on roller path.	None allowed.	Replace bearing.
(c) Scoring.	Any amount that cannot be felt with a 0.030-inch-radius tip scriber.	Replace bearing.
(d) Cracks.	None allowed.	Replace bearing.
(e) Skidding (dull areas in an otherwise shiny roller path) on roller path.	None allowed.	Replace bearing.
(5) Roller bearing raceway inactive surfaces for:		
(a) Axial scratches on OD of outer race and ID of inner race.	(1) Axial scratches are acceptable, provided defect dimensions are within limits and scratch does not extend across corner radii, across chamfers onto the bore, or across outer diameter surface. No high metal allowed.	Replace bearing.
	(2) Scratches that exceed 0.015 inch in width are not allowed.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
	(3) Ten scratches per race greater than 0.1 inch long with no high metal, provided width is within limits.	Replace bearing.
	(4) Any number of scratches per race less than 0.1 inch long with no high metal, provided width is within limits.	Replace bearing.
(b) Corrosion stains on surfaces other than roller track.	25 percent of width, thickness, or circumference with no measurable depth.	Replace bearing.
(c) Fretting on ID, OD, and side surfaces of roller bearing.	Max fretted area 0.5 square inch; max depth in fretted area 0.001 inch, with no high metal.	Replace bearing.
(d) Pits.	None allowed.	Replace bearing.
(e) Nicks and smooth dents.	(1) Nicks and dents that do not exceed 0.015 inch in greatest dimension are within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
	(2) Up to three nicks or dents per raceway allowed within 0.25 inch diameter circle, provided defect dimensions are within limits.	Replace bearing.
(6) No. 2 and accessory drive ball bearings for:		

NOTE: The only ball bearing that can be easily inspected is the No. 2 bearing. Accessory gearbox, transfer gearbox, and PTO ball bearings can be 100 percent inspected only after disassembly by a qualified bearing inspection vendor.

Inspect	Maximum Serviceable Limits	Remarks
(a) Scratches on balls.	(1) Scratches that exceed 0.010 inch in width are not allowed.	Replace bearing.
	(2) No crossed scratches allowed.	Replace bearing.
	(3) One scratch per ball allowed up to half the circumference, provided width is within limits.	Replace bearing.
	(4) Any number less than 0.1 inch in length, provided width is within limits.	Replace bearing.
(b) Pits on balls.	None allowed.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
(c) Nicks and smooth dents on balls.	(1) Nicks or dents that exceed 0.025 inch in greatest dimension are not allowed.	Replace bearing.
	(2) Three nicks or dents per ball allowed in 0.25 inch diameter circle, provided defect dimensions are within limits.	Replace bearing.
(d) Skidding (dull areas in an otherwise shiny path) on balls.	None allowed.	Replace bearing.
(e) Scoring on balls.	None allowed.	Replace bearing.
(f) Cracks on balls.	None allowed.	Replace bearing.
(7) Ball bearing raceway active surfaces for:		
(a) Scratches.	(1) Scratches that exceed 0.010 inch width are not allowed.	Replace bearing.
	(2) No crossed scratches allowed.	Replace bearing.
	(3) One circumferential scratch allowed per raceway up to 0.50 inch in length, provided width is within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
	(4) Three scratches allowed per raceway, no more than 50 percent across raceway, provided width is within limits.	Replace bearing.
	(5) Any number less than 0.1 inch in length, provided width is within limits.	Replace bearing.
(b) Pits.	None allowed.	Replace bearing.
(c) Nicks and smooth dents.	(1) Nicks or dents that exceed 0.010 inch in greatest dimension are not allowed.	Replace bearing.
	(2) Three nicks or dents per raceway allowed in 0.25 inch diameter circle, provided defect dimensions are within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
(8) Ball bearing raceway inactive surfaces for:		
(a) Axial scratches on the OD of outer race and ID of inner race.	(1) Axial scratches are acceptable provided defect dimensions are within limits and scratches do not extend across corner radii, across chamfers onto the bore, or across outer diameter surface. No high metal allowed.	Replace bearing.
	(2) Scratches that exceed 0.015 inch in width are not allowed.	Replace bearing.
	(3) Any number of scratches per race less than 0.10 inch long, with no high metal, provided width is within limits.	Replace bearing.
	(4) Up to 10 scratches longer than 0.10 inch, with no high metal, provided width is within limits.	Replace bearing.

Inspect	Maximum Serviceable Limits	Remarks
(b) Fretting on OD of bearing outer race.	Max fretted area 1.0 sq. inch in a 6-inch circumference; max depth in fretted area 0.001 inch with no high metal.	Replace bearing.
(c) Corrosion stains on surfaces other than raceway path.	20 percent of width, thickness, or circumference with no measurable depth.	Replace bearing.
(d) Pits.	Any number that cannot be detected using 0.030-inch-radius tip scriber not exceeding 20 percent of contact area of the inner race bore, outer race outside diameter, and surfaces affecting face squareness or assembly.	Replace bearing.
(e) Cracks.	None allowed.	Replace bearing.

WELDING PROCEDURES - GENERAL

1. General. All welding should be done by a qualified welding operator. No repair welds other than those authorized in the repair procedures should be attempted without approval of a General Electric Representative. Any procedure involving the melting of a filler or of the parent metal will be performed in accordance with this section. This includes welding, brazing, or soldering.

2. General Welding Procedures.

   NOTE: Weld repairs may be difficult in some areas due to space restrictions. In these cases it may be helpful to consider the use of torches having flexible type necks.

   A. Clean all oils and grease from surface to be welded. If any other foreign material is present, remove it by wire brushing, vapor degrease or vapor blasting the surface.

   B. Remove any defect in the part before welding. Grind out the cracked area and spot fluorescent-penetrant, per 72-03-1, to make sure entire cracked area has been removed.

   C. Weld the damaged area using the rod suited for the metal being repaired. A suitable weld rod will be found in the repair procedure for any part that has allowable weld repair.

   D. After repair welding is completed, the weld should be cleaned and inspected to make sure a good quality weld has been performed.

3. General Inert Arc Procedure.

A. Preparation of Material. Prior to welding the area to be welded should be cleaned, inspected, ground, etched and inspected.

WARNING: TRICHLOROETHANE VAPORS ARE HARMFUL - DO NOT USE NEAR OPEN FLAMES, OR ON VERY HOT SURFACES.

DO NOT USE NEAR WELDING AREAS, A SOURCE OF CONCENTRATED ULTRA-VIOLET RAYS. INTENSE ULTRAVIOLET RAYS CAN CAUSE THE FORMATION OF PHOSGENE GAS, WHICH IS INJURIOUS TO THE LUNGS.

USE ONLY WITH ADEQUATE VENTILATION. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS.

AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. WEAR APPROVED GLOVES AND GOGGLES (OR FACE SHIELD) WHEN HANDLING AND WASH HANDS THOROUGHLY AFTER HANDLING.

DO NOT TAKE INTERNALLY.

DO NOT SMOKE WHEN USING IT.

STORE IN APPROVED METAL SAFETY CONTAINERS.

(1) Clean the area of all dirt, paint, scale, rust and inorganic foreign material. Remove all oil or grease by wiping area with a solvent that does not leave a film upon drying. Trichloroethane, Fed. Spec. O-T-620, is recommended.

(2) Inspect the area, using spot fluorescent penetrant, to determine location and extent of crack. Where possible both sides of material should be inspected.

(3) Cracks should be prepared for welding by grinding and/or benching.

(a) Cracks that do not extend to both surfaces shall be completely removed. Length should extend 0.125 inch beyond the end of the crack and the width should be enough to completely remove the crack.

(b) Through-cracks should be prepared as follows:

Stock Thickness	Preparation
to 0.045 inch	Grind to 50 percent of parent metal thickness.
0.045 to 0.090 inch	Grind to 75 percent of parent metal thickness.
0.090 inch and larger	Grind to within 0.030 inch of opposite surface.

(4) Etch all areas to be welded.

(5) Inspect the area using spot fluorescent-penetrant method to make certain all of the crack has been removed.

B. Weld the crack using the following:

(1) Filler Material - See specific part information

(2) Shielding Gas - Argon to 10 to 15 cubic feet per hour

(3) Amperage requirements:

Nominal Thickness	Amperage (DC Straight Polarity)
to 0.045	30-40
0.045 to 0.065	50-60
0.065 to 0.090	60-80
over 0.090	60-80 (Multipass)
Castings	60-100

NOTE: A remote control, variable current device should be employed to minimize heat input. Arctrol (Mullenback Electrical Manufacturing Co., P.O. Box 15436, 2300 East 27th Street, Los Angeles, Calif.) or equivalent is recommended.

(4) Use gas and/or copper backing directly behind repair weld areas. Never allow the weld penetration to be directly exposed to air since this causes the formation of oxides on the weld bead which reduces the strength of the weld.

NOTE: Gas backing provides the best protection against oxidation while copper backing is used mainly to prevent distortion of the part in the repair area. If both backing methods cannot be used at the same time, gas is the preferred backing method.

(5) Multipass weld if required. Each bead should be thoroughly cleaned by grinding or rotary filing, followed by wire-brushing. Wipe clean with acetone prior to next pass. Where welding is performed on both sides, the root shall be ground or rotary filed to sound metal, inspected, wire-brushed and cleaned with acetone before resuming welding.

C. Clean the welded area thoroughly with a wire brush to remove scale or oxide.

D. Inspect weld area using spot fluorescent-penetrant method.

4. Welding Standards. All welds should conform to standards contained in General Electric Spec M50T1.

TOUCHUP, PROTECTIVE COATING (SERMETEL AND SOLARAMIC)

1. General. Solaramic S5-8A (International Harvester Co., Solar Division, 2200 Pacific Highway, San Diego, California 92101) is an oven-fired ceramic coating. Solaramic coated parts having minor damage may be touched-up in place with SermeTel 413. The part must be removed and returned to an overhaul facility to accomplish touch-up with Solaramic. SermeTel 413 (Teleflex Inc., North Wales, Pennsylvania) is a room temperature curing chromium oxide coating compound. If unavailable, SermeTel 196 or 250 may be used.

WARNING: SERMETEL COMPOUNDS ARE HIGHLY COMBUSTIBLE. CARE SHALL BE TAKEN TO MINIMIZE DANGER OF EXPLOSION AND FIRE HAZARDS.

2. Procedure. SermeTel may be used to touch-up areas not exceeding 10 percent of the total coated area.

A. Clean the area to be touched up, using only dry or wet blasting with 200-500 mesh aluminum oxide or with abrasive cloth. If wet blasting is used, part should be dried immediately after rinsing to prevent corrosion.

WARNING: TRICHLOROETHANE VAPORS ARE HARMFUL - DO NOT USE NEAR OPEN FLAMES, OR ON VERY HOT SURFACES.

DO NOT USE NEAR WELDING AREAS, A SOURCE OF CONCENTRATED ULTRA-VIOLET RAYS. INTENSE ULTRAVIOLET RAYS CAN CAUSE THE FORMATION OF PHOSGENE GAS, WHICH IS INJURIOUS TO THE LUNGS.

USE ONLY WITH ADEQUATE VENTILATION. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS.

AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. WEAR APPROVED GLOVES AND GOGGLES (OR FACE SHIELD) WHEN HANDLING AND WASH HANDS THOROUGHLY AFTER HANDLING.

DO NOT TAKE INTERNALLY.

DO NOT SMOKE WHEN USING IT.

STORE IN APPROVED METAL SAFETY CONTAINERS.

B. Clean the part by vapor degreasing or by wiping the area with a clean rag, moistened in trichloroethane, Fed. Spec. O-T-620, or equivalent.

C. Apply SermeTel 413 by brushing (1 coat) or by spraying (3 coats). If SermeTel 413 (green color) is not available, use SermeTel 196 or 250 (aluminum color).

D. Air dry for 24 hours (10 minutes between spray coats).

NOTE: Make sure that no water or foreign matter comes in contact with the coated surface during this period.

TOUCHUP, A12/HI51 INTERMETALLIC DIFFUSION COATING

1. General.

   A. A12 (Manufactured by Chromalloy American Corp., Turbine Support Division (TSD), 4430 Director Drive, San Antonio, Texas 78220). The touchup solution (TSD process No. SPM-1771) is available with touchup kit, P/N PM-11. The kits have a shelf-life of 6 months (90 days maximum after container is opened).

   B. HI51 (Manufactured by Alloy Surfaces, 100 Justison Road, Wilmington, Delaware 19849).

   NOTE: HI51 and A12 material may be used interchangeably to touch up coated surfaces.

   C. These coatings are aluminum base, intermetallic diffusion types which give ferrous alloys excellent corrosion resistance.

   WARNING: AVOID PROLONGED OR REPEATED CONTACT WITH SKIN -- WASH HANDS WITH SOAP AND WATER AFTER USE.

2. Surface Preparation:

   WARNING: TRICHLOROETHANE VAPORS ARE HARMFUL - DO NOT USE NEAR OPEN FLAMES, OR ON VERY HOT SURFACES.

   DO NOT USE NEAR WELDING AREAS, A SOURCE OF CONCENTRATED ULTRA-VIOLET RAYS. INTENSE ULTRAVIOLET RAYS CAN CAUSE THE FORMATION OF PHOSGENE GAS, WHICH IS INJURIOUS TO THE LUNGS.

   USE ONLY WITH ADEQUATE VENTILATION. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS.

   AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. WEAR APPROVED GLOVES AND GOGGLES (OR FACE SHIELD) WHEN HANDLING AND WASH HANDS THOROUGHLY AFTER HANDLING.

   DO NOT TAKE INTERNALLY.

   DO NOT SMOKE WHEN USING IT.

   STORE IN APPROVED METAL SAFETY CONTAINERS.

   A. Remove contaminants from the area to be repaired, using an abrasive pad such as Scotchbrite (manufactured by 3M Co.) or equivalent.

   B. Degrease the surface area, using an abrasive pad moistened with trichloroethane.

   C. Remove loose particles in area to be touched up, using 600-grid silicon carbide abrasive paper.

   D. Remove abrasive dust, using oil-free and moisture-free compressed air or a lint-free swab and trichloroethane.

3. Application.

A. Apply A12 or HI51 touchup solution, using a brush or other suitable lint-free applicator. Cover all exposed metal completely. Remove all excess solution to produce a thin, continuous film before curing.

B. Air-cure for at least 10 minutes.

NOTE: For maximum protection, 2 touchup coats are recommended. Allow the first coat to cure for at least 10 minutes before applying the second coat.

TOUCHUP, TSM-3 INTERMETALLIC DIFFUSION COATING

1. General. TSM-3 (Manufactured by Chromalloy American Corp., Turbine Support Division (TSD), 4430 Director Dr., San Antonio, Texas, 78220) is a magnesium base, intermetallic diffusion coating that has a dark gray appearance which gives low alloy steels excellent corrosion resistance. The touchup material (TSD process No. SPM-1777) adheres to parent metal and to surfaces coated with TSM-3 when properly applied. The touchup mixture, P/N PM-12, can be applied with a brush or thinned with solvent, P/N PM-13, and applied with a spray gun. The shelf-life of the touchup kit is limited to 90 days. Kits can be purchased from Chromalloy American Corp.

WARNING: TSM-3 TOUCHUP COATING VAPORS ARE HARMFUL - USE ONLY IN WELL VENTILATED AREAS.

FLAMMABLE - DO NOT USE NEAR WELDING AREAS, OR NEAR OPEN FLAMES OR SPARKS.

AVOID PROLONGED OR REPEATED CONTACT WITH SKIN - WASH HANDS WITH SOAP AND WATER AFTER USE.

STORE IN APPROVED METAL SAFETY CONTAINERS.

DO NOT SMOKE IN VICINITY OF APPLICATION.

2. Surface Preparation.

WARNING: TRICHLOROETHANE VAPORS ARE HARMFUL - DO NOT USE NEAR OPEN FLAMES, OR ON VERY HOT SURFACES.

DO NOT USE NEAR WELDING AREAS, A SOURCE OF CONCENTRATED ULTRA-VIOLET RAYS. INTENSE ULTRAVIOLET RAYS CAN CAUSE THE FORMATION OF PHOSGENE GAS, WHICH IS INJURIOUS TO THE LUNGS.

USE ONLY WITH ADEQUATE VENTILATION. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS.

AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. WEAR APPROVED GLOVES AND GOGGLES (OR FACE SHIELD) WHEN HANDLING AND WASH HANDS THOROUGHLY AFTER HANDLING.

DO NOT TAKE INTERNALLY.

DO NOT SMOKE WHEN USING IT.

STORE IN APPROVED METAL SAFETY CONTAINERS.

A. Remove contaminants from the area to be repaired, using an abrasive pad such as Scotchbrite (manufactured by 3M Co.) or equivalent.

B. Degrease the surface area, using an abrasive pad moistened with trichloroethane.

C. Remove loose particles in area to be touched up, using 600-grit silicon carbide abrasive paper.

D. Remove abrasive dust, using oil-free and moisture-free compressed air or a lint-free swab and trichloroethane.

3. Touchup Application.

A. Thoroughly mix contents in bottle of touchup coating material.

B. Apply mixture, while particles are in suspension, using a brush or other suitable lint-free applicator. Cover all exposed metal completely.

NOTE: To keep particles in suspension while using the touchup mixture, repeat step A. as required.

C. Heat the coated area to 500-550°F (260-288°C) for at least 10 minutes. Curing can be done in an oven or with a heat gun providing the cure cycle limits are adhered to.

D. Trial-fit mating parts and, if necessary, remove high spots, using 600-grit silicon carbide paper.

TOUCHUP, SERMETEL 725 PROTECTIVE COATING

1. General. SermeTel (725 - Teleflex Inc., North Wales, PA) coating is applied as a protective coating to surfaces that are subject to corrosion. SermeTel coating is light gray and has a dull finish similar to a vapor-blasted surface. The procedure is of a general nature and should be used in conjunction with details given for individual parts.

WARNING: SERMETEL 725 COATING CONTAINS ALUMINUM PARTICLES OF A 5 TO 10 MICRON SIZE. THESE PARTICLES, WHEN ACCUMULATED IN THE DRIED STATE, REACT SIMILAR TO PURE ALUMINUM OF THE SAME PARTICLE SIZE WHEN IGNITED. EXPLOSIVE PRESSURES ARE GENERATED WHEN IGNITION OF AN AIR MIXTURE (DUST CLOUD) OCCURS.

SERMETEL 725 COATING ALSO REACTS WITH ALKALINE SOLUTIONS AND MANY ACIDS TO LIBERATE HYDROGEN GAS WHICH, WHEN IGNITED, GENERATES EXPLOSIVE PRESSURE.

CARE SHALL THEREFORE BE TAKEN TO PREVENT ACCUMULATION OF SERMETEL 725 COATING OVERSPRAY RESIDUES. PARTICULAR ATTENTION SHALL BE TAKEN TO ASSURE ACCUMULATIONS DO NOT OCCUR WHERE THEY CAN BE DISPERSED IN AIR (SHAKEDOWN OF A DUCT FOR EXAMPLE) OR WHERE THEY MAY BECOME MIXED WITH ALKALINES OR CERTAIN ACIDS.

2. Preparation for Coating.

A. Mask all areas not to be painted per detailed part instructions.

B. Wipe clean with a lint-free cotton cloth.

NOTE: Following cleaning operations do not handle parts with bare hands. Clean, white, cotton gloves should be worn to handle parts after cleaning. If parts are not to be coated within four hours after cleaning, they should be stored in clean, sealed polyethylene bags.

3. Application of Coating.

A. Coating shall be applied to the required thickness in separately cured coats.

NOTE: Unless otherwise specified, coating shall be 0.0015-0.003 inch thick.

B. Standard paint spray equipment is preferred for application. Use a DeVilbiss Model PEGA-502-390F nozzle (DeVilbiss Corporation, Somerset, Pennsylvania) or equivalent.

C. SermeTel 725 is used as received; no thinning is necessary.

NOTE: During use, the coating should be continuously agitated to assure that solids do not settle out of suspension.

4. Procedure.

A. Apply touchup coat by either brush or spray as follows:

(1) Spray part until a uniform green coating is obtained. Spray with nozzle held 8 inches from and parallel to the work piece.

(2) Brush coating material on the part.

(3) Air-dry part at room temperature for at least 15 minutes.

CAUTION: CURING MUST BE ACCOMPLISHED AS SOON AS POSSIBLE AFTER SPRAYING OR BRUSHING. IF NOT, THE COATING WILL ABSORB MOISTURE AND WEAKEN THE EFFECTIVENESS OF THE PROTECTIVE COATING.

B. Apply and cure second base coat same as the first coat if necessary.

C. Check the finish as follows:

(1) Coating should be free from cracks, foreign matter, bubbles, pin holes, runs, sags, or other imperfections.

(2) When finish is rubbed with either cloth or cotton dampened with water, the base metal will not be exposed; if it is, the coating must be stripped and reapplied.

NOTE: A light uniform deposit of powdery material may be deposited on the cotton swab and not require re-finishing.

SPOT METHOD OF POST EMULSIFIED LIQUID PENETRANT INSPECTION

1. General. This method is not intended as a substitute for the standard method of post emulsified liquid penetrant inspection. However, it is considered an acceptable alternate process for the detection of surface defects after repair operations to remove known defects, or for the inspection of isolated areas when it is not considered practical to process the entire part.

2. Materials and Equipment Required.

   A. Post emulsifiable fluorescent liquid penetrant (ZL-2 or ZL-22, Magnaflux Corp., or equivalent).

   B. Cleaner (spray-can used in red dye penetrant inspection, Magnaflux Corp., or equivalent).

   C. Developer (ZP-4, or spray-can used in red dye penetrant inspection, Magnaflux Corp., or equivalent).

   D. Black light equipped with canvas hood and viewing slot (Magnaflux Corp., or equivalent).

3. Procedure.

   A. Parts should be thoroughly cleaned by a process that will remove all traces of scale, carbon, grease, and oils or other foreign matter.

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN..

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

   B. Apply penetrant oil (ZL-2 or ZL-22) to areas to be inspected. Penetrant oil may be applied by either brushing or spraying.

C. Allow penetrant oil to remain on parts for a minimum period of 15 minutes.

D. Remove excess penetrant oil from surface of part by wiping the area, using a cloth moistened with the cleaner used in the red dye penetrant inspection kit.

E. Inspect area with black light to ensure complete removal of excess penetrant oil.

F. Apply developer.

<u>NOTE</u>: The ZP-4 Fluffy Dry Powder provides the greatest sensitivity and can be applied by brushing or any other means of application that will provide coverage of the area to be inspected. The wet developer, also included in the red dye penetrant inspection kit, may be used as an alternate when a wet developing method is desired.

G. Allow a minimum period of 5 minutes for proper development of indications.

H. Place hooded canvas area of black light directly over area to be inspected. View area through slot provided for this purpose.

<u>NOTE</u>: Parts may be inspected in black light inspection booth if conditions permit.

I. Encircle defective areas with suitable identification, such as layout fluid or chalk.

COMPRESSOR SECTION - DESCRIPTION AND OPERATION

1. General. The Compressor Section of the CF700 engine consists of the compressor front frame, compressor stator casing, compressor rotor and mainframe assemblies. A brief description of their construction and function will be covered in the following paragraphs.

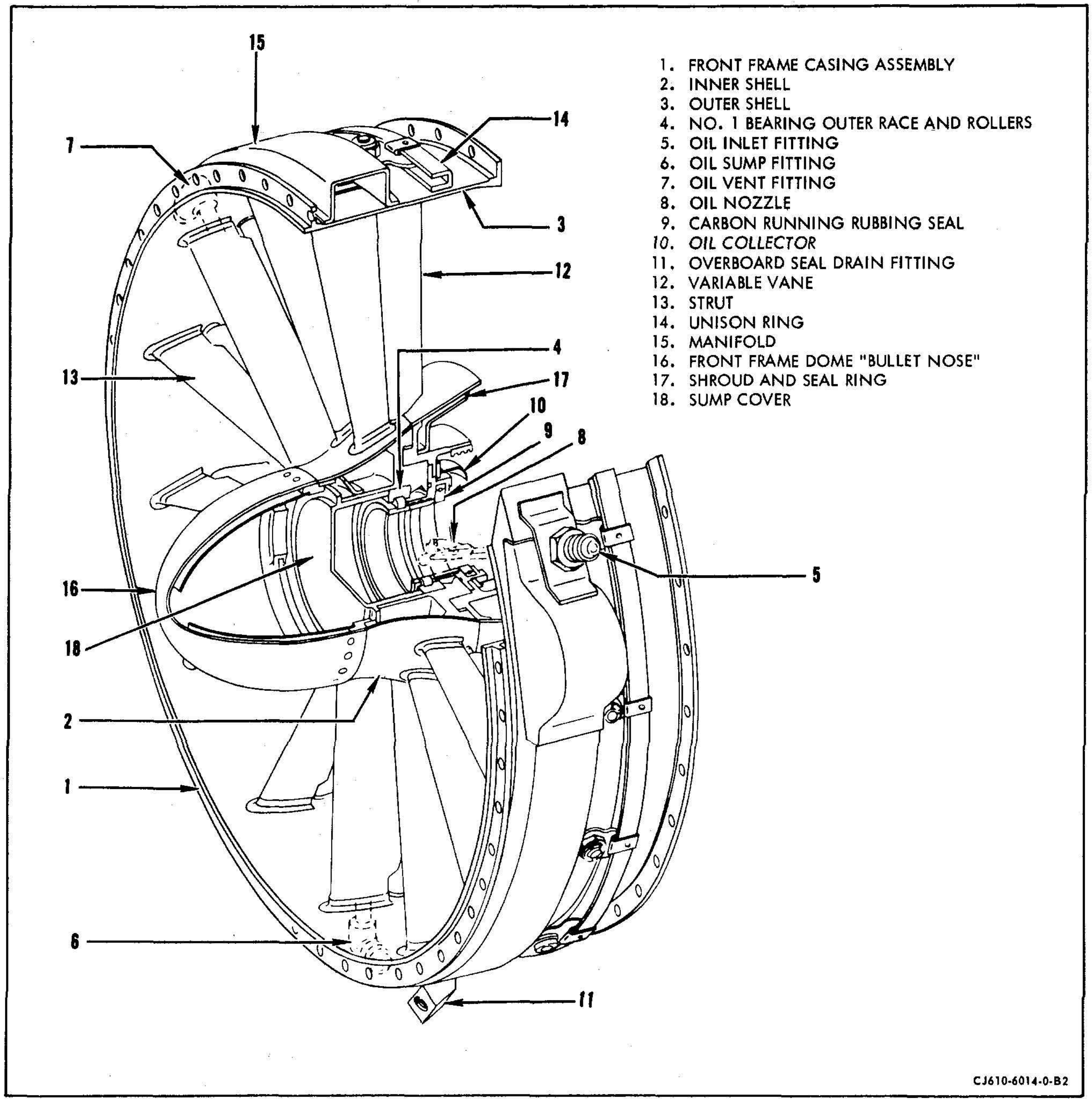
2. Description.

   A. Compressor Front Frame. The compressor front frame (see figure 1) is a stainless steel fabrication made up of an inner and outer casing joined together by fifteen hollow struts. Three of the struts are larger and house the No. 1 bearing service tubes. The No. 3 strut houses the No. 1 bearing sump vent tube; the No. 8 strut houses the scavenge oil tube and the No. 13 strut houses the oil inlet tube. An overboard drain tube is located in the No. 9 strut to drain any oil that may leak past the No. 1 bearing carbon seal.

   The No. 1 bearing housing, which houses the No. 1 bearing outer race, is brazed to the rear of the inner casing and reinforced at the front by three stiffening ribs. The carbon seal, inlet guide vane shroud and seal ring and collector assemblies are bolted to the No. 1 bearing housing. A sump cover is bolted to the front of the inner casing and prevents oil leakage from the bearing area and also functions as a retainer for the outer race of the No. 1 bearing.

   The front frame also provides a mount for the fifteen variable inlet guide vanes which are located directly behind each strut. Around the outer casing the inlet guide vane actuating ring is assembled and is connected through linkage to the variable vane actuators. Movement of the actuator piston is transmitted through the linkage to the actuating ring, which positions the vanes.

   B. Compressor Stator Casing. The compressor stator casing assembly (see figure 2) is a matched chromoloy steel unit, split and flanged along the horizontal centerline. Mounted on the inner surface are seven stages of fixed stator vanes. The vanes are held in segments, 12 per stage, which are assembled circumferentially into tracks that are machined into the inner diameter of the casings. Locking keys are assembled at the split line to prevent the vane segments from rotating. The first and second-stage vanes have shroud rings attached to the inner bands. The shroud rings form the static halves of the interstage labyrinth seals. All parts are split at the horizontal split line to permit assembly/disassembly of the casing halves.



Front Frame Assembly
Figure 1

Holes drilled through the casing at stages 3, 4, and 5 allow compressor air to enter manifolds around the compressor casing. The manifolds direct the air to the four bleed port pads on the outside of the casings. Each pad has three openings, one for each of the three stages, on each half of the casings.

Two variable vane actuators, one at 10 o'clock, one at 5 o'clock, are mounted on the compressor casing. Two bleed valves, one at 3 o'clock, one at 9 o'clock are mounted on the compressor casing bleed port pads. The ignition unit is mounted at the 12 o'clock position on brackets attached to the front and rear compressor casing flanges.

C. Compressor Rotor. The compressor rotor assembly (see figure 2) is an 8 stage axial rotor. The rotor consists of a front disc shaft and blade assembly, seven stages of discs and blades, seven spacers, a main drive shaft, seals and hardware. The front disc shaft (AM 355) is a one piece assembly made up of a shaft, disc, and spacer. The serrated rotating half of the compressor front labyrinth air seal is attached to the front shaft.

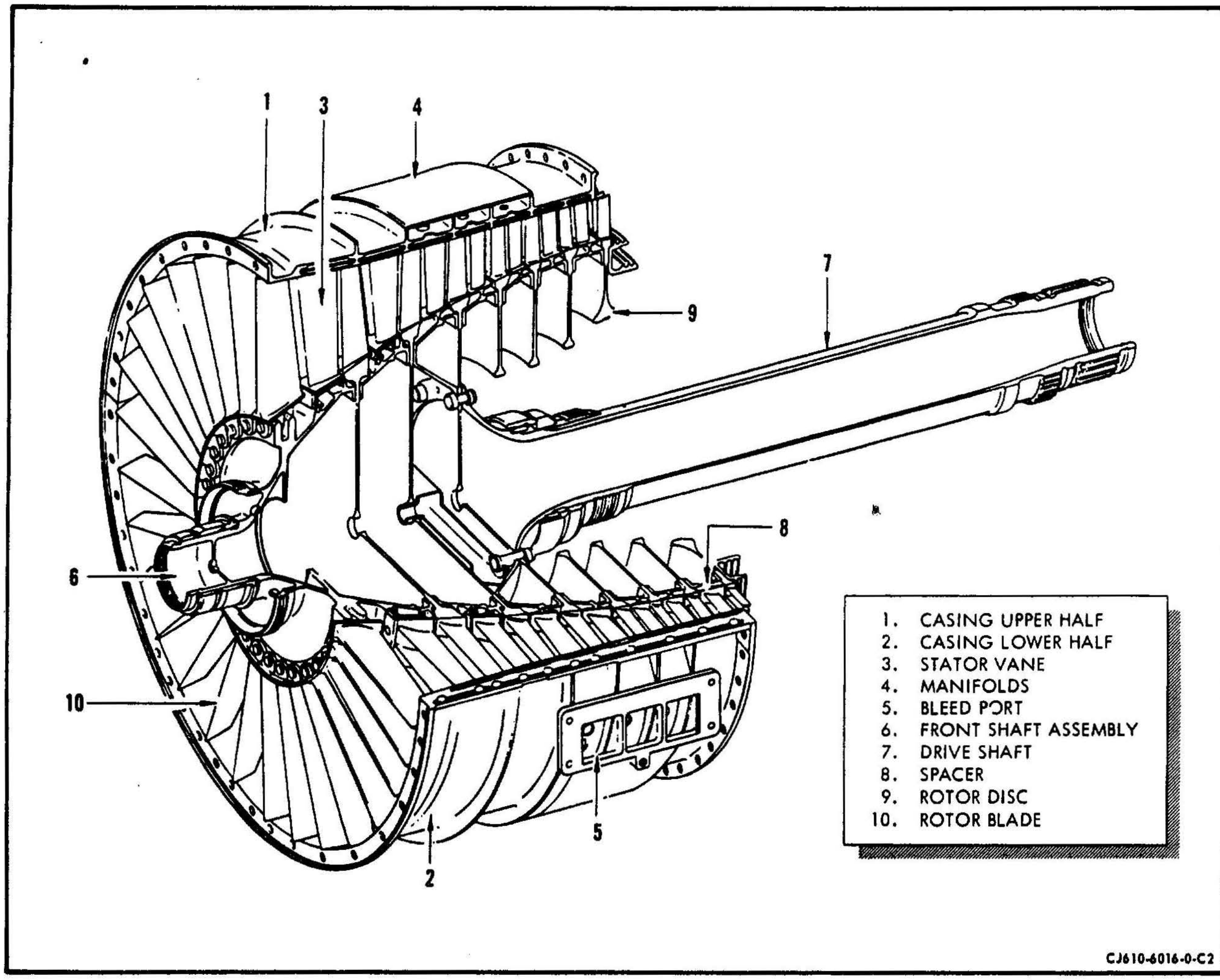
The first-stage blades are attached to the first-stage disc shaft by pins and snap rings. The remaining stages of blades are dovetailed to the disc and held in by the spacers. The first and second-stage blades are of greek ascoloy material and coated with a corrosion resistant coating. The remaining blades, disc and spacers are of AM 355 material.

The main drive shaft is of A-286 material and is bolted to the rear of the fourth-stage disc and third-stage spacer inner flange. Two external splines on the rear of the shaft mate with the power take-off bevel gear and the turbine rotor front shaft.

The rotor has an air duct of A-286 material assembled between the third and fourth-stage discs. The duct provides positive pressurization of the No. 1 bearing seal.

The first and second-stage spacers have serrated labyrinth-type seals. The seals mate against the first and second-stage compressor stator shroud seals. The eighth-stage air seal is mounted on the rear of the eighth-stage disc and is a labyrinth-type seal. This seal mates with a stationary seal on the rear frame and controls compressor air leakage, which is then used for sump pressurization.

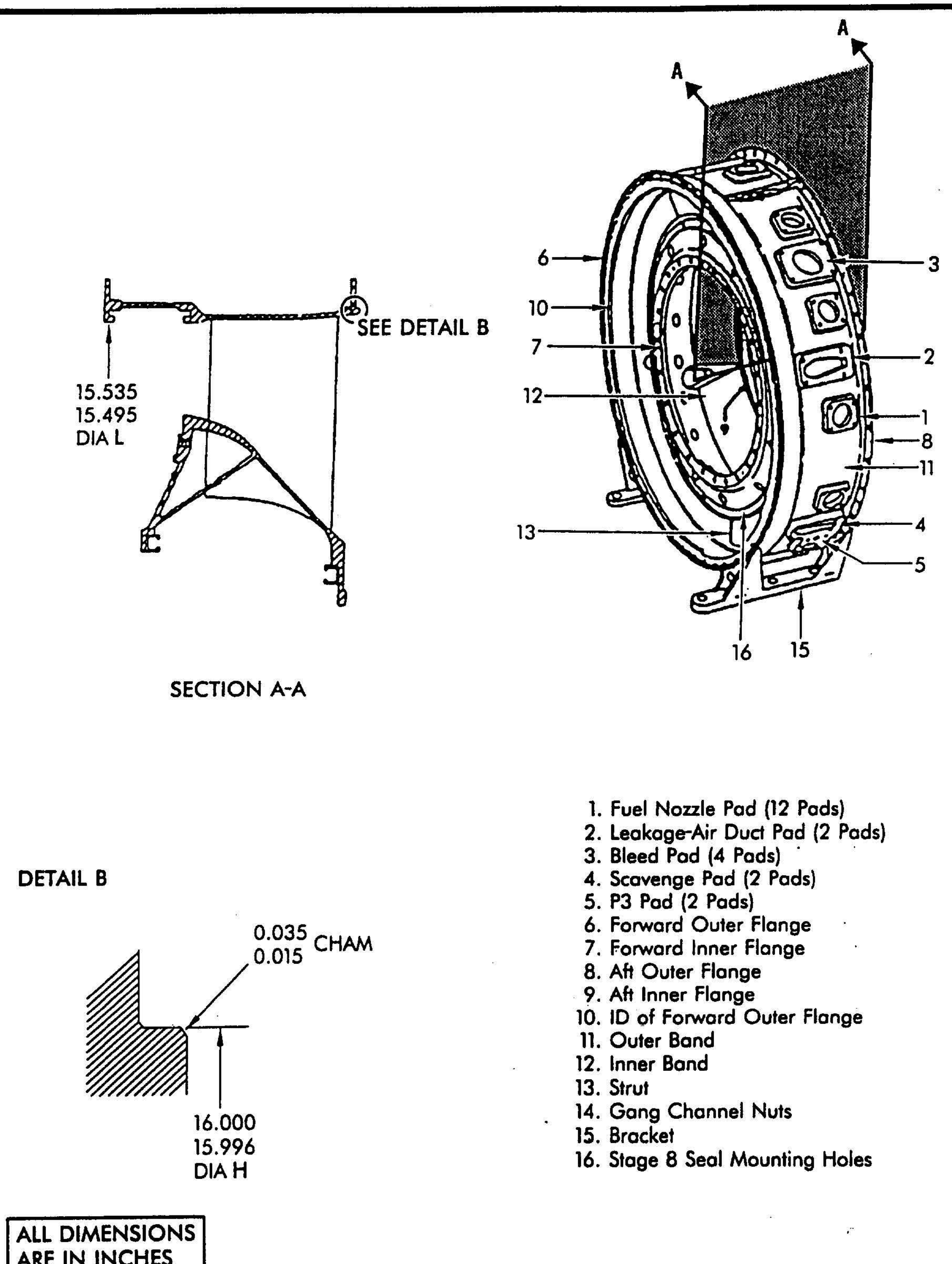
D. Mainframe. The mainframe (see figure 3) is either an Inconel 718 casting (figure 2A) or a chromoloy steel fabrication made of an inner and outer casing joined by six hollow struts welded in openings in the casing. Struts No. 2 and 6 vent eighth-stage leak air through poppet valves mounted on the strut pads. The No. 3 strut houses the No. 3 bearing scavenge tube and the sump vent tube.



Compressor Stator and Rotor Assemblies
Figure 2

The No. 4 strut provides a passage way for the radial drive shaft. The No. 5 strut houses the No. 2 and 3 bearing lube supply tube and the No. 2 bearing scavenge tube. The No. 1 strut is not used during engine operation and is blanked-off.

The No. 2 bearing support is aligned and bolted to the front inner (mainframe) flange and supports the front of the power take-off (PTO) housing and the No. 2 bearing carbon seal support. The PTO drive assembly is assembled in the PTO housing and transfers power from the main engine drive shaft through the radial drive shaft to the accessory drive train.



1. Fuel Nozzle Pad (12 Pads)
2. Leakage-Air Duct Pad (2 Pads)
3. Bleed Pad (4 Pads)
4. Scavenge Pad (2 Pads)
5. P3 Pad (2 Pads)
6. Forward Outer Flange
7. Forward Inner Flange
8. Aft Outer Flange
9. Aft Inner Flange
10. ID of Forward Outer Flange
11. Outer Band
12. Inner Band
13. Strut
14. Gang Channel Nuts
15. Bracket
16. Stage 8 Seal Mounting Holes

000CF7-899100

Mainframe Cast (Inco 718) Configuration (6051T95) All 8 Stage Models
Figure 2A

COMPRESSOR SECTION - MAINTENANCE PRACTICES

1. General. The following paragraphs describe the removal, installation, disassembly and assembly procedures that are approved for the compressor section.

WARNING: ASBESTOS

THIS ENGINE MAY CONTAIN SMALL AMOUNTS OF ASBESTOS. WHEN WORKING WITH THIS ENGINE, THE FOLLOWING PRECAUTIONS MUST BE RIGIDLY ADHERED TO:

BEFORE ANY MAINTENANCE ACTIVITIES ARE UNDERTAKEN, REVIEW THE ILLUSTRATED PARTS BREAKDOWN/CATALOG INDEX TO DETERMINE IF THE HARDWARE TO BE WORKED ON OR USED CONTAINS ASBESTOS.

WHENEVER MECHANICAL REMOVAL OF MATERIAL, SUCH AS MACHINING, GRINDING, BUFFING, DRILLING, SANDING OR ANY TYPE OF MATERIAL BUILD-UP ON PARTS THAT CONTAIN ASBESTOS IS NECESSARY, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT MUST BE WORN, AND NATIONAL ENVIRONMENTAL CONTROLS REQUIRED FOR THE HANDLING OF ASBESTOS-CONTAINING MATERIAL MUST BE COMPLIED WITH.

BEFORE HANDLING, REPLACING, OR DISPOSING OF ASBESTOS-CONTAINING HARDWARE, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND NATIONAL ENVIRONMENTAL CONTROLS MUST BE STRICTLY ADHERED TO FOR HANDLING ASBESTOS-CONTAINING HARDWARE.

2. Front Frame Removal/Installation.

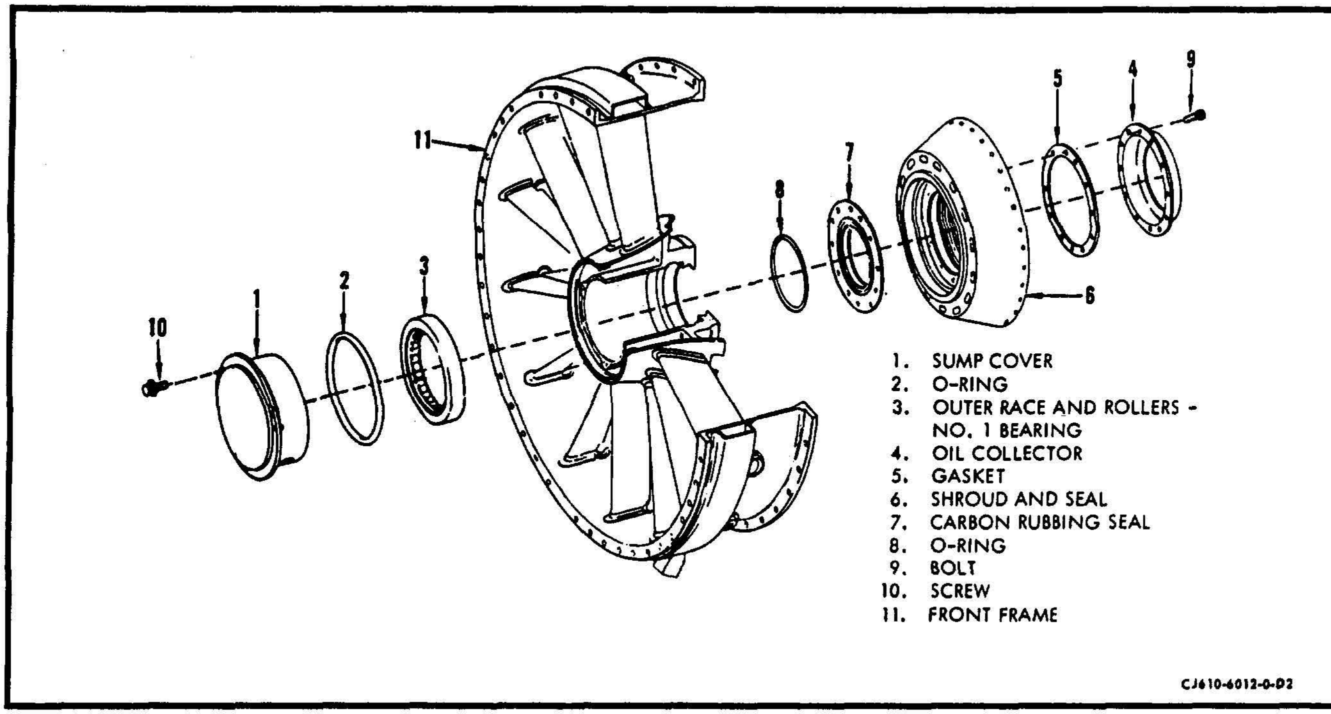
NOTE: 1. Whenever the front frame is removed, a complete gearbox bracket alignment per paragraph 7 and a complete accessory gearbox alignment per paragraph 7 and a complete accessory gearbox alignment per 72-64-0 is required.

2. Whenever the shroud and seal (6, figure 201) is exposed, check that each bolt (9) is a 12-point head with letter A marked on head. Replace only those bolts that are not 12-point head with latest part number.

A. Removal. It is recommended that the front frame be removed with the engine in the vertical position, front end up, suitably supported on the rear turbine casing flange. However, the front frame can be removed with the engine in a horizontal position, in which case, the removal of the aft fan per step (1) is not required.

(1) Remove the aft fan as instructed in 72-70.

(2) Remove the accessory gearbox as instructed in 72-64-0.



Front Frame
Figure 201

(3) Remove the anti-icing valve as instructed in 75-11-0.

(4) Disconnect the turnbuckle (bellcrank to actuating ring) as instructed in 75-31-0.

(5) Remove the gearbox mounting bracket as instructed in paragraph 7.

(6) Remove the bulletnose as follows:

(a) Using a screwdriver or other suitable tool, depress, toward the engine centerline, the plunger that locks the dome to the forward hub of the front frame.

(b) Turn the dome approximately 1/6 of a turn clockwise (facing the front frame). Remove the dome.

(c) If the bulletnose cannot be turned, apply several turns of cloth tape to circumferential surface of dome that is adjacent to front frame. (See figure 201A.) Place a flat band (hose type) clamp over taped area of the dome. (2 clamps may be joined together to fit the diameter). Tighten clamp so that it does not slip.

(d) Depress the plunger that locks the dome to the forward hub of the front frame. Tap the clamp, with a mallet, in a clockwise direction to loosen dome. Remove the dome. (After removal of bulletnose, remove clamp and tape.)

(7) Remove the sump cover as follows:

(a) Remove the 3 bolts that secure the sump cover (1, figure 201) to the forward face of the front frame inner hub.

(b) Remove the sump cover. Remove the O-ring from the cover and discard the O-ring.

(c) Remove the No. 1 bearing locknut retaining ring and remove the locknut using spanner wrench 2C5359. Prevent the engine rotor from turning by locking the gearbox with the gearbox locking adapter, 2C5360, as follows:

1 Remove the 4 locknuts, 4 washers and cover from the axis "B" aft transfer gearbox pad.

2 Install the gearbox locking adapter, 2C5360, onto the axis "B" aft transfer gearbox pad by engaging the axis "B" gearshaft female spline with the tool male spline. Assemble the flat plate of the tool against the gearbox pad face, with 4 gearbox pad studs protruding through the 4 holes in the tool.

NOTE: Alignment of the holes in the tool with the gearbox pad studs can be accomplished by positively engaging the spline teeth and slowly rotating the tool by hand until alignment is accomplished.

3 Press the tool firmly in place against the gearbox pad face, install two washers and two nuts on two studs (diagonally opposite). Use the fingers to run-on and tighten the nuts. Do not torque; the nuts are used only to position the tool in place to assure rotor locking.

NOTE: The use of plain nuts rather than locknuts is recommended. Be certain that the nuts used have the same NF threads as the studs to assure that thread damage does not occur.

4 Check the compressor rotor for locking by carefully inserting the hand past the front frame struts and attempting to rotate the compressor. With the locking tool in place, rotor "play" may be as much as one stage 1 blade platform width.

(d) Remove the bearing spacer.

(8) Remove the engine support ring as instructed in the Aircraft Maintenance Manual, if necessary.

CAUTION: BOTH CASING HALVES MUST BE INSTALLED.

(9) If the front frame is being removed with the engine in a horizontal position, support the forward end of the compressor rotor by inserting shims between the first-stage blade tips and the compressor casing ID.

(10) Screw the pilot guide 2C5326G1 or G2 (depending on type of No. 1 bearing) into the compressor rotor forward shaft.

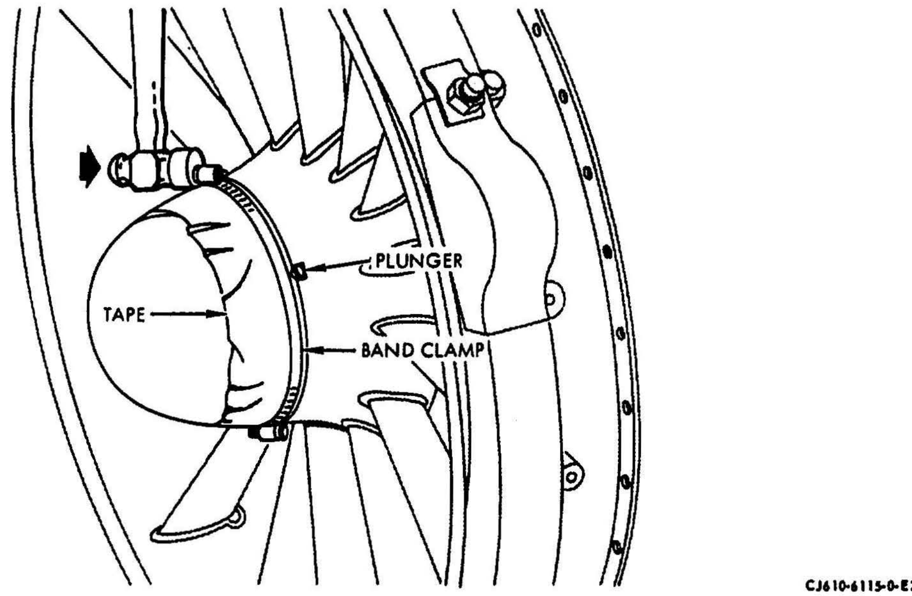
WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(11) Disconnect the oil scavenge, vent, and supply lines at the 6, 2 and 0 o'clock positions on the front frame.

CAUTION: TO PREVENT DAMAGE TO THE NO. 1 CARBON SEAL, DO NOT ALLOW THE FRONT FRAME TO BECOME "COCKED" DURING REMOVAL.

(12) Remove the bolts and nuts that secure the front frame to the compressor casing. Carefully move the front frame forward, away from the compressor casing, until it is free of the compressor rotor front shaft.



Bulletnose Removal
Figure 201A

B. Installation.

CAUTION: TO PREVENT DAMAGE TO THE NO. 1 CARBON SEAL, DO NOT ALLOW THE FRONT FRAME TO BECOME "COCKED" DURING INSTALLATION.

(1) Carefully install the front frame over the pilot assembly 2C5326G1 or G2 (depending on type of No. 1 bearing) and the compressor rotor front shaft until the frame seats on the compressor casing flange. Be sure the No. 1 bearing outer race does not move axially forward off its seat.

(2) Rotate the frame into position so that the oil scavenge port is at the 6 o'clcok position.

(3) Install the accessory gearbox mounting bracket as instructed in paragraph 7.

(4) Install the accessory gearbox as instructed in 72-64-0.

(5) Connect the turnbuckle (bellcrank to actuating ring) as instructed in 75-31-0.

(6) Install the anti-icing valve as instructed in 75-11-0.

WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(7) Connect the oil scavenge, vent, and oil supply lines at the 6, 2 and 10 o'clock positions on the front frame.

(8) Replace the remaining bolts and nuts at the front frame-compressor casing flange. Torque the nuts to 35-40 lb-in.

(9) Remove the pilot guide from the compressor rotor forward shaft. Install the spacer and No. 1 bearing locknut per paragraph 3.G.

(10) Install the sump cover as follows:

(a) Lubricate the O-ring with a light coat of petrolatum, Specification VV-P-236, or engine oil, and install it in the groove of the front frame sump cover.

(b) Install the sump cover (1, figure 201) into the bore of the front frame. Secure the cover with 3 bolts. Torque the bolts to 6-10 lb-in. and lockwire them.

NOTE: Insure that the sump cover is seated against the front frame flange before securing with the 3 bolts. The sump cover is seated if a 0.001 inch shim will not slip between the two mating flagnes. When installed properly, the sump cover prevents the No. 1 bearing outer race from mvoing axially forward.

(11) Install the bulletnose as follows:

(a) Clean frame and bulletnose contact areas with trichloroethane.

(b) Apply sealant RTV 106 (G.E. Silicone Products Dept., Waterford, N.Y.), or equivalent on the outer circumference of shoulder in 3 palces 1/2-inch long, opposite the three flange lugs.

(c) Depress the locking plunger inward and insert the dome into the front frame hub. Turn the dome counterclockwise until the plunger engages the slot in the front frame.

(12) Install the engine support ring as instructed in the Aircraft Maintenance Manual, if it was removed.

3. No. 1 Bearing Replacement.

A. Remove the front frame per paragraph 2.

B. Place front frame on bench, rear side down. Insert hand into frame bore and check bearing outer race (3, figure 201) for looseness. If bearing is loose, use puller, 2C5313, to remove bearing from bore. If bearing is tight in bore, turn frame so that front side is down. Remove oil collector (4, figure 201), shroud and seal (6) and carbon seal (7) by removing the bolts that secure them to frame. Turn frame over so that rear side is down and proceed to remove bearing outer race, using puller 2C5313, as follows:

(1) Adjust the puller legs to obtain the maximum grip on the bearing outer race and pull bearing approximately 0.250 inch forward.

(2) Reposition puller legs on tool to grip the outer aligning ring and remove bearing.

CAUTION: DO NOT COCK THE BEARING DURING REMOVAL.

C. Remove the No. 1 bearing locknut retaining ring, bearing locknut, and bearing spacer per paragraph 2.A.(7) steps (c) and (d).

D. Use puller, 2C5311, and remove the No. 1 bearing inner race and seal runner from the compressor rotor front shaft.

NOTE: The seal runner must be removed as it has the puller grooves.

CAUTION: BEFORE INSTALLATION, BE SURE THAT ANTIROTATION PIN OF NO. 1 BEARING IS FLUSH TO 0.005 INCH BELOW SURFACE AT OD.

E. Place the front frame on the bench, front side up. Lubricate the bore lightly with engine oil. Using pusher, 2C5312, if necessary, to seat the No. 1 bearing outer race and rollers in the bore. Be sure the pin in the bore nests in the groove of the bearing outer race.

NOTE: Be sure the No. 1 bearing oil slinger is in place on the compressor rotor front shaft before doing the next step.

F. Heat both the No. 1 bearing inner race and the seal runner in an oven at 121°C (250°F) for 20 minutes; then seat them on the compressor rotor front shaft (after lubricating lightly with engine oil) with pusher, 2C5310. Check to be sure they are seated after the parts return to normal temperature.

G. Screw the pilot guide 2C5326G1 or G2 (depending on type of No. 1 bearing) into the compressor rotor forward shaft and install the front frame per paragraph 2.B.

(1) Install No. 1 bearing locknut. Prevent the engine rotor from turning by locking the gearbox using gearbox locking adapter, 2C5360, per paragraph 2.A.(7)(c) steps 1 through 4.

(2) Observe the clock positions of the two notches in the forward edge of the compressor rotor shaft. Using a colored marking pencil (grease or felt tip), mark the corresponding notch locations on the sump cover mounting flange of the front frame. These marks will facilitate location of the shaft notches during assembly of the locking nut and installation of the retaining ring. (Notches are not visible after installation of the locking nut).

(3) Assemble the spacer onto the exposed end of the compressor rotor shaft. Seat the spacer firmly against the No. 1 bearing inner race.

NOTE: The spacer must extend beyond end of compressor rotor shaft when seated against the No. 1 bearing inner race.

(4) Using engine oil, lubricate the threads and the surface of the nut that contacts the compressor rotor shaft threads and the spacer, respectively. Assemble the nut into the exposed end of the compressor rotor shaft.

(5) Insert the spanner wrench, 2C5359, lugs into the holes on the forward side of the nut. Using a standard torque wrench, torque the nut to 450 lb-in. to seat the parts on thecompressor rotor shaft.

(6) Back-off the nut to free running torque. Torque the nut to 150 lb-in. and remove the torque wrench and spanner wrench.

(7) Using the marks on the sump cover mounting flange (see step (2)) as references, locate a radial hole on the ID of the nut that aligns with either of the notches in the compressor rotor shaft.

NOTE: A drill rod end, or equivalent, that has been flattened on the end to be similar to the tang on the retaining ring, will facilitate determining an aligned radial/hole shaft notch condition.

(8) Observe the following conditions:

(a) If alignment has occurred, proceed to the following step (9).

(b) If alignment has not occurred, advance the nut in the tightening direction by torquing until alignment is accomplished, then proceed to soep (9). DO NOT exceed 450 lb-in of torque.

(c) If alignment DOES NOT occur at 450 lb-in. of torque, remove the nut. Using a new nut perform steps (4) through (7).

(9) After establishing radial hose/shaft notch alignment, assemble the retaining ring.

CAUTION: ASSURE THAT THE RETAINING RING IS PROPERLY SEATED INTO THE NUT AND WILL NOT "POP" OUT.

(10) Remove marks made on the sump cover mounting flange in step (2). Do not use abrasive material or action that will damage or otherwise remove material from the mounting flange.

(11) Remove the gearbox locking adapter and reinstall the transfer gearbox axis "B" pad cover using a new gasket. Torque the nuts to 120-150 lb-in.

4. No. 1 Bearing Carbon Seal Removal/Installation.

A. Removal.

(1) Remove the front frame as instructed in paragraph 2.

(2) Place the frame on a bench, front side down.

(3) Remove the oil collector (4, figure 201) shroud and seal (6) and carbon seal (7) by removing the bolts that secure them to the frame. Discard oil collector gasket and carbon seal O-ring.

B. Installation.

NOTE: Whenever the shroud and seal (6, figure 201) is exposed, check that each bolt (9) is a 12-point head with letter A marked on head. Replace only those bolts that are not 12-point head with latest part number.

(1) Install a new carbon seal and O-ring on frame inner hub.

(2) Install the shroud and seal to the frame.

(3) Install a new gasket and the oil collector to rear of shroud and seal and install onto the frame.

(4) Secure the oil collector, shroud and seal, and carbon seal with bolts. Torque the bolts to 20-24 lb-in. and lock-wire.

(5) Install the front frame as instructed in paragraph 2.

5. Compressor Casing Upper Half Removal/Installation.

A. Removal. (May be done with engine in vertical or horizontal position.)

(1) Remove the ignition exciter as instructed in 80-21-0.

(2) Remove the right-hand variable geometry actuator as instructed in 75-31-0.

(3) Remove both bleed valves as instructed in 75-32-0.

(4) Remove the anti-icing valve as instructed in 75-11-0 and anti-icing air tube as instructed in 75-12-0.

(5) Disconnect the upper-half of the synchronizing cable at the left-hand variable geometry actuator by removing the cotter pin, washer and clevis pin. The cable was disconnected on the right-hand side when the right-hand actuator was removed.

CAUTION: DO NOT REMOVE THE COMPRESSOR CASING UPPER HALF IF THE FRONT FRAME HAS BEEN REMOVED AND THE ENGINE IS IN A HORIZONTAL POSITION.

(6) Remove the upper-half of the compressor casing as follows:

CAUTION: DO NOT ALLOW BODY-BOUND BOLTS TO TURN WHEN REMOVING THE NUTS. ALSO, DO NOT TURN THE BOLTS TO AID BOLT REMOVAL. TURNING OF THE BODY-BOUND BOLTS WILL ENLARGE THE HOLES AND THE ALIGNMENT OF THE COMPRESSOR CASING WITH THE COMPRESSOR ROTOR WILL BE AFFECTED.

(a) Holding the bolt heads, remove the locknuts and washers from the body-bound bolts (first, fifth and eleventh bolts from the front flange) in both horizontal flanges. Remove the body-bound bolts, using a plastic or brass pin to drive the bolts out of the holes.

(b) Remove the remaining bolts and locknuts from the horizontal flanges.

(c) Remove the bolts from the front and rear flanges of the compressor casing upper-half. Note the location of all brackets and supports that are attached to the flanges.

(d) Remove the compressor casing stator upper-half (3, figure 202) by pulling it radially away from the engine. Remove 2 locking vane keys (1, figure 202).

NOTE: Whenever stator sectors have been removed, be sure that holes in stages 3, 4, and 5 sectors are aligned with the bleed holes in the bleed manifold. Sectors are aligned when gage, 2C5501, fits into both holes with sectors positioned against retainer key at the split-line flange. When properly assembled, at least one hole in each bleed port shall be aligned.

B. Installation.

(1) Place the keys (1, figure 202) in the slots of the compressor casing horizontal flanges. The keys must seat on the slots so that they are either flush or below the mating surfaces of the horizontal flanges. The ends of the stator sectors (stages 1 and 2) and vane segments (stages 3 through 7) must be either flush or below the flange faces.

(2) Install the stator upper-half (3, figure 202). Be careful not to damage the blades or vanes.

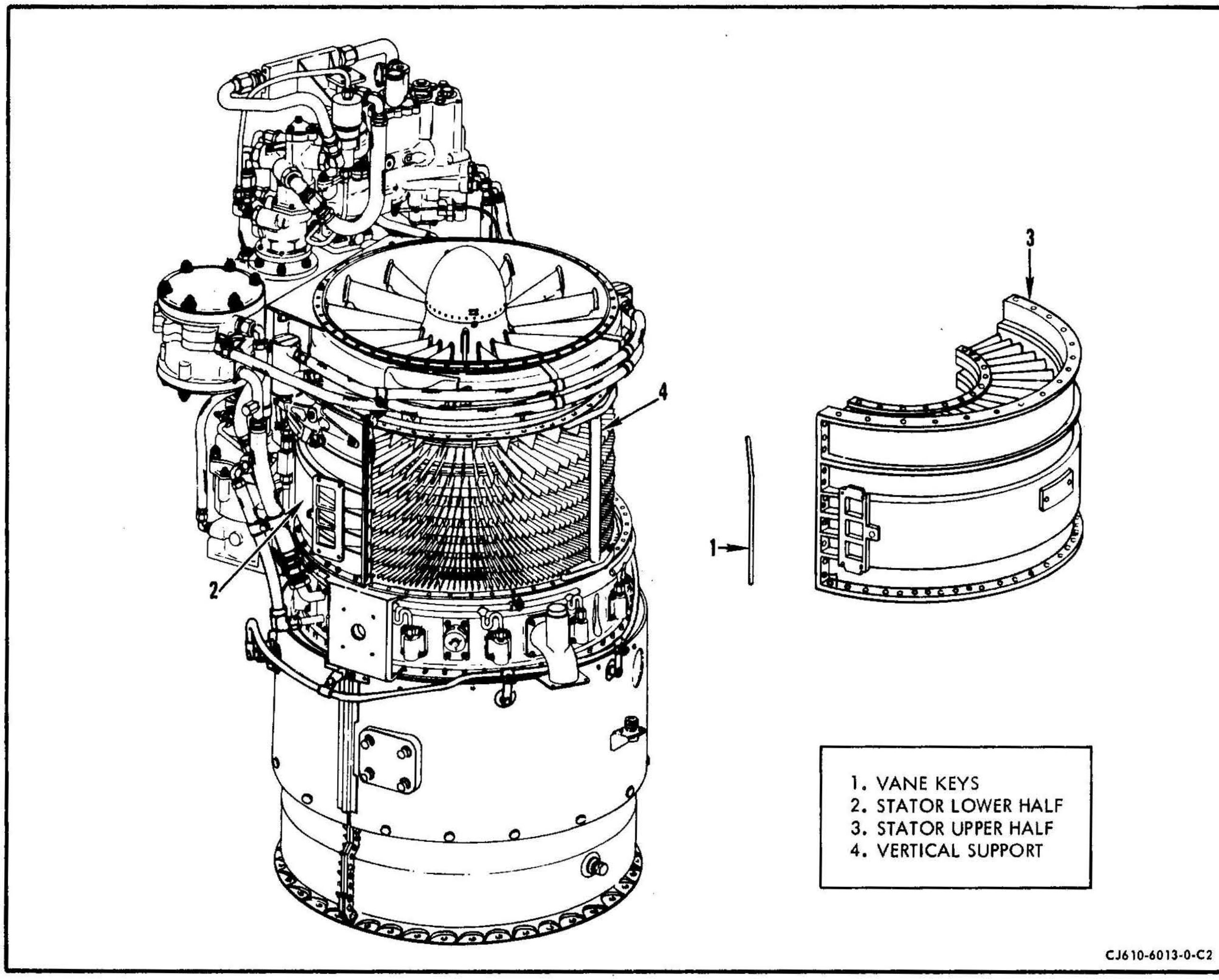
CAUTION: DRIVE THE BODY-BOUND BOLTS STRAIGHT THROUGH AT INSTALLATION. DO NOT TURN THEM. TURNING THE BOLTS MAY ENLARGE THE BOLT HOLES AND ADVERSELY AFFECT ALIGNMENT OF THE CASING.

THE HORIZONTAL FLANGE BOLT TORQUING SEQUENCE HAS A DEFINITE EFFECT ON COMPRESSOR CASING RUNOUTS. DO NOT TIGHTEN OR TORQUE THESE BOLTS AND NUTS IN ANY OTHER THAN THAT DESCRIBED.

(3) Install the body-bound bolts, nuts and washers in both horizontal flanges. Bolt casing halves together and tighten nuts in the sequence of 5, 1, 11, 6, 4, 7, 3, 8, 2, 10, and 9. Torque nuts 1-7 to 44-48 lb-in., and nuts 8-11 to 70-80 lb-in.

(4) Install the synchronizing cable supports and the remaining bolts, nuts and washers in the horizontal flanges. Torque the first seven nuts to 44-48 lb-in. Torque the last four nuts to 70-80 lb-in.

(5) Install the vertical flange bolt and any brackets or supports. Torque the front flange bolts to 35-40 lb-in. and the rear flange bolts to 44-48 lb-in. Use a 0.001 inch thick by 0.200 inch wide piece of shim stock to check the gap between the mating surfaces of the horizontal flanges. The shim shall not enter more than 0.100 inch anywhere along the inside or the outside of the flange.



Compressor Stator Upper Half Removal
Figure 202

(6) Install the anti-icing valve and tube as instructed in 75-11-0 and 75-12-0.

(7) Install both bleed valves as instructed in 75-32-0.

(8) Install the right hand actuator as instructed in 75-31-0.

(9) Install the ignition exciter as instructed in 80-21-0.

(10) Connect the synchronizing cable to the left-hand actuator using the pin, washer and cotterpin.

(11) Adjust the variable geometry system as instructed in 75-00, Maintenance Practices.

6. First-Stage Rotor Blade Removal/Installation.

A. Removal.

(1) Remove the front frame as instructed in paragraph 2.

(2) Remove the compressor casing upper-half as instructed in paragraph 5.

(3) Remove any number of first-stage compressor rotor blades (all of them if required) as follows:

CAUTION: THE COMPRESSOR ROTOR IS DYNAMICALLY-BALANCED TO A CLOSE TOLERANCE WHICH MUST BE MAINTAINED. TO PREVENT DISTURBANCE OF THIS BALANCE CONDITION, ALWAYS IDENTIFY EACH BLADE (WHEN IT IS REMOVED) AND PIN HOLE WITH THE CORRECT MOMENT WEIGHT OF THE BLADE TO ENSURE THAT A REPLACEMENT BLADE OF EQUAL MOMENT WEIGHT IS USED. ALSO IF BALANCING WASHERS ARE USED, BE SURE THE WASHER IS IDENTIFIED WITH ITS PIN HOLE.

(a) Remove the pin retainer, using a sharpened screwdriver. Use care so as not to damage air seal serrations. Remove the pin that secures the blade to the disc.

(b) Mark the blade for location on the disc; then remove the blade (and balancing washer) if installed.

B. Installation.

NOTE: The preferred method of blade replacement is with equal moment weight blades. However, replacement by pan weight in grams is acceptable provided the replacement blade is within $\pm$ 0.1 gram of the removed blade. The removed blade must have all of the original material remaining for an accurate pan weight. Blending of the blade being installed to provide equal pan weight is not permitted.

(1) Assemble the blade (or its moment-weighted equivalent) to the disc (with the balancing washer, if applicable) in the location for which the blade was marked at removal. Secure the blade to the disc with the pin. (The head of the pin is on the forward side of the disc.)

(2) Assemble the retaining ring to the pin using tool 2C5319. Be sure the retaining ring is seated properly in the pin groove.

(3) Install the compressor casing upper-half as instructed in paragraph 5.

(4) Install the front frame as instructed in paragraph 2.

7. Accessory Gearbox Bracket Removal/Installation.

A. Removal.

(1) Remove the accessory gearbox as instructed in 72-64-0 and transfer gearbox as instructed in 72-62-0.

(2) Remove the bolts and nuts that secure the accessory gearbox mounting bracket to the front frame and compressor casing flanges.

(3) Remove the bracket and shims.

B. Installation.

(1) Position the gearbox bracket onto the rear side of the front flange of the front frame at the 6 o'clock position.

(2) Secure with 2 bolts at holes 22 and 28 of the front flange of the front frame.

<u>NOTE</u>: Bolt holes are numbered in a clockwise direction, starting at 12 o'clock, aft looking forward.

(3) Install the alignment fixture, 2C5323, onto the engine at the transfer gearbox adapter, with the large locating plug inserted into the bore of the transfer gearbox adapter.

<u>CAUTION</u>: THE DOWEL PIN ON THE ADAPTER WILL FIT INTO THE BUSHING OF THE FIXTURE. USE EXTREME CARE WHEN INSERTING THE LOCATING PLUG TO PREVENT FORCING OR BENDING THE DOWEL PIN.

(4) Loosen the hand knob on the fixture and locate the 2 pin locaters of the cross pad into the gearbox bracket; install 2 shoulder bolts with the heads of the bolts on the side of the fixture.

(5) Install the 4 bolts (1/4-28) into the transfer gearbox adapter and torque to 60-90 lb-in.; tighten the bolts on the cross pad.

(6) Tighten bolts securing bracket front flange and tighten hand knob. Loosen the bolts and tighten again.

(7) Check the gap between the bracket and the rear side of the compressor casing front flange; add shims at each set of 2 holes to maintain a gap of 0.000-0.004 inch.

(8) Remove the alignment fixture to provide access for installing shims.

(9) Install shims and all bolts and nuts in bracket rear flange. Do not tighten.

(10) Reinstall alignment fixture per steps (3) through (6).

(11) Torque the bolts in the bracket rear flange to 35-40 lb-in.; in bracket front flange to 24-27 lb-in.

(12) Remove alignment fixture.

(13) Install the accessory gearbox as instructed in 72-64-0 and the transfer gearbox as instructed in 72-62-0.

8. Scavenge Tubes Removal/Installation.

WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

A. Removal.

(1) Remove bolts that secure scavenge tubes to the mainframe.

(2) Remove scavenge tubes by pulling radially from the mainframe.

(3) Discard O-rings, backup rings and gaskets.

B. Installation.

(1) Lubricate O-rings and backup rings with engine oil. Install the backup rings on the tubes first, then install the O-rings. Install gasket on the scavenge tubes with raised sides toward mainframe pad.

(2) Assemble the scavenge lube tube to the mainframe at the 8 o'clock position and the scavenge air tube a the 4 o'clock position. Push in firmly to seat.

(3) Secure the tubes with bolts lubricated with Ease-Off 990 (Texacone Co., Box 4236, Dallas, Texas) or G-392 Versilube (G.E. Products Co., Waterford, N.Y.). Torque bolts to 10-12 lb-in. and lockwire in 2 groups of 2.

9. Installation of Air Pad Covers or Airframer Fittings.

A. Air pad covers or airframer fittings should be secured to mainframe with bolts lubricated with Ease-Off 990 (Texacone Co., Box 4236, Dallas, Texas) or G-392 Versilube (G.E. Products Co., Waterford, N.Y.).

10. Stator Sector Removal/Installation.

A. Removal. (Compressor casing upper half must be removed from engine per paragraph 5.)

NOTE: Stator sectors are normally identified as to their position in the stage in numerical order at the time of original installation. This order is 1 through 12 inclusive, in the clockwise direction starting at the right horizontal (split-line) flange, aft looking forward. During removal of sectors, check the outer support of each sector as it is removed to verify the numerical order. If the sector is not marked, or the marking is illegible, identify and mark the sector by vibro-peen or electro-chemical etch 0.003 inches deep on the sector outer support being careful not to touch the brazed joints in any of the sectors and the bleed holes in the third, fourth and fifth stage sectors.

(1) Position the upper casing half in support 2C5371.

NOTE: Removal of sectors from lower casing half may be accomplished with casing in place on engine, and upper casing half removed.

(2) Remove stage 1 and stage 2 sector assemblies using pusher, 2C5371. If sector assemblies are difficult to remove, penetrating oil may be used along the lands and grooves of the casing.

(3) Remove stages 3 through 7 sector stops and sectors using pusher 2C5371. Use penetrating oil on vane sector grooves, if necessary, to facilitate removal of sectors.

NOTE: The sector stop is the vane sector that is located at the 9 o'clock position on each stage of the lower-half compressor casing and the 3 o'clock position on each stage of the upper half.

B. Installation. (Replacement of stator sectors, with preground sectors, is limited to 50 percent er stage.)

(1) Using applicator tool 2C5442, lubricate the stator sector grooves with General Electric Grease, G-392, or equivalent.

(2) Assemble the stage 1 and stage 2 sector assemblies into the casing.

CAUTION: MAKE CERTAIN THE VANE SECTORS IN EACH STAGE, 3 THROUGH 7, ARE PROPERLY POSITIONED. IT IS POSSIBLE TO ASSEMBLE THESE SECTORS IN REVERSE ORDER SINCE THE SECTOR SUPPORTS ARE SYMMETRICAL.

(3) Assemble the sector stops and sectors, stages 3 through 7, into the casing, using pusher 2C5371.

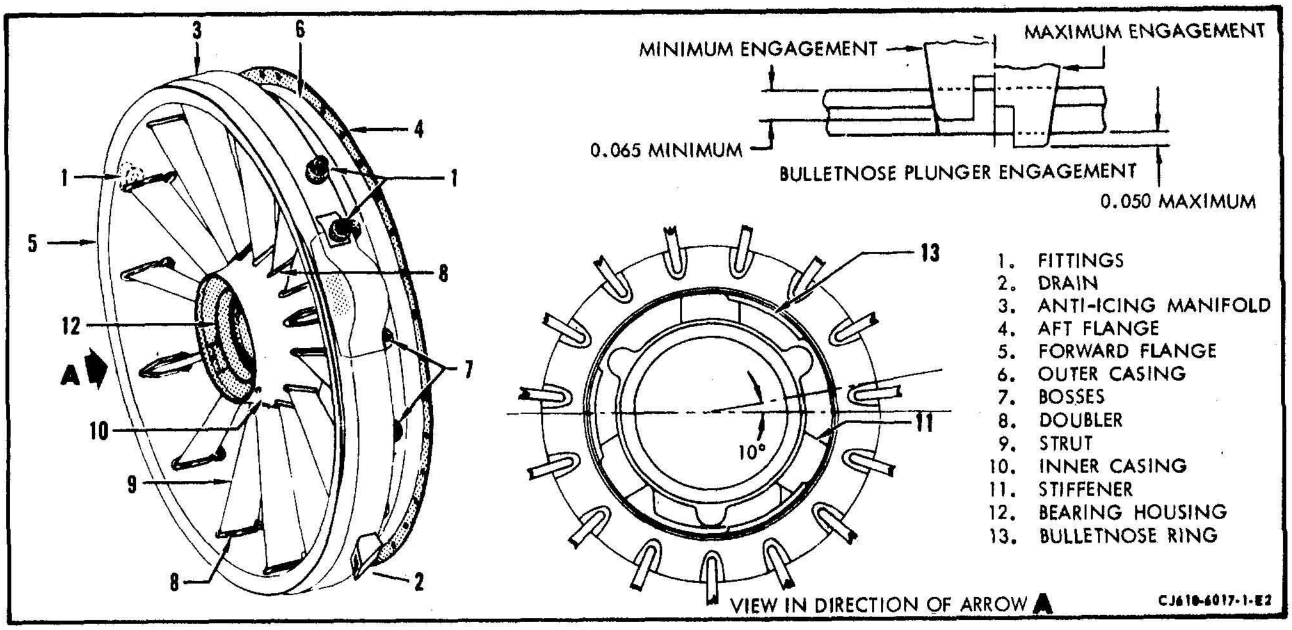
(4) Assemble the key at the horizontal flange.

FRONT FRAME ASSEMBLY - MAINTENANCE PRACTICES

1. General. Maintenance of the front frame assembly is limited to those items that are accessible.

2. Inspection/Check. Where serviceable limits are exceeded, parts may be repaired in accordance with Overhaul Manual instructions.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Visually inspect the front frame as follows: (Frame assembled to engine.)		
(1) Cracks (see figure 201).		
(a) In "U" section at rear of strut.	One crack per strut, 1-1/2 inches long provided adjacent struts are not cracked.	
(b) All other areas.	Not serviceable.	
(2) Nicks and scratches (see figure 201).		
(a) Struts.	One per strut, 0.010 inch deep, 2 inches long; or any number up to 2 inches cumulative length, 1/2 inch from doublers.	
(b) All other areas.	Any number 0.010 inch deep.	
(3) Dents (see figure 201).		
(a) Inner and outer casings.	Any number 1/8 inch deep.	
(b) Struts.	Any number 1/16 inch deep.	
(c) Anti-icing manifold.	Any number provided cross section area is not reduced more than 25 percent and no sharp edges or bends are present.	
(4) Missing paint.	Any amount.	

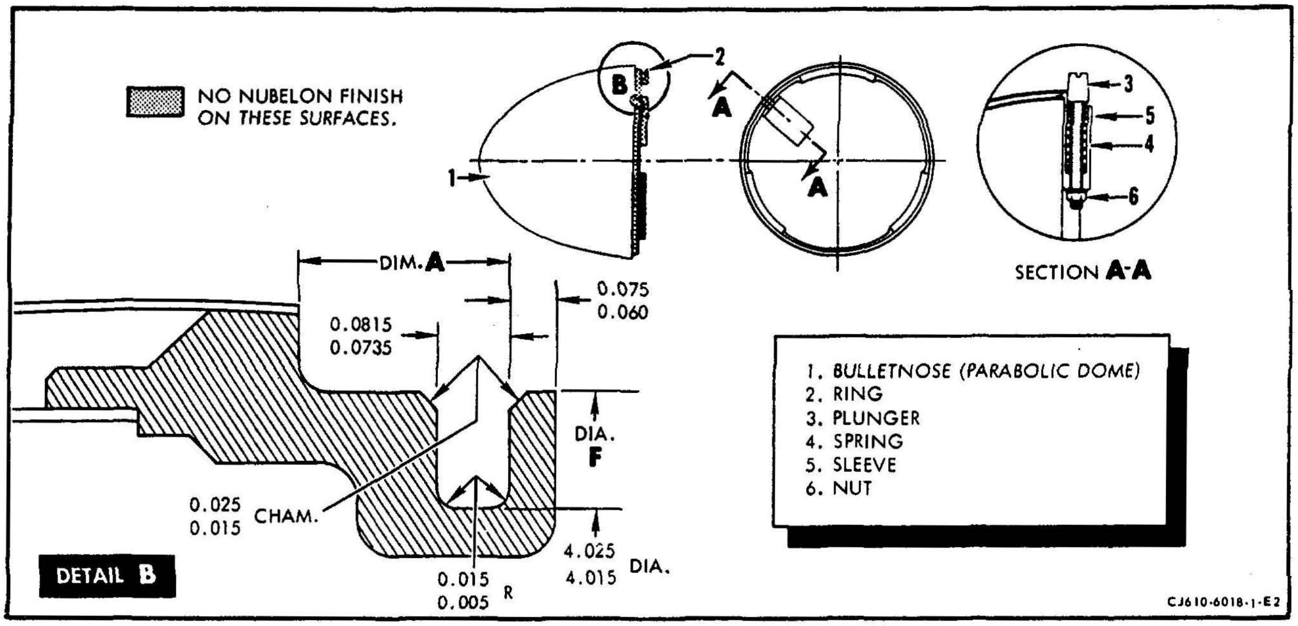


Front Frame Inspection Limits
Figure 201

Inspection/Check	Maximum Serviceable Limits	Remarks
(5) Fittings for thread damage (see figure 201).	One full thread, continuous or cumulative may be missing after chasing.	
(6) Bulletnose plunger height above frame inner casing (see figure 201).	Not to exceed 0.050 inch above inner casing; minimum plunger engagement must be 0.065 inch.	Install new plunger in bulletnose. It must not extend more than 0.040 inch above inner casing.
(7) Missing A12 coating.	Any amount.	

B. Visually inspect the front frame as follows: (Frame removed from engine.)

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Rear flange ID for rotor blade rub.	Up to 0.003 inch deep; 15 inches in length; from 0.003 inch to 0.007 inch deep; 6 inches in length; from 0.007 to 0.010 inch deep; 4 inches in length, after removal of all high metal.	
(2) Bearing housing stiffeners for cracks or dents.	Not serviceable.	



Bulletnose Inspection Limits
Figure 202

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Bearing housing for:		
(a) Cracks.	Not serviceable.	
(b) Damaged threads.	25 percent of threads may be missing after chasing.	

C. Visually inspect the bulletnose for: (See figure 202.)

NOTE: Bulletnose should be removed from engine for inspection. Bulletnose to be removed for inspection only when it is excessively loose.

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Cracks in:		
(a) Outer shell.	3 cracks, 1/2 inch long.	Stop-drill both ends of cracks.
(b) Inner shell.	Not serviceable.	
(c) Ring.	Not serviceable.	
(d) Retainer support.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Braze defects.	Cumulative length not to exceed 20 percent of braze area.	
(3) Dents.		
(a) Nose area (first 1/2 inch).	One dent, 1/8 inch deep, 5/8 inch in diameter.	
(b) All other areas.	Four dents, 1/8 inch deep, 5/8 inch in diameter.	
(4) Retaining ring wear on:		
(a) OD (Dia. F, figure 202).	4.272 inches minimum. (Average of 6 equally spaced readings.)	
(b) Front face (Dim. A, figure 202.) (If noted visually.)	0.236 inch maximum.	
(5) Missing paint.	Any amount.	
(6) Missing A12 coating.	Any amount.	
D. Visually inspect the variable vanes for:		
(1) Cracks.	Not serviceable.	
(2) Bends.	1/32 inch from original contour.	
(3) Nicks, scratches and pits.	Any number, 0.010 inch deep.	
(4) Dents.	Any number, 0.020 inch deep; 5 per vane 0.060 inch deep.	
(5) Missing paint.	Any amount.	
(6) Missing A12 coating.	Any amount.	
(7) Radial movement.	Inlet guide vane (IGV) shall not move more than 0.020 inch maximum.	Replace IGV. Send vane to an approved GE Aircraft Engines overhaul facility for repair.

Inspection/Check	Maximum Serviceable Limits	Remarks
E. The actuator ring for:		
(1) Cracks.	Not serviceable.	
(2) Scratches, nicks, or chafing.		
(a) Rear band of ring (with 1/4 inch x 1/2 inch through slots).	Any number, 0.020 inch deep up to 1 inch long after re-removal of all high metal	
(b) Remainder of ring.	Any number, 0.010 inch deep after removal of all high metal.	
(3) Ring pivot pin holes for wear, if noted visually.	0.099 inch maximum diameter.	
(4) Lug pin holes.	0.130 inch maximum diameter.	
(5) Braze joint defect.	Any number up to 0.030 inch long and not closer together than 0.120 inch.	
F. The actuator levers for:		
(1) Cracks, dents, or bends.	Not serviceable.	Replace lever.
(2) Ball for:		
(a) Movement.	Ball shall move freely with not more than 0.002 inch radial movement. Bearing assembly must be tight in lever but the torque to move ball not to exceed 4 inch-ounces.	Replace lever.
(b) Wear in I.D.	0.097 inch maximum diameter.	Replace lever.
(3) Wear in square hole.	No looseness allowed between lever and variable vane.	Replace lever.
(4) Nicks and scratches.	Any number after removal of all high metal.	

Inspection/Check	Maximum Serviceable Limits	Remarks
G. The locking clips for:		
(1) Cracks or distortion.	Not serviceable.	Replace clip.
(2) Spring characteristic.	Clip surfaces must meet when removed from actuator ring.	Replace clip.
(3) Nicks and scratches.	Any number after removal of all high metal.	
H. The pivot pins for:		
(1) Cracks, bends or distortion.	Not serviceable.	Replace pin.
(2) Wear if noted visually.	0.0922 inch minimum.	Replace pin.
(3) Nicks and scratches.	Any number after removal of all high metal.	
I. Gearbox mounting bracket for:		
(1) Cracks.	Not serviceable.	
(2) Cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
(3) All areas for missing A12 coating.	Not serviceable if base metal is exposed.	Any amount up to 1 square inch may be touched-up per 72-02-6. Return bracket to Overhaul Facility for stripping and recoating if any amount exceeds 1 square inch.

J. No. 1 bearing for:

NOTE: Remove the bulletnose and sump cover as instructed in 72-30, Maintenance Practices, paragraph 2.

(1) Missing rollers or tangs.	Not serviceable.	Replace bearing.
(2) Discoloration (evidence of overheating).	Not serviceable.	Replace bearing.

Inspection/Check	Maximum Serviceable Limits	Remarks
K. Sump cover for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and dents.	Any number after removal of high metal.	
L. Shroud and seal for:		
(1) Cracks.	Not serviceable.	Replace shroud and seal.
(2) Nicks and dents.	Any number up to 1/16 inch deep after removal of high metal.	Replace shroud and seal if depth exceeds 1/16 inch.
(3) Missing paint.	Any amount.	
(4) Missing A12 coating.	Any amount.	

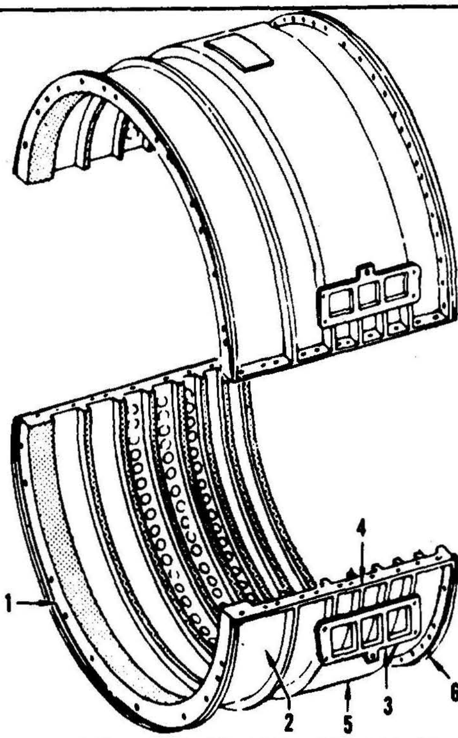
COMPRESSOR STATOR CASING ASSEMBLY - MAINTENANCE PRACTICES

1. General. Maintenance of the compressor stator assembly is limited to those items that are accessible.

1A. Preparation for Inspection. Prior to inspection, it is acceptable to prepare the stator sector vane leading and trailing edges by hand using a fine stone or 600-grit wet or dry abrasive paper or equivalent. Time used to prepare each leading or trailing edge shall not exceed 2 minutes. No localized preparation is allowed.

2. Inspection/Check. Where serviceable limits are exceeded, parts may be repaired in accordance with Overhaul Manual instructions.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Visually inspect the compressor casings as follows: (See figure 201.)		
(1) Cracks.		
(a) In welds between casing and flanges.	2 per flange, 1/8 inch long spaced 2 inches apart.	
(b) All other areas.	Not serviceable.	
(2) Nicks and scratches.		
(a) Casing body and air manifold.	Any number 0.015 inch deep.	
(b) Casing flanges.	Any number 0.020 inch deep.	
(3) Dents.		
(a) Casing.	Any number 0.020 inch deep.	
(b) Air manifold.	Any number 0.040 inch deep.	
(4) Cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
(5) Casings coated with TSM-3 for missing coating on:		
(a) External surfaces.	Not serviceable.	Cumulative area not to exceed 2 square inches. Touch-up per 72-02-7.



Compressor Casing Inspection
Figure 201

(b)' Blade path lands. Any amount.

Inspection/Check	Maximum Serviceable Limits	Remarks
(6) Flanges (1, 4, 6) for local distortion.	With flanges bolted together, a 0.001 inch thick by 0.200 inch wide shim shall not be able to be inserted more than 0.100 inch anywhere along the outside or inside of the flange.	Cold work flanges within max. serviceable limits. Fluorescent penetrant inspect area for cracks. None allowed.

3. Inspection of Stator Sector Vanes for Pits (Corrosion). (See figure 202.)

NOTE: The eighth-stage and exit guide vane are included in this inspection.

A. Vanes with the following defects in the airfoil are to be scrapped:

(1) Corrosion pits on the leading or trailing edge which can be felt with a wire. (Refer to inspection paragraph 4 for applicable wire sizes). Slide the wire up and down the edge at different angles to pick up defects on all portions of the edge.

(2) Corrosion of the leading or trailing edge which may appear as a stain, darker than the balance of the vane surface, and containing occasional pits.

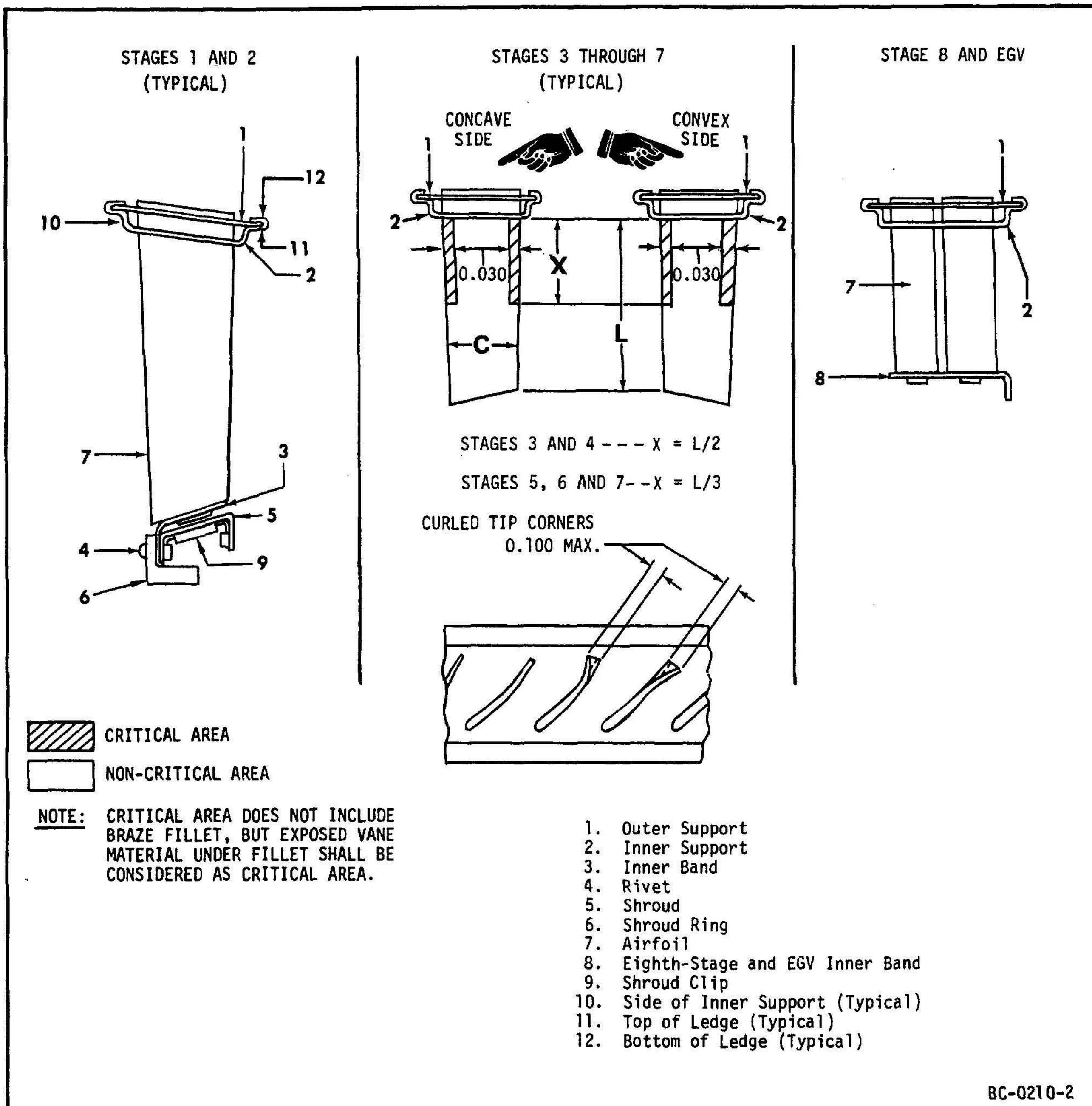
(3) Rough appearance of the surface including eroded areas which are depressed from the surrounding surface and appear as black or dark patches on the surface (random visible pits are acceptable).

NOTE: If a single vane is found to contain any of the above conditions the entire vane sector/segment shall be scrapped.

B. Intermetallic diffusion coated vanes with more than 10% of the coating missing after all other defects have been repaired shall be touched up per 72-02-6.

NOTE: Disregard missing coating within 0.100 inch of the vane tip.

C. Vanes with defects, other than those described in steps A. and B., in the vane airfoil shall be inspected per paragraph 4.



Stator Sectors - Inspection
Figure 202

4. Inspect the Vane Sectors/Segments as follows: (See figure 202.)

Inspection/Check	Maximum Serviceable Limits	Remarks
A. First- and second-stage sector halves for:		
(1) Loose or missing rivets (4).	Not serviceable.	Replace rivets.
B. First- and second-stage inner band (3) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and scratches.	Any number 0.015 inch deep after removal of all high metal.	
(3) Dents.	Any number 0.015 inch deep.	Cold-work to original contour. Fluorescent-penetrant inspect - no cracks allowed.
(4) Pits.	Any number 0.010 inch deep.	
(5) Elongated rivet holes.	None allowed.	

Inspection/Check	Maximum Serviceable Limits	Remarks
C. First- and second-stage shroud (5) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and scratches.	Any number 0.015 inch deep after removal of all high metal.	
(3) Dents.	Any number 0.015 inch deep.	Cold-work to original contour. Fluorescent-penetrant inspect - no cracks allowed.
(4) Broken spot welds on clips (9).	Not serviceable.	
(5) Pits.	Any number 0.010 inch deep.	
(6) Rubs.	Not more than 0.005 inch deep after removal of high metal.	
D. First- and second-stage shroud ring (6) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks, dents, pits, and scratches.	Any amount 0.030 inch deep after removal of all high metal.	
(3) Wear grooves.	Any number not over 0.020 inch deep.	

Inspection/Check	Maximum Serviceable Limits	Remarks
E. Inner support (2) (all stages) for:		
(1) Cracks.	None allowed.	
(2) Nicks, scratches, and dents.	Any number 0.015 inch deep after removal of all high metal.	
(3) Rubs.	Any amount 0.005 inch deep after removal of all high metal.	
(4) Pits.	Any number 0.010 inch deep.	
(5) Wear.	Any amount provided:	
	(a) 0.005 inch minimum stock thickness remaining on radial side of support (10) at end showing most severe wear.	
	(b) Top (11) or bottom (12) layer of ledge material is not reduced more than 25% of stock thickness.	
F. Outer support (1) (all stages) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and scratches.	Any number 0.015 inch deep after removal of all high metal.	
(3) Dents.	0.060 inch deep with no torn metal.	
(4) Fits.	Any number 0.010 inch deep.	

Inspection/Check	Maximum Serviceable Limits	Remarks
G. Airfoils (7) all stages for:		
(1) Cracks.	Not serviceable.	
(2) Edge waviness and bends.	Any number 0.050 inch from original contour.	Cold-work to original shape. Fluorescent-penetrant inspect; no cracks allowed.
(3) Trailing edge erosion (airfoil thinning).	Any amount if edges are not curled or rolled.	
(4) Missing coating on A12 coated vanes in:		
(a) Area within 0.100 inch of blade tip.	Any amount.	
(b) Other areas.	10% of coating missing.	Refer to paragraph 3.B.
H. Stage 1 and 2 airfoils for:		
(1) Nicks, dents, pits, and scratches on 0.030 inch area along entire leading and trailing edges. (Using light finger pressure, slide a 0.070-0.075 inch diameter wire along the edge at various angles.)	Any amount which cannot be felt.	Blend within limits per paragraph 5.

Inspection/Check	Maximum Serviceable Limits	Remarks
I. Stages 3 thru 7 airfoils for:		
(1) Nicks, dents, pits, and scratches on:		
(a) Critical areas. (Using light finger pressure, slide a 0.070-0.075 inch diameter wire along the edge at various angles).	(a) On assembled vanes, any amount that cannot be felt.	(a) If the defect cannot be felt using a 0.120-0.125 inch diameter wire or if they are clearly the direct result of FOD, blend within limits per paragraph 5.
	(b) On unassembled vanes, any number that cannot be felt.	(b) If the defect can be felt with a 0.120-0.125 inch diameter wire and is not clearly the result of FOD, the sector is not repairable and shall be replaced.
(b) Non-critical areas of leading and trailing edges. (Using light finger pressure, slide a 0.120-0.125 inch diameter wire along the edge at various angles).	Any amount which cannot be felt.	Blend within limits per paragraph 5.
(2) Corrosion (except leading and trailing edges). (Using light finger pressure, slide a wire across the corroded area).	Any amount which cannot be felt.	(a) Stages 3 and 4; use a 0.070-0.075 inch diameter wire.

Inspection/Check	Maximum Serviceable Limits	Remarks
		(b) Stages 5, 6, and 7; use a 0.120-0.125 inch diameter wire.

NOTE: To ensure proper installation on the stage 6 and 7 stator sectors at assembly, after inspection mark the first vane (counting clockwise, aft looking forward) of each serviceable stator sector. Make the mark on the aft (concave) side of the vane in the form of a 1/2 inch dot using yellow dykem or equivalent. (See figure 203.) Do not use paint.

Inspection/Check	Maximum Serviceable Limits	Remarks
J. Stage 8 and EGV airfoils for:		
(1) Nicks, dents, pits, and scratches on a 0.030 inch area along leading and trailing edges. (Using light finger pressure, slide a 0.070-0.075 inch diameter wire along the edge at various angles.)	Any amount which cannot be felt.	Blend within limits per paragraph 5.
(2) Corrosion (except leading and trailing edges). (Using light finger pressure, slide a 0.070-0.075 inch diameter wire across the corroded area.	Any amount which cannot be felt.	
K. Cracks, gaps, and porosity in all brazed joints:		
(1) Stages 1 and 2 vane sector inner band (3).	Any number up to 1/4 inch long, cumulative length not to exceed 50 percent of joint length.	
(2) Stages 1 and 2 outer support (1) and inner support.	Any number up to 1/8 inch long, cumulative length not to exceed 50 percent of joint length.	
(3) Stages 3 through 8.	Any number up to 1/8 inch long, cumulative length not to exceed 50 percent of joint length.	

5. Airfoil Blending Procedure. (See figure 204.)

A. Blending is done to remove the stress concentration of nicks, pits, and scratches to prevent vane failure. The removal of high metal is done to restore the airfoil to nearly its original aerodynamic shape.

NOTE: Blending is restricted to leading and trailing edges and tip corners.

B. Hand blending should be finished with a fine stone or 600 grit wet or dry abrasive paper. Finish blending must be done in a direction along the length of the vane and must remove all evidence of crosswise marks that may have been made during initial blending.

C. All FOD defects more than 1/4-inch apart should be blended separately; those less than 1/4-inch apart should be blended together. All blends must have a minimum radius of 1/4-inch. The total reduction in chord width may be taken on either side or split between the sides. Amount of rework is controlled by the minimum chord width limit. Minimum allowable chord is given for root and tip of airfoil, minimum chord at other points is proportional. (See figure 204.)

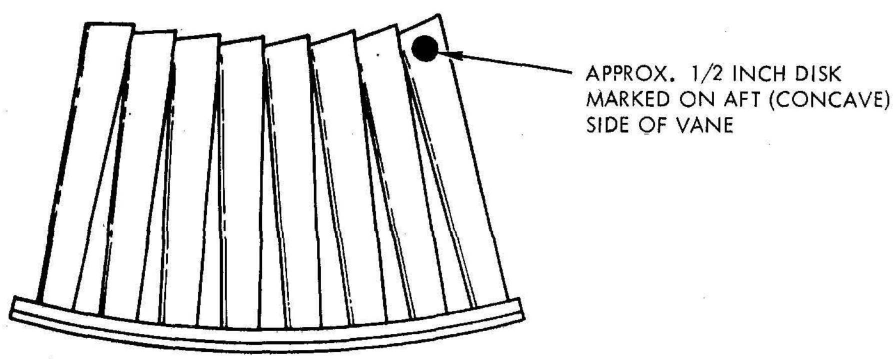
D. If FOD minor repair limits are not exceeded in a stage, any number of vanes in that stage may be repaired. If both major and minor FOD repair is required in a stage, major repair is limited to 10 percent of the vanes, and minor repair is allowed on the remaining vanes of that stage. Tip rubs may be repaired on any number of vanes.

CAUTION: EXCESSIVE BLENDING OF CORROSION PITS MAY HIDE DEFECTS THAT COULD LEAD TO VANE FAILURE. THE CHORD LIMITS SPECIFIED IN FIGURE 204 APPLY TO FOD ONLY.

E. Corrosion pits shall be hand blended parallel to the leading and trailing edges using a fine Arkansas stone. If blending for several minutes does not reduce corrosion pits to within serviceable limits the vane sector shall be scrapped.

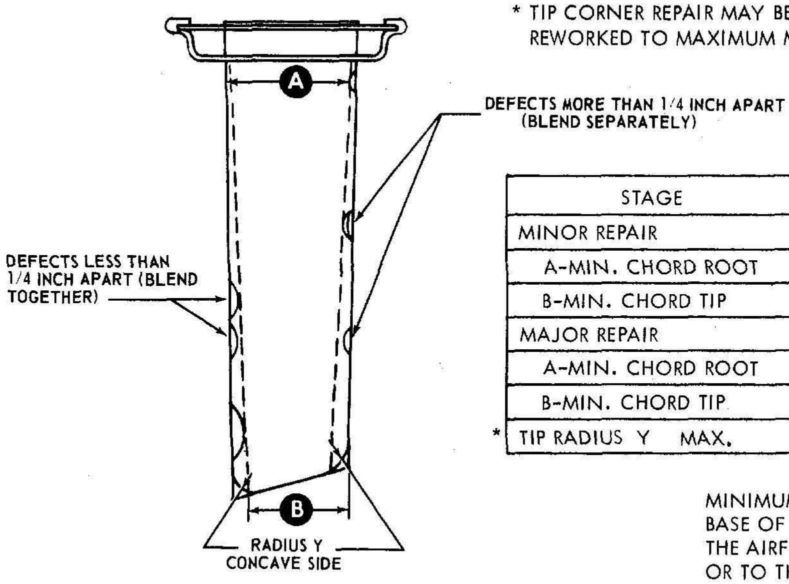
F. The shape of the vane leading edge is very important to engine performance. Leading edges are to be smoothly radiused as shown in figure 2-5.

G. Repair and touchup of A12 coated vanes shall not exceed limits specified in paragraph 3.B.



Marking of Stage 6 and 7 Stator Sectors (Typical)
Figure 203

* TIP CORNER REPAIR MAY BE PERFORMED ON VANES WHICH HAVE BEEN REWORKED TO MAXIMUM MINOR OR MAJOR LIMITS

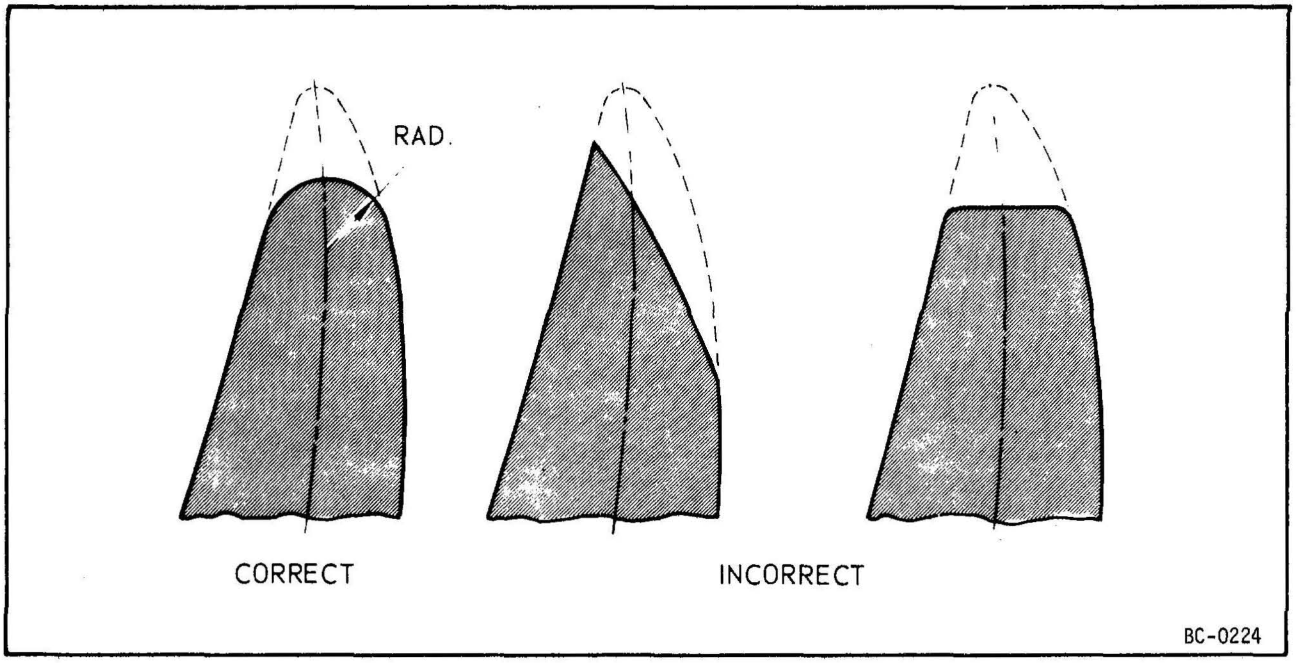


STAGE	1	2	3	4	5	6	7	8	EGV
MINOR REPAIR									
A-MIN. CHORD ROOT	.900	.700	.580	.490	.430	.400	.400	.400	.400
B-MIN. CHORD TIP	.830	.660	.560	.480	.420	.400	.400	.400	.400
MAJOR REPAIR									
A-MIN. CHORD ROOT	.830	.650	.580	.490	.430	.400	.400	.360	.360
B-MIN. CHORD TIP	.770	.610	.520	.440	.390	.360	.360	.360	.360
* TIP RADIUS Y MAX.	-	-	.125	.100	.100	.100	.100	-	-

NOTE
MINIMUM CHORD IS MEASURED FROM THE BASE OF ANY REWORKED AREA ACROSS THE AIRFOIL TO THE OPPOSITE EDGE OR TO THE BASE OF ANY OPPOSITE REWORKED AREA

CJ610-3068-0-E2

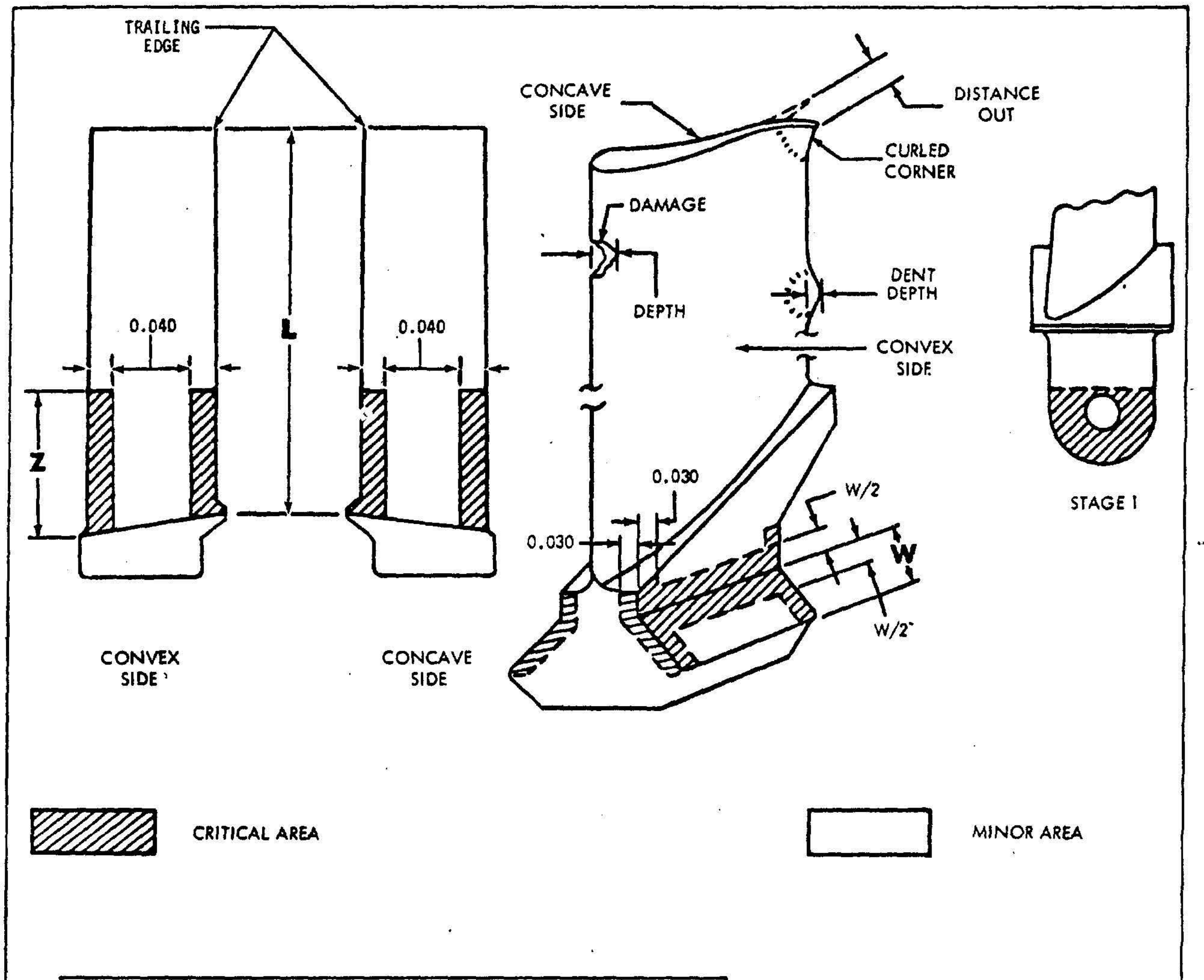
Stator Vane - FOD Repair
Figure 204



Typical Leading Edge After Blending
Figure 205

COMPRESSOR ROTOR ASSEMBLY - MAINTENANCE PRACTICES

1. General. Maintenance of the compressor rotor assembly is limited to those items that are accessible.



DIMENSION	STAGE 1	2	3	4	5	6	7	8
Z	1/3 L	2/3 L	1/2 L	1/2 L	2/3 L	2/3 L	2/3 L	2/3 L

Compressor Rotor Blades - Inspection
Figure 201

1A. Preparation for Inspection. Prior to inspection, it is acceptable to prepare the compressor rotor blade leading and trailing edges by hand using a fine stone or 600-grit, wet or dry abrasive paper or equivalent. Time used to prepare each leading or trailing edge shall not exceed 2 minutes. No localized preparation is allowed.

2. Inspection of Blades for Pits (Corrosion)

A. Blades with the following defects in the airfoil critical areas (see figure 201) are to be scrapped:

(1) Corrosion pits on the leading or trailing edge which can be felt with a wire (refer to paragraph 3 for applicable wire sizes), or pits which appear to be sharp notches in the leading or trailing edge. Slide the wire at different angles to pick up defects on all portions of the edge.

(2) Rough appearance of the surface including eroded areas which are depressed from the surrounding surface and appear as black or dark patches on the surface (random visible pits are acceptable).

B. Intermetallic diffusion coated blades with more than 10% of the coating missing after all other defects have been repaired shall be touched up per 72-02-6.

NOTE: Disregard missing coating within 0.100 inch of the blade tip.

C. Inspect blades with defects, other than those described in step A, in the leading or trailing edge of the airfoil per inspection paragraph 3.

3. Inspection/Check. Where serviceable limits are exceeded, parts may be repaired in accordance with Overhaul Manual instructions.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Entire blade for:		
(1) Fatigue crack indications.	Not serviceable.	If crack is within 3/16 inch of the trailing edge tip corner blend out crack but do not exceed limits per paragraph 4.
(2) Manufacturing process defect indications.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
B. Airfoils all stages for:		
(1) Bends, distortion, or edge waviness.	Leading and trailing edges must be straight within 0.015 inch per inch of height, provided such defects form long, smooth curves.	
(2) Nicks, dents, pits, and scratches on:		
(a) Critical areas. (Using light finger pressure slide a 0.070-0.075 inch diameter wire along the edge at various angles).	Any amount which cannot be felt.	Blend within limits per paragraph 4 if the defect cannot be felt with a 0.120-0.125 inch diameter wire.
(b) Non-critical areas. (Using light finger pressure, slide a 0.120-0.125 inch diameter wire along the edge at various angles).	Any amount which cannot be felt.	Blend within limits per paragraph 4.
(3) Visible corrosion in critical areas:		
(a) Stage 1, 2, 5, 6, 7, and 8.	Any amount if the area does not appear rough or eroded.	
(b) Stage 3 and 4.	Not serviceable.	
C. Blade tips for:		
(1) Curled corners.	Not over 0.010 inch.	Repair per paragraph 4.
(2) Burrs due to rubs.	Not serviceable.	Remove burrs.

Inspection/Check	Maximum Serviceable Limits	Remarks
D. Pin holes (first stage) for:		
(1) Wear.	Not over 0.255 inch ID.	
(2) Burrs on edge.	Not serviceable.	Remove burr. Edges of holes must have a 0.005 inch minimum radius.
E. Critical areas of blade shanks (1st stage) for nicks, dents, scratches, and pits.	Any number 0.005 inch deep after removal of all high metal.	
F. Minor area of platform and blade shanks (1st stage) for nicks, dents, scratches, and pits.	Any number 0.020 deep after removal of all high metal.	
G. Missing coating on A12 coated blades in:		
(1) Area within 0.100 inch of blade tip.	Any amount.	
(2) Other areas.	10 percent of coating missing.	Refer to paragraph 2.B.
H. Spacer vane path for nicks, dents, pits, scratches, and rubs.	Any amount not exceeding 0.005 inch deep, with no high metal.	Remove high metal 70-42-0.

Inspection/Checks	Maximum Serviceable Limits	Remarks
I. Stage 1 blade retaining pin:		
(1) All areas for cracks.	Not serviceable.	Replace pin.
(2) Pin shank for:		
(a) Nicks, dents, and scratches.	Any number less than 0.005 inches deep with no high metal.	Blend per 70-42-0.
(b) Wear.	0.2490 inch min OD.	Replace pin.
(3) Pin head for nicks, dents, and scratches.	Any number less than 0.010 inches deep with no high metal.	Blend per 70-42-0.
(4) All areas for pits due to corrosion or fretting.	Not serviceable.	Replace pin.

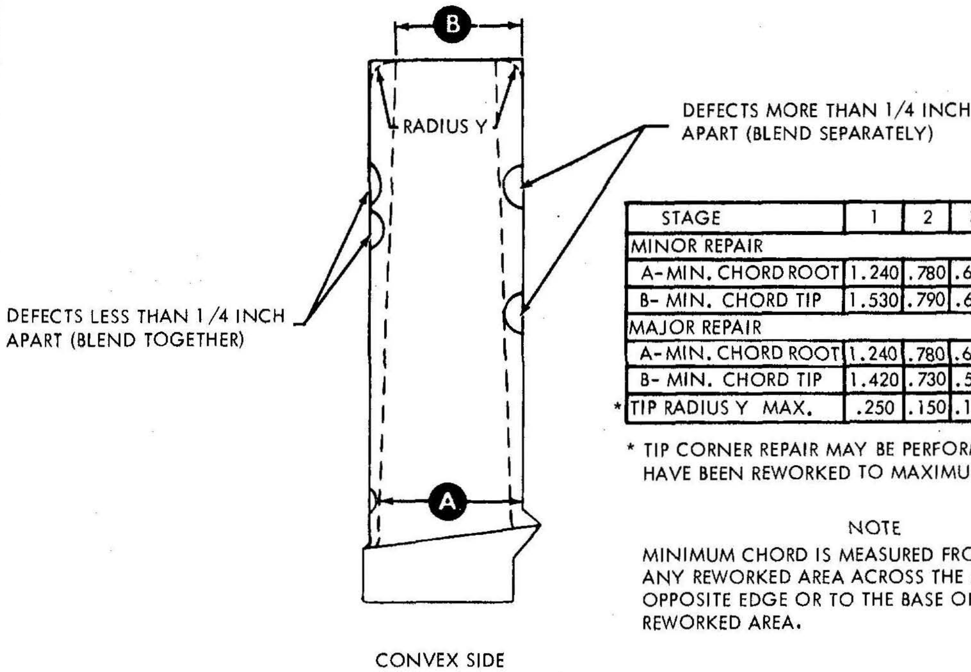
4. Airfoil Blending Procedure. (See figure 202.)

A. Blending is done to remove the stress concentration of nicks, pits, and scratches to prevent blade failure. The removal of high metal is done to restore the airfoil to nearly its original aerodynamic shape.

CAUTION: BLENDING OF CONCAVE AND CONVEX AIRFOIL SURFACES WHICH WOULD REDUCE THICKNESS IS PROHIBITED. REMOVAL OF HIGH METAL ONLY IS PERMITTED ON THESE SURFACES.

B. Hand blending should be finished with a fine stone or 600 grit wet or dry abrasive paper. Finish blending must be done in a direction along the length of the vane and must remove all evidence of crosswise marks that may have been made during initial blending.

C. All FOD defects more than 1/4-inch apart should be blended separately; those less than 1/4-inch apart should be blended together. All blends must have a minimum radius of 1/4-inch. The total reduction in chord width may be taken on either side or split between the sides. Amount of rework is controlled by the minimum chord width limit. Minimum allowable chord is given for root and tip of airfoil, minimum chord at other points is proportional. (See figure 202.)



STAGE	1	2	3	4	5	6	7	8
MINOR REPAIR								
A-MIN. CHORD ROOT	1.240	.780	.610	.540	.460	.420	.400	.495
B-MIN. CHORD TIP	1.530	.790	.610	.540	.460	.440	.420	.445
MAJOR REPAIR								
A-MIN. CHORD ROOT	1.240	.780	.610	.540	.460	.420	.400	.495
B-MIN. CHORD TIP	1.420	.730	.570	.500	.430	.400	.390	.415
* TIP RADIUS Y MAX.	.250	.150	.150	.100	.100	.100	.100	.100

* TIP CORNER REPAIR MAY BE PERFORMED ON BLADES WHICH HAVE BEEN REWORKED TO MAXIMUM MINOR OR MAJOR LIMITS.

NOTE

MINIMUM CHORD IS MEASURED FROM THE BASE OF ANY REWORKED AREA ACROSS THE AIRFOIL TO THE OPPOSITE EDGE OR TO THE BASE OF ANY OPPOSITE REWORKED AREA.

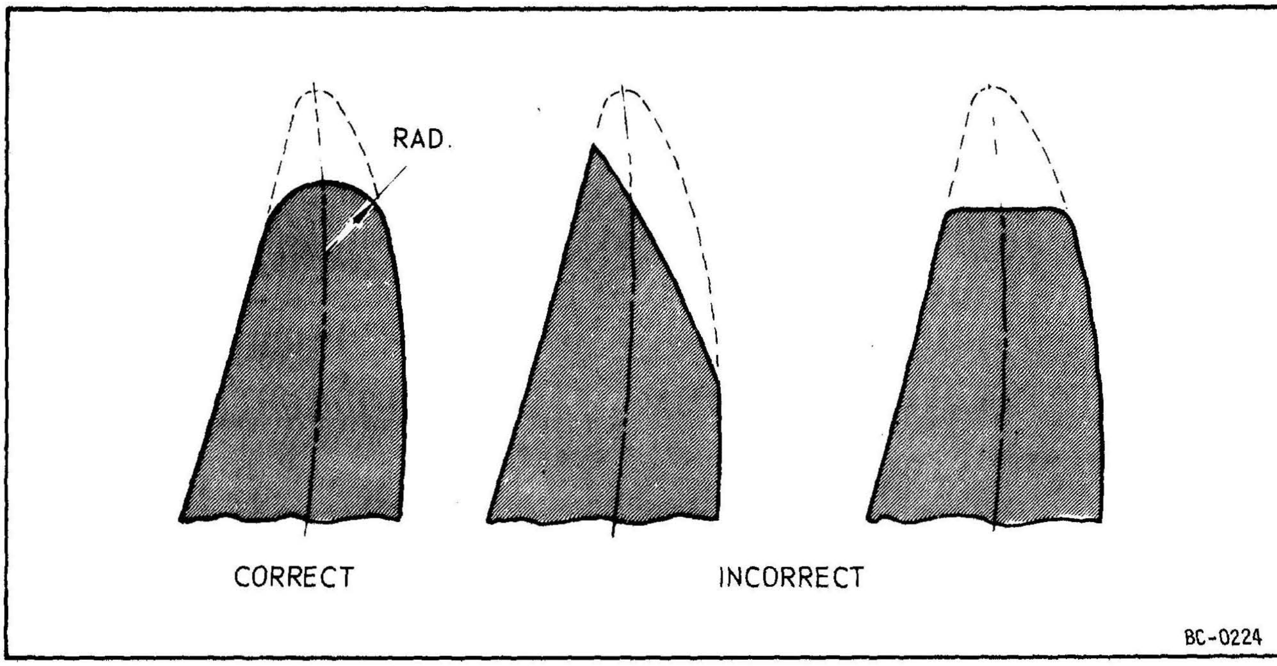
CJ610-3079-1-D2

Compressor Rotor Blade - FOD Blending Limits
Figure 202

D. If FOD minor repair limits are not exceeded in a stage, any number of blades in that stage may be repaired. If both major and minor repair is required in a stage, major repair is limited to 10 percent of the blades, and minor repair is allowed on the remaining blade of that stage. Tip rubs may be repaired on any number of blades.

CAUTION: EXCESSIVE BLENDING OF CORROSION PITS MAY HIDE DEFECTS THAT COULD LEAD TO BLADE FAILURE. THE CHORD LIMITS SPECIFIED IN FIGURE 202 APPLY TO FOD ONLY.

E. Corrosion pits shall be hand blended parallel to the leading and trailing edges using a fine Arkansas stone. If blending for several minutes does not reduce corrosion pits to within serviceable limits the blade shall be scrapped.



Typical Leading Edge After Blending
Figure 203

F. The shape of the blade leading edge is very important to engine performance. Leading edges are to be smoothly radiused as shown in figure 203.

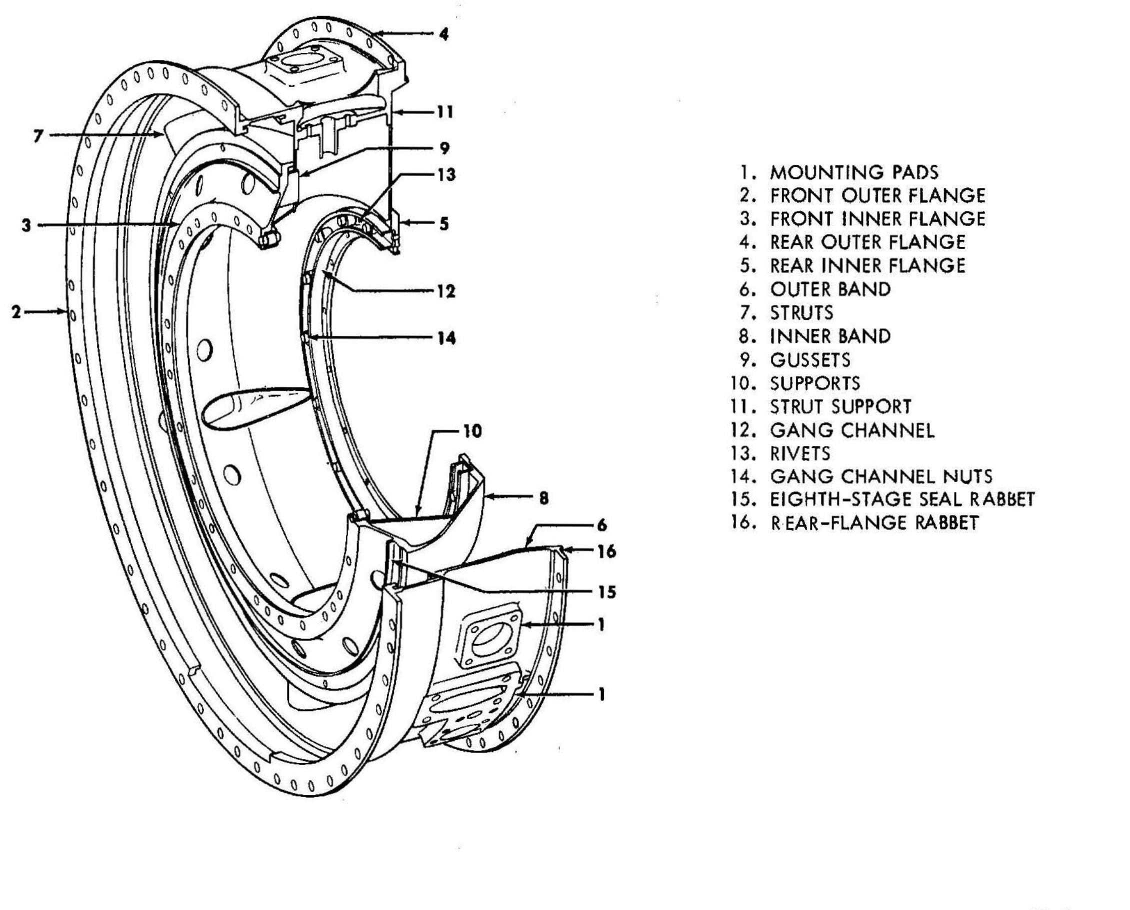
G. Repair and touchup of A12 coated blades shall not exceed limits specified in paragraph 3.B.

MAINFRAME - MAINTENANCE PRACTICES

1. General. Maintenance of the mainframe assembly is limited to those items that are accessible.

2. Inspection/Check. Where serviceable limits are exceeded, parts may be repaired in accordance with Overhaul Manual instructions.

   NOTE: Confirm suspected cracks per 72-03-1.



Mainframe
Figure 201

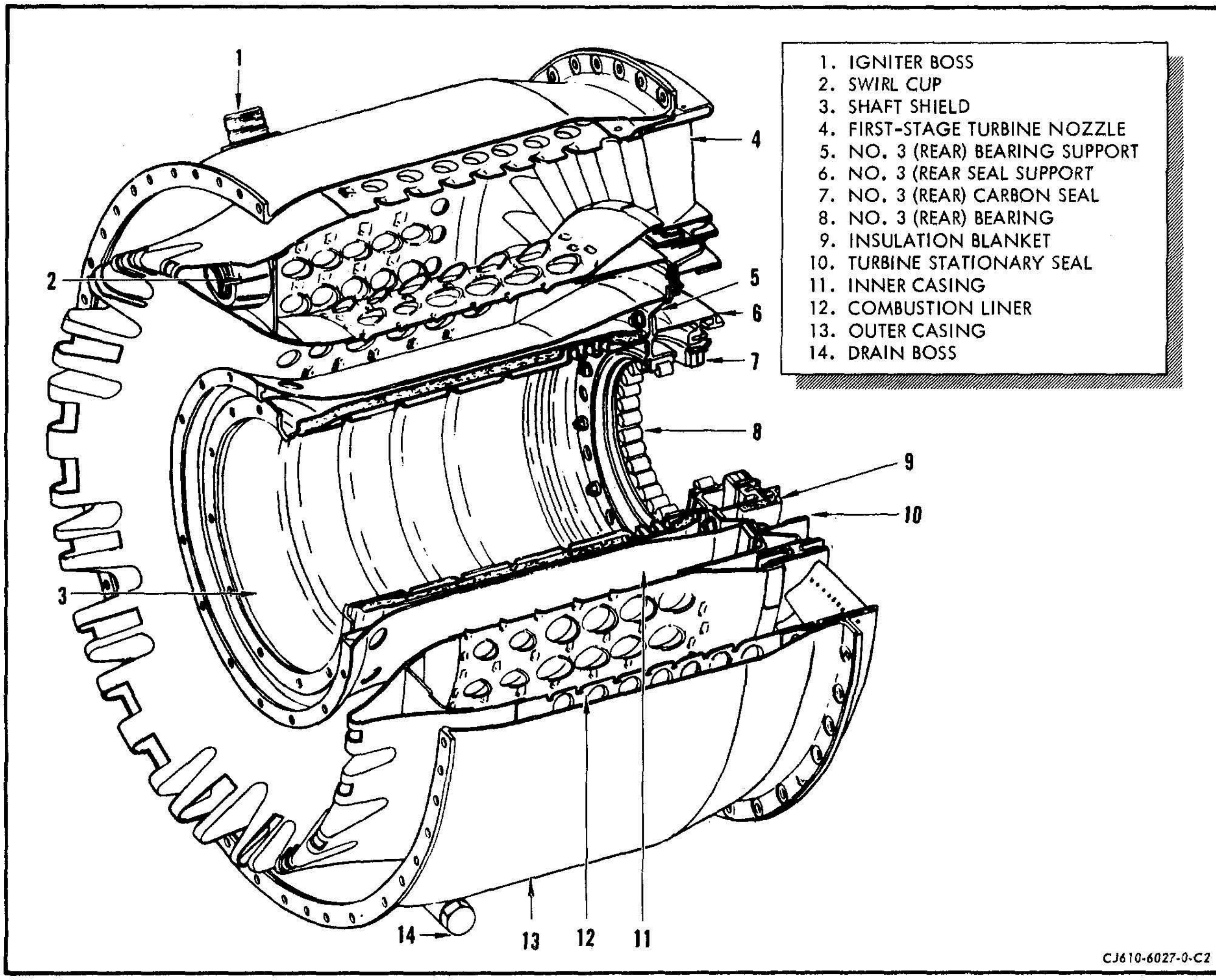
Inspection/Check	Maximum Serviceable Limits	Remarks
A. Visually inspect the external areas of the mainframe as follows:		
(1) Mounting pads for:		
(a) Damaged threads.	Damage equivalent to one full thread missing after chasing.	
(b) Cracks.	One per pad, 3/4 inch long.	
(c) Nicks, dents, scratches, and pits.	Any number, 0.020 inch deep.	
(d) Broken bolts.	Not serviceable.	Remove and replace all broken bolts.
(2) Flanges for cracks.	Not serviceable.	
(3) Outer band for:		
(a) Cracks.	Not serviceable.	
(b) Nicks and scratches.	Any number, 0.020 inch deep.	
(c) Dents.	Any number, 0.030 inch deep, 1 inch in diameter.	
(4) All welds for cracks.	No through cracks allowed. Surface cracks 0.030 inch long, with a cumulative length of 0.090 inch in any 1.0 inch of weld. Cumulative length not more than 8 percent of joint length.	
(5) Gearbox adapter for cracks.	Not serviceable.	
(6) Mainframe for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
(7) Mainframes coated with TSM-3 for missing coating.	Not serviceable.	Cumulative area not to exceed 2 square inches. Touch-up per 72-02-7.

Inspection/Check	Maximum Serviceable Limits	Remarks
B. Visually inspect the internal areas of the mainframe as follows:		
NOTE: Inspect these areas only when the combustion section has been removed.		
(1) Struts and inner band for cracks.		
(a) Outer band.	Not serviceable.	
(b) Strut.	Not serviceable.	
(c) Inner band.	Not serviceable.	
(2) Nicks, pits, and scratches.	Any number, 0.020 inch deep, with no high metal.	
(3) Dents.	Any number, 0.030 inch deep, 1 inch diameter that does not cause interference or improper fit.	
(4) Welds for cracks.	No through cracks allowed. Surface cracks 0.030 inch long, with a cumulative length of 0.090 inch in any 1.0 inch of weld. Cumulative length not more than 8% of joint length.	
(5) Eighth-stage stator vanes: (See 72-32-0, paragraph 3.)		
(6) Bearing support for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
C. Borescope inspect internal flowpath area for:		
NOTE: Inspect this area only when the combustion section has been removed.		
(1) Corrosion.	No surface roughness due to corrosion allowed.	Remove excess corrosion with emery cloth or equivalent.

COMBUSTION SECTION - DESCRIPTION AND OPERATION

1. General.

The combustion section, figure 1, consists basically of the outer combustion casing, inner combustion casing, combustion liner, the number 3 bearing and support, the number 3 carbon seal and support, the turbine stationary air seal, the shaft shield and the combustion heat shield (optional equipment). The first-stage turbine nozzle is shown because it attaches to the combustion section rather than the turbine section. The description for the first-stage turbine nozzle is covered in the turbine section.



Combustion Section
Figure 1

2. Description.

A. Outer Combustion Casing. The outer combustion casing (13) is one piece, and is made of chromoloy material. It is a major structural unit, bolting to the mainframe at the front and to the turbine stator at the rear. An igniter plug is seated at each of the two igniter bosses (1) and extend through the casing into the combustion liner. An insulation shield (optional) is secured around the outer surface of the casing to shield airframe components from excessive heat.

B. Inner Combustion Casing. The annular inner combustion casing (11) is made of chromoloy and is one-piece. At the front, it bolts to the inner casing of the mainframe and at rear and supports the No. 3 bearing support (5). Extra holes are provided in the rear flange to form passages so air can enter the balance piston chamber area.

C. Combustion Liner. The combustion liner (12) consists of a cowl section, a dome section, an outer shell, an inner shell, and the outer and inner shell, and the outer and inner flanges. All of these components are welded and riveted to form a one-piece fabrication, made from Hastelloy material. Air from the compressor section enters the liner through perforated areas designated as thimble holes and louvers. The thimble holes direct air into the burning area while the louvers provide boundary layers of air along the inner surfaces of the liner to prevent formation of hot spots. Free thermal expansion of the liner is allowed by the following method of support. The twelve fuel nozzles protrude into the liner at the swirl cups (2) and provide a steady support at the front. At the rear, the outer flange is held in place by the common joint of the turbine casing and the outer combustion casing.

The inner flange is held in place by the common joint of the inner combustion casing and the first-stage nozzle. Thus, the liner is supported mainly by its inner and outer flanges at the aft end. Equally spaced holes in the outer flanges direct the passage of the relatively cool air from along the outer combustion casing into the hollow partitions of the first-stage turbine nozzle (4).

D. No. 3 Bearing Support. The No. 3 bearing support is made from chromoloy and retains the outer race and cage assembly of the No. 3 bearing (8); it retains the oil nozzle assembly which lubricates the No. 3 bearing; and it also retains the No. 3 seal support. The seal support retains the oil seal and the inner turbine air seal. The No. 3 bearing support and the forward race of the first-stage turbine wheel form the balance piston air chamber. Boundary layer air from the inner combustion casing enters this chamber and bears against the face of the turbine wheel to counteract the rotor forward thrust.

E. Shaft Shield. The shaft shield (3) is made from 321 stainless steel. The forward flange is bolted to the collar of the power take-off assembly and the aft flange is bolted to the No. 3 bearing support (5). It protects the oil lines and the engine shaft from excessive heat and connects the No. 2 bearing area to the No. 3 bearing area to form a common oil sump.

3. Operation.

Fuel enters the combustor through the 12 fuel nozzles. Each fuel nozzle incorporates a flow divider, a primary and secondary flow passage, ensuring a proper fuel spray pattern and flow through the engine operating speed range. The compressor discharge air enters the space between the outer combustion casing and inner combustion casing, and passes through the louvers and thimble holes into the liner where combustion takes place with the fuel. A small amount of air enters the combustion dome through the swirl cups to provide primary combustion, dome cooling and fuel nozzle carbon sweeping. The resulting gases pass to the turbine through an annular opening at the rear of the liner and the first-stage turbine nozzle.

COMBUSTION SECTION - MAINTENANCE PRACTICES

1. General. The following paragraphs describe removal, installation, disassembly and assembly procedures that are approved for "hot section" inspection and No. 3 bearing replacement.

2. Removal/Installation Procedures for Combustion Heat Shield. (Optional Equipment.)

   A. **Removal.**

      (1) Disconnect the two igniter leads. Remove the igniter plugs.

      (2) Remove the 2 nuts from the igniter bosses.

      (3) Remove the 2 bolts and washers from ignition lead supports.

      (4) Remove the 2 nuts, bolts and gaskets from the 2 pairs of supports located at the aft end of the horizontal split line. Note that the nut, bolt and gasket on the left side of the engine also attaches a bracket for the ignition lead clamp.

      (5) Remove the union and packing from the combustion casing drain (located at 6 o'clock position).

      (6) Remove the 16 bolts and washers that attach the heat shield to the heat shield brackets that are bolted to the forward side of the outer combustion casing rear flange.

      (7) Remove the heat shield halves.

   B. **Installation.**

      (1) Install the upper-half of the heat shield over the outer combustion casing. Install the lower-half of heat shield so that the splitline edge fits between the inner and outer spring clips of the upper half.

      (2) Align and insert the 16 bolts and washers that attach the heat shield to the heat shield brackets. Torque the bolts to 21-27 lb-in. Lockwire the bolt heads to the brackets if no firewall has to be installed later.

      (3) Insert the 2 bolts (bolt head up) that are used to bolt the two halves of the heat shield together at the forward heat shield supports. Insert the gasket-type washers between the 2 pair of supports. Assemble the locknut and the clamp for the thermocouple

harness on the left-hand side of the engine. Assemble the locknut to the bolt on the right-hand side of the engine. Torque the locknuts to 24-27 lb-in. and lockwire the bolt head to the support.

(4) Using a new packing, assemble and torque the combustion casing drain fitting to 40-60 lb-in.

(5) Attach the 2 ignition lead brackets to the heat shield using 2 bolts and 2 washers. Torque the bolts to 24-27 lb-in. and lockwire.

(6) Assemble the gasket and nut that secures the heat shield to the outer combustion casing igniter boss.

(7) Igniter plug tips must have an immersion depth into the combustion liner of 0.000-0.015 inch. The immersion depth is controlled by the number of washers or shims used on the plug. Set the immersion depth per section 80-23-0.

3. Removal/Installation Procedures for Combustion Section Inspection. (See figure 201.) Use this procedure for routine combustion section removal, inspection and re-installation.

A. Removal.

(1) Remove the exhaust section and turbine sections as outlined in the sections 78-11, and 72-50 respectively, the necessary external lines and leads, and the igniter plugs per section 80-23-0.

(2) Remove the turbine stationary seal, the first-stage nozzle, and the combustion liner as follows:

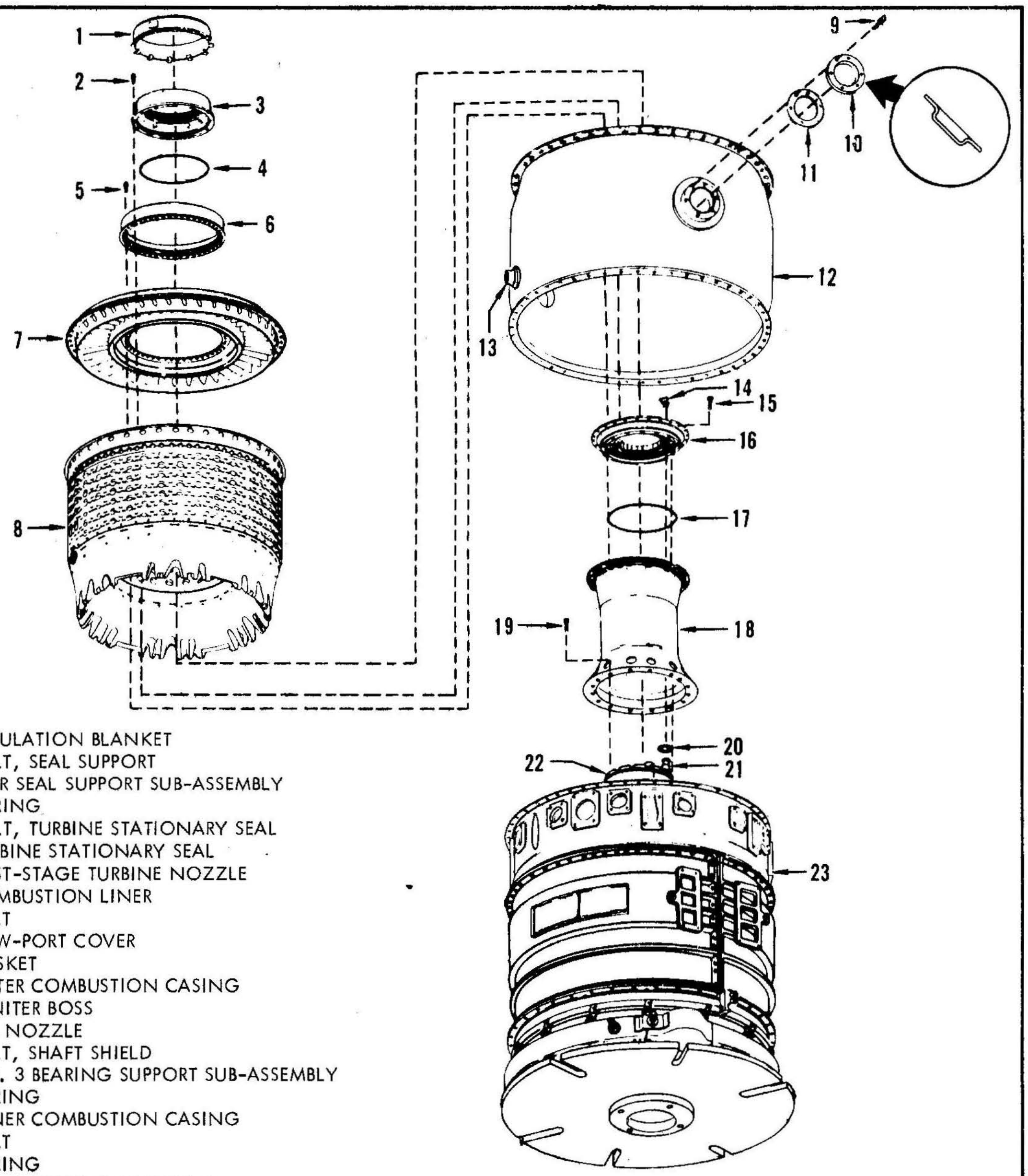
NOTE: First-stage turbine nozzles have 5 "T" positions (T1 through T5) stamped circumferentially around the aft face of the outer flange. Before removing the nozzle, record in the engine records the "T" number located at the 12 o'clock position.

(a) Match-mark the turbine outer stationary seal with first-stage nozzle. Match-mark the first-stage nozzle with the outer combustion casing.

(b) Remove the bolts (5) that attach the turbine stationary seal (6). Remove the seal, first-stage nozzle (7), and the combustion liner (8).

B. Installation. Install the combustion liner (8), first-stage nozzle (7), and the turbine stationary seal as follows:

NOTE: Use procedure outlined in paragraph 5 if the No. 3 bearing support has been removed from engine.



1. INSULATION BLANKET
2. BOLT, SEAL SUPPORT
3. REAR SEAL SUPPORT SUB-ASSEMBLY
4. O-RING
5. BOLT, TURBINE STATIONARY SEAL
6. TURBINE STATIONARY SEAL
7. FIRST-STAGE TURBINE NOZZLE
8. COMBUSTION LINER
9. BOLT
10. VIEW-PORT COVER
11. GASKET
12. OUTER COMBUSTION CASING
13. IGNITER BOSS
14. OIL NOZZLE
15. BOLT, SHAFT SHIELD
16. NO. 3 BEARING SUPPORT SUB-ASSEMBLY
17. O-RING
18. INNER COMBUSTION CASING
19. BOLT
20. O-RING
21. NO. 3 BEARING LUBE TUBE
22. SHAFT SHIELD
23. MAIN FRAME

Combustion Section - Installation
Figure 201

(1) Install the combustion liner (8) over the inner combustion casing (18) and line up the opening for the igniter with the igniter boss (13) on the outer combustion casing (12).

(2) Visually check the rear flanges of the combustion liner (8) to be sure they are seated on the rear flanges of the inner and outer combustion casings (12, 18).

(2A) Check the fit between the first-stage nozzle and the combustion liner before assembly to the liner. See figure 201A, View A. The nozzle outer band should fit snugly into the liner and should be capable of rotating in it. If interference exists between these parts, proceed as follows:

Interference	Corrective Action
(a) Nozzle fits into liner, but interferes with outer tabs; or nozzle fits into liner on one side, but interferes with rivets on the other.	Bend tabs uniformly outward around circumference of liner. Max allowable bend on any tab is 0.02 in. See figure 201A, View B.
(b) Nozzle fits into liner, but interferes with rivets.	Bend rivets inward until nozzle fits without interference. See figure 201A, View C.
(c) Nozzle band has a wavy pattern and interferes with outer tabs and rivets.	Remove waves from nozzle outer band, using a rawhide mallet or plastic hammer. Nozzle outer band must be 15.35-15.37 inch ID on forward end.

(3) Install the first-stage turbine nozzle (7) by inserting the nozzle outer band over the flanges of the combustion liner (8). Check the engine disassembly records for the designation of the "T" number that is located at the 12 o'clock position. Before seating the nozzle, align the bolt circles at the inner and outer combustion casing flanges with the designated "T" mark on the nozzle at the 12 o'clock position. [See note paragraph 3.A.(2)]. Secure the nozzle to the aft flange of the outer combustion casing (12) with 4 bolts and locknuts equally spaced. Install the bolts from the combustion casing side of the flange.

WARNING: LUBRICATING OIL

IF OIL IS DECOMPOSED BY HEAT, TOXIC GASES ARE RELEASED.

PROLONGED CONTACT WITH LIQUID OR MIST MAY CAUSE DERMATITIS AND IRRITATION.

IF THERE IS ANY PROLONGED CONTACT WITH SKIN, WASH AREA WITH SOAP AND WATER. IF SOLUTION CONTACTS EYES, FLUSH EYES WITH WATER IMMEDIATELY. REMOVE SATURATED CLOTHING.

IF OIL IS SWALLOWED, DO NOT TRY TO VOMIT. GET IMMEDIATE MEDICAL ATTENTION.

WHEN HANDLING LIQUID, WEAR RUBBER GLOVES. IF PROLONGED CONTACT WITH MIST IS LIKELY, WEAR APPROVED RESPIRATOR.

(4) Lubricate the threads of bolts (5) with a light coat of engine oil.

(5) Position the turbine stationary seal (6) so that the match-marks on the seal and nozzle are aligned. Secure the first-stage nozzle (7) and the stationary seal to the inner combustion casing (18) with the 4 equally spaced bolts (5). Torque the bolts to 10-12 lb-in. Check each bolt to make certain that it is snug against the stationary seal. If any bolt is not snug remove the bolts; realign and reseat the parts and reinstall the bolts. When each bolt is snug with a 10-12 lb-in. torque, apply a final torque of 45-50 lb-in.

NOTE: The bolts (5) are assembled into shank nuts in the inner combustion casing aft flange. Turn the bolts into the shank nuts by hand until the first few threads are engaged. Then torque the bolts carefully to avoid unseating the shank nuts.

(6) Check the radial runout between the engine centerline and ID (bronze sealing surface) of the No. 3 seal support and ID of stationary seal per paragraph 5.B.(4)(f).

(7) Lubricate threads of remaining bolts (5) with a light coat of engine oil and install. Torque the bolts to 10-12 lb-in. Check each bolt to make certain that it is snug against the stationary seal. If any bolt is not snug remove the bolt, inspect threads and for other conditions causing bolt hang up. When each bolt is snug with a 10-12 lb-in. torque, apply a final torque of 45-50 lb-in.

(8) Lockwire the turbine stationary seal bolts being careful not to pass the lockwire over the louver edges so as to block the louver openings.

(9) Prior to assembling the turbine casing, remove the bolts used to attach nozzle to combustion outer casing.

C. Install the turbine and exhaust sections per 72-50 and 78-11, respectively. Assemble all removed lines, leads, and accessories removed per applicable sections of manual, such as igniter plugs per 80-23-0.

4. <u>Removal/Installation Procedures for the Outer Combustion Casing.</u>

A. Removal.

(1) Remove the first-stage turbine nozzle and combustion liner as outlined in paragraph 3, before removing casing as follows:

(a) Remove casing by removing all bolts, locknuts, the installation lug and brackets from the combustion casing - mainframe flange.

(b) Remove the casing from engine.

(c) Remove view port cover and discard gasket.

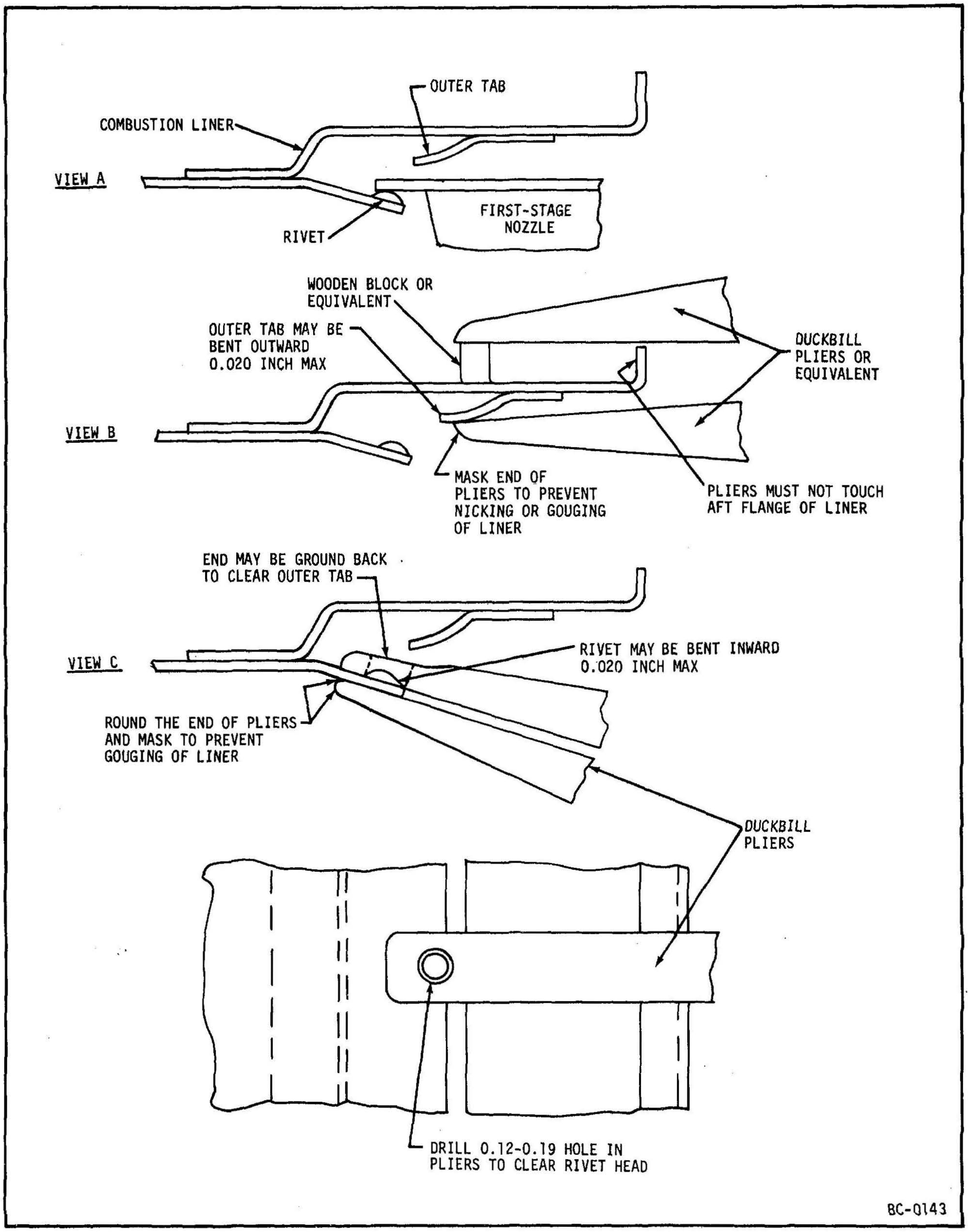
B. Installation. Install the outer combustion casing as follows: (See figure 202.)

(1) Position the outer combustion casing on the mainframe with the drain boss at the 6 o'clock position and the flange bolt holes aligned.

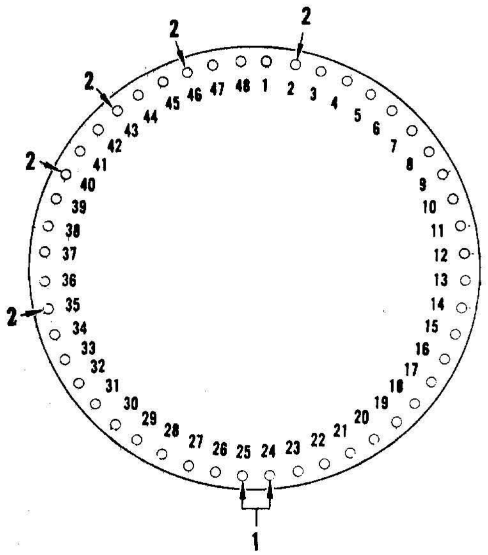
(2) Secure the forward flange of the outer combustion casing to the mainframe as follows:

(a) Install the 2 bolts at holes 24 and 25. Torque the bolts and lockwire them.

(b) Secure the 4 offset brackets (4) to the aft side of flange, at holes 2, 35, 40, 43 and 46 with bolts and locknuts. Torque the bolts.



Fitting First-Stage Nozzle to Combustion Liner
Figure 201A

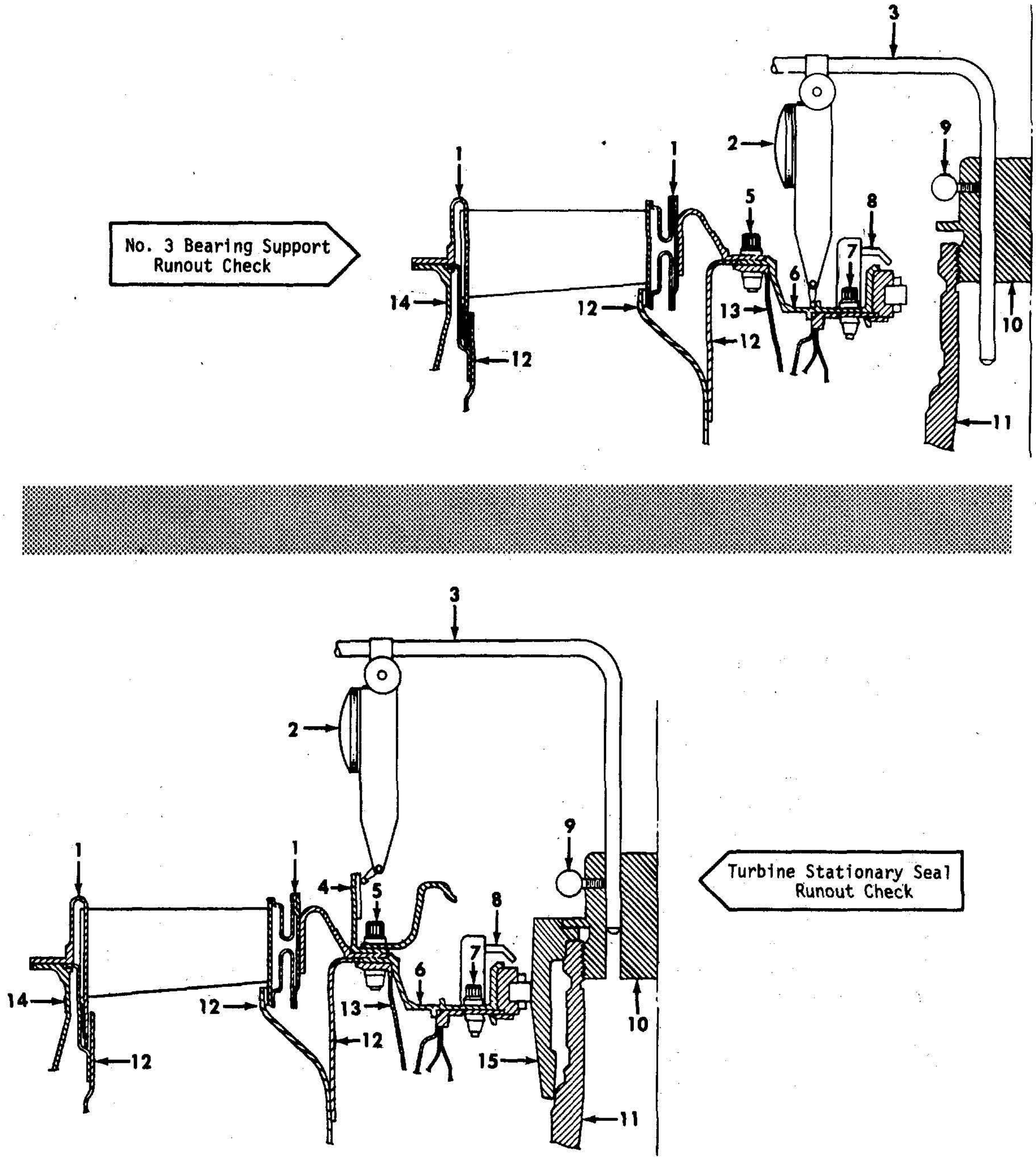


Outer Combustion Casing - Mainframe Flange Bolt Circle
Figure 202

(c) Assemble the remaining bolts and locknuts to the flange. Torque all the bolts.

(3) Coat both sides of new gasket (11, figure 201) with a light coat of sealing compound, Plastiseal F (Johns-Manville Co., 22 East 40th Street, New York, N.Y. 10016) or equivalent. Coat mating surfaces of cover (13) with a light coat of Molykote Type Z (Dow Corning Corp. Alph-Molykote Plant, 65 Harvard Ave., Stamford, Conn. 06902) or equivalent. Secure the view-port cover gasket to the inspection port on the outer combustion casing with the 6 bolts. Tighten bolts and lockwire. Bolts to be lubricated with Ease-Off 990 (Texacone Co., Box 4236, Dallas, Texas) or G-392 Versilube (G.E. Products Co., Waterford, N.Y.)

NOTE: Be sure to install cover (10, figure 201) with concave surface external.



1. FIRST-STAGE TURBINE NOZZLE
2. INDICATOR
3. INDICATOR ROD
4. TURBINE STATIONARY SEAL
5. BOLT
6. NO. 3 BEARING SUPPORT
7. BOLT
8. NO. 3 BEARING OIL NOZZLE
9. THUMBSCREW
10. DRIVER
11. COMPRESSOR ROTOR DRIVE SHAFT
12. COMBUSTION LINER
13. INNER COMBUSTION CASING
14. OUTER COMBUSTION CASING
15. SIMULATOR

JF
BC0044-1

No. 3 Bearing Support and Turbine Stationary Seal Runout Checkout
Figure 203

4.A. Removal/Installation Procedure for Inner Combustion Casing. (See figure 201.)

NOTE: Use this procedure whenever it is necessary to remove the inner combustion casing.

A. Removal.

(1) Remove 16 bolts (19) that attach the inner combustion casing (18) to the mainframe.

(2) Remove the inner combustion casing.

B. Installation.

(1) Install inner combustion casing (18) over shaft shield (19).

(2) Attach the forward flange to the mainframe with 16 bolts (19).

(3) Turn the bolts all the way in; then, back them off one-half of a turn. This will allow the inner combustion casing to line up with the outer bolt circle of No. 3 bearing support after it is installed.

5. Removal/Installation Procedure for No. 3 Bearing. (See figure 203, unless otherwise stated).

NOTE: This procedure is to be followed when removing the No. 3 bearing.

A. Removal. Remove the first-stage nozzle, as outlined in paragraph 3, prior to the following procedure for removal of No. 3 bearing.

(1) Remove the lockwire from seal support bolts (2, figure 201) and then remove the insulation blanket (1).

(2) Remove the bolts (2) that attach the seal support to the bearing support. Remove the seal support and the attached carbon seal assembly. (The carbon seal assembly can be removed from the support by removing screws. Discard O-ring.)

(3) Remove and discard the O-ring (4).

(4) The No. 3 bearing support sub-assembly (16) is removed with the No. 3 bearing locking key attached to the support and the outer race and cage of the No. 3 bearing installed in the support. Remove the support and oil nozzle (14) as follows:

(a) Remove the bolts (15) that attach the bearing support to the shaft shield. Remove the No. 3 bearing support with the oil nozzle attached.

(b) Remove and discard the O-rings (17 and 20) for the oil nozzle supply tube and the No. 3 bearing support.

(c) Remove the No. 3 bearing outer race snap ring (4, figure 204). Remove the 2 screws (1) and nuts (2) that secure the locking key (3) to the No. 3 bearing support; remove the key. Remove the 2 bolts or screws (9) that secure the oil nozzle (8). Use a pusher, 2C5309, and and push the bearing outer race (5) out of the bearing support by tapping the pusher with a soft face mallet.

NOTE: The No. 3 bearing inner and outer races are matched assemblies and must be replaced with a matched set. Refer to section 72-50 for removal and installation of the No. 3 bearing inner race with the turbine rotor shaft.

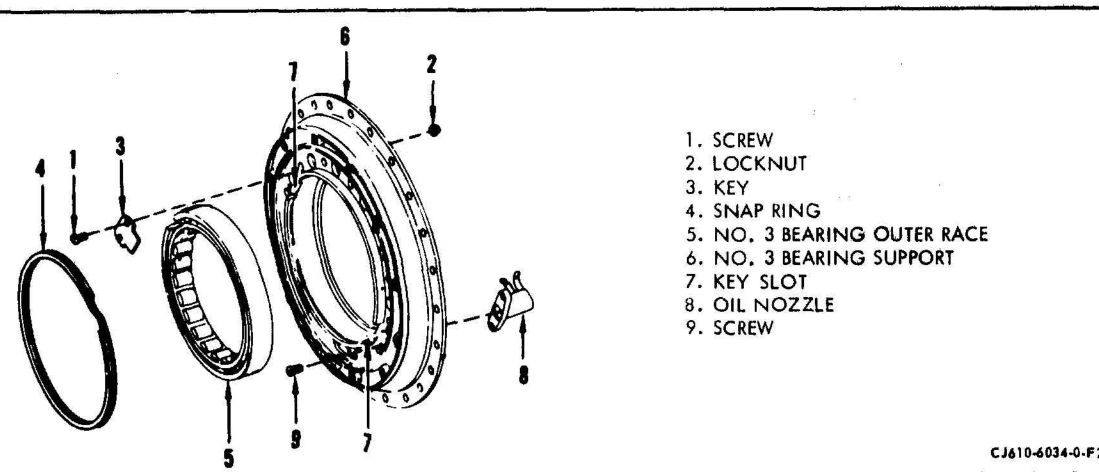
B. Installation. Install the No. 3 bearing outer race, bearing support, seal support, and first-stage turbine nozzle in accordance with the following procedure.

(1) Sub-assemble the No. 3 bearing support as follows: (See figure 204.)

(a) Lubricate the OD of the bearing outer race (5) with engine oil.

(b) Align the key slot in the outer race with the key slot in the bearing support (180° from the oil nozzle position).

(c) Assemble the outer race into the bearing support (6). The bearing support may require slight heating with a lamp in order to seat the bearing.



No. 3 Bearing Support Assembly
Figure 204

(d) Assemble key (3) to the bearing support and secure with the screws (1) and locknuts; torque the screws 8-10 lb-in. and lockwire.

(e) Install the snap ring (4) that retains the outer race in the support.

(f) Assemble the No. 3 oil nozzle (8) to the bearing support. Torque the screws (9) to 6-10 lb-in. and lockwire.

(2) Assemble the carbon seal to rear seal support if removed as follows: (See figure 205.)

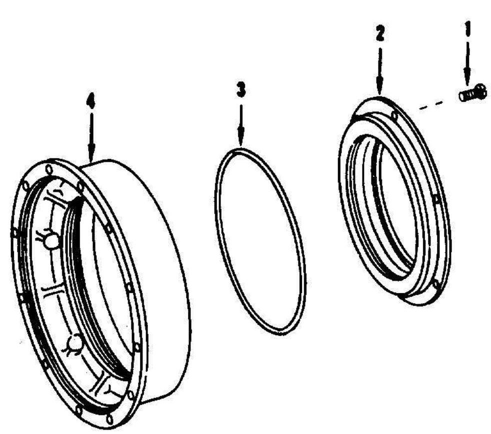
(a) Install the O-ring (3) into the groove in the bore of the rear seal support (2); assemble the rear carbon seal (2) into the support.

CAUTION: DO NOT DAMAGE THE O-RING.

(b) Assemble screws (1) to the carbon seal and seal support. Torque the screws 6-10 lb-in. and lockwire.with 0.020 inch diameter single strand wire.

(3) Install the No. 3 bearing support to engine as follows: (See figure 201.)

(a) Install new O-ring (17) into the groove in the shaft shield aft flange and new O-ring (20) on the No. 3 oil nozzle supply line.



1. SCREW
2. NO. 3 CARBON RUBBING SEAL
3. O-RING
4. REAR SEAL SUPPORT

CJ610-6035-0-F2

Rear Carbon Seal Support Build-Up
Figure 205

(b) With the No. 3 bearing lube tube adapter hole aligned in the No. 3 bearing support, install the No. 3 bearing support (16). Use a straight downward motion, and seat the bearing support, being careful not to damage or cut the O-ring (17).

(c) Align the bolt and the air cooling holes (in the bearing support) with the bolt and the air holes in the shaft shield and the inner combustion casing.

(d) Attach the No. 3 bearing support to the shaft shield with four bolts.

(e) Install the remaining bolts that attach the No. 3 bearing support to the shaft shield. Torque all the bolts to 28-32 lb-in.

(f) Cross-torque the 16 bolts (19) that attach the inner combustion casing to the mainframe (these bolts were installed in paragraph 4.A.) to 40-50 lb-in.

(4) Install the first-stage turbine nozzle (refer to figure 201) as follows:

(a) Install the combustion liner (8) on the inner combustion casing (18); then, align the opening for the igniter with the igniter bosses (13) on the outer combustion casing.

(b) Inspect the aft inner flange of the combustion liner (8) for burrs and sharp edges. Remove the burrs and blend the sharp edges.

(c) Install the nozzle as follows:

1 Put the nozzle one or more "T" positions from where it was when removed (the "T" position must be aligned to obtain proper cooling of the nozzle). If the new "T" position cannot be identified, the nozzle must be marked again (refer to 72-51-0, paragraph 4.D.).

2 Put the nozzle on the engine. Connect the forward edge of the turbine nozzle outer band with the aft flange of the combustion liner.

(d) Install four bolts (5), equally-spaced, through the turbine nozzle inner flange and the No. 3 bearing support outer flange. Torque the bolts to 10-12 lb-in. Check each bolt to make sure that the bolt is snug against the turbine nozzle. If any bolt is not snug remove the bolts, re-align and reseat the parts, and install the bolts again.

(e) Use your hand and install the bolts (5) in the shank nuts on the aft flange of the inner combustion casing until the first few threads are engaged. Then torque the bolts to 10-12 lb in. carefully to avoid unseating the shank nuts.

(f) Use four bolts and locknuts, at approximately the 1:30, 4:30, 7:30, and 10:30 clock positions, and attach the turbine nozzle to the outer combustion casing. Make sure that the nozzle flange rabbet is seated

(g) Check the radial runout between the engine centerline and the rabbet OD, on the No. 3 bearing support, that locates the No. 3 seal support. Use tool 2C5308, as shown in figure 203, and do as follows:

NOTE: 1. If the No. 3 seal support has not been removed to expose the rabbet on the No. 3 bearing support, measure the runout check using the non-grooved area of the bronze sealing surface, on the ID of the No. 3 seal support.

NOTE: 2. For CF700-2C engines, a 0.005-0.012 inch TIR runout is necessary to preload the bearing.

1 Put the dial indicator at the 12 o'clock position. Set the dial indicator to read minus (-) 0.014 inch if the engine is in the horizontal position, or zero if the engine is in the vertical position.

2 Put the dial indicator at the 6 o'clock position, and record the indicator reading.

3 Put the dial indicator at the 3 o'clock position, and set the indicator to zero.

4 Put the dial indicator at the 9 o'clock position, and record the indicator reading.

5 The readings obtained in steps 2 and 4 must be within these limits:

For CF700-2C engines:	0.005 to 0.012* inch TIR
For CF700-2D, 2D-2, 2D-2 engines with the letter B after the Serial No.	0.000 to 0.020* inch TIR

*Readings can be plus or minus.

6 If the TIR is not within these limits, remove the bolts and turn the nozzle to another "T" number position. Attach the nozzle and check the rabbet runout again. Repeat this procedure until the runout is within the limits.

(h) Remove the bolts that you installed in step (d). Be careful not to unseat the turbine nozzle.

(i) Measure the axial runout on the aft face of the No. 3 bearing support (6, figure 203), adjacent to the seal support rabbet. The maximum TIR limit is 0.005 inch.

(j) If the maximum TIR limit is exceeded, remove the support and inspect the mating surfaces for burrs or foreign particles. If necessary, remove the inner combustion casing and inspect the forward flange.

(5) Install the No. 3 seal support assembly and insulation blanket (refer to figure 201) as follows:

(a) Install the O-ring (4) in the groove on the flange of the rear seal support (3). Check the position of the O-ring, and attach the seal support to the bearing support (16) with bolts (2). Torque the bolts to 18-22 lb-in.

(b) Lockwire the bolts (2) with 0.032-inch diameter, single strand, safety wire.

(c) Install the insulation blanket (1) on the rear seal support. Work the tabs on the insulation blankets under the back, around the lockwire for bolts (2), to retain the insulation blanket in position.

(6) Install the turbine stationary air seal (refer to figure 201) as follows:

(a) Put the turbine stationary seal (6) on the first-stage turbine nozzle. Install four bolts (5), equally spaced, through the seal flange, the inner flange of the turbine nozzle, and the outer flange of the No. 3 bearing support. Torque the bolts to 10-12 lb-in.

(b) Check each bolt (5) to make sure that each bolt is snug against the stationary seal. If any bolt is not snug, remove the bolts, re-align and reseat the parts, and install the bolts again.

(c) Use your hand and install the bolts (5) in the shank nuts on the aft flange of the inner combustion casing until the first few threads are engaged. Then torque the bolts to 10-12 lb in. carefully to avoid unseating the shank nuts.

(d) Install the simulator (15, figure 203), and check the runout on the ID of the stationary seal (4). Remove the bolts and turn the seal to obtain minimum runout.

(e) Remove the simulator (15).

WARNING: LUBRICATING OIL

DO NOT LET LUBRICATING OIL STAY ON YOUR SKIN. DO NOT BREATHE THE FUMES RELEASED FROM LUBRICATING OIL FOR A LONG TIME. LUBRICATING OIL IS DANGEROUS TO YOUR EYES, NOSE, AND LUNGS.

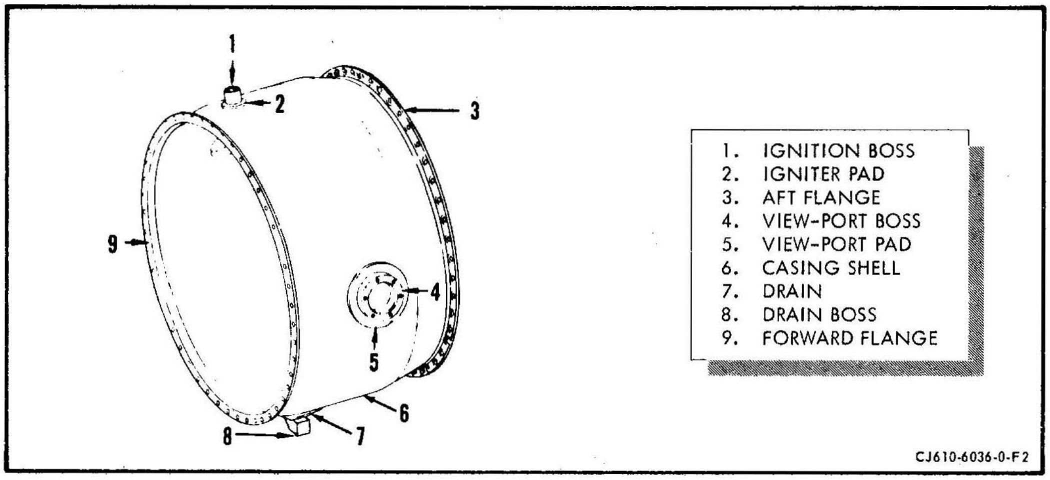
(f) Use lubricating oil and lubricate the threads of the bolts for the turbine stationary seal (6, figure 201).

(g) Install the bolts. Pre-tighten the bolts to 10-12 lb-in. Make sure that all the bolts are seated against the seal (6). If the bolts are not seated, remove the bolt and inspect the threads for damage. When each bolt is seated and pre-tightened to 10-12 lb-in., apply a final torque of 45-50 lb-in.

(h) Lockwire the turbine stationary seal bolts, being careful not to pass the lockwire over the louver edges so as to block the louver openings.

(i) Before you assemble the turbine casing, remove the bolts used to attach the nozzle to the combustion outer casing.

OUTER COMBUSTION CASING - MAINTENANCE PRACTICES



Outer Combustion Casing
Figure 201

1. General. Maintenance of the outer combustion casing is limited to those items which are accessible. (See figure 201.)

   A. Visual inspection of the casing usually involves only the external area of casing.

   B. Visual inspection of the internal area is required when the combustion liner is removed from engine.

   C. Internal inspection per 72-03-1 of the welds around the drain, viewport bosses, and igniter bosses is required at hot section inspection (HSI) when the combustion liner is removed from the engine.

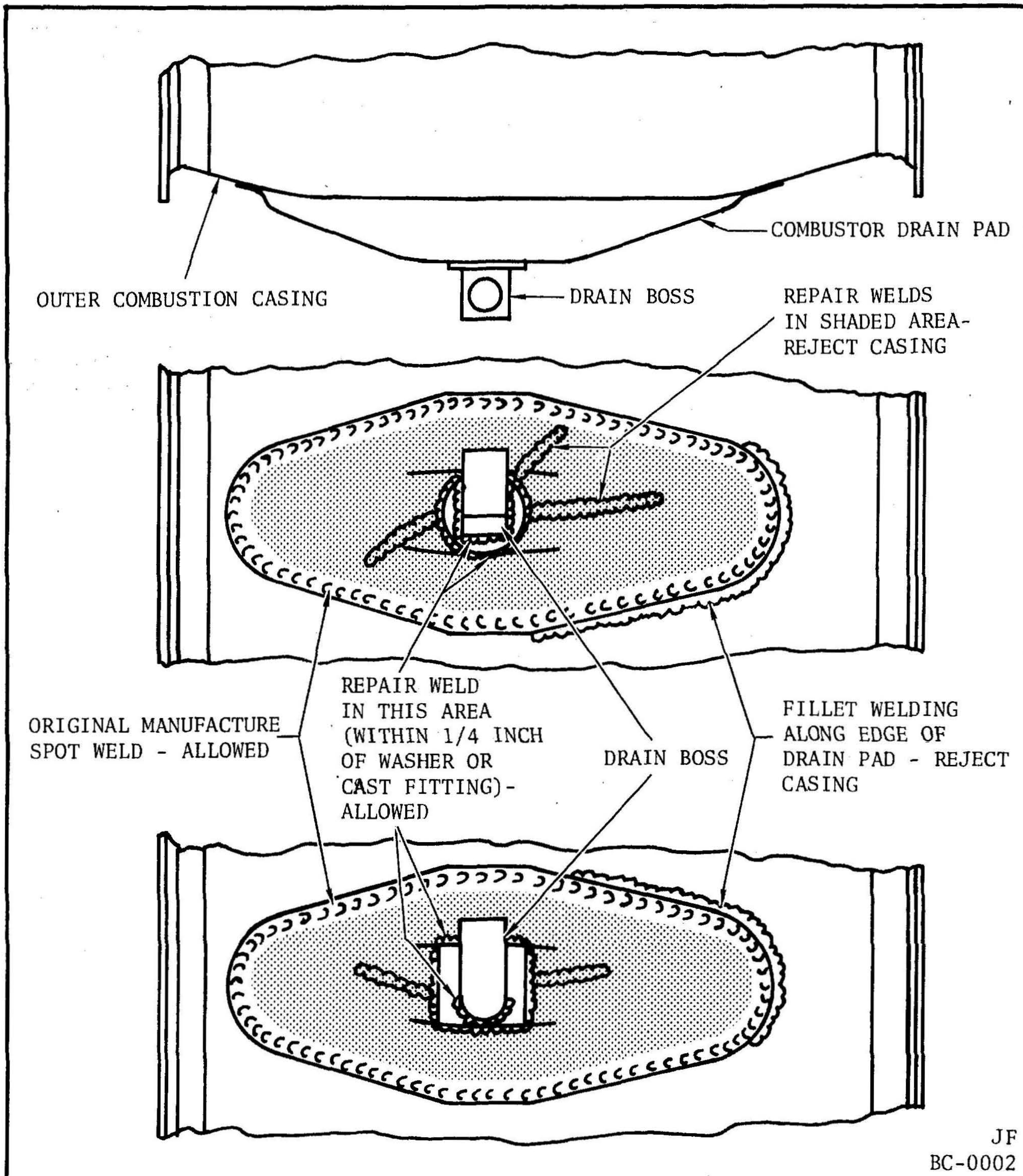
2. Removal/Installation. Refer to section 72-40 for procedures.

3. Inspection/Check. When serviceable limits are exceeded, the casing may be repaired in accordance with overhaul manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Combustion section assembled to engine:		
(1) Cracks in shell or body.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Dents in shell or body.	Any number, 1/4 inch deep with a minimum radius of 8 times the depth and not closer together than 3 inches.	Cold work any number up to 3/8 inch deep and not closer than 1 inch to flange. No cracks are serviceable.
(3) Igniter boss for:		
(a) Cracks.	Not serviceable.	
(b) Igniter boss broken off.	Not serviceable.	
(4) Drain boss for:		
(a) Clogging.	Not serviceable.	Pass a wire (No. 9 gage) through the drain, including the 2 holes in casing skin.
(b) Cracks or boss broken off.	Not serviceable.	
(c) Excessive weld repair.	Weld repairs at edge of drain pad or across drain pad skin are not allowed. (See figure 202).	
(5) All fusion welds for cracks.	Any number, cumulative length of cracks in any one inch of weld not to exceed 0.100 inch.	
(6) View port pads for cracks.	Not serviceable.	
(7) View port pads for gasket blowout.	Not serviceable.	Replace gasket.
(8) Casing for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
B. Combustion section removed from engine:		
(1) Flanges for:		
(a) Cracks.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(b) Dents.	Any number of dents provided sealing capability of the flange is maintained and the casing can be assembled to mating parts without abnormal force.	
(c) Missing Al2 coating.	Any amount.	
(2) Damaged threads in drain or igniter boss.	Cumulative length of damage not to exceed 1-1/2 threads with no high metal.	Chase threads if damage does not exceed 1-1/2 threads.
(3) Casing for:		
(a) Cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
(b) Corrosion pits.	Any number 0.010 inch deep if protective coating is intact in the defect area.	
(c) Areas of general corrosion that reduce wall thickness.	None allowed that reduce wall thickness to less than 0.023 inch.	
(d) Missing Al2 coating.	Any amount.	



Outer Combustion Casing Drain Pad Weld-Inspection
Figure 202

COMBUSTION LINER - MAINTENANCE PRACTICES

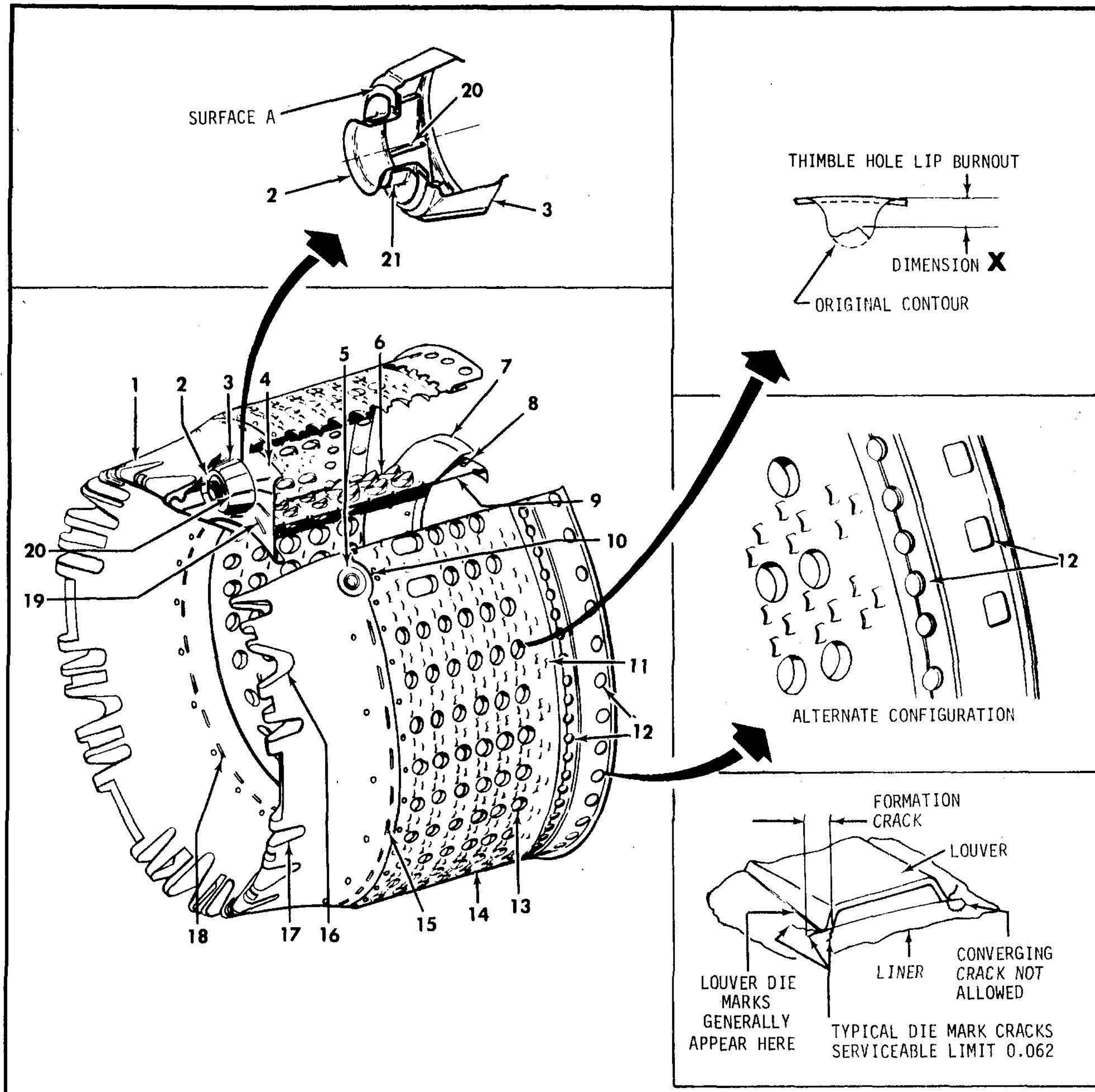
1. General. Visual inspection and maintenance of the combustion liner is usually required only at time of "hot section" inspection.

   NOTE: At "hot section" inspection the inner and outer shells are to be replaced with new shells and the cowl and dome assembly reconditioned in accordance with overhaul manual or replace the combustion liner with a new or overhauled liner with zero time.

2. Removal/Installation. Refer to section 72-40 for procedures.

3. Inspection/Checks. When the combustion liner is made accessible at other than the specified inspection interval as stated in Service Bulletin (CF700) 72-39, the liner may be removed from the engine to perform the inspection checks as listed in the following section of this maintenance manual.

   If only maximum serviceable crack limits of the inner and outer shells are exceeded, repair weld them at an authorized CJ610/CF700 overhaul facility in accordance with applicable sections of this manual. Inner and outer shell replacement prior to the specified Hot Section inspection interval is not required unless the maximum serviceable limits cannot be attained by weld repair. If replacement of the inner and/or outer shells is required, the cowl-dome assembly along with the shell(s) replacement must be reconditioned at an authorized CJ610/CF700 overhaul facility in accordance with the overhaul manual.



1. Cowl
2. Fuel Nozzle Ferrule
3. Swirl Cup
4. Dome
5. Igniter Washer
6. Inner Shell
7. Aft End of Inner Shell
8. Inner Flange Cooling Holes
9. Inner Flange
10. Cowl Tab
11. Louver
12. Outer Flange Cooling Holes
13. Thimble Hole
14. Outer Shell
15. Cowl O.D. Louvers
16. Shield
17. Fuel Nozzle Cutouts
18. Cowl I.D. Louvers
19. Dome Louvers
20. Swirl Cup Louver
21. Washer, Fuel Nozzle Ferrule

BC-0321-1

Combustion Liner
Figure 201

Inspection/Checks	Maximum Serviceable Limits	Remarks
A. The liner for:		
(1) Missing or broken rivets.	Not serviceable.	Replace liner.
(2) Loose rivets.	Not serviceable.	Replace liner.
(3) Missing metal.	Not serviceable.	Replace liner.
(4) Louver opening. (Inspect visually.)	Any amount.	Reset louvers per paragraph 4.A.
(5) Rivet tack-weld cracks.	Not serviceable.	Retack-weld rivet heads, 180 degrees from original tack-weld, per paragraph 4.C.
B. The inner and outer shells for:		
(1) Burn holes.	Not serviceable.	
(2) Thimble holes for burned or eroded lips.	Any number of burned or eroded lips, provided dimension "X", figure 201 is no less than 3/16 inch and two thimble lips are alternate axial row with dimension "X" no less than 5/32 inch and one lip no less than 1/8 inch.	
(3) Burned metal.		
(a) At outer shell aft inner edge.	None allowed unless corrective action has been taken.	Blend burned areas to unburned edge to max of 1/4 inch from aft edge, 1 inch long and 3 inches apart.

Inspection/Check	Maximum Serviceable Limits	Remarks
(b) At the inner shell aft edge.	None allowed unless corrective action has been taken.	One area can be blended to unburned edge, to max depth of 1/4 inch from aft edge, not to exceed 1.50 inches long. Blend to smooth contour.
(c) At all other areas.	Not serviceable.	
(4) Buckles, warps, or dents.	Not serviceable.	Cold-work any deformation 3/8 inch or less to original contour.
(5) Cracks at rivet holes.	Not serviceable.	Replace liner.

(6) Cracks at louver and thimble holes:

NOTE 1: The dies that are used in forming the louvers (in the combustion liner) leave a mark on the surface being formed and also cracks, approximately 0.030 inch long. These marks and cracks do not represent any deterioration of the liner and should not be identified as defects. When viewed with a 10 power glass they can be distinguished from the thermal stress cracks by their even, uniform pattern. The cracks that are to be inspected around the louvers generally appear to be jagged and the material is usually separated. When measuring the length of the louver crack, begin where the louver embossment radius blends with the surface of the dome or shell. See figure 201 and 202.

NOTE 2: Previous weld repairs that are cracked, cannot be weld repaired.

Inspection/Check	Maximum Serviceable Limits	Remarks
	Any amount provided the sum of the uncracked fractional portion of each ligament in any crack loop is more than 2. (See figure 202.)	Repair-weld per paragraph 4.B., all cracks longer than 1/16 inch to meet serviceable limits.

C. The outer flange for:

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Cracks at the forward and aft cooling holes.	Any number 1/16 inch long, not more than one per hole.	Repair-weld per paragraph 4.B., to meet serviceable limits.

DEFINITIONS

Ligament - (see view **B**) Shell material between any 2 adjacent stamped openings. If a crack should exist any uncracked portion of shell material between such openings will be considered a fraction of the ligament.

LIGAMENT STRENGTH VALUES
(See view **C**)

A - Connecting crack	= 0
B - No crack	= 1
C - 1/2 length uncracked	= 1/2
D - 3/4 length uncracked	= 3/4

Crack-Loops - (see view **D** and **E**) Any number of ligaments which, if completely cracked, would allow a shell section to fall out. There must be at least 2 partially cracked ligaments to establish a crack-loop.

NOTES:

- Only the shell material between stamped openings is used to establish a crack-loop.
- This method is to determine the strength of the remaining material to retain a shell section, not to measure crack length.
- Cracks shown in views **A** thru **D** are typical and do not show all configurations of crack loops which could develop.
- Add only uncracked ligaments and/or uncracked fractions of ligaments to determine serviceable status of cracks in any loop.

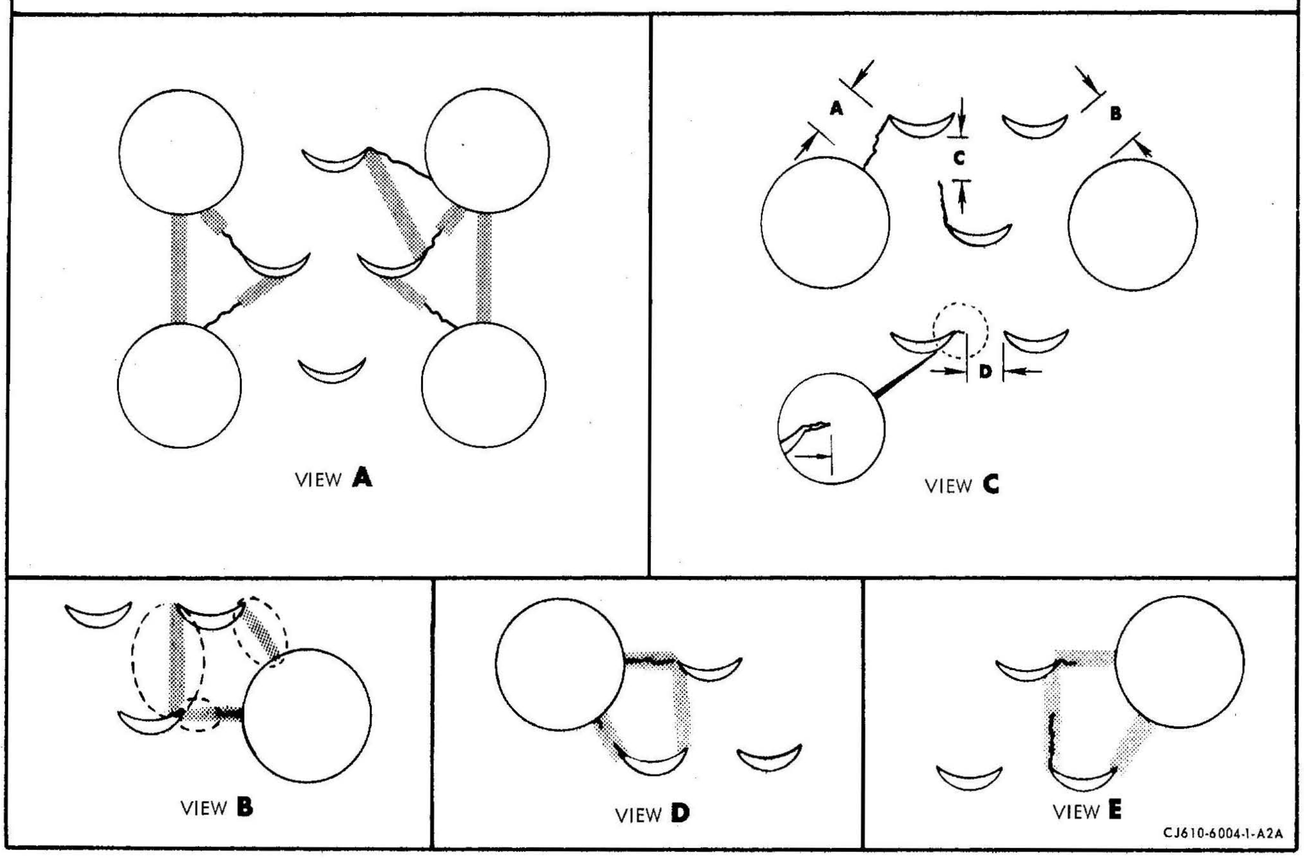
INSPECTION PROCEDURE

a. Inspect the liner for thimble hole or louver cracks.

b. Using view **A**, find the smallest crack-loop.

c. Expand the crack-loop concept to determine the serviceability of larger areas as applicable.

d. Determine serviceability of cracks in a crack-loop as follows:
   1. Add the uncracked ligaments or fractional parts in the crack-loop.
   2. If the sum is more than 2, the cracks in the crack-loop are serviceable.
   3. If the sum is 2 or less, the cracks are not serviceable.



Combustion Liner Crack Loop - Analysis
Figure 202

Inspection/Check	Maximum Serviceable Limits	Remarks
D. The inner flange for:		
(1) Cracks at the holes.	Any number, 1/16 inch long, not more than one per hole.	Repair-weld per paragraph 4.b. to meet serviceable limits.
E. The seam weld between the aft end of the inner shell and the inner flange for:		
(1) Cracks.	Not serviceable.	
F. The dome for:		
(1) Cracks.	Any number, 1/16 inch long; 1 per louver 1/8 inch long provided no piece is in danger of falling out.	Stop-drill cracks over service limit, but extending no closer to another louver than 1/16 inch and no more than 2 such cracks at each fuel nozzle louver pattern. Use a 0.047 inch diameter drill.
(2) Swirl cup for cracks.	Any number, 1/16 inch long.	
(3) Wear on swirl cup end plate (cowl and dome assembly).		
(a) Plate wear.	With fuel nozzle ferrule and washer moved off center to extreme limit in four directions (see figure 201), there shall be no wear grooves in Surface A. Use a 0.030 inch radius ball scribe to measure wear.	Remove fuel nozzle ferrule and washer and measure thickness of end plate. If thickness is under 0.025 inch, replace end plate at an approved overhaul facility.
(b) End plate opening.	With fuel nozzle ferrule and washer moved off center to extreme limit in four directions (see figure 201), the edge of the end plate opening shall not be uncovered.	Remove fuel nozzle ferrule and washer and measure inside diameter of end plate opening. If the opening exceeds 0.800 inch, replace end plate at an approved overhaul facility.
G. The cowl for:		
(1) Cracks.	6 cracks 1/8 inch long per each band of rivets.	
(2) Deleted.		

Inspection/Check	Maximum Serviceable Limits	Remarks
H. The fuel nozzle ferrules for:		
(1) Burnt metal.	Remaining material must extend 0.125 inch min beyond ferrule ID for 270 degrees of arc and 0.156 inch min for remaining 90 degrees of arc.	
(2) Seizure.	The ferrules shall slide freely.	Work ferrule free, application of lubricating oil may help to free seized parts.
I. The igniter washers for:		
(1) Tightness.	The washer shall slide freely.	Work washer free, application of lubricating oil may help to free seized parts.
(2) Burnt metal.	Not serviceable.	
(3) Looseness.	Clearance between washer and cowl not to exceed 0.030 inch.	Reswage or replace washer.

4. Repair.

A. Louver Inspection and Resetting Procedures.

CAUTION: DO NOT USE THE GO/NO-GO CAGES FOR PRYING THE LOUVERS OPEN. DO NOT BEND LINER INTO COMBUSTION AREA. SEE FIGURE 203.

(1) Inspect and reset the dome louvers as follows:

(a) Inspect the dome louver openings using gage, 2C5483.

1 If opening is too small, use tool, 2C5482, to open.

2 If opening is too big, use tool, 2C5482, to close by tapping lightly with small brass hammer.

(2) Inspect and reset swirl cup louvers as follows:

(a) Inspect and reset swirl cup louver openings using gage, 2C5452.

1 If opening is too small, use spreader, 2C5450, to open.

2 If opening is too big, use tool, 2C5451, to close.

(3) Inspect and reset cowl louvers as follows:

(a) Inspect inner cowl louver openings using gage, 2C5453P11.

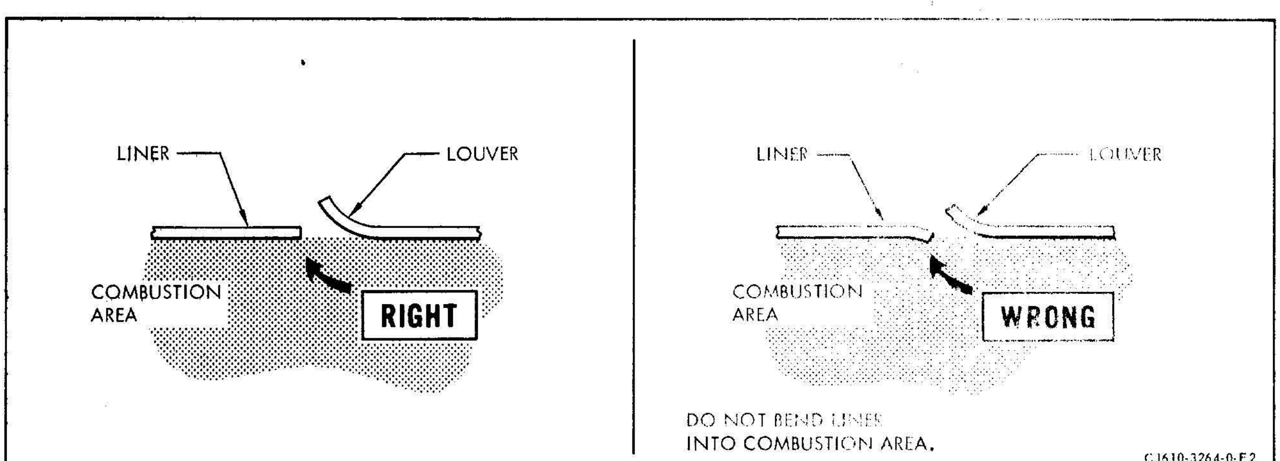
1 If opening is too small, use spreader, 2C5453P08, to open.

2 If opening is too big, use small brass hammer to close.

(b) Inspect outer cowl louver openings using gage, 2C5453P12.

1 If opening is too small, use spreader, 2C5453P07, to open.

2 If opening is too big, use small brass hammer to close.



Resetting Louver Openings
Figure 203

(4) Inspect and reset inner and outer shell louvers as follows:

(a) Inspect inner shell louver openings to the dimensions shown in figure 203A, using standard steel wire-type plug gages.

NOTE: The go-size of the gage shall be the minimum lover size and the no-go size shall be the maximum louver size. The wire-type plug gage shall be made of hardened tool steel and be manufactured within ± 0.0001 inch of the go-no-go size required. Wire-type plug gages in standard sizes are available from most precision measuring tool manufacturers. One such source is the Van Keuren Company, Watertown, Mass.

1 If opening is too small, use spreader 2C5453P05 to open.

2 If opening is too big, use small brass hammer to close.

(b) Inspect outer shell louver openings to the dimensions shown in figure 203B using standard steel wire-type plug gages.

NOTE: The go-size of the gage shall be the minimum louver size and the no-go size shall be the maximum louver size. The wire-type plug gage shall be made of hardened tool steel and be manufactured within ±0.0001 inch of the go-no-go size required. Wire-type plug gages in standard sizes are available from most precision measuring tool manufacturers. One such source is the Van Keuren Company, Watertown, Massachusetts.

1 If opening is too small: use spreader, 2C5453P06, P07 or P08, as applicable, to open.

2 If opening is too large: use small brass hammer to close.

B. Weld Repair of Combustion Liner.

CAUTION: THIS PROCEDURE MUST BE PERFORMED BY A CERTIFIED WELDER.

(1) Grind out through-cracks to a depth of approximately 0.020 inch, from the outside, keeping width to an absolute minimum.

(2) Cracks that do not connect 2 openings are ground 1/16 inch beyond end of crack and checked with a 10 power glass. Keep grinding width to a minimum. Grind to an approximate depth of 0.020 inch.

(3) Clean surface and back side of weld area within 1/4 to 1/2 inch of the crack, using fine emery cloth or soft abrasive wheel. Do not reduce material thickness.

(4) Use aluminum foil to make a pocket for back-up gas on the back side of the weld area. Permit gas to flow for 3 - 4 minutes to force out all air before welding.

(5) Weld using data specified in Table 201.

(6) Blend out all repair welds that obstruct louver openings. Blend as necessary all repair welds flush with parent material.

CAUTION: DO NOT UNDERCUT PARENT MATERIAL.

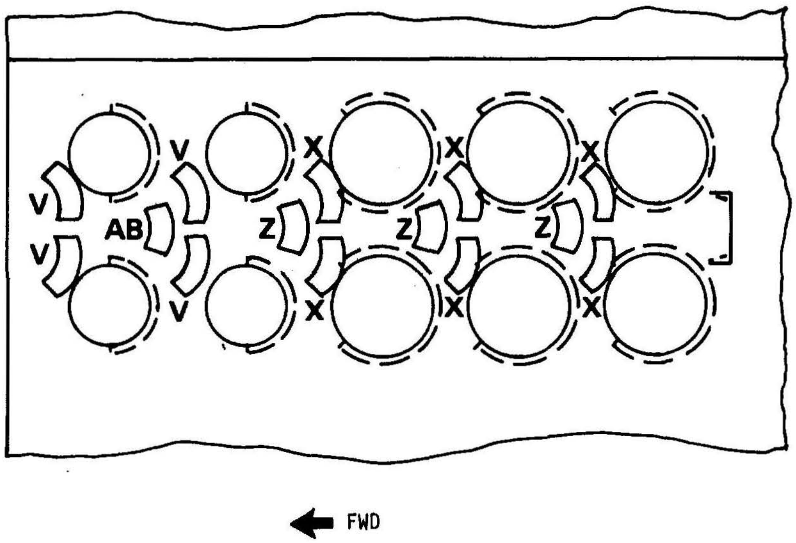
(7) Inspect welds with a 10 power glass. No cracks permitted. If cracked, repeat paragraph 4.B.

C. Tack-weld of Rivet Heads.

(1) Clean both manufactured and upset rivet heads, and liner metal, in areas to be tack-welded, using 80-100 grit emery cloth.

(2) Vapor degrease or clean the area to be welded using trichloroethylene or equivalent.

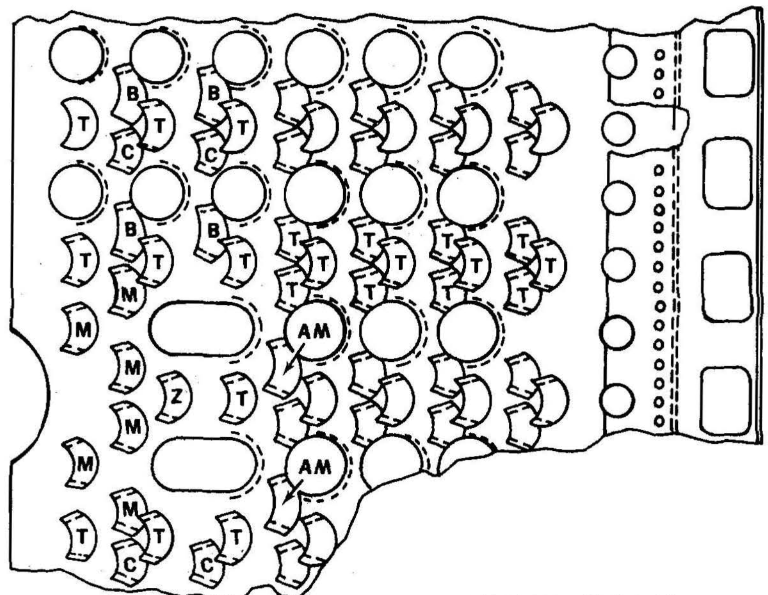
(3) Tack-weld both manufactured and upset rivet heads per figure 204 using weld data in Table 201.



LOUVERS	HEIGHT	GAGE GO SIZE	GAGE NO -GO SIZE
V	0.018 0.013	0.013	0.018
X	0.027 0.023	0.023	0.027
Z	0.042 0.038	0.038	0.042
AB	0.018 0.013	0.013	0.018

BC-0141

Inner Shell Louver Measurements
Figure 203A



* **NOTE** LOUVERS MARKED M & Z AT EACH IGNITER CUT OUT.

LOUVERS	HEIGHT	GO SIZE	NO GO SIZE
T	0.025 0.030	0.025	0.030
AM	0.017 0.022	0.017	0.022
Z *	0.025 0.030	0.025	0.030
M *	0.020 0.024	0.020	0.024
B	0.017 0.022	0.017	0.022
C	0.020 0.024	0.020	0.024

BC-0351

Outer Shell Louver Inspection
Figure 203B

TABLE 201

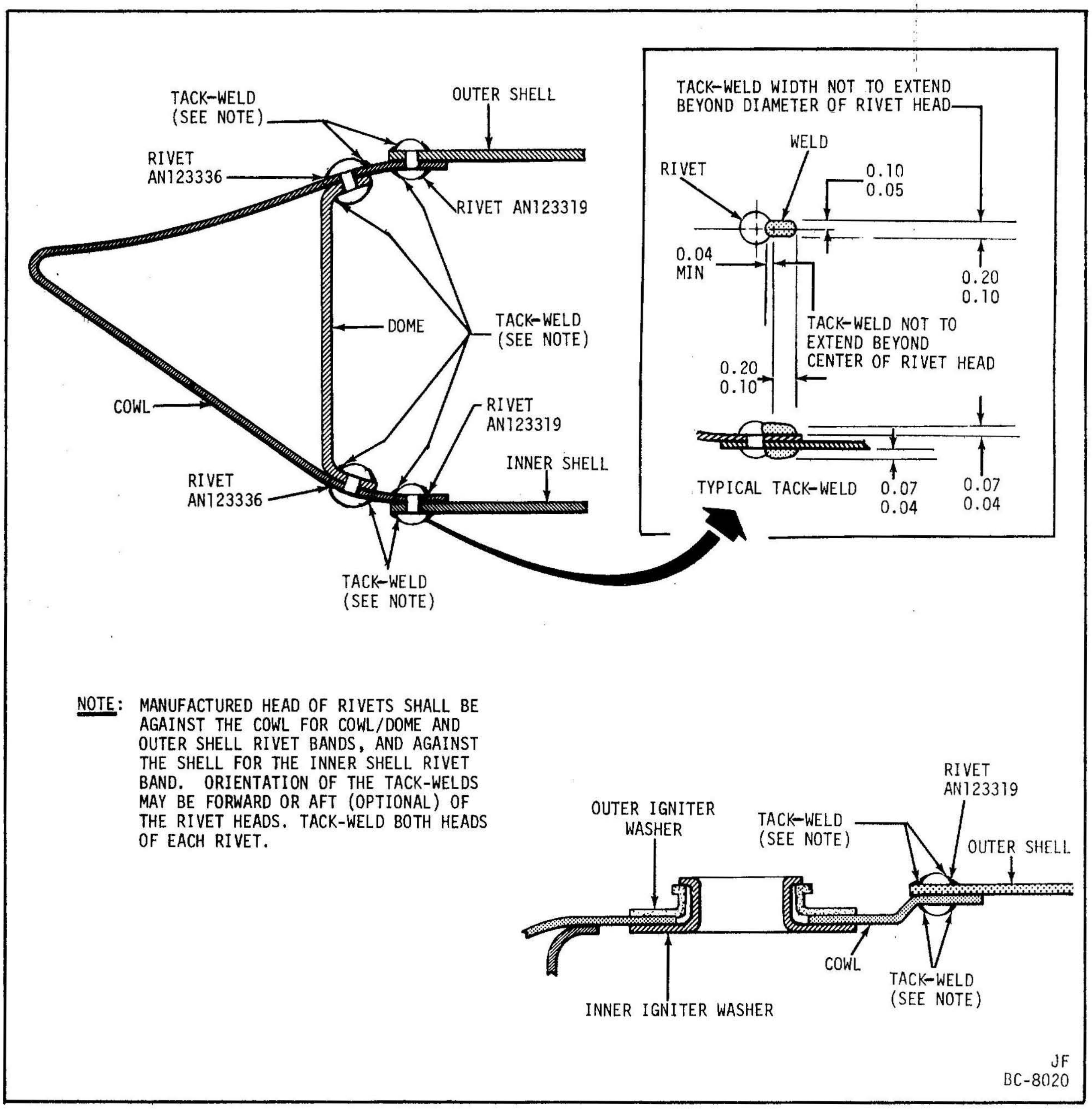
WELD DATA

NOTE:

- Use 1/16 inch diameter, pointed, one percent thoriated tungsten electrode.
- Keep the torch in a near vertical position to achieve good gas coverage over and around the melt. Electrode extension 1/8 - 3/16 inch beyond ceramic cup.
- Upon reaching end of weld, rotate the torch so that the arc goes back into the bead and, with the remote control, slowly decrease the current until the arc goes out. Hold torch over the bead with gas flowing until the red glow disappears.
- Use 1/32 - 1/16 inch diameter filler wire (1/32 inch preferred).
- Keep filler rod in gas stream to keep hot end from oxidizing.

Combustion Liner Component	Component Material	Filler Wire Material	Current* (Amps) DC Straight Polarity	Torch Gas Flow (CFH)	Backup Gas Flow (CFH)	Weld Contour
(1) Inner and outer shell and outer flange.	Hastelloy X (AMS5536)	Hastelloy X (AMS5798) or Alternate Hastelloy W (AMS5786)	15-35	Argon 8-14	Argon 5-10	Flush
(2) Inner flange.	Incoloy T (AMS5552)	Hastelloy X (AMS5798) or Alternate Hastelloy W (AMS5786)	10-35	Argon 8-14	Argon 5-10	Flush
(3) Rivet heads.	Inconel 600 (AMS5540)	Hastelloy W (AMS5786)		Argon 5-10		Tack-weld

*Use a remote control variable current device to minimize heat input. Actrol (Mullenback Electrical Manufacturing Co., 2300 East 27th St., Los Angeles, Californis) or equivalent, is recommended.



Tack-Welding Combustion Liner Rivet Heads
Figure 204

INNER COMBUSTION CASING - MAINTENANCE PRACTICES

1. General. Inspection of the inner combustion casing is usually required only at time of "hot section" inspection.

   A. Visual inspection of the casing usually involves only the outer areas of casing.

   B. Visual inspection of the internal areas, which are accessible, is required when the No. 3 bearing support is removed from engine.

2. Removal/Installation. Refer to section 72-40 for procedures.

3. Inspection/Check. When serviceable limits are exceeded, the casing may be repaired in accordance with overhaul manual.

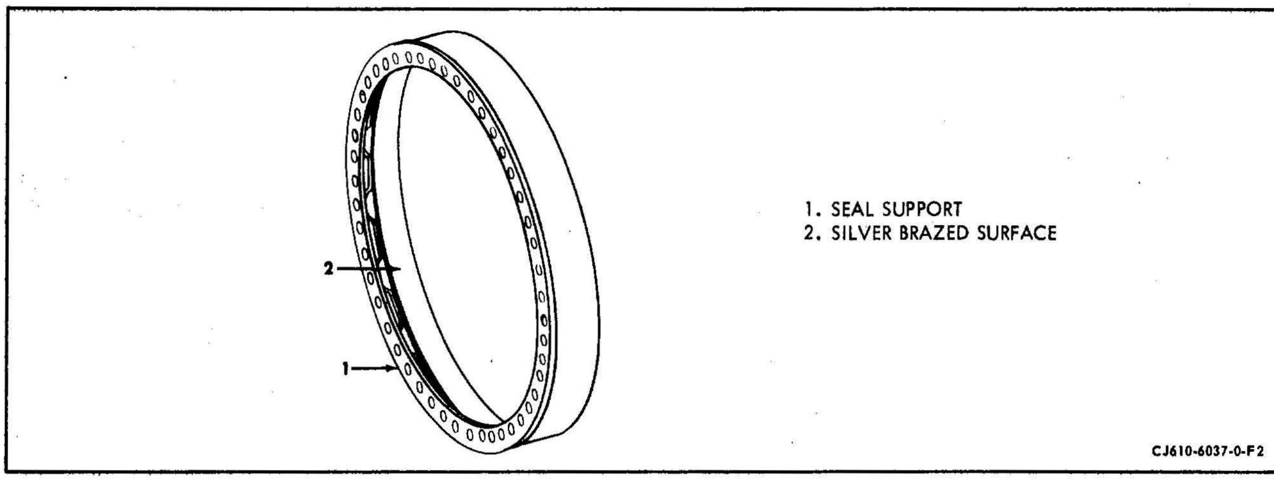
Inspection/Check	Maximum Serviceable Limits	Remarks
A. Inner Combustion Casing with No. 3 bearing support installed on engine:		
(1) Welds for cracks.	Total length of cracks in any joint shall not exceed 1/4 inch.	
(2) Shell for dents.	Any number of small dents with smooth indention, 1/4 inch deep.	
(3) Shell for nicks and scratches.	Any number 0.010 inch deep.	
(4) Casing for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
B. Inner Combustion casing with No. 3 bearing support removed from engine:		
(1) Flange for:		
(a) Cracks.	Not serviceable.	
(b) Nicks and scratches.	Any number 0.010 inch deep with no high metal.	
(c) Dents.	Any number of small dents with no high metal on the flange faces or on mating ID.	
(d) Missing A12 coating.	Any amount.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Casing for:		
(a) Cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
(b) Missing A12 coating.	Any amount.	

TURBINE STATIONARY SEAL - MAINTENANCE PRACTICES

1. General. Visual inspection and maintenance of the turbine stationary seal is usually required only at time of "hot section" inspection.

2. Removal/Installation. Refer to section 72-40 for procedures.



Turbine Stationary Seal
Figure 201

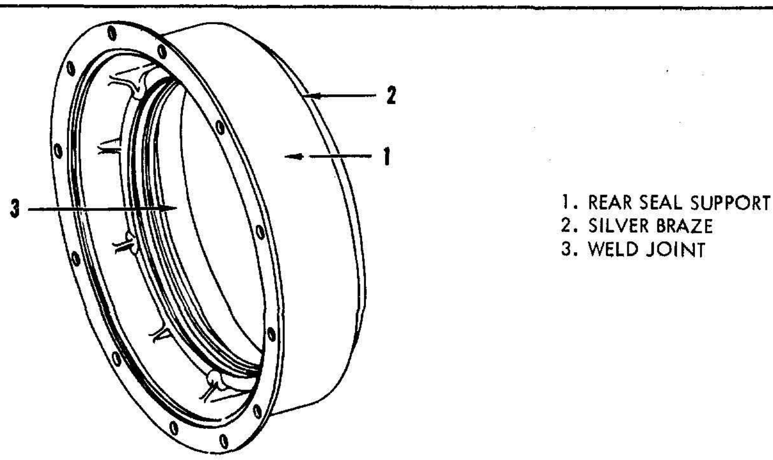
3. Inspection/Checks. When serviceable limits are exceeded, the seal may be repaired in accordance with overhaul manual. (See figure 201.)

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Seal support for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and scratches.	Any number 0.015 inch deep after removal of high metal.	
(3) Dents.	Any number 0.015 inches deep after removal of high metal.	
B. The silver brazed surface for:		
(1) Grooves.	Any depth, provided they do not penetrate to the steel ring and not wider than 0.090 inches.	

NO. 3 CARBON SEAL SUPPORT - MAINTENANCE PRACTICES

1. General. Visual inspection and maintenance of the seal support is usually required only at time of "hot section" inspection.

2. Removal/Installation. Refer to section 72-40, No. 3 Bearing Replacement, for procedures.



No. 3 Carbon Seal Support
Figure 201

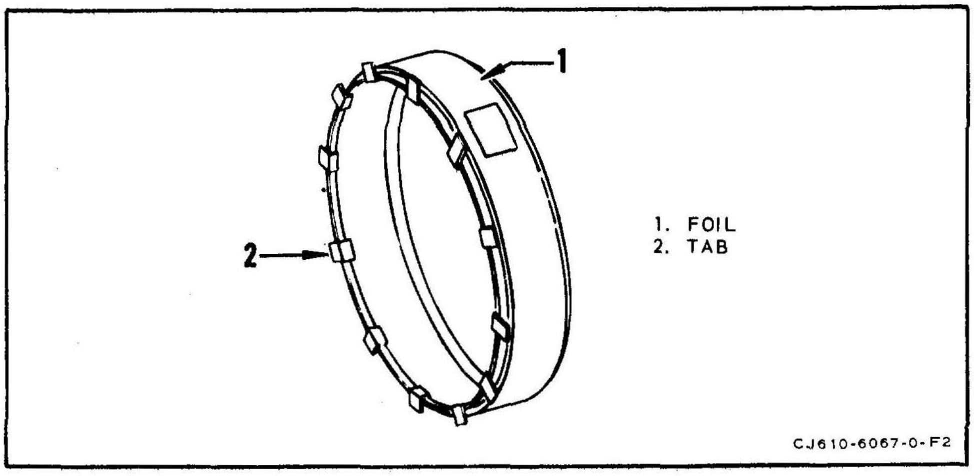
3. Inspection/Checks. When serviceable limits are exceeded, the seal support may be repaired in accordance with overhaul manual. (See figure 201.)

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Seal support for:		
(1) Cracks	Not serviceable	
(2) Nicks and scratches	Any number 0.010 inch deep after removal of high metal	
(3) Pits due to corrosion	Any number, 0.015 inch diameter, 0.010 inch deep	

Inspection/Check	Maximum Serviceable Limits	Remarks
B. Welds for cracks.	Any number, 0.030 inch long, provided cumulative length in any 1 inch does not exceed 0.090 inch or does not exceed 1/4 inch in any joint.	
C. Silver braze surface for grooves.	Any number 0.080 inch wide and depth not into base material.	
D. Threaded holes for defects (with support removed from engine).	Cumulative length of damage not to exceed 1-1/2 threads with no high metal.	

INSULATION BLANKET (NO. 3 BEARING AREA) - MAINTENANCE PRACTICES

1. General. Visual inspection and maintenance of the insulation blanket is usually required only at time of No. 3 bearing carbon seal replacement.



No. 3 Bearing Insulation Blanket
Figure 201

2. Inspection/Checks. When serviceable limits are exceeded, the seal support may be repaired in accordance with the overhaul manual (see figure 201).

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Cracks in foil or separation at welds.	Any amount provided insulation is not missing or oil soaked.	
B. Missing tabs.	3 per blanket provided no 2 are adjacent.	

CARBON SEAL (NO. 3 BEARING) - MAINTENANCE PRACTICES

1. General. Visual inspection of the No. 3 bearing carbon seal is outlined in section 72-02-2. Inspection is usually required only at time of "hot section" inspection.

2. Removal/Installation. Refer to section 72-40, No. 3 Bearing Replacement, for procedures.

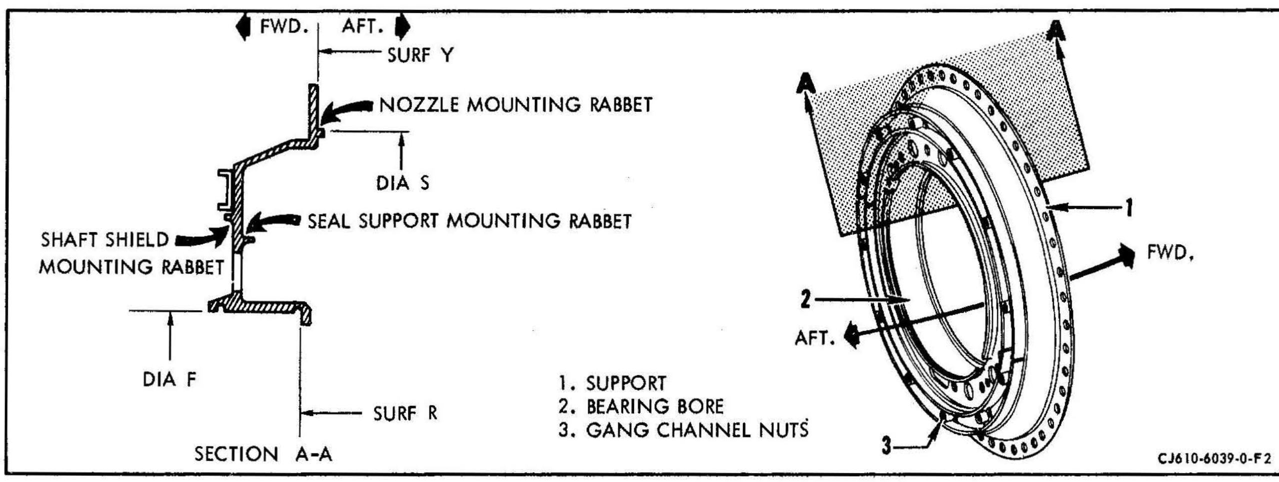
NO. 3 BEARING SUPPORT - MAINTENANCE PRACTICES

1. General. Inspection of the No. 3 bearing support is usually required only at time of "hot section" inspection.

   A. Visual inspection of the No. 3 bearing support usually involves only the aft surfaces of the support.

   B. Visual inspection of the forward surfaces is required when the No. 3 bearing support is removed from engine.

2. Removal/Installation. Refer to section 72-40, No. 3 Bearing Replacement procedure.



No. 3 Bearing Support
Figure 201

3. Inspection/Check. When serviceable limits are exceeded, the support may be repaired in accordance with overhaul manual. (See figure 201.)

Inspection/Check	Maximum Serviceable Limits	Remarks
A. No. 3 bearing support installed on engine:		
(1) Cracks.	Not serviceable.	
(2) Nicks, scratches and dents.	Any number 0.010 inch deep after removal of high metal from mating surfaces.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Corrosion pits.		
(a) Conical portion of web.	0.030 inch of metal remaining.	
(b) All other areas.	0.050 inch of metal remaining.	
(4) Support for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.
B. No. 3 bearing support removed from engine:		
(1) Gang channel nuts for:		
(a) Cracks or broken nut retainers.	Not serviceable.	
(b) Nuts for self-locking capability.	Serviceable provided a bolt cannot be threaded (using fingers only) all the way through the nut.	
(2) Surfaces R and Y, Diameter F for nicks, dents and local scoring.	Any number 0.010 inch deep with not over 50 percent of surface damage in any one quadrant after removal of high metal.	
(3) Support for cracked or missing Solaramic coating.	Not serviceable.	Touch-up per 72-02-5.

NO. 3 BEARING - MAINTENANCE PRACTICES

1. General. Visual inspection of the No. 3 bearing is outlined in section 72-02-3. Inspection is usually required only at time of "hot section" inspection. It is not required to remove bearing from engine for inspection.

2. Removal/Inspection. Refer to section 72-40, No. 3 Bearing Replacement, for procedure.

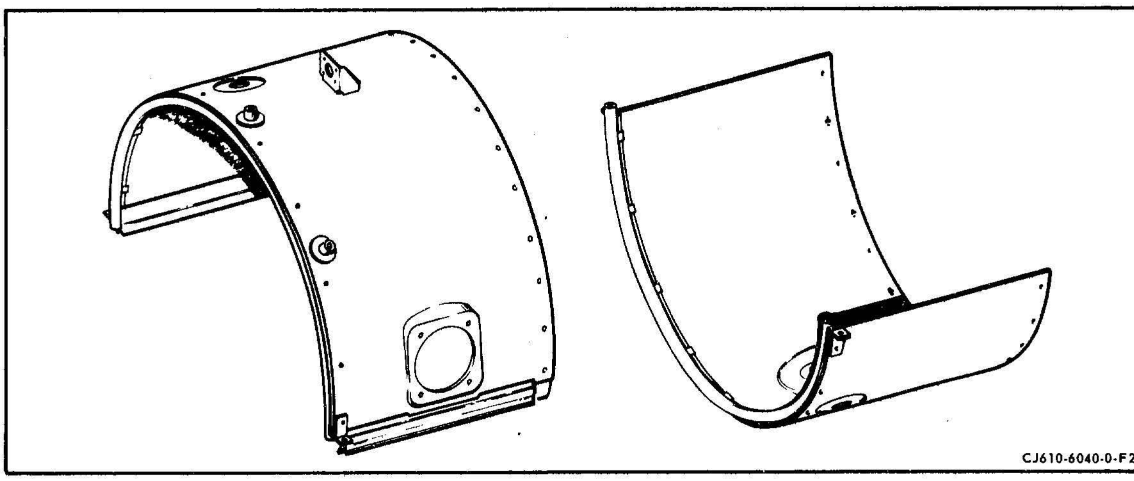
HEAT SHIELD - MAINTENANCE PRACTICES

1. General. Maintenance of the heat shield (optional equipment) is limited to those items which are accessible. (See figure 201.)

   A. Visual inspection of the heat shield usually involves only the external area.

   B. Visual inspection of the internal area is only required if the heat shield is suspected to have damage.

2. Removal/Installation. Refer to 72-40 for procedures.



Heat Shield
Figure 201

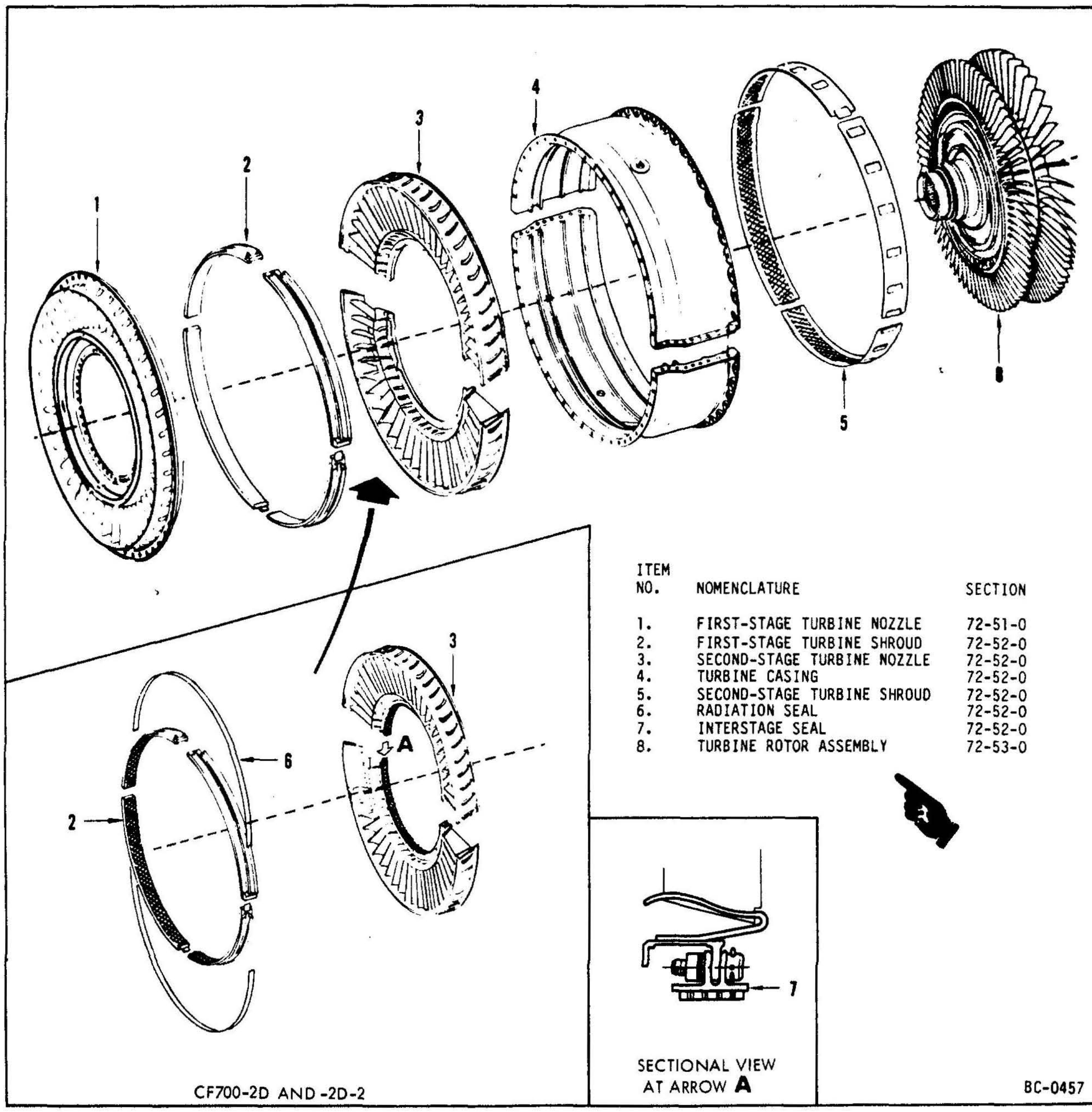
3. Inspection/Check. When serviceable limits are exceeded the heat shield may be repaired in accordance with overhaul manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Cracks in shell (body) or welds.	4 per half, 1/4 inch long.	
B. Cracks in gussets or bosses.	1 per gusset or boss, 1/8 inch long.	
C. Rivets.		
(1) Missing.	Not serviceable.	Replace rivet.

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Loose.	Not serviceable.	Re-strike rivet or replace.
D. Dents in shell or body.	Any number, 1/4 inch deep provided they do not interfere with assembly and are not cracked.	
E. Anchor nuts for:		
(1) Cracked or broken nut retainer.	Not serviceable.	Replace anchor nut.
(2) Damaged thread.	Not serviceable.	Replace anchor nut.
(3) Self-locking capability.	Serviceable provided a bolt cannot be threaded (using fingers only) all the way through the nut.	

TURBINE SECTION - DESCRIPTION AND OPERATION

1. General. The turbine section consists of the turbine casing, shrouds, nozzles, and rotor. The primary function of the turbine is to extract energy from the heated air to drive the compressor.



ITEM NO.	NOMENCLATURE	SECTION
1.	FIRST-STAGE TURBINE NOZZLE	72-51-0
2.	FIRST-STAGE TURBINE SHROUD	72-52-0
3.	SECOND-STAGE TURBINE NOZZLE	72-52-0
4.	TURBINE CASING	72-52-0
5.	SECOND-STAGE TURBINE SHROUD	72-52-0
6.	RADIATION SEAL	72-52-0
7.	INTERSTAGE SEAL	72-52-0
8.	TURBINE ROTOR ASSEMBLY	72-53-0

Turbine Section
Figure 1

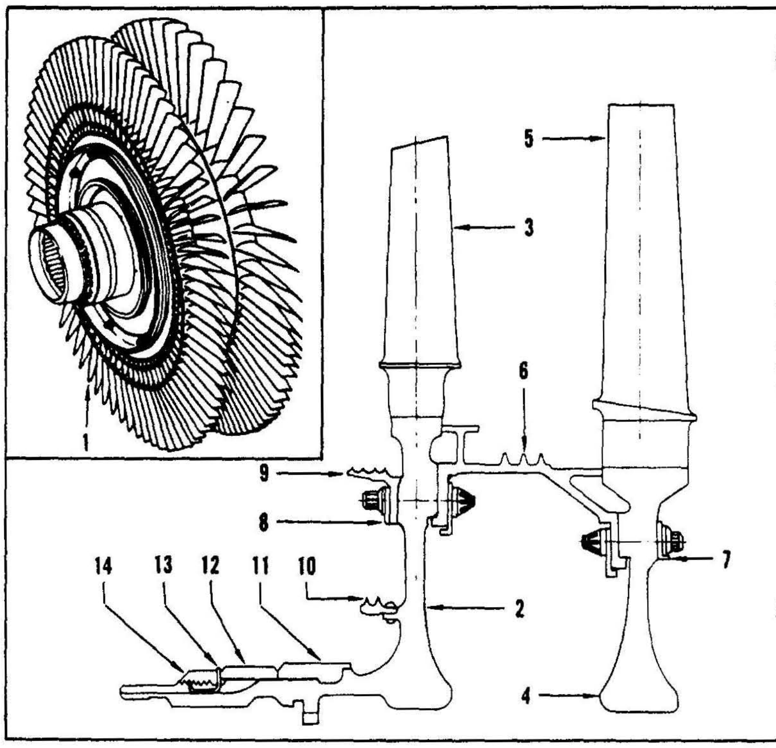
2. Description.

A. Turbine Casing. The turbine casing is an annular shaped steel case, split and flanged along its horizontal centerline. Tracks inside the casing serve as mounts for the first- and second-stage turbine shrouds and the second-stage turbine nozzles. Two external bosses admit the anti-rotation bolts which lock the second-stage nozzle to the casing. The CF700-2D and -2D-2 engines have cooling air passages to provide additional cooling air to the second-stage nozzle area and also has dams adjacent to the split-lines to decrease leakage.

B. Turbine Shrouds. The CF700-2C first-stage turbine shroud is a solid, metal shroud; the second-stage shroud is a honeycomb shroud. Each shroud consists of four interlocking segments which slide into mounting tracks inside the turbine case. The CF700-2D and -2D-2 first- and second-stage turbine shrouds are Bradelloy-filled honeycomb shrouds. Each stage of shrouding consists of four interlocking segments which slide into mounting tracks inside the turbine case.

C. Turbine Nozzles. The first-stage nozzle consists of an outer band joined to an inner band by radially positioned, hollow partitions, welded in place. The outer band has a flange with holes for the bolts that fasten the outer combustion casing, the first-stage nozzle and the turbine casing together. An inner support flange, welded to the inner band, is bolted to the number three bearing support and the inner combustion casing. The second-stage nozzle consists of an outer band joined to an inner band by welded partitions and is split horizontally. The outer band mounts in tracks inside the turbine casing. The inner band flange retains the stationary position of the turbine interstage seal on the CF700-2C. The CF700-2D and -2D-2 turbine interstage seal consists of 6 segments bolted to the inner flange of the second-stage nozzle. Both engine models employ a honeycomb construction type seal.

D. Turbine Rotor. The major components of the turbine rotor assembly are: two turbine wheel assemblies, a turbine interstage seal assembly, a torque ring assembly, and standard hardware. The first-stage turbine wheel is integral with an internally splined shaft which mounts the entire assembly on the engine drive shaft. Turbine blades are inserted into dovetails in the circumference of the wheel and are held in place by locking strips. Baffles are inserted between turbine blade shanks to prevent cross-flow of gases, and to dampen vibration. The inner air seal labyrinth ring is riveted to the forward face of the first-stage wheel. A locking nut and a washer retain the No. 3 rubbing seal runner and the No. 3 roller bearing inner race. The torque ring assembly is mounted on the rear of the first-stage wheel. The bolts that secure this assembly also secure the outer air seal labyrinth ring on the forward face of the first-stage wheel. The torque ring assembly couples the two turbine wheels and has an integral baffle with holes that allow the passage of cooling air. The turbine interstage seal on the CF700-2C engine is supported by pins which rest on the slotted inner band of the second-stage



ITEM NO.	NOMENCLATURE
1.	TURBINE ROTOR ASSEMBLY
2.	FIRST-STAGE TURBINE WHEEL
3.	FIRST-STAGE TURBINE BLADE
4.	SECOND-STAGE TURBINE WHEEL
5.	SECOND-STAGE TURBINE BLADE
6.	TORQUE RING
7.	BALANCE WASHER
8.	BALANCE WASHER
9.	OUTER LABRYRINTH SEAL
10.	INNER LABRYRINTH SEAL
11.	NO. 3 BEARING CARBON SEAL RUNNER
12.	NO. 3 BEARING INNER RACE
13.	NO. 3 BEARING LOCKWASHER
14.	NO. 3 BEARING LOCKNUT

NOT SHOWN

FIRST-STAGE BLADE LOCKING STRIP
FIRST-STAGE TURBINE BLADE BAFFLE
SECOND-STAGE BLADE LOCKING STRIP
SECOND-STAGE TURBINE BLADE BAFFLE
INTERSTAGE SEAL

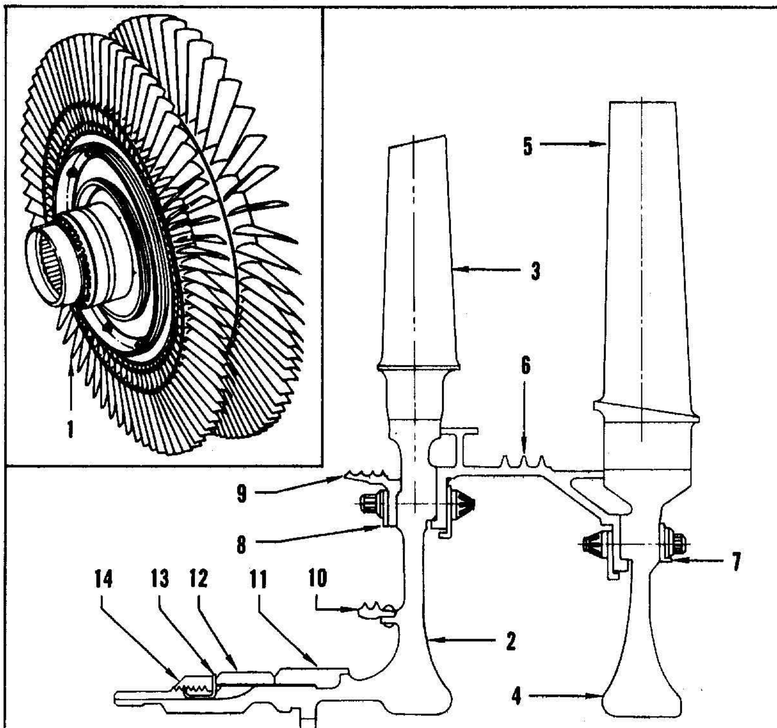
NOTE: FOR INSPECTION OF ALL PARTS, SEE SECTION 72-53-0.

Turbine Rotor Assembly
Figure 2

nozzle (the seal for CF700-2D and -2D-2, bolts to the second-stage nozzle). The honeycomb portion of this seal bears against the torque ring for sealing. The labyrinth portion of the seal is integral with the torque ring.

3. Operation.

The heated gases pass from the combustion chamber through the turbine nozzles, across both turbine wheels and into the aft fan section. The turbine wheels extract energy from the heated gases and transmit this energy forward by means of the engine drive shaft to drive the compressor rotor and accessories. Temperatures of the exhaust gases are so high that without provisions for cooling air, the life of the turbine components would be very short. A portion of the compressed air not used for combustion flows from the combustion section outward through radial holes in the first-stage nozzle outer band and aft to cool the first-stage nozzle and the turbine casing at which point it re-enters the main gas stream. The remainder of the air flows inward through the hollow partitions of the first-stage nozzle into the inner band of the nozzle, and is expelled aftward against the shanks of the first-stage turbine buckets. Some of the air, as it passes through the partitions is expelled through small slots drilled in the concave surface and cools the trailing edges of the partitions. Another portion of air flows aft from the combustion section through holes in the first-stage nozzle inner flange and pressurizes the balance piston chamber formed by the inner and outer air seals on the forward face of the first-stage turbine wheel. This pressure utilizes the wheel as a piston to offset the forward thrust moment of the compressor rotor, reducing the loading on the number two bearing. Some of the balance piston air flows through the inner air seal and pressurizes the number three carbon seal. The remainder of the air flows aft through holes in the first-stage wheel and cools the remainder of the turbine rotor before passing into the main exhaust stream.



ITEM NO.	NOMENCLATURE	SECTION
1.	TURBINE ROTOR ASSEMBLY	72-53-0
2.	FIRST STAGE TURBINE WHEEL	72-53-2
3.	FIRST STAGE TURBINE BLADE	72-53-1
4.	SECOND STAGE TURBINE WHEEL	72-53-3
5.	SECOND STAGE TURBINE BLADE	72-53-1
6.	TORQUE RING	72-53-4
7.	BALANCE WASHER	72-53-9
8.	BALANCE WASHER	72-53-9
9.	OUTER TURBINE SEAL	72-53-5
10.	INNER LABYRINTH SEAL	72-53-2
11.	NO. 3 BEARING CARBON SEAL RUNNER	72-53-7
12.	NO. 3 BEARING	72-46-5
13.	NO. 3 BEARING LOCKWASHER	72-53-9
14.	TURBINE ROTOR AND NO. 3 BEARING LOCKWIRE	72-53-8
	NOT SHOWN	
	FIRST STAGE BLADE LOCKING STRIP	72-53-9
	FIRST STAGE BLADE TURBINE BAFFLE	72-53-9
	SECOND STAGE BLADE LOCKING STRIP	72-53-9
	SECOND STAGE BLADE TURBINE BAFFLE	72-53-9

CF700-3123-0-D2

Turbine Rotor Assembly
Figure 2

TURBINE SECTION - MAINTENANCE PRACTICES

1. General. This section will give the procedures, for the removal/installation of the turbine section parts, that will be required for hot section inspection or component replacement.

2. Removal/Installation.

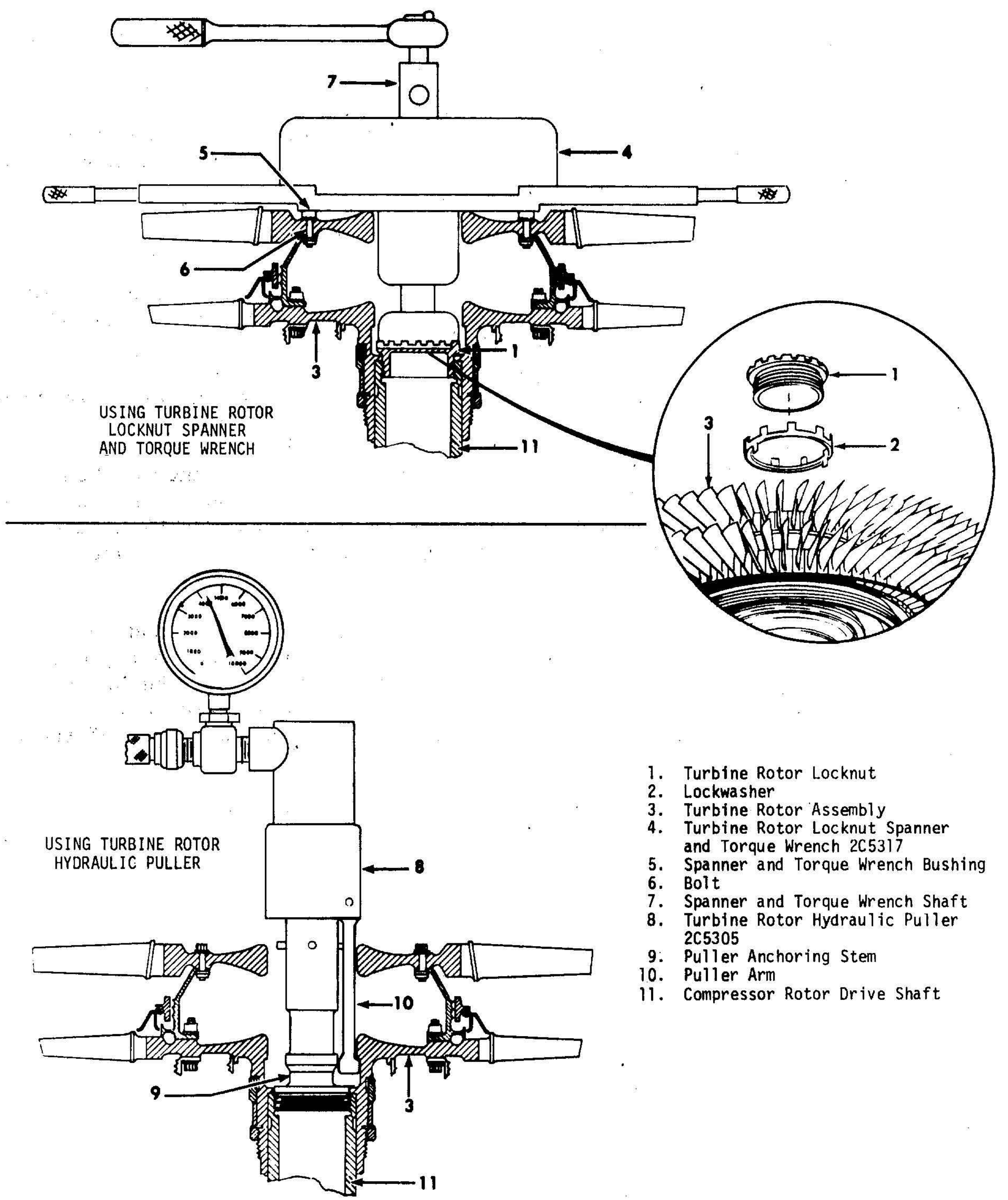
NOTE: The aft fan section (see Section 72-70) must be removed prior to starting this procedure. The required special tools are listed in Section 72-00.

A. Removal of Turbine Stator. Remove the turbine stator halves (with second-stage nozzle and turbine shrouds installed) as follows:

NOTE: Anti-rotation bolts (used on CF700-2C) with rectangular heads, marked "Y" on the shank, are not reusable. Those marked with "A" must pass inspection per 72-52-0, before reuse. Oval head bolts (not marked) (used on CF700-2D and -2D-2) must pass inspection per 72-52-0, before reuse.

(1) Remove the 9 horizontal flange (see figure 205) nuts and bolts on each side of the engine. Do not let the body-bound bolts, which align the stator halves, turn when removing the nuts. If the bolts are allowed to turn, alignment of the halves may be affected. After the nuts are removed, it is permissible to tap the bolts out of the holes using a plastic or brass drift.

(2) Remove the forward flange bolts from the upper turbine stator half. Match-mark the upper stator half with the combustion casing. Remove the upper stator half by carefully pulling it radially away from the engine.



1. Turbine Rotor Locknut
2. Lockwasher
3. Turbine Rotor Assembly
4. Turbine Rotor Locknut Spanner and Torque Wrench 2C5317
5. Spanner and Torque Wrench Bushing
6. Bolt
7. Spanner and Torque Wrench Shaft
8. Turbine Rotor Hydraulic Puller 2C5305
9. Puller Anchoring Stem
10. Puller Arm
11. Compressor Rotor Drive Shaft

Removal of Turbine Rotor
Figure 201

Figure 202
Deleted

(3) Match-mark the interstage seal with the second-stage nozzle.

(4) Remove the forward flange bolts from the lower turbine stator half. Remove the lower stator half by carefully pulling it radially away from the engine.

B. Removal of Turbine Rotor. (See figure 201.) Remove the turbine rotor as follows:

(1) Remove the turbine rotor locknut by straightening the bent tab of lockwasher, and then removing the locknut using the spanner and torque wrench (2C5317). Be sure that the wrench properly engages with the locknut and that the 12 bushings of the wrench are seated

over the heads of the 12 bolts of the turbine rotor. Hold one of the handles of the wrench and back off the turbine rotor locknut using a wrench with a standard 1/2 inch square drive. Remove the wrench, locknut and lockwasher. Discard the lockwasher.

(2) Pull the turbine rotor using the hydraulic puller (2C5305) as follows:

(a) Match-mark the turbine rotor and the compressor rotor by marking the end of the compressor rotor shaft and the inside diameter of the turbine rotor using paint, chalk, or other suitable marking material.

(b) Holding the puller arms close to the puller anchoring stem, screw the hydraulic puller anchoring stem into the compressor rotor driveshaft. Turn in the hydraulic puller until it is hand tight and then back it off 1/2 turn.

NOTE: A force of 5000 psig is usually required to free the rotor. If this force does not free the rotor, check the puller for proper installation. If properly installed, continue to apply pressure until the rotor becomes free.

CAUTION: REMOVAL OF THE TURBINE ROTOR IS A TWO MAN OPERATION. ONE MAN MUST SUPPORT THE ROTOR TO PREVENT DAMAGE IF THE ROTOR SUDDENLY BREAKS FREE.

(c) Connect hydraulic actuator 2C5337 or equivalent to the puller coupling. Apply pressure to the hydraulic puller to unseat the turbine rotor. While pressure is being applied to the puller, hold the turbine rotor by hand so that should it suddenly break free, it will not drop down onto the engine and damage the No. 3 carbon seal or the No. 3 bearing. Continue to apply hydraulic pressure until the turbine rotor is free of the end of the compressor rotor shaft. (The turbine rotor is free when it can be lifted by hand from the end of the compressor rotor shaft.) Disengage the hydraulic puller from the turbine rotor by pushing the 3 puller arms in close to the anchoring stem and at the same time carefully reseating the turbine rotor onto the end of the compressor shaft. Disconnect the hydraulic line from the puller and remove the puller.

(3) Remove the turbine rotor being careful not to damage the No. 3 carbon seal and the No. 3 bearing.

(4) Install the turbine rotor onto the turbine rotor stand (2C5303).

C. Determination of Turbine Rotor Rotating Seal Clearances. The turbine rotor radial clearances must be determined before the rotor is assembled to the engine.

NOTE: Turbine rotor radial clearances are not required unless affected parts have been replaced.

(1) Measure the diameter of the seals in 3 places.

(2) Determine the minimum radial clearance by subtracting the largest OD of the rotating seal from the smallest diameter ID of the mating stationary seal. The result is the minimum diametral clearance between the parts. Divide the result by 2 to obtain the minimum radial clearance.

(3) Determine the maximum radial clearance by subtracting the smallest OD of the rotating seal from the largest ID of the stationary seal and dividing by 2.

(4) Determine the minimum and maximum radial clearances between:

(a) The turbine outer rotary seal and the outer stationary seal. (See figure 204, ref. No. 8.)

(b) The turbine inner rotary seal and the inner stationary seal. (See figure 204, ref. No. 9.)

(c) Turbine interstage seal and torque ring. This clearance applies to CF700-2D and -2D-2 engines only. (See figure 204A, reference No. 13.)

(d) Torque ring seal and second-stage nozzle inner baffle. This clearance applies to CF700-2D and -2D-2 engines only. (See figure 204A, reference No. 12.)

D. Installation of Turbine Rotor. Install the turbine rotor as follows:

CAUTION: THE NO. 3 BEARING INNER RACE, LOCATED ON THE TURBINE ROTOR SHAFT, MUST BE REPLACED IF THE OUTER RACE WAS REPLACED. BEARING COMPONENTS ARE MATCHED ASSEMBLIES AND MUST NOT BE INTERMIXED.

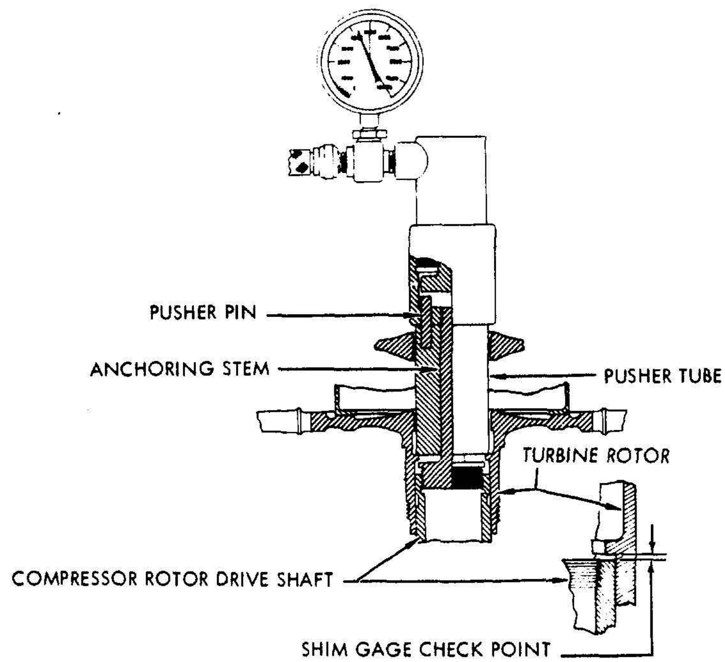
(1) Check the mating surfaces of the turbine rotor shaft and the compressor rotor shaft for burrs and pickup that could interfere with assembly. Remove any burrs or pickup. Using a light coat of engine oil, lubricate the mating splines of the compressor rotor shaft and the turbine rotor shaft.

CAUTION: DO NOT DAMAGE THE NO. 3 SEAL OR THE NO. 3 BEARING DURING TURBINE ROTOR ASSEMBLY. THE PUSHER TUBE AND ANCHORING STEM IS USED AS A GUIDE AND PROTECTOR.

NOTE: Axial clearances between turbine rotor and combustion section parts must be determined per paragraph E.

(2) Assemble the turbine rotor pusher (2C5300) as follows: (See figure 203.)

(a) Remove the thread-protector cap from the anchoring stem. Screw the anchoring stem out of the tool.



Turbine Rotor Hydraulic Pusher
Figure 203

(b) Screw the anchoring stem into the end of the compressor rotor shaft, until it seats and then back it off 1/2 turn.

CAUTION: THE POSITION OF THE ANCHORING STEM IS IMPORTANT. IF THE STEM SEATS AGAINST THE END OF THE COMPRESSOR ROTOR SHAFT, IT IS DIFFICULT TO REMOVE. IF THE STEM IS NOT TURNED IN FAR ENOUGH THE TOOL WILL BOTTOM AGAINST THE STEM AND WILL NOT SEAT THE ROTOR.

(c) Install the pusher tube inside the turbine rotor.

(d) Align the matchmarks for the turbine rotor and compressor rotor shaft. Carefully assemble the turbine rotor onto the end of the compressor rotor shaft.

(e) Screw the rest of the tool assembly onto the end of the anchoring stem by aligning the 6 holes in the pusher housing with the 6 pins in the pusher tube. Turn in the tool assembly until it seats against the turbine rotor.

CAUTION: MAKE SURE THE ANCHORING STEM DOES NOT TURN WHILE THE TOOL ASSEMBLY IS BEING INSTALLED. IF THE ANCHORING STEM BOTTOMS ON THE END OF THE COMPRESSOR ROTOR SHAFT IT MAY BE VERY DIFFICULT TO REMOVE THE ANCHORING STEM AFTER THE TURBINE ROTOR IS PUSHED INTO PLACE.

DO NOT EXCEED 5000 PSI.

(f) Connect hydraulic actuator 2C5337 or equivalent to the pusher coupling. Apply up to 5000 PSI to tool.

(g) Remove the pusher assembly and replace the thread-protector cap on the anchoring stem.

(h) Using a 0.001-inch thickness gage, check the seating. The 0.001-inch feeler gage shall not fit between the end of the compressor rotor shaft and the shoulder in the turbine rotor.

(i) If the turbine rotor is not seated, make sure the tool was not seating on the anchoring stem. Next, pull the turbine rotor again and remove any burrs or pickup that could interfere with assembly. Do not heat or cool parts to aid assembly.

CAUTION: NEVER REUSE A LOCKWASHER.

(3) Lubricate a new turbine rotor lockwasher (figure 201) with engine oil and install it so that the 2 tabs mate with the key slots in the compressor rotor shaft.

(4) Check the surfaces of the turbine rotor locknut for burrs. If necessary, remove burrs. Lubricate the locknut threads with Molykote Type M77, anti-seize compound per MIL-A-907 or equivalent. Lubricate the lockwasher mating surface with engine oil. Assemble the locknut handtight using the turbine rotor spanner wrench, 2C5321. Remove the wrench and check the lockwasher for proper seating and alignment with the key slot in the compressor rotor shaft. Matchmark one lockwasher tab with the inside of the turbine rotor shaft.

(5) Torque the turbine rotor locknut using the spanner and torque wrench, 2C5317. Install the turbine rotor locknut spanner and torque wrench on the turbine rotor. Be sure that the spanner wrench properly engages the turbine rotor locknut and that the 12 bushings of the wrench are seated on the 12 bolt heads on the second-stage turbine wheel. Install a standard 0-50 lb ft torque wrench on the drive shaft of the spanner and torque wrench. Hold the handles of the spanner and torque wrench to prevent the turbine rotor from turning. Torque the turbine rotor locknut to 225-250 lb ft by multiplying the torque indicated on torque wrench indicator by the ratio on the name plate of the spanner wrench.

NOTE: Due to the internal gearing in the turbine rotor locknut spanner and torque wrench, each lb-ft. of torque applied through a standard torque wrench is equal to the result of the ratio (on the name plate of the spanner wrench) times the indicated torque on torque wrench.

(6) Remove the torque wrench and check the lockwasher for alignment by noting the position of the match-marks made in step (4).

(7) Select a lockwasher tab that lines up with one of the slots in the turbine rotor locknut and bend the tab into the slot. If none of the lockwasher tabs line up with a slot, gradually tighten the nut until one does.

CAUTION: BE SURE THE LOCKWASHER DOES NOT MOVE WHEN TORQUING THE LOCKNUT. IF THE LOCKWASHER MOVES, THE BENT TABS THAT FIT INTO THE COMPRESSOR ROTOR SHAFT KEY SLOTS MAY SHEAR OFF.

NEVER LOOSEN THE TURBINE ROTOR LOCKNUT TO LINE UP A LOCKWASHER TAB AND A LOCKNUT SLOT.

E. Determination of Axial Clearances Between Turbine Rotor and Combustion Section Parts. (See figure 204 or 204A.)

(1) Axial clearance between turbine outer stationary seal rear edge and first-stage turbine wheel (Ref. No. 1) must be determined at assembly.

(2) Axial clearance between turbine inner stationary seal rear edge and first-stage turbine wheel (ref. No. 2) must be checked only when the seal support has been replaced.

(3) Axial clearance between No. 3 seal support attaching screw heads and first-stage turbine wheel (ref. No. 3) must be checked only when the carbon seal has been replaced.

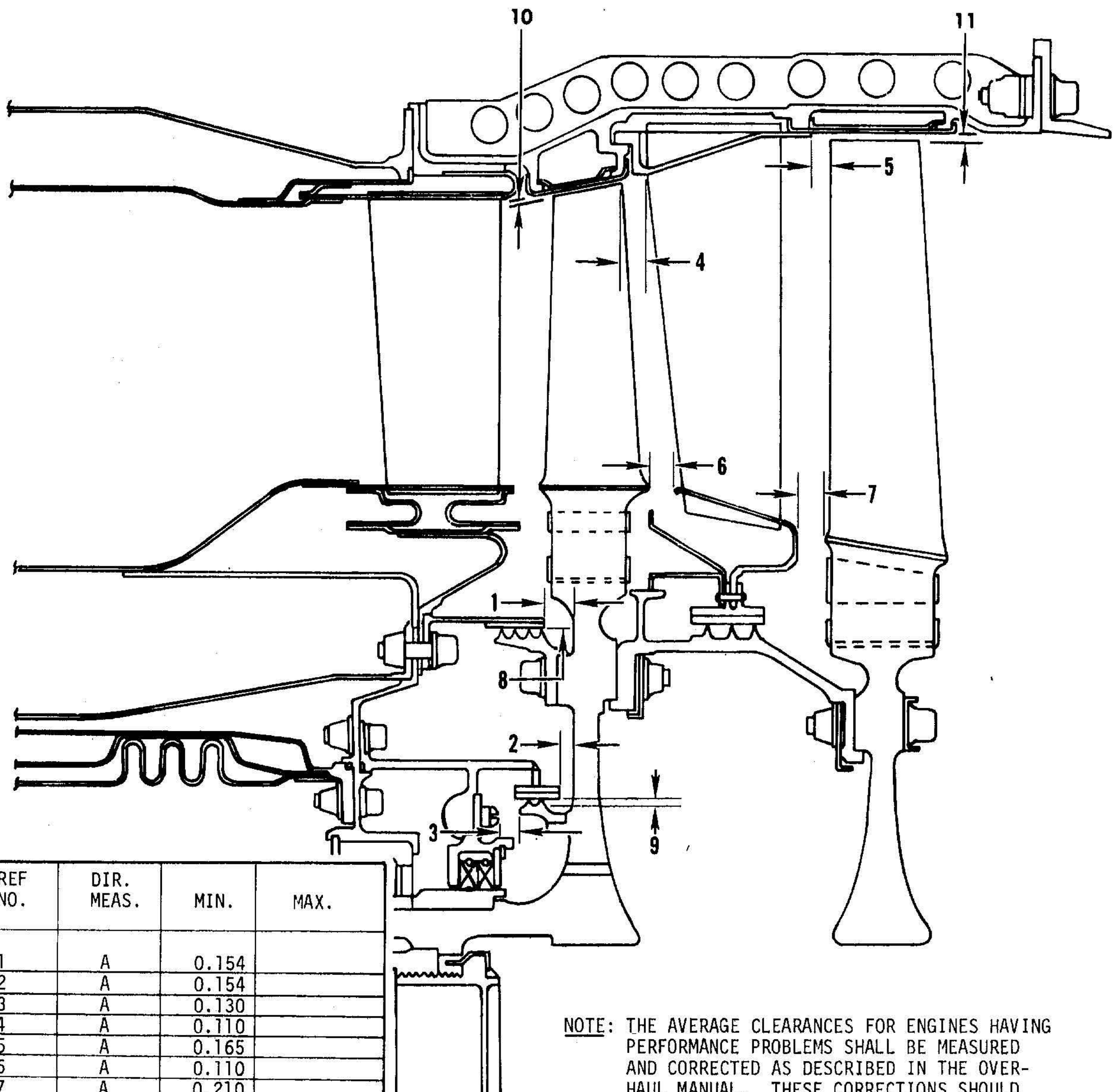
(4) Clearances may be taken as follows:

(a) Place sufficient thickness of wax at 6 equally spaced locations at each required clearance check point.

(b) Install turbine rotor per paragraph 2.D. except do not install locknut.

(c) Rotate rotor one complete revolution.

(d) Remove rotor per paragraph 2.B.

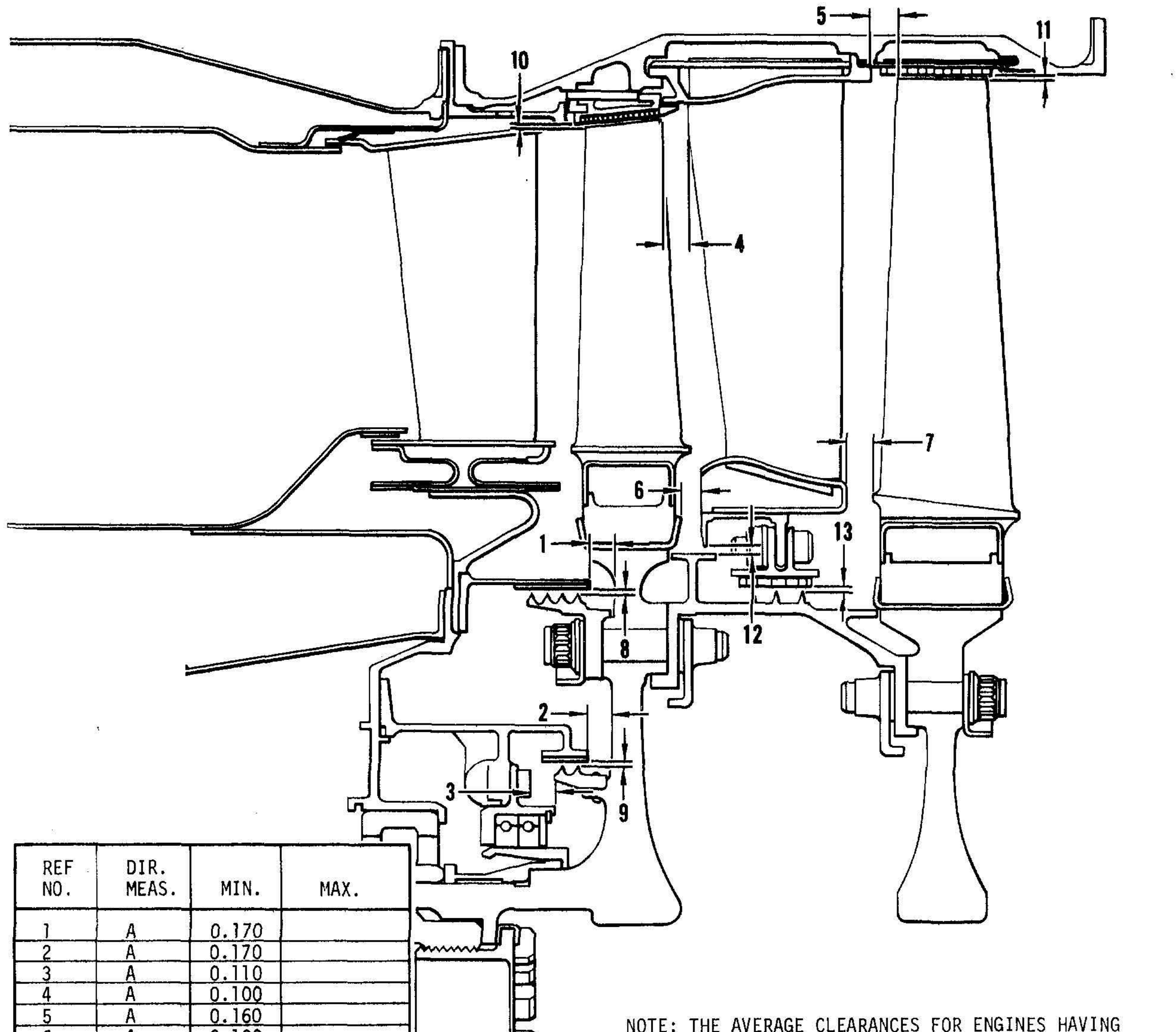


REF NO.	DIR. MEAS.	MIN.	MAX.
1	A	0.154	
2	A	0.154	
3	A	0.130	
4	A	0.110	
5	A	0.165	
6	A	0.110	
7	A	0.210	
8	R	0.001	0.008
9	R	0.001	0.006
10	R	0.045	SEE NOTE
11	R	0.005	

NOTE: THE AVERAGE CLEARANCES FOR ENGINES HAVING PERFORMANCE PROBLEMS SHALL BE MEASURED AND CORRECTED AS DESCRIBED IN THE OVERHAUL MANUAL. THESE CORRECTIONS SHOULD BE MADE IN CONJUNCTION WITH OTHER ESTABLISHED MAINTENANCE PROCEDURES FOR TROUBLESHOOTING ENGINE PERFORMANCE

BC-0177

Turbine Section Clearances - CF700-2C
Figure 204



REF NO.	DIR. MEAS.	MIN.	MAX.
1	A	0.170	
2	A	0.170	
3	A	0.110	
4	A	0.100	
5	A	0.160	
6	A	0.130	
7	A	0.160	
8	R	0.001	0.008
9	R	0.001	0.006
10	R	0.040	SEE NOTE
11	R	0.020	0.055
12	R	0.070	0.100
13	R	0.010	0.035

NOTE: THE AVERAGE CLEARANCES FOR ENGINES HAVING PERFORMANCE PROBLEMS SHALL BE MEASURED AND CORRECTED AS DESCRIBED IN THE OVERHAUL MANUAL. THESE CORRECTIONS SHOULD BE MADE IN CONJUNCTION WITH OTHER ESTABLISHED MAINTENANCE PROCEDURES FOR TROUBLESHOOTING ENGINE PERFORMANCE.

BC-0178

Turbine Section Clearances - CF700-2D and -2D-2
Figure 204A

(e) Determine clearances by measuring minimum thickness of wax at point of clearance.

F. Installation of Turbine Stator. After the turbine rotor is installed, install the turbine stator halves. Check the serial number to be sure that the stator halves are matched halves. Install the stator halves as follows:

NOTE: If either the turbine casing, second-stage nozzle, interstage seals, turbine rotor, turbine rotor torque ring and first- or second stage wheels have been replaced, it is necessary to assemble the lower half of the stator to the engine and then make the clearance checks specified in paragraph G.

(1) Position the interstage seal in the same relationship to the second-stage nozzle as previously installed.

(2) Align the stator half with the outer combustion casing using the match-marks made during disassembly. Assemble the stator half to the engine. On CF700-2C engines make sure that the inner flange of the second-stage nozzle is engaged with the interstage seal, and the 3 rivets of the interstage seal are in the 3 slots in the nozzle inner flange.

(3) Install two bolts in the forward flange and snug but do not tighten.

(4) Assemble the other stator half. Again, on CF700-2C engines make sure that the second-stage nozzle inner flange is properly fitted between the flanges of the seal support on the interstage seal as follows:

(a) Guide the stator half slowly into place until the horizontal flanges on both sides of the stator half are approximately one inch from mating with the horizontal flanges of stator half already installed. With the aid of a bright light, visually assure that the second-stage nozzle inner flange is properly engaged between the flanges of the seal support on the interstage seal. Proper engagement must be possible and visible; if not, the second-stage nozzle inner band flange or interstage seal support flange must be inspected for distortion or warpage. If necessary, correct these faults before proceeding with further installation attempts.

(b) After proper engagement of the second-stage nozzle inner flange and interstage seal is visually made, seat and mate the stator horizontal flanges.

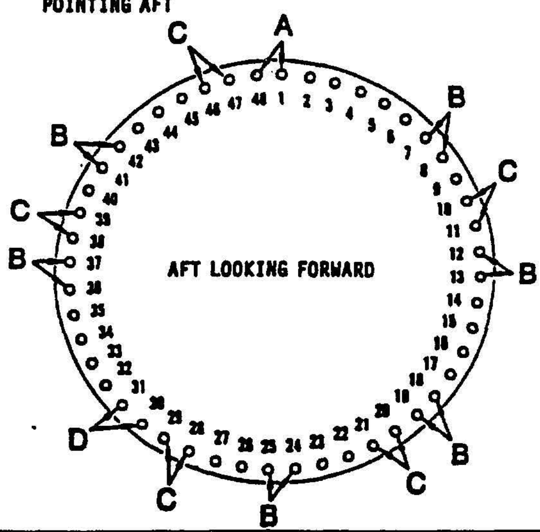
(c) An alternate method of assuring proper engagement of the second-stage nozzle inner flange and interstage seal can be achieved by tilting the stator half until the second-stage nozzle inner flange

COMBUSTION CASING-TURBINE CASING FLANGES

ASSEMBLY NOTES

- APPLY LIGHT COAT OF ENGINE OIL TO ALL BOLTS
- INSERT ALL BOLTS WITH HEADS FORWARD
- TORQUE ALL NUTS TO 35-39 LB IN.

A SUPPORT-FIREWALL (FORWARD SIDE) POINTING FORWARD
B BRACKETS-FIREWALL (FORWARD SIDE) POINTING FORWARD
C BRACKETS, SPACERS-THERMOCOUPLE HARNESS (AFT SIDE) POINTING AFT



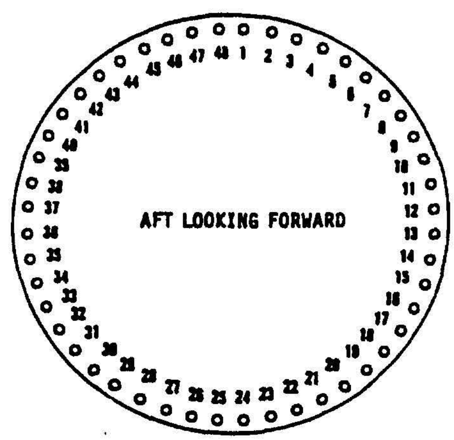
TURBINE CASING-AFT FAN FLANGES

ASSEMBLY NOTES

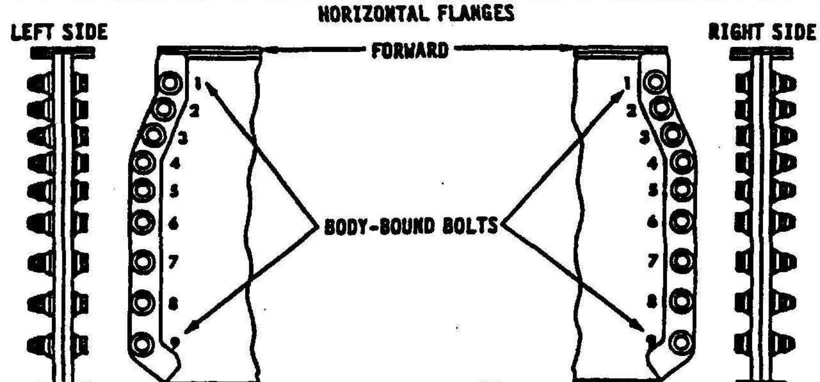
- APPLY LIGHT COAT OF ENGINE OIL TO ALL BOLTS
- INSERT ALL BOLTS WITH HEADS AFT
- TORQUE ALL NUTS TO 36-40 LB IN.

D BRACKET-THERMOCOUPLE (AFT SIDE) POINTING AFT

* THE WORD "FORWARD" OR "AFT" ENCLOSED IN PARENTHESIS INDICATES ON WHICH SIDE OF THE BOLTED FLANGES THE PART IS LOCATED



HORIZONTAL FLANGES



ASSEMBLY NOTES

- APPLY LIGHT COAT OF ENGINE OIL TO ALL BOLTS
- INSERT ALL BOLTS WITH HEADS UP
- USE A WASHER UNDER LOCKNUTS OF BODY-BOUND BOLTS
- TORQUE ALL LOCKNUTS TO 50-55 LB IN.
- DO NOT ALLOW BODY-BOUND BOLTS TO TURN WHEN TORQUING LOCKNUTS
- TORQUE THE BOLTS IN THIS SEQUENCE ORDER: 1, 9, 5, 6, 4, 7, 3, 8, AND 2

C
000CF7-882701

Bolting Diagram for Turbine Stator
Figure 205

at the 3 o'clock location is engaged between the flanges of the seal support on the interstage seal. Before final seating of the stator half, assure that proper engagement of the second-stage nozzle and interstage seal can be made as described in step (a). After proper engagement is visually made, assure that the engagement achieved at the 3 o'clock location is maintained; then seat and mate the horizontal flanges.

(5) Bolt the turbine casing horizontal flanges together as follows:

NOTE: Refer to figure 205 for assembly notes.

(a) Using a soft-face mallet, and starting at the forward end of the horizontal flange with bolthole No. 1, tap the four body-bound bolts (figure 205) into boltholes No. 1 and 9; alternate from left side to right side until all four body-bound bolts and their locknuts have been installed. Alternating from side to side, tighten each locknut fingertight.

(b) Install the remaining bolts and locknuts starting with bolthole No. 5; alternate from the left side to the right side following torque sequence in figure 205. Tighten remaining bolts fingertight.

CAUTION: DO NOT ALLOW THE BODY-BOUND BOLTS IN BOLTHOLES NO. 1 AND 9 TO TURN WHILE TORQUING THE LOCKNUTS.

(c) Using the sequence in figure 205, torque all locknuts 50-55 lb-in., starting with the body-bound bolts; alternate from the left side to the right side for each locknut.

(d) Back off the locknuts and retorque each locknut in the same torque sequence (figure 205) used in step (c).

(e) Check the gap between the mating surfaces of the horizontal flanges using a piece of shim stock, 0.002 inch thick by 1/8 inch wide. The gage shall not slide more than 3/8 inch into the flange.

(6) Install two bolts in the forward flange of the upper casing half and snug but do not tighten.

(7) Check turbine rotor for freedom of rotation.

(a) If rotor is binding determine point of rub.

(b) The casing can be repositioned by tapping firmly with a soft mallet opposite the point of rub.

(c) When rotor turns free tighten the four bolts in the forward flange.

(8) Attach the forward flanges of the stator halves to the outer combustion casing. See figure 205 for assembly notes and torques.

(a) Insert the bolts around the forward flange. The longer bolts are used to attach the thermocouple harness, firewall and fifth-stage air tube brackets.

(b) Assemble the thermocouple harness support with the offset facing aft. Assemble the firewall supports with the offset facing forward.

(c) Assemble the locknuts to all the bolts.

(d) Starting with the bolts next to the horizontal flanges and working towards the center of the flanges (top or bottom), torque all the bolts.

G. Clearance Checks Between Turbine Rotor and Stator. After the turbine stator has been assembled to the engine, rotate the engine rotor clockwise and listen for rubs. Rubbing is not allowed except a light drag or rub between the turbine rotary and stationary seals is permissible. Rubbing between the turbine rotary seals and the stationary seals is normal and allows the seals to wear or cut in, particularly if new seals have been installed. If the rotor does not turn easily by hand it is advisable to remove the turbine stator and rotor and reposition the turbine outer stationary seal and turbine interstage seal. Re-assemble removed components per applicable paragraphs.

(1) With the upper half of the turbine case removed measure the following clearances (see figure 204 or 204A) using a standard commercially available feeler gage.

(a) Axial clearance between first-stage turbine blades and the second-stage nozzle (Ref. No. 4).

(b) Axial clearance between second-stage nozzle outer band and second-stage turbine blades (Ref. No. 5).

(c) Axial clearance between first-stage turbine blade platform and second-stage nozzle inner band (Ref. No. 6).

(d) Axial clearance between second-stage nozzle inner band and second-stage turbine blade platform (Ref. No. 7).

(e) Radial clearance between first-stage turbine blade tips and first-stage shroud (Ref. No. 10).

(f) Radial clearance between second-stage turbine blade tips and second-stage shroud (Ref. No. 11).

(2) Install turbine stator upper half per paragraph F.

FIRST STAGE TURBINE NOZZLE ASSEMBLY - MAINTENANCE PRACTICES

1. General. The first-stage nozzle can only be inspected when removed from the engine.

2. Removal/Installation. Refer to Section 72-40.

3. Inspection/Check. Visually inspect the first-stage nozzle as follows: Any crack or cracks that may converge and permit metal breakout during further service, is not allowed.

   A. Incoming Inspection:

   If Diameter U, H, or V has evidence of previous weld repair, measure over existing welds to determine serviceability. (Example: If there are eight equally spaced welds, make four measurements.) If no welds are present, make six equally spaced measurements. (All other requirements apply.)

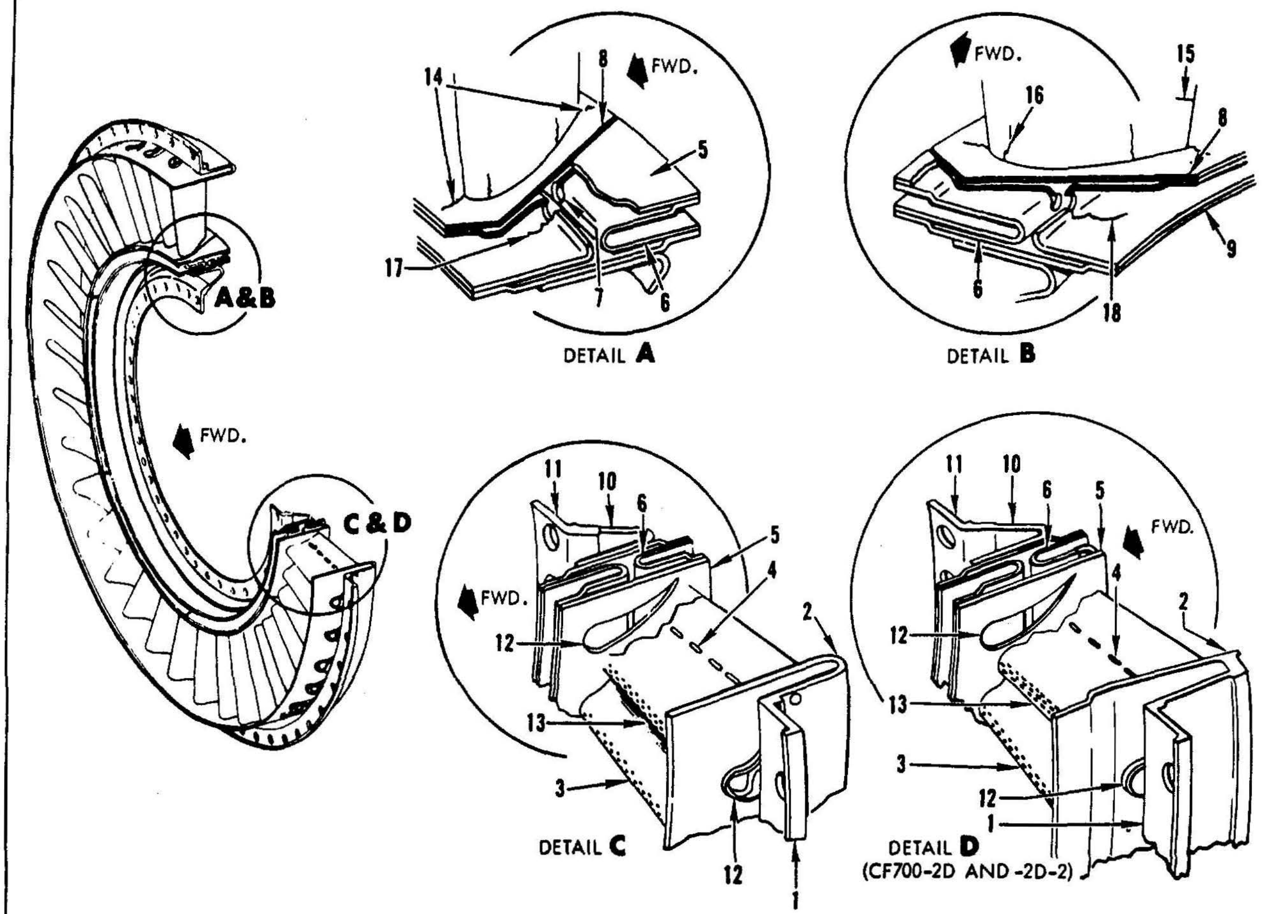
   B. In Process Repair:

   Repair/inspection of Diameters U, H, or V.

   This may require repair of only one, two, or three diameters. Repair only out-of-limit diameters. On diameters requiring repair, process as directed per applicable paragraphs. If weld repair is required, process as directed per applicable paragraphs and TR's. After weld and machine, measure across welded areas (i.e. eight equally welded areas on a diameter requires four measurements).

   NOTE: All other requirements still apply.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. The partitions for:		
(1) Axial cracks in the trailing edge (15, figure 201).	Any number, 1/8 inch long max. 5 per partition, 3/8 inch long, max. 15 partitions. 2 per partition, 5/8 inch long, max. 5 Partitions.	
(2) Cracks in the leading edge.	10 cracks per partition with max. of 10 cracked partitions. No triangular cracks which might allow loss of parent metal. No cracks within 3/16 inch of outer band.	Any number, any length may be re-paired per para-graph 4.B. provided not more than 5 cooling air holes are plugged during weld repair.



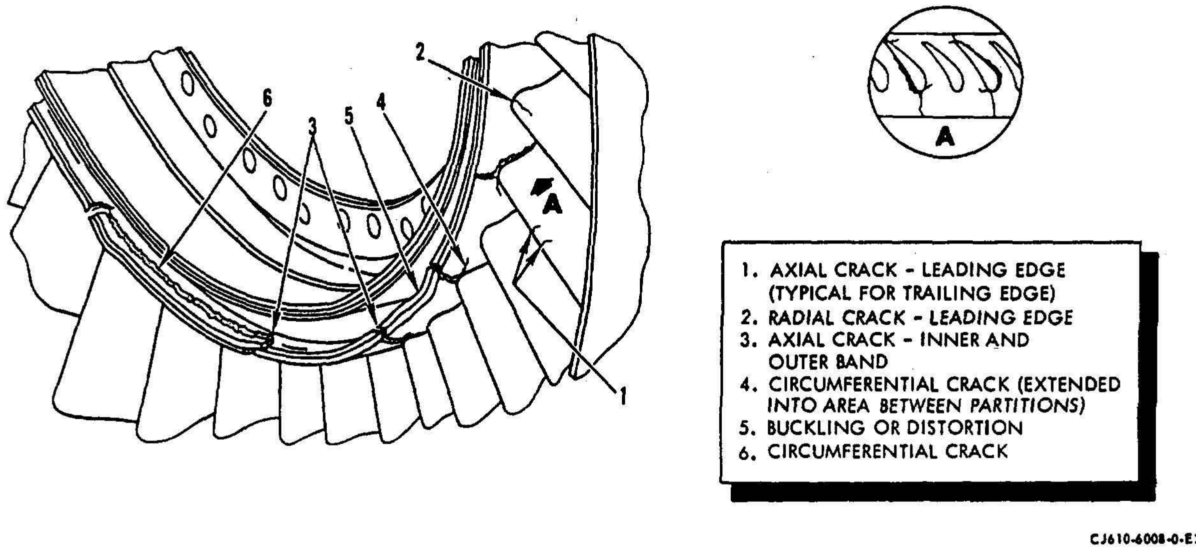
1. OUTER FLANGE
2. OUTER BAND
3. PARTITION
4. COOLING AIR SLOTS
5. INNER BAND
6. SEAL
7. SEAL HOLES
8. EXPANSION SLOT
9. SEAL TRAILING EDGE
10. SEAL SUPPORT
11. INNER FLANGE
12. PARTITION SLOTS
13. COOLING AIR HOLES
14. PARTITION SLOT CRACKS (CRACKS EXTENDING FROM END OF SLOT)
15. PARTITION TRAILING EDGE AXIAL CRACKS
16. PARTITION RADIAL CRACK
17. SEAL HOLE CRACK EXTENDING FWD.
18. SEAL HOLE CRACK EXTENDING AFT

CF700-3080-4-B2

First-Stage Turbine Nozzle
Figure 201

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Radial cracks (16, figure 201).	Any number 1/16 inch long. One crack per partition 3/8 inch long in trailing half of partition. Max. of 15 partitions.	
(4) Burns or erosion.		
(a) Trailing edge.	1/8 inch in from trailing edge axial. One inch long radial. Max of 20 partitions.	
(b) Leading edge.	1/4 inch wide axial by one inch radial. Max. of 20 par titions, provided erosion does not open into partition cavity when inspected visually.	
(5) Nicks, dents, or gouges along trailing edge (within 3/16 inch of edge).	Any number, 0.015 inch deep, with no high metal	Remove high metal.
(6) Nicks, dents, or gouges other than on trailing edge.	Any number, 0.040 inch deep, with no high metal, or punctures.	Remove high metal.
(7) Cooling air holes in leading edge blocked by other than weld repair.	Not serviceable.	Clean holes with fine wire.
(8) Trailing edge cooling air slots (4, figure 201)		
(a) Cracks extending into partition (not converging).	Two per slot 3/32 inch long max.	
(b) Converging cracks.	Not serviceable if crack extension would allow loss of parent metal.	Replace partition.
(c) Closed area (when noted visually).	0.013 inch min. opening.	Open to 0.013-0.019 inch.

Inspection/Check	Maximum Serviceable Limits	Remarks
(d) Baffles for:		
1 Cracks.	Any number, 1.0 inch long.	Replace nozzle.
2 Missing pieces.	One piece, 1.0 inch long.	Replace nozzle.
B. The weld area (partition to inner and outer band) for cracks.	One crack, 5/8 inch long per partition. Maximum of 15 partitions per nozzle.	
C. The seal and the inner or outer band for:		
(1) Buckling and/or distortion.	No distortion allowed which causes interference at assembly.	Cold-work and inspect for cracks.
(2) Cracks.		
(a) Cracks extending from the end of the partition slot to the leading or trailing edge of the band (14, figure 201).	12 cracks in each band (inner and outer).	
(b) Cracks extending from the partition slot and terminating in the band.	Any number.	
(3) Circumferential cracks:		
(a) Inner band and support structure (6, figure 202).	Ten cracks, 1/2 inch long.	
(b) Outer band (2, figure 201).	Not serviceable.	Repair-weld per paragraph 4.B.
(4) Burnouts (outer band).	Not serviceable.	
(5) Burnouts (inner band).	Not serviceable.	



First-Stage Nozzle Defects
Figure 202

Inspection/Check	Maximum Serviceable Limits	Remarks
D. The seals for cracks originating at the seal holes:		
(1) Cracks extending aft (18, figure 201).	One crack per hole, 5/16 inch long provided the crack does not branch or there is no danger of parent metal loss.	
(2) Cracks extending forward (17, figure 201).	Any number, 5/16 inch long, provided the crack does not branch and there is no danger of parent metal loss.	
E. Outer flange (1) for:		
(1) Radial cracks from boltholes.	Any amount, providing cracks do not connect and there is no danger of any material breaking off.	
(2) "T" position marking.	All "T" positions must be clearly marked.	Relocate and mark per paragraph 4.C.

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Fretting and galling.	Not less than 0.050 inch thick (based on an average of 12 equally spaced measurements, if none of the 12 measurements are less than 0.040 inch). Not closer than 0.060 inch to edge of boltholes.	Repair per paragraph 4.E.
(4) Visual damage (dents, distortion, etc.) to rabbet diameter and/or boltholes.	Two circumferential lengths each 1.750 inches long, at least 90 degrees apart.	
(5) Elongated boltholes.	Any number, 0.060 inch oversize.	
(6) Aft outer rabbet OD (Diameter V, figure 207).	15.984-15.992 inch diameter. Free state average diameter taken at six equally spaced locations must fall within these limits. Individual readings may exceed limits.	15.969 inch diameter max. repairable. Repair per paragraph 4.E.

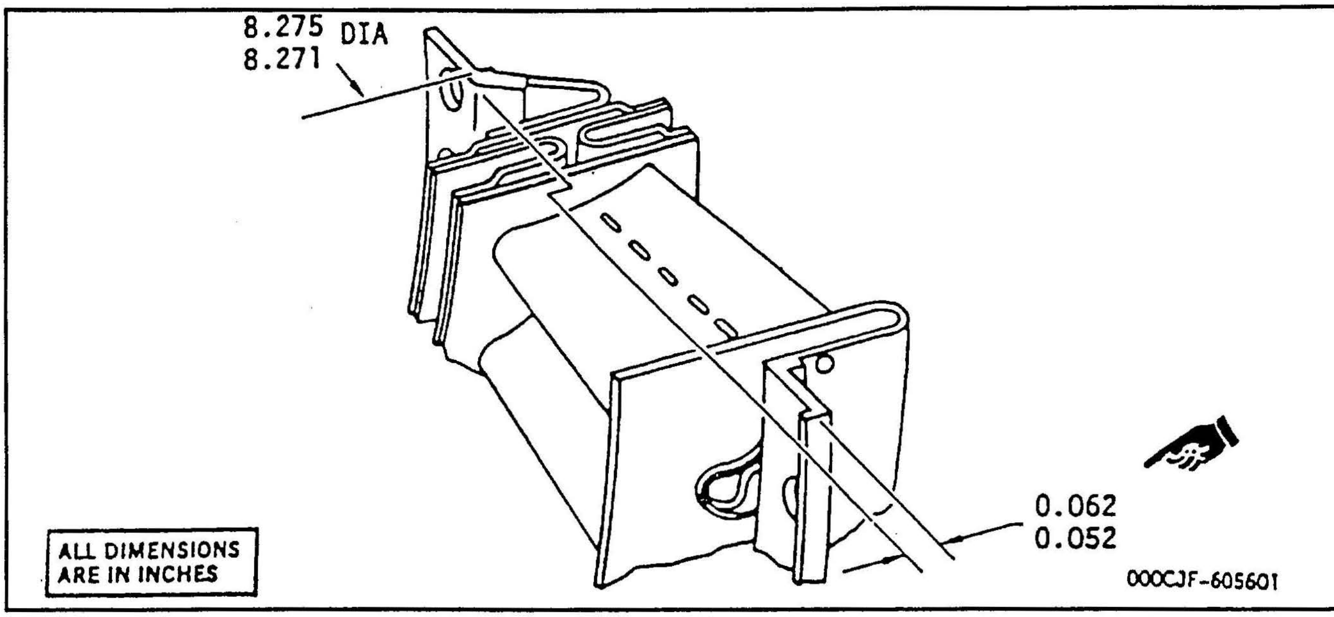
NOTE: Concentricity of Diameter V relative to Diameter U is taken with an axis established by Diameter U and Surface AP (see figure 207).

Inspection/Check	Maximum Serviceable Limits	Remarks
(7) Diameter V (figure 207) concentricity with Diameter U.	0.010 inch TIR.	Any amount can be repaired per paragraph 4.E.
F. Inner flange (11, figure 201) for:		
(1) Out-of-flatness.	Not visually out-of-flat.	Repair per paragraph 4.A.
(2) Fretting and galling.	Not closer than 0.060 inch to end of boltholes. Flange thickness not less than 0.050 inch.	Repair per paragraph 4.E.
(3) Undersize ID (Diameter U, figure 207).	7.296-7.306 inch diameter. Free state average and individual min. readings taken at six equally spaced locations must fall within these limits. Individual max. readings may exceed limits.	7.321 inch dia meter max. repairable per paragraph 4.E.

Inspection/Check	Maximum Serviceable Limits	Remarks
(4) Undersize inner rabbet ID (Diameter H, figure 207).	8.271-8.275 inch diameter. Free state average and individual minimum readings taken at six equally spaced locations must fall within these limits. Individual maximum readings may exceed limits.	8.290 inch diameter max. repairable per paragraph 4.E.

NOTE: Concentricity of Diameter H relative to Diameter U is taken with an axis established by Diameter U and Surface AP (see figure 207).

(5) Diameter H (figure 207) concentricity with Diameter U.	0.004 inch TIR.	Any amount can be repaired per paragraph 4.E.



Bent Inner Flange Repair
Figure 203

4. Repair.

A. Repair of Bent Inner Flange. (See figure 203.)

(1) Gradually and locally cold-work to match original contour.

(2) Finish cold-work to the drop dimension from the forward face of the inner flange to the forward face of the outer flange as shown in figure 203.

(3) Control cold-working by using a parallel bar to obtain the final drop dimensions.

NOTE: A crescent wrench with smooth face jaws may be used effectively to cold-work the flange.

(4) Measure the aft rabbet diameter on the inner flange at 6 equally spaced locations. The average diameter must be within the limits shown in figure 203. If the average diameter is not within limits, the nozzle is not usable.

(5) Spot fluorescent-penetrant inspect the reworked area per Section 72-03-1. No cracks allowed.

(6) When assembling the nozzle, check the bolthole alignment using the proper stationary air seal and bolts.

A1. Repair of Seal (Non film cooled nozzle only).

(1) Cracks originating at the seal holes and extending aft to the trailing edge of the louver opening and/or spot weld joint may be repaired as follows:

(a) Starting at air seal hole, cut parent metal as required to remove all cracks. Parent metal cutouts should have generous radii throughout. (See figure 204.)

(b) Blend all edges.

B. Partition Weld Repair. Weld per 72-02-4 using the following information.

(1) Grind out cracks before welding.

(2) Inert arc weld partitions using the filler specified in paragraph (7).

(3) Keep amperages at a minimum to reduce shrinkage.

(4) Purge interior of partition thoroughly with inert gas by feeding gas through the open end, at the outer band.

(5) Do not weld in one area so as to overheat the nozzle. Cool with dry ice or weld in opposite sections.

(6) Bench after welding to remove all excess material. Use small diameter or pointed files to work into corners. Maintain smooth surfaces. Restrictions in the nozzle area are undesirable. Repair welding is to be kept to a minimum.

(7) The welding rod and part material are as follows:

(a) Partition Material - AMS 5537 (L-605)

(b) Welding Rod - AMS 5796 (L-605)

C. Locating and Marking "T" Number Positions.

(1) Place the nozzle on a table with the partition trailing edges up.

NOTE: The inner band is sectioned into 6 segments. One of the segments has 8 partitions; all the other segments have 7 partitions.

(2) Locate the segment with the 8 partitions and place it in the position shown in figure 204.

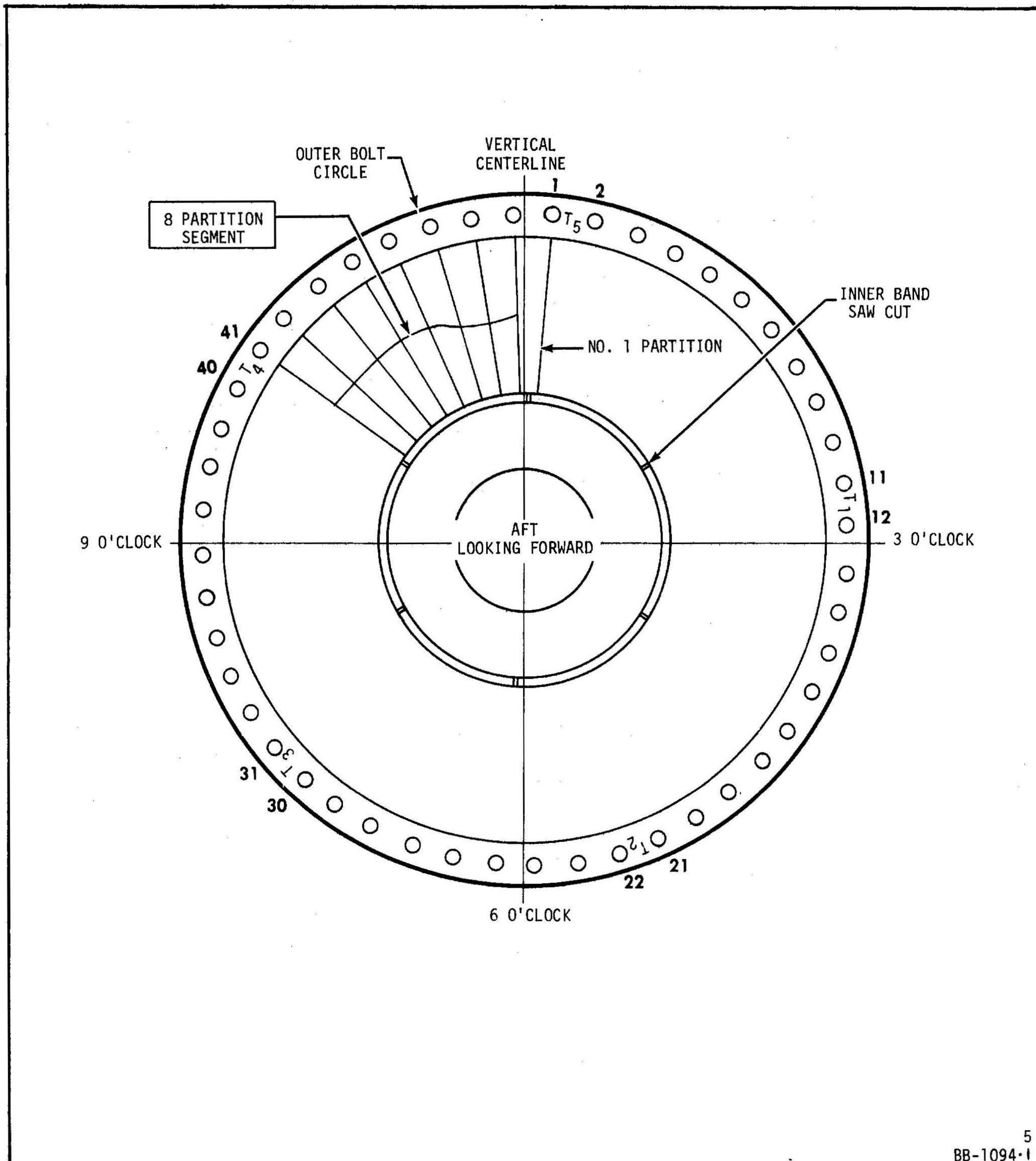
NOTE 1: The first partition in the 7-partition segment, clockwise from the 8-partition segment, is the number 1 partition. The centerline of the number 1 partition corresponds to the centerline of the nozzle.

NOTE 2: The number 1 bolt hole is the first hole clockwise from the nozzle centerline. Bolt holes are numbered 1 through 48 in a clockwise direction. "T" marks are located between the following bolt hole numbers:

"T" Mark	Between Bolt Holes
T5	1 & 2
T1	11 & 12
T2	21 & 22
T3	30 & 31
T4	40 & 41

(3) Notch the nozzle flange OD at each "T" position using a small rat-tail file. Notches to be 0.01-0.02 inch deep with no sharp edges or burrs. Notch as follows:

"T" Position	No. of Notches
T1	1
T2	2
T3	3
T4	4
T5	5



Location of "T" Marks on First-Stage Turbine Nozzle
Figure 205

D. *Repair of Inner Flange. This repair should be done only after out-of-*flatness of inner flange has been restored to serviceable limits. See step E.(1).

(1) Secure nozzle in a locally made turning fixture, functionally similar to the one shown in figure 206.

(2) Diameter U shall be within 0.005 inch TIR when using the 4-point check method. Surfaces A and N shall be within 0.005 inch TIR.

(3) Mask outer partition ports to avoid contaminating air-cooling passages during repair. Masking should be made of heat-resistant material.

(4) Machine off all fretted and galled metal, removing a minimum amount of material. Note the minimum thickness allowed for each flange.

(5) Remove nozzle from fixture.

(6) Prepare and plasma-spray machined surfaces with Metco 450 per STANDARD PRACTICES, 70-49-1, paragraph 6, step D of Overhaul Manual (SEI-133).

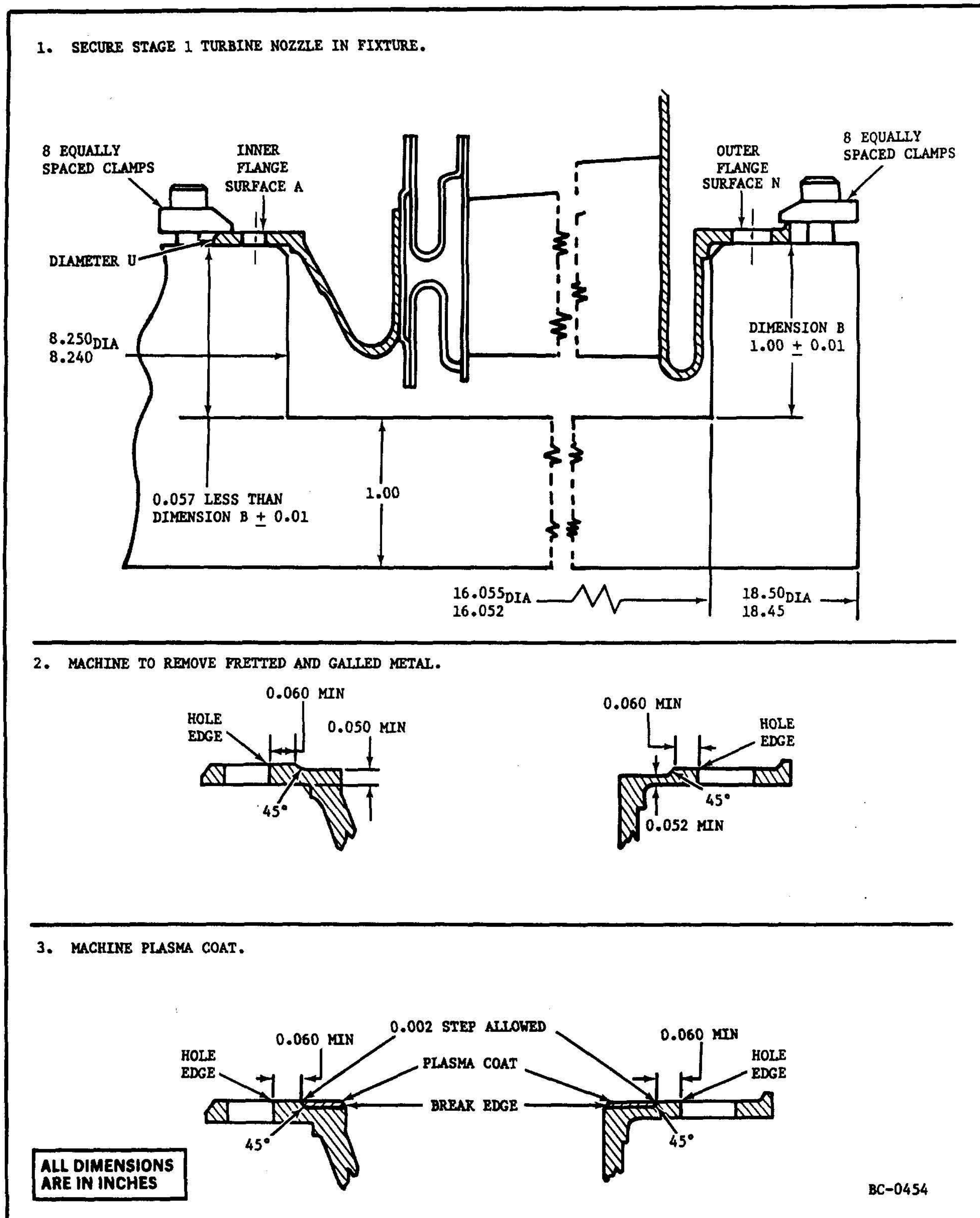
(7) Remove all masking except at outer partition ports.

(8) Secure nozzle in turning fixture per steps (1) and (2).

(9) Machine plasma coat until it is flush with parent metal. A 0.002 inch step is allowed as indicated in figure.

(10) Remove *nozzle from fixture. Remove all masking. Clean and vapor-*degrease nozzle per STANDARD PRACTICES, 70-20-1 of Overhaul Manual (SEI-133).

(11) Inspect flanges using a 10-power magnifying glass. Cracks, chips, and loose plasma are not allowed. Plasma overspray is not allowed and must be removed.



Repair of Flanges with Plasma Spray
Figure 206

E. Repair of First-Stage Turbine Nozzle Flanges.

(1) Repair undersize Diameters U and/or H (figure 207) as follows:

WARNING: TRICHLOROETHANE O-T-620

DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON VERY HOT SURFACES. DO NOT SMOKE WHEN USING IT. HEAT AND FLAMES CAN CAUSE THE FORMATION OF PHOSGENE GAS WHICH IS INJURIOUS TO THE LUNGS.

REPEATED OR PROLONGED CONTACT WITH LIQUID OR INHALATION OF VAPOR CAN CAUSE SKIN AND EYE IRRITATION, DERMATITIS, NARCOTIC EFFECTS, AND HEART DAMAGE.

AFTER PROLONGED SKIN CONTACT, WASH CONTACTED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. IF VAPORS CAUSE IRRITATION, GO TO FRESH AIR. GET MEDICAL ATTENTION FOR OVEREXPOSURE OF SKIN AND EYES.

WHEN HANDLING LIQUID IN VAPOR-DEGREASING TANK WITH HINGED COVER AND AIR EXHAUST, OR AT AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GLOVES AND GOGGLES.

WHEN HANDLING LIQUID AT OPEN, UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

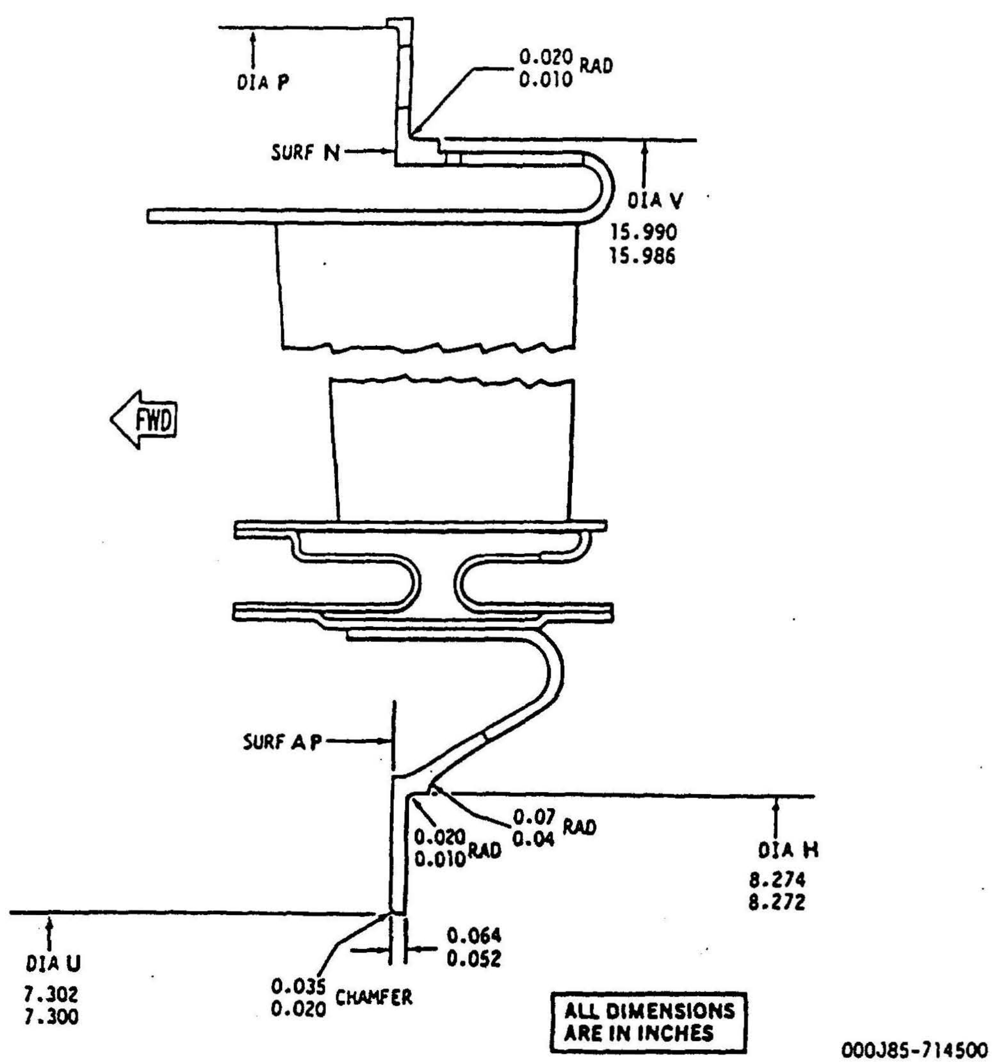
DISPOSE OF LIQUID-SOAKED RAGS IN APPROVED METAL CONTAINER.

(a) Clean nozzle with trichloroethane, O-T-620, or equivalent.

(b) Setup and restrain nozzle on Diameter P and Surface N.

(c) Obtain best runout on Diameter U.

(d) Machine Diameters U and/or H to repairable limits. Limit machining to minimum amount.



First-Stage Nozzle Flange - Repair
Figure 207

(2) Repair oversize Diameters U and/or H using either the flame spray or the weld repair method.

NOTE: Flame spray is the preferred method.

(a) For flame spray method proceed as follows:

1 Set up and restrain nozzle on Diameter P and Surface N. Obtain best runout on Diameter U or Diameter H.

2 Machine Diameters U and H only enough to produce a finished machine metal spray material thickness of 0.010 inch. Machining cleanup dimensions prior to metal spray must not exceed the following:

Diameter U - 7.310 inches
Diameter H - 8.284 inches

3 Vapor-degrease nozzle per Section 72-20-1, SEI 133.

WARNING: COMPRESSED AIR

WHEN USING COMPRESSED AIR FOR ANY COOLING, CLEANING, OR DRYING OPERATION, DO NOT EXCEED 30 PSIG AT THE NOZZLE.

EYES CAN BE PERMANENTLY DAMAGED BY CONTACT WITH LIQUID OR LARGE PARTICLES PROPELLED BY COMPRESSED AIR. INHALATION OF AIR-BLOWN PARTICLES OR SOLVENT VAPOR CAN DAMAGE LUNGS.

WHEN USING AIR FOR CLEANING AT AN AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GOGGLES OR FACE SHIELD.

WHEN USING AIR FOR CLEANING AT AN UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR AND GOGGLES.

4 Vapor-blast surface to be metal sprayed to remove oxides and other contaminants.

5 Mask off all areas that are not to be sprayed.

WARNING: NICKEL METCO POWDERS

HIGHLY REACTIVE - DO NOT MIX WITH STRONG ACIDS AND COMBUSTIBLE MATERIAL SUCH AS WOOD, PAPER, AND SULFUR.

DO NOT HAVE ANY CONTACT WITH POWDER. CONTAINS NICKEL. CONTACT WITH POWDER CAN CAUSE SKIN SENSITIZATION AND EYE IRRITATION. REPEATED INHALATION OF POWDER CAN CAUSE COUGHING AND WHEEZING, AND CAN CAUSE PERMANENT DAMAGE TO LUNGS AND NASAL PASSAGES.

IF ANY POWDER CONTACTS SKIN OR EYES, FLUSH AFFECTED AREA THOROUGHLY WITH WATER. REMOVE CONTAMINATED CLOTHING. IF COUGHING AND WHEEZING PERSIST, GET MEDICAL ATTENTION.

CHARGING AND REMOVAL OF POWDER FROM SPRAY GUN AND APPLICATION OF COATING MUST BE PERFORMED IN AIR-EXHAUSTED, PARTIALLY ENCLOSED SPRAY BOOTH. WHEN SPRAY GUN IS IN OPERATION, WEAR APPROVED GOGGLES AND HEARING PROTECTION. IF ANY AIRBORNE POWDER IS PRESENT, WEAR APPROVED RESPIRATOR.

DO NOT EAT, SMOKE, OR CARRY SMOKING MATERIALS IN AREAS WHERE POWDER IS HANDLED.

6 Metal spray Diameters U and/or H using either Metco 405 or Metco 450. Be sure spray is thick enough to produce a finished spray thickness of 0.010 inch.

NOTE: Metco 405 spray requires grinding. Metco 450 may be machined by means other than grinding.

WARNING: POWER GRINDING

AVOID PROLONGED OR REPEATED CONTACT WITH DUST. INHALATION OF DUST MAY CAUSE TEMPORARY COUGHING AND WHEEZING, RESPIRATORY TRACT IRRITATION, AND PERMANENT LUNG PROBLEMS. IF COUGHING OR WHEEZING PERSISTS, GET MEDICAL HELP.

IF DUST CONTACTS EYES, FLUSH THEM THOROUGHLY WITH WATER.

WHEN USING AN AIR-EXHAUSTED GRINDING WHEEL, WEAR APPROVED GOGGLES, OR FACE SHIELD.

IF GRINDER IS NOT EQUIPPED WITH LOCAL EXHAUST VENTILATION, WEAR AN APPROPRIATE RESPIRATOR AND GOGGLES OR FACE SHIELD.

7 Grind or machine to dimensions shown in figure 207.

8 Dimensionally inspect nozzle.

(b) For weld repair method proceed as follows:

1 Install turbine nozzle into locally manufactured stage 1 turbine nozzle welding fixture (figure 208) to prevent excessive distortion.

2 Restrain nozzle on Diameter P and Surface N.

3 Restrain inner flange forward surface (Surface AP, figure 207).

WARNING: GENERAL WELDING

DO NOT LET FLAMMABLE SOLVENTS SUCH AS ACETONE AND METHYL ETHYL KETONE CONTACT HEATED WELDED PARTS.

CONTACT WITH FUMES MAY CAUSE SKIN IRRITATION, DERMATITIS, AND EYE IRRITATION. REPEATED INHALATION OF FUMES CAN CAUSE COUGHING, WHEEZING, AND PERMANENT LUNG DAMAGE.

IF FUMES CAUSE IRRITATION, GO TO FRESH AIR. IF COUGHING OR WHEEZING PERSISTS, GET MEDICAL ATTENTION.

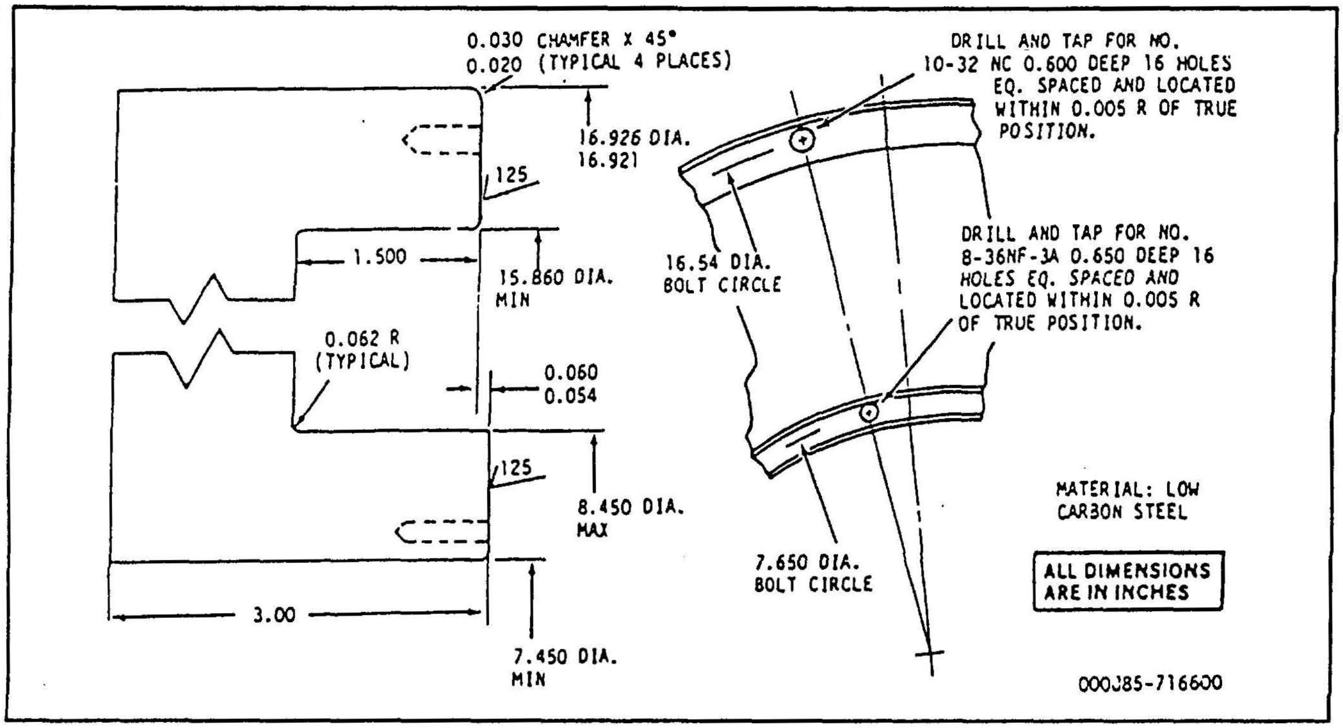
WELDING SHOULD ONLY BE DONE IN AN AIR-EXHAUSTED ENCLOSED OR SHIELDED WORK AREA.

CONTACT WITH ULTRAVIOLET RAYS MAY CAUSE FATIGUE, NAUSEA, AND FEVER. REPEATED CONTACT MAY CAUSE PERMANENT SKIN AND TISSUE DAMAGE.

COVER ALL EXPOSED SKIN TO AVOID REDDENING OF SKIN. IF REDDENING OF SKIN OCCURS AFTER REPEATED USE OF WELDING MACHINE, GET MEDICAL ATTENTION.

ONLY EXPERIENCED TRAINED PERSONNEL SHOULD USE WELDING MACHINES. WHEN USING EQUIPMENT, FOLLOW APPROVED SAFETY PROCEDURES FOR SHIELDING AND PERSONAL PROTECTIVE EQUIPMENT.

4 Build up Diameter U and/or H, as required, using TIG weld method and weld data table.



Stage 1 Turbine Nozzle Welding Fixture
Figure 208

WELD DATA TABLE

Nomenclature	Material Being Welded	Filler Wire Material (1/32-1/16 inch dia.)	Current Amperes	Torch Gas Flow (CFH)	Backup Gas Flow (CFH)	Weld Contour
Outer Flange	AMS 5759	AMS 5786 (Hastelloy W)	20-35 DC Straight Polarity	Argon, 8-14	Argon, 10-15	Buildup
Inner Flange	AMS 5510	AMS 5786 (Hastelloy W)	20-35 DC Straight Polarity	Argon, 8-14	Argon, 10-15	Buildup

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN..

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

5 Fluorescent-penetrant inspect welds for cracks. No cracks are allowed.

6 Machine Diameter U and/or H to dimensions shown in figure 207.

7 Correct concentricity of Diameter H or Diameter V as follows:

a Restrain nozzle on Diameter P and Surface N, and obtain best runout on Diameter U.

b Buildup Diameters U, H, or V with weld, as required, using eight equally spaced welds 3/8 to 1/2 inch long. Use weld data from flange weld repair.

c Set up same as step a. If Diameter U is being repaired, the inner flange forward surface must also be restrained.

d Machine Diameters U, H, and V as required to dimensions shown in figure 207.

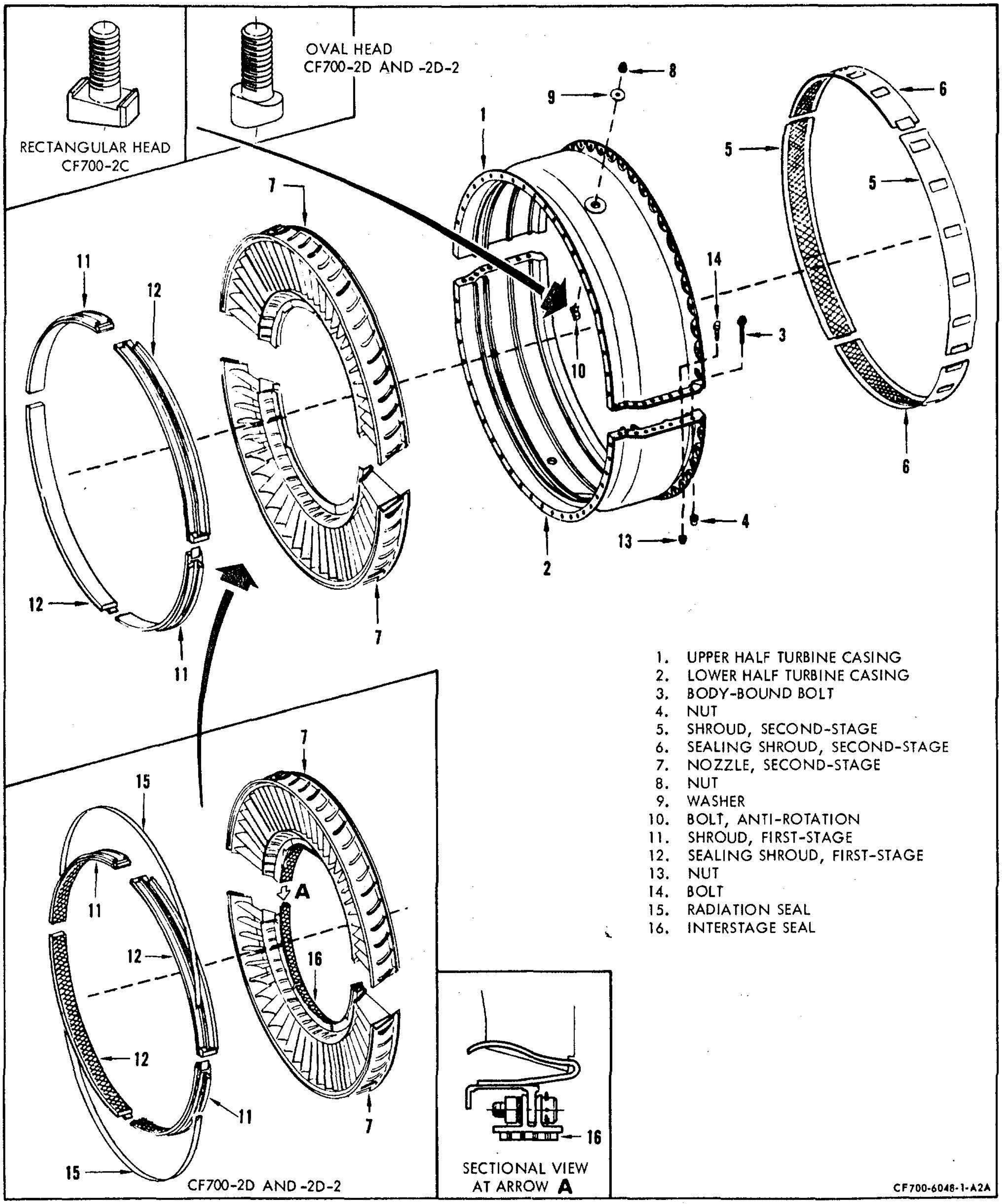
TURBINE CASING ASSEMBLY - MAINTENANCE PRACTICES

1. General. Only the external areas of the turbine casing are inspected unless the casing is removed from the engine.

2. Removal/Installation. Refer to section 72-50.

3. Inspection/Check. Visually inspect the turbine casing assembly as follows: Where serviceable limits are exceeded, parts may be repaired in accordance with the Overhaul Manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. The turbine casing: (Figure 201B)		
(1) The forward (1) and aft (2) flanges for:		
(a) Cracks on radius side of each flange.	Not serviceable.	Replace casing.
(b) High spots (caused by nicks) on the mating surface.	Not serviceable.	Remove high spots.
(c) Loose bolts.	Not serviceable.	Re-torque flange bolts.
(2) The casing for cracks	Not serviceable.	
(3) The horizontal flange (3)		
(a) Cracks (cracks immediately adjacent to the weld are considered flange cracks.)	3 cracks each 1/4 inch long separated by 1/2 inch. One bolt hole on each casing half may be cracked from the bolt hole to edge of flange.	
(b) High spots (caused by nicks) on the mating surface.	Not serviceable.	Remove high spots.
(c) Loose bolts.	Not serviceable.	Re-torque flange bolts.



Turbine Stator Assembly
Figure 201

Inspection/Check	Maximum Serviceable Limits	Remarks
NOTE: The following items are to be inspected if the turbine casing assembly is removed from the engine.		
(4) The turbine shroud tracks for deformation.	Any amount which does not cause interference during assembly of the shrouds.	
(5) Dents.	Any number 0.020 inch deep, 3 per casing half 0.060 inch deep providing there is no interference at casing.	
(6) Cooling air tubes in first stage shroud tracks for looseness (CF700-2D and -2D-2).	Not serviceable.	Reset tab on forward end of tube with brass drift.

B. Anti-rotation bolt (rectangular head, marked "A" on shank, and unmarked oval head bolt) for:

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN..

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

(1) Fluorescent-penetrant inspect for cracks.	Not serviceable.	Replace bolt.

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Thread damage.	Cumulative length one full thread after chasing.	Replace bolt.
(3) Shank deformation.	Not serviceable.	Replace bolt.

C. First-stage shrouds for: (11 and 12, figure 201)

NOTE: Inspect CF700-2D and 2D-2 first-stage shrouds according to paragraph 3.D. All CF700 first-stage shrouds are machined at assembly and cannot be replaced according to this manual. If the shrouds are removed for inspection, be sure to identify as to location to facilitate re-installation. Remove and re-install according to Overhaul Manual.

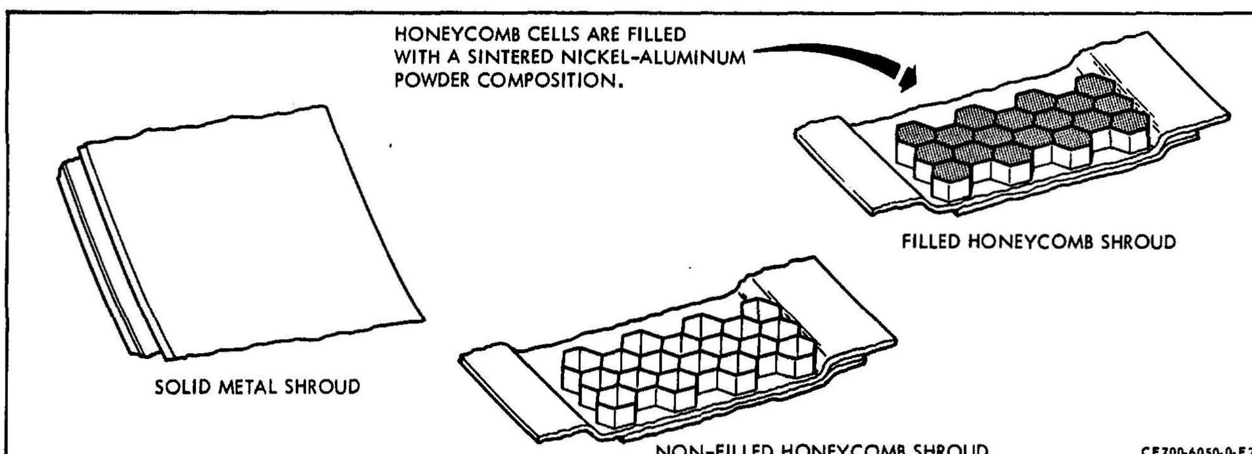
Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Cracks.	1 crack, 3/8 inch long, 3 cracks, 3/16 inch long per segment provided no material is in danger of falling out. No cracks allowed in rails.	
(2) Burns.	Not serviceable.	
(3) Rubs.	Any amount 0.025 inch deep with no high metal.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(4) Missing anti-rotation stops.	Not serviceable.	
(5) Distortion (blisters).	Any amount 0.025 inch deep with no high metal.	
(6) Nicks and dents.	Any amount 0.025 inch deep with no high metal.	Remove high metal.
(7) Metal deposits.	Any amount with no high metal.	

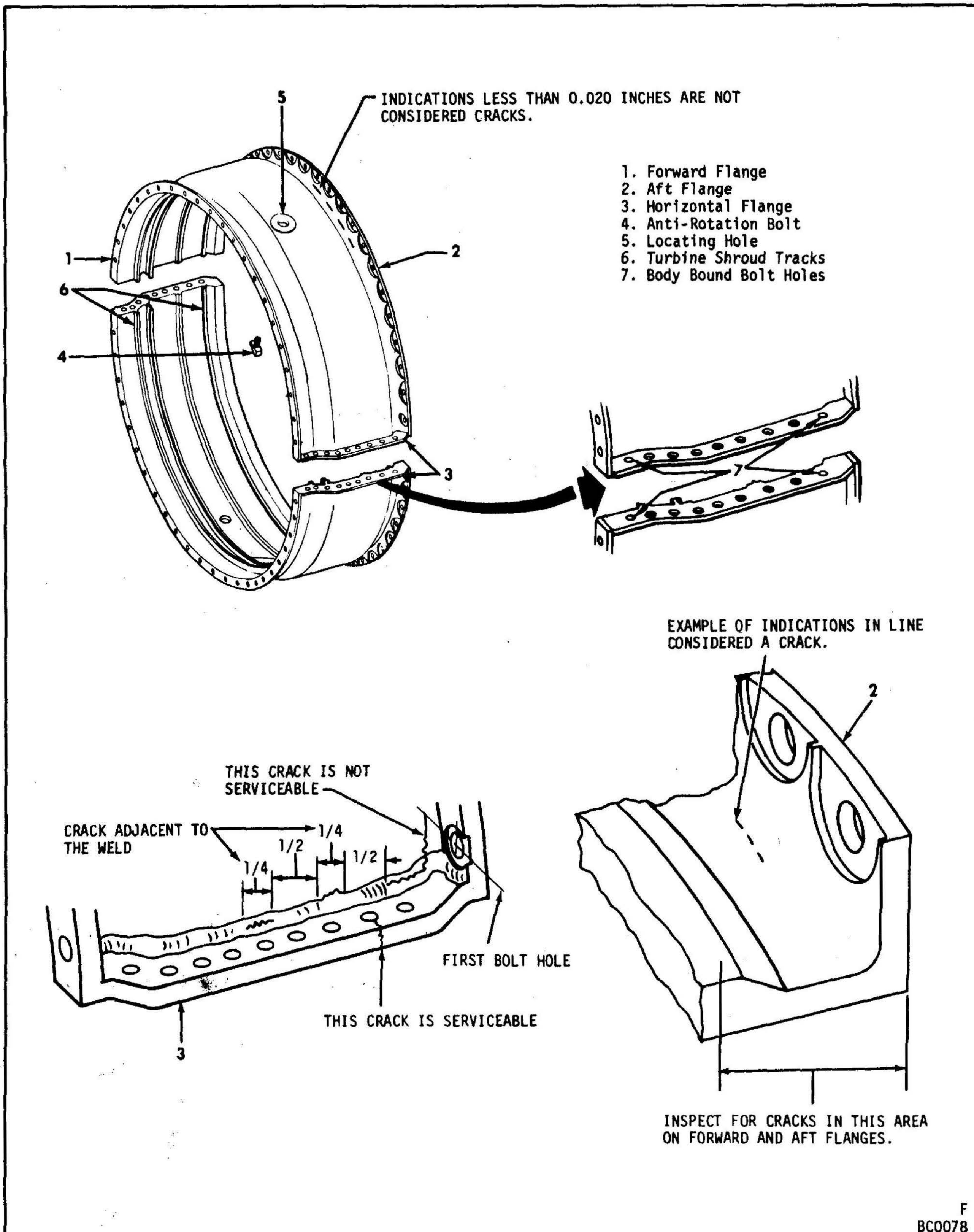
D. Second-stage shrouds for: (See figure 201C)

NOTE: First and second-stage shrouds on the CF700-2D and -2D-2 engines are filled honeycomb shrouds (see figure 201A). These shrouds are machined during engine assembly and cannot be replaced according to this manual. If the shrouds are removed for inspection, be sure to identify as to location to facilitate re-installation. Remove and re-install according to the Overhaul Manual.

(1) Cracks.	Any number 1/4 inch long with no danger of a piece breaking away provided there are no cracks in the rails.	Non-filled shrouds may be welded per paragraph 4.E. (provided honeycomb removal does not exceed serviceable limits) or replaced per paragraph 4.B.



Typical Turbine Shrouds
Figure 201A

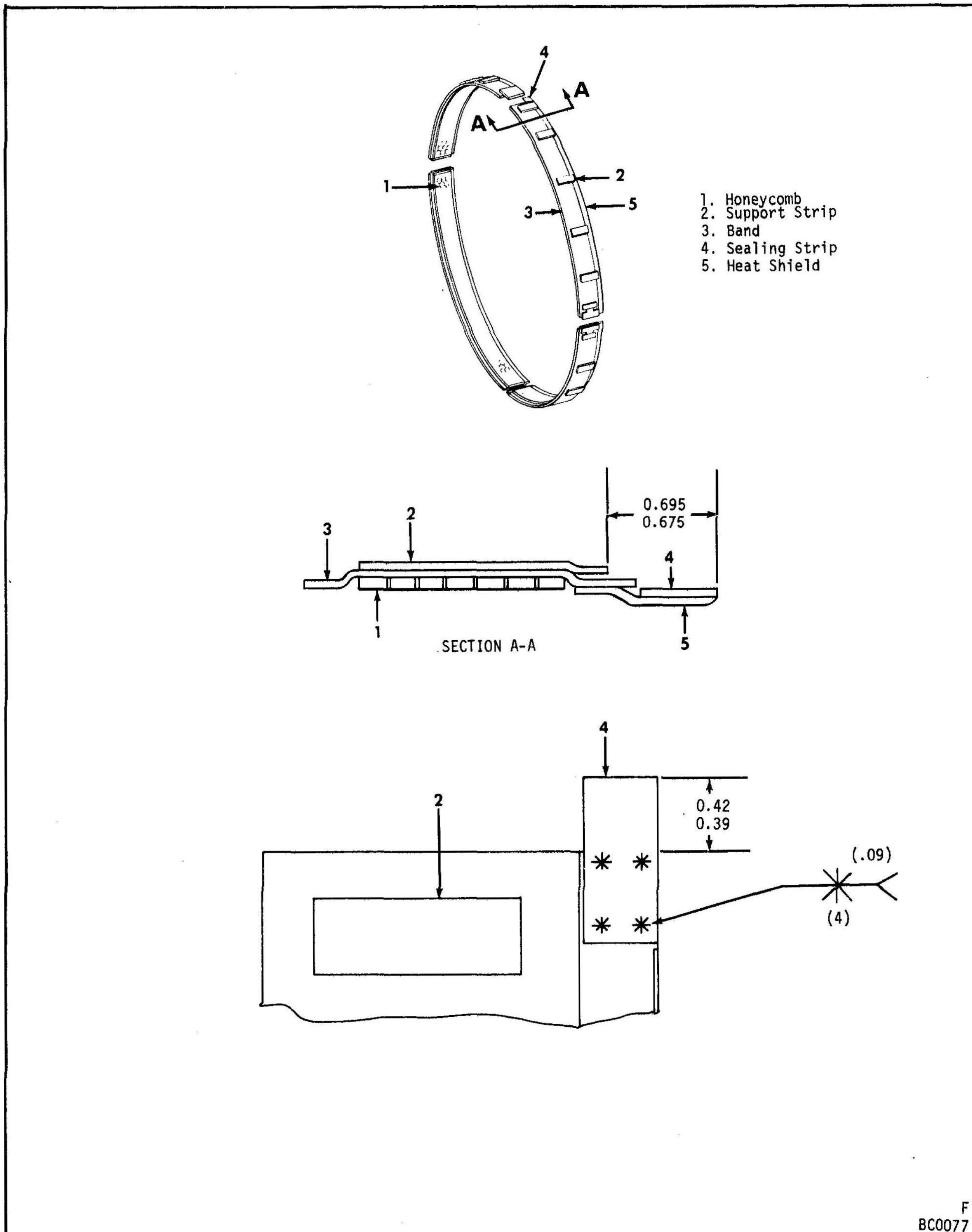


Turbine Casing
Figure 201B

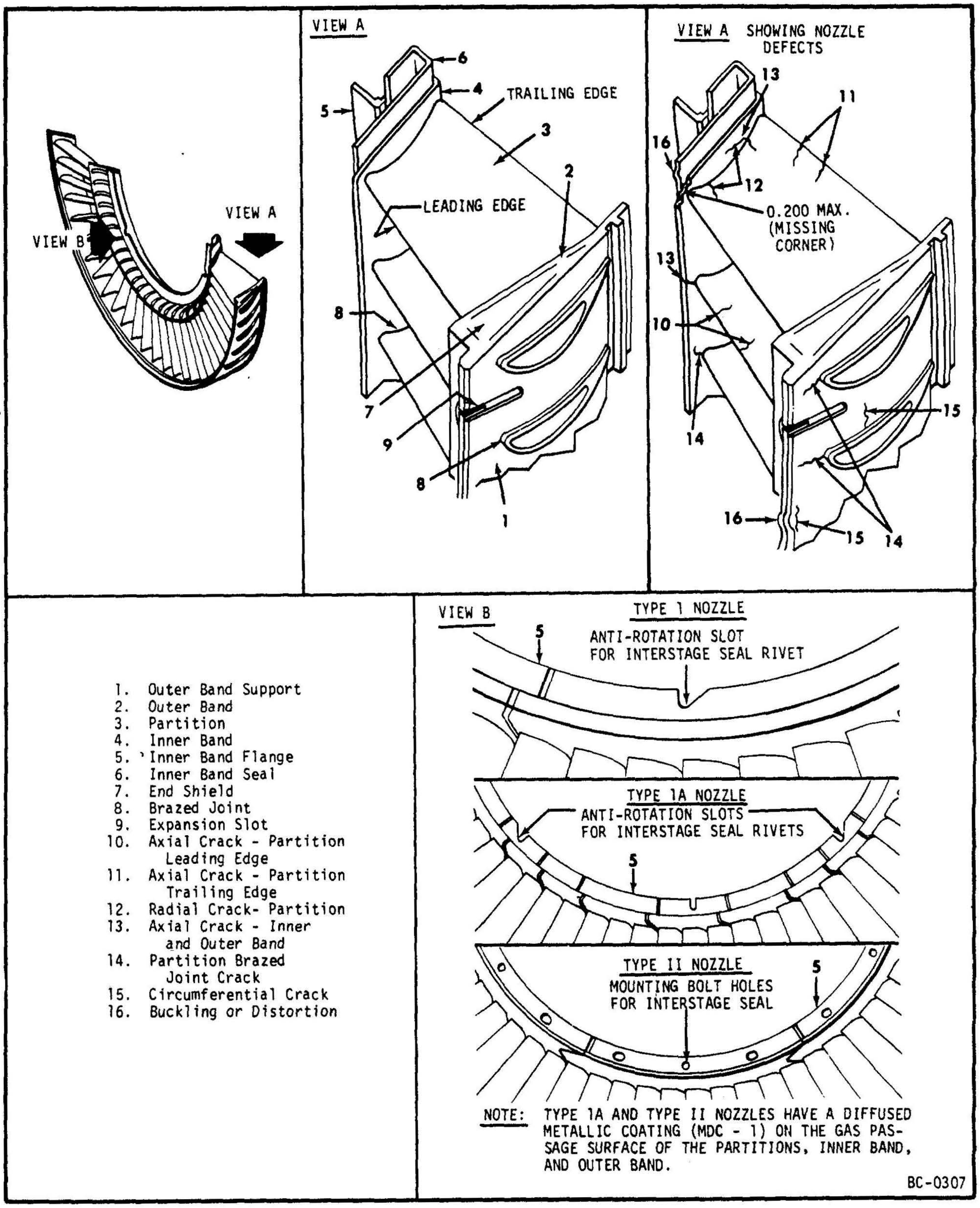
Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Rubs.	Any amount not into the band.	
(3) Deleted.		
(4) Nicks and dents.	Any amount 0.025 inch deep with no high metal.	Remove high metal.
(5) Missing or damaged honeycomb.	Not to exceed 80 missing or damaged cells per segment.	
(6) Missing support strips.	One per segment except end strips.	
(7) Cracks in heat shield (5) or seam weld.	Any number 1/4 inch long, accumulated total length of 1 inch, and with no danger of a piece breaking away or the heat shield separating from the shroud.	
(8) Buckling or warpage of heat shield (5).	0.060 in from normal contour.	Cold-work to normal contour and inspect for cracks.
(9) Missing or broken heat shield sealing strips (4).	Not serviceable.	Replace shroud segment.
(10) Worn heat shield sealing strips (4).	0.010 inches deep.	Replace shroud segment.

E. The second-stage nozzle for: (See figure 202)

NOTE: Any crack or cracks that may converge and permit metal breakout during further service, is not allowed. Any unserviceable half of a stage 2 nozzle may be replaced with a serviceable half having a different serial number. For replacement procedure see paragraph 4.C.



Second-Stage Turbine Shroud
Figure 201C



Second-Stage Turbine Nozzle
Figure 202

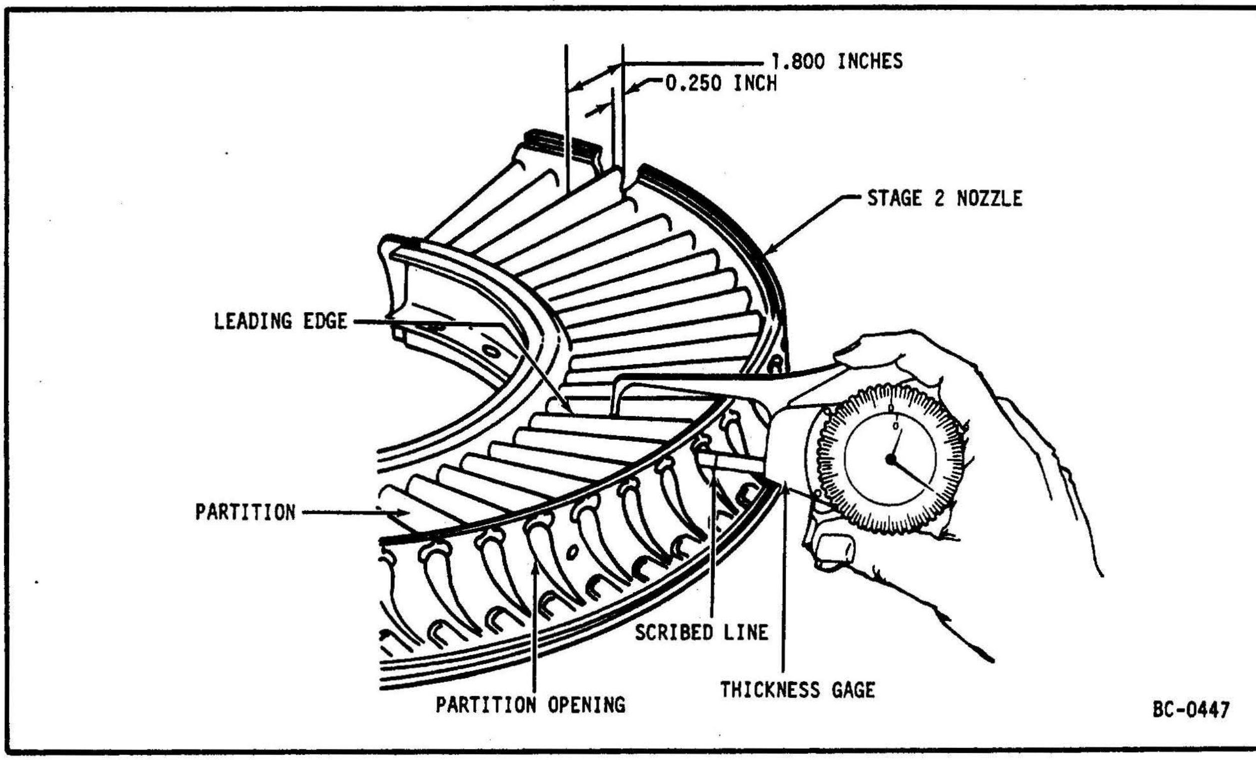
Inspection/Check	Maximum Serviceable Limits	Remarks
(1) The partitions for:		
(a) Axial cracks in the trailing edge (11).	Any number, 1/8 inch long. Five per partition, 3/8 inch long, max of 8 partitions per half. Two per partition, 5/8 inch long, max of 6 partitions per half.	
(b) Axial cracks in leading edge (10).	Any number, 1/8 inch long. Four per partition, 1/4 inch long, provided crack does not open into partition cavity when inspected visually.	
(c) Radial cracks (12).	Any number, 1/16 inch long. One crack per partition 3/8 inch long, in trailing half of partition. Max of 15 partitions.	
(d) Burns or erosion on:		
1 Trailing edge.	1/8 inch in from trailing edge axial. One inch long radial. Max of 12 partitions per nozzle half.	
2 Leading edge.		
a PN 6028T79G01 and 3902T49P01 nozzles.	Thickness of leading edge shall be at least 0.024 inch at location 1.8 inches in from partition opening, and at least 0.029 inch at location 0.250 inch in from partition opening. See paragraph 3A.	
b All other nozzles.	1/4 inch wide axial by one inch long radial. Max of 12 partitions per nozzle half, provided erosion does not open into partition cavity when inspected visually.	
(e) Nicks, dents or gouges along trailing edge (within 3/16 inch of edge).	Any number, 0.015 inch deep with no high metal.	Remove high metal.

Inspection/Check	Maximum Serviceable Limits	Remarks
(f) Nicks, dents or gouges other than trailing edge.	Any number, 0.040 inch deep with smooth deformation.	
(g) Type IA and type II nozzles for missing coating in gas passage.	Any amount providing there are no cracks, burns or erosion beyond serviceable limits.	
(2) The partition braze joint for cracks (14).	Not over 25% of any joint affected.	
(3) The inner band flange and the inner or outer band for:		
(a) Distortion.	No distortion which would prevent assembly of nozzle in casing or affect engagement of interstage seal.	Cold work to original shape and inspect for cracks.
(b) Axial cracks extending from the end of the partition slot to the leading or trailing edge of the band (13).	15 cracks in each band (inner and outer) per nozzle half. Axial cracks connecting to circumferential cracks are not serviceable.	
(c) Axial cracks extending from the partition slot and terminating in the band.	Any number.	
(d) Circumferential cracks (15).	10 cracks, 1/2 inch long, in each band and the support structure.	
(e) Burnouts.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(f) Outer band expansion slot cracks (Type IA and type II nozzles only).	One axial crack per expansion slot, 1/2 inch long max and does not extend into partition braze joint.	
(4) Inner band for:		
(a) Missing corner.	Any amount up to 0.200 inch from apex of corner measured along either edge.	
(b) Dents.	Any amount up to 0.030 inch deep, and no cracks.	
(5) Inner band flange for:		
(a) Fretting and pitting (CF700-2C only).	Any amount, if the thickness is not less than 0.040 inch. Thickness as low as 0.030 inch is allowed if no more than 15 percent of any 60° segment is affected.	
(6) Outer band for:		
(a) Dents.	Any amount, 0.020 inch deep.	Remove high metal.
(b) Bulged sections (CF700-2C only).	No appreciable distortion.	Repair per paragraph 4.D.
(c) Braze void at corner of frame stop hole.	Length 0.22 inch, width 0.06 inch. See Note and figure 203B.	Repair per paragraph $4.D_1$.

NOTE: A braze void located at the corner of the frame stop hole on the forward side of the second-stage nozzle (specifically the 0.08-0.06 inch chamfer) is inherent in the design. When measured in the direction of arrow (figure 203B) and does not exceed 0.22 inch in length, or 0.06 inch in width, the void is acceptable.

Inspection/Check	Maximum Serviceable Limits	Remarks
(d) Cracks emanating from antirotation bolt slots.	Not serviceable.	Repair per paragraph $4.D_1$.
(7) Inner band seal for:		
(a) Deleted.		
(b) Cracks.	Not serviceable.	
(c) Missing Seal.	Not serviceable.	
(8) Nozzle end shield (7) for dents, nicks, and scratches.	Any amount, providing there are no cracks in the brazed or welded joint or in the end shield.	
F. Radiation seal for:		
(1) Cracks.	Not serviceable.	
(2) Burns.	Not serviceable.	



Measuring Second-Stage Nozzle Partition Leading Edge
Figure 203

3A. Measuring Leading Edge Thickness of Partitions on Second-Stage Turbine Nozzle. (See figure 203.)

A. Place nozzle on flat surface with leading edge of partition facing up.

B. Open jaws of gage 21C6198 or equivalent. Insert smaller probe into partition opening on outside diameter of nozzle until partition opening and scribed line (1.8 inches) on lower jaw of gage are aligned.

C. Release pressure on gage and allow probes to contact inner and outer surface of leading edge of partition.

D. Move gage radially outward along leading edge, and read minimum thickness on dial indicator of gage.

E. Repeat steps A through D for remaining nozzle partitions.

F. Open jaws of gage and insert smaller probes into partition opening to a depth of 0.250 inch.

G. Repeat steps C and D.

H. Repeat steps F and G for remaining nozzle partitions.

4. Repair.

A. Replacement of interstage seal segments. (CF700-2D and -2D-2)

(1) Removal.

(a) Break lockwire and remove the 3 screws holding segment to nozzle.

NOTE: Matchmark the segments to facilitate re-installation in the same positions.

(b) Remove segment.

(2) Assembly.

NOTE: Check matchmarks on segments to re-align in the same positions.

(a) Position segment on nozzle inner flange.

CAUTION: POSITION SEGMENT WITH THICK FLANGE FORWARD. (SEE VIEW A, FIGURE 201.)

(b) Install 3 screws, nuts, and washers.

(c) Torque screws to 7-9 lb in. and lock-wire.

NOTE: Lock-wire the 3 screws of each segment together. Do not lock-wire across segment end gaps.

(d) Check gap between segment ends. Gap must be a minimum of 0.025 inch. Bench end of segment if required.

B. Replacement of Second-Stage Shrouds. (CF700-2C only)

NOTE: All CF700-2C second-stage shroud segments may be replaced provided assembly clearances are met. First-stage shrouds on CF700-2C and first- and second-stage shrouds on CF700-2D and -2D-2 engines are machined at assembly and cannot be replaced according to this manual.

(1) Removal.

(a) Soak shroud tracks with penetrating oil or engine oil to facilitate removal.

(b) Slide shroud segments (5 and 6) from casing half.

(2) Assembly.

NOTE: Lubricate edges of shrouds with Ease-Off 990 Texacone Co., Box 4236, Dallas, Texas) or G-392 Versilube (G.E. Products Co., Waterford, N.Y.)

(a) Slide shroud segments (5 and 6) into casing half.

NOTE: Every other shroud segment is a locking segment.

(b) Shrouds must be installed so that they interlock at the horizontal split line when the casing halves are assembled. Be sure the clearance between shrouds at the horizontal split line is at least 0.020 inch across the entire shroud ends and the shroud ends are flush with the horizontal split line. Bench the shroud ends are required to obtain this clearance. The clearance between shrouds at the 6 and 12 o'clock positions shall be 0.100-0.250 inch. (See figure 203A.)

C. Replacement of Second-Stage Nozzle. (See figure 201.)

(1) Removal.

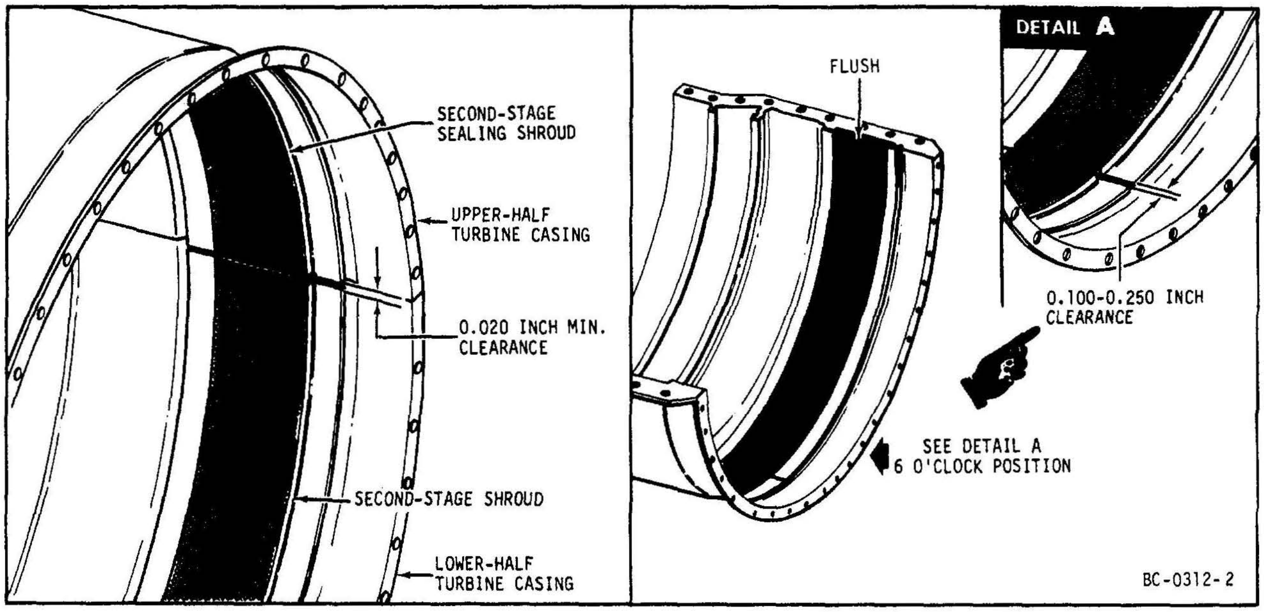
(a) Remove anti-rotation bolt (10). Discard rectangular headed bolt if marked "Y" on the shank. A bolt marked "A" must pass inspection before reuse. Oval head bolts (not marked) (used on CF700-2D and -2D-2) must pass inspection before reuse.

(b) Remove the nozzle half (7) by sliding it from the turbine case (1). It may be necessary to soak the tracks with penetrating oil or engine oil to facilitate removal.

(2) Assembly.

(a) Lubricate the edges of the nozzle outer ring with Ease-Off 990 (Texacone Co., Box 4236, Dallas, Texas) or G-392 Versilube (G.E. Products Co., Waterford, N.Y.).

(b) Shrouds must be installed so that the shroud anti-rotation tabs mate with the slots at the horizontal split line when the casing halves are assembled. Be sure the clearance between shrouds at the horizontal split line is at least 0.020 inch across the entire shroud ends and the shroud ends are flush with the horizontal split line. Bench the shroud ends as required to obtain this clearance. The clearance between shrouds at the 6 and 12 o'clock positions shall be 0.100-0.250 inch. (See figure 203A.)



Second-Stage Turbine Shrouds - Installation CF700-2C
Figure 203A

(c) Install the anti-rotation bolt (10, figure 201) into the frame stop of the nozzle half.

NOTE: Lubrication of threads on anti-rotation bolts not required.

(d) Hold nozzle half in the extreme aft position. Secure the bolt to the turbine casing with nut (8). On CF700-2C engines also use washer (9). Washer must be installed with recessed face against turbine casing. Torque the nut to net torque of 40 lb inches; loosen nut and retorque to net torque of 20-40 lb inches.

NOTE: Net torque equals gross torque minus run-on torque.

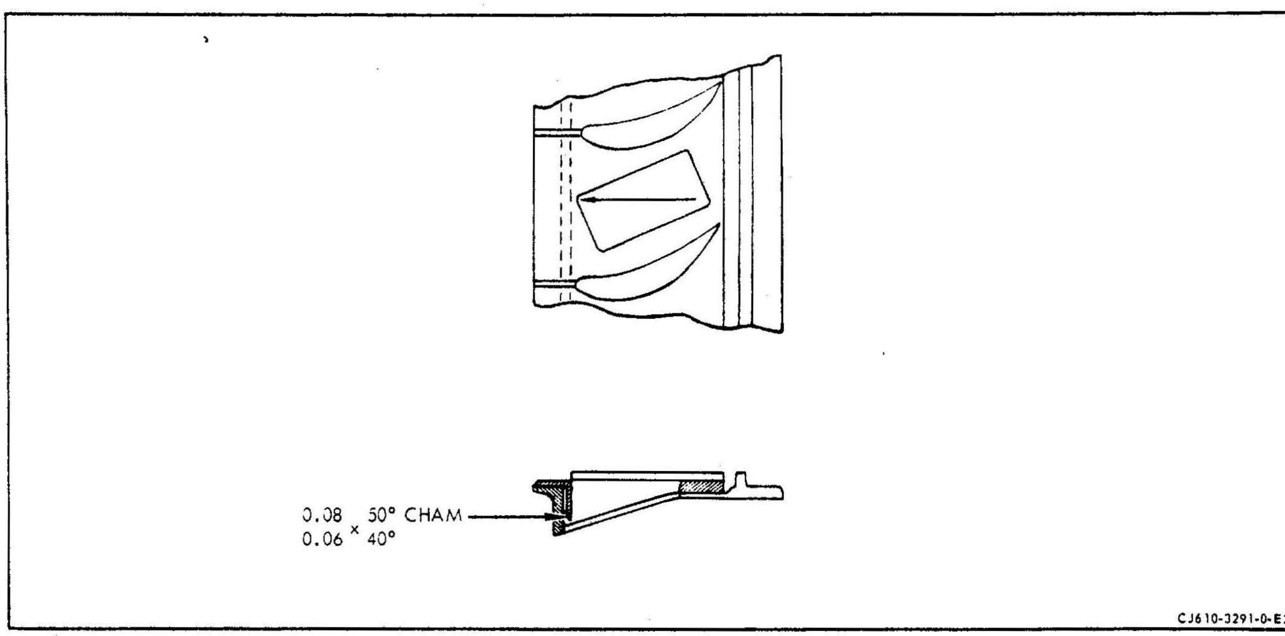
(3) If only one half of the nozzle is serviceable, proceed as follows:

(a) Replace the faulty nozzle half with a like serviceable half having the same part number. (Serial number will be diferent.) When matching nozzle halves, the exit area for the replacement half must fall within the following limits:

Nozzle Half Part No.		Nozzle Half Area Limits
On CF700-2C:		
37R601096	(Type I)	37.200 - 37.600 sq. in. Am*
6010T32	(Type IA)	36.615 - 37.352 sq. in. Am*
On CF700-2D and -2D-2		
6006T90	(Type II)	35.368 - 35.723 sq. in. Am*
6028T79	(Type II)	35.589 - 36.304 sq. in. Am*

*Am = Area, mechanical (measured by gage).

Trial assemble the halves in a casing and check the outer band gaps. Gaps must be within 0.100 - 0.200 inch and equal to each other within 0.010 inch. If gaps are too small, bench material equally from all four ends (both ends of both halves) or try another half. (Do not mix nozzles of different part numbers.)



Braze Void at Frame Stop Hole
Figure 203B

D. Repair of Second-Stage Nozzle Bulges Outer Band.

(1) Cold work the bulged section of the outer band to its original contour by tapping with a light hammer.

(2) Drill a 0.080 inch diameter hole in the reworked area in the location shown in figure 204.

<u>NOTE</u>: Exercise care to prevent chips from entering the hole. It may be helpful to remove chips before breaking through the outer band while drilling.

(3) Spot fluorescent-penetrant inspect the reworked area per Section 72-03-1.

D1. Second-Stage Nozzle Weld-Repair. Weld per 72-02-4 using the following information.

(1) Grind out cracks before welding. Whenever possible, grind out 50% of crack depth on one side, weld and repeat procedure for other side. Before attempting to repair-weld cracks containing braze filler material, remove as much of the braze material as possible in areas to be repair-welded to minimize weld contamination.

(2) Weld using the filler specified in paragraph (8).

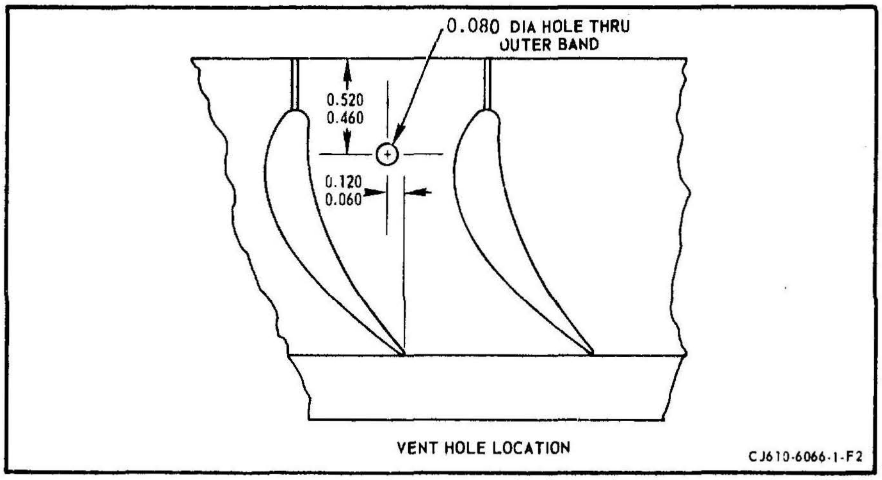
<u>NOTE</u>: Type IA and Type II Nozzles have an aluminide diffusion coating on the gas passage surfaces of the partitions, inner band and outer band. Difficulty may be encountered when welding in these areas due to contamination of the weld by the coating; so when repair is required, remove the coating in the affected area with a carbide burring tool and 60-grit sanding pads. Type II nozzle partitions made of Mar-M-509 cast material does not have or require any coating.

<u>CAUTION</u>: DO NOT REMOVE MORE COATING THAN THAT WHICH IS NECESSARY. DO NOT UNDERCUT PARENT METAL MORE THAN THAT WHICH IS REQUIRED TO PREPARE THE WELD AREA.

(3) Keep amperages at a minimum to reduce shrinkage.

(4) Back up repair welds in the bands with copper to maintain alignments. If area is inaccessible, use inert gas backing.

(5) Do not weld in one area so as to averheat the nozzle. Cool with dry ice or weld in opposit sections.



Second-Stage Turbine Nozzle Outer Band Repair
Figure 204

(6) Bench after welding to remove all excess material. Use small-diameter or pointed files to work into corners. Maintain smooth surfaces where possible. Try to maintain the nozzle area. Restrictions in the nozzle area are undesirable. Repair welding is to be kept to a minimum.

NOTE: It is not necessary to recoat areas on Type IA and Type II nozzles where the coating had been removed for weld repair.

(7) Trial assemble nozzle into casing half.

(8) The welding rod and part material is as follows:

NOTE: When welding L605 to Rene 41 material, use Hastelloy X (AMS 5798) welding rod.

Part Nomenclature	Part Material	Welding Rod	Process
(1) Partitions			
(a) Type I Nozzle	AMS 5537 (L-605)	AMS 5796 (L-605)	Inert arc.
(b) Type IA Nozzle	AMS 5545 (Rene 41) (MDC-1 or CO-DEP-B-1 coated)	AMS 5798 (Hastelloy X)	Inert arc.
(c) Type II Nozzle	AMS 5545 (Rene 41) (MDC-1 or CO-DEP-B-1 coated)	AMS 5798 (Hastelloy X)	Inert arc.
	MAR-M-509	AMS 5796	Inert arc.

Part Nomenclature	Part Material	Welding Rod	Process
(2) Inner band			
(a) Type I Nozzle	AMS 5537 (L-605)	AMS 5796 (L-605)	Inert arc.
(b) Type IA Nozzle	AMS 5537 (L-605) (MDC-1 or CO-DEP B-1 coated)	AMS 5796 (L-605) or AMS 5798 (Hastelloy X)	Inert arc.
(c) Type II Nozzle	AMS 5537 (L-605) (MDC-1 or CO-DEP B-1 coated)	AMS 5796 (L-605) or AMS 5798 (Hastelloy X)	Inert arc.
(3) Inner Band Seal	AMS 5537 (L-605)	AMS 5796 (L-605)	Inert arc.
(4) Outer Band			
(a) Type I Nozzle	AMS 5759 (L-605)	AMS 5796 (L-605)	Inert arc.
(b) Type IA Nozzle	AMS 5537 (L-605) (MDC-1 or CO-DEP B-1 coated)	AMS 5796 (L-605) or AMS 5798 (Hastelloy X)	Inert arc.
(c) Type II Nozzle	AMS 5537 (L-605) (MDC-1 or CO-DEP B-1 coated.	AMS 5796 (L-605) or AMS 5798 (Hastelloy X)	Inert arc.
(5) Outer Band Support	AMS 5537 (L-605)	AMS 5796 (L-605)	Inert arc.
(6) End Shield	AMS 5537 (L-605)	AMS 5796 (L-605)	Inert arc.
(7) Inner Flange	AMS 5759 (L-605)	AMS 5796 (L-605)	Inert arc.

E. Second-Stage Shroud Repair.

(1) Remove honeycomb, as required, in the area of the cracks up to a limit of 80 cells per segment. If number of damaged or missing cells exceeds 80, the shroud must be replaced per paragraph 4.B. (CF700-2C only). Shrouds on CF700-2D and -2D-2 engines must be replaced per overhaul manual.

(2) Weld the crack per 72-02-4 using filler rod AMS 5798.

TURBINE ROTOR ASSEMBLY - MAINTENANCE PRACTICES

1. General. This section covers the maintenance practices that can be performed on the turbine rotor for either the scheduled, hot section inspection or unscheduled repair.

2. Removal/Installation. Refer to 72-50 for this procedure.

CAUTION: TURBINE BLADE FAILURE WILL RESULT IN TURBINE ROTOR UNBALANCE AND CAN CAUSE THE INNER COMBUSTION CASING/MAINFRAME BOLTS TO FAIL. WHENEVER INSPECTION REVEALS ANY BLADES HAVE FAILED, REPLACE ALL INNER COMBUSTION CASING/MAINFRAME BOLTS.

3. Inspection/Check. (See figure 201.) Visually inspect the turbine rotor assembly. When serviceable limits are exceeded the rotor may be repaired in accordance with the Overhaul Manual.

Inspection/Check	Maximum Serviceable Limits	Remarks

A. Turbine blades (figure 201A).

CAUTION: USED, SERVICEABLE BLADES CAN BE INSTALLED IN ENGINES OTHER THAN THE ENGINE FROM WHICH THEY WERE REMOVED, WITH THE FOLLOWING RESTRICTIONS:

CONVENTIONALLY CAST R80 AND R100 MATERIAL BLADES, P/N 5008T30P01, 5039T11P01, AND 6009T97P01, REMOVED FROM CF700-2D AND -2D2 ENGINES MUST BE REINSTALLED BACK INTO THE ENGINE FROM WHICH THEY WERE REMOVED.

USED, SERVICEABLE BLADES MAY BE MOVED FROM ENGINE TO ENGINE ONLY IN COMPLETE SETS. IF A SET IS INCOMPLETE, THE SET SHOULD BE COMPLETED USING NEW BLADES.

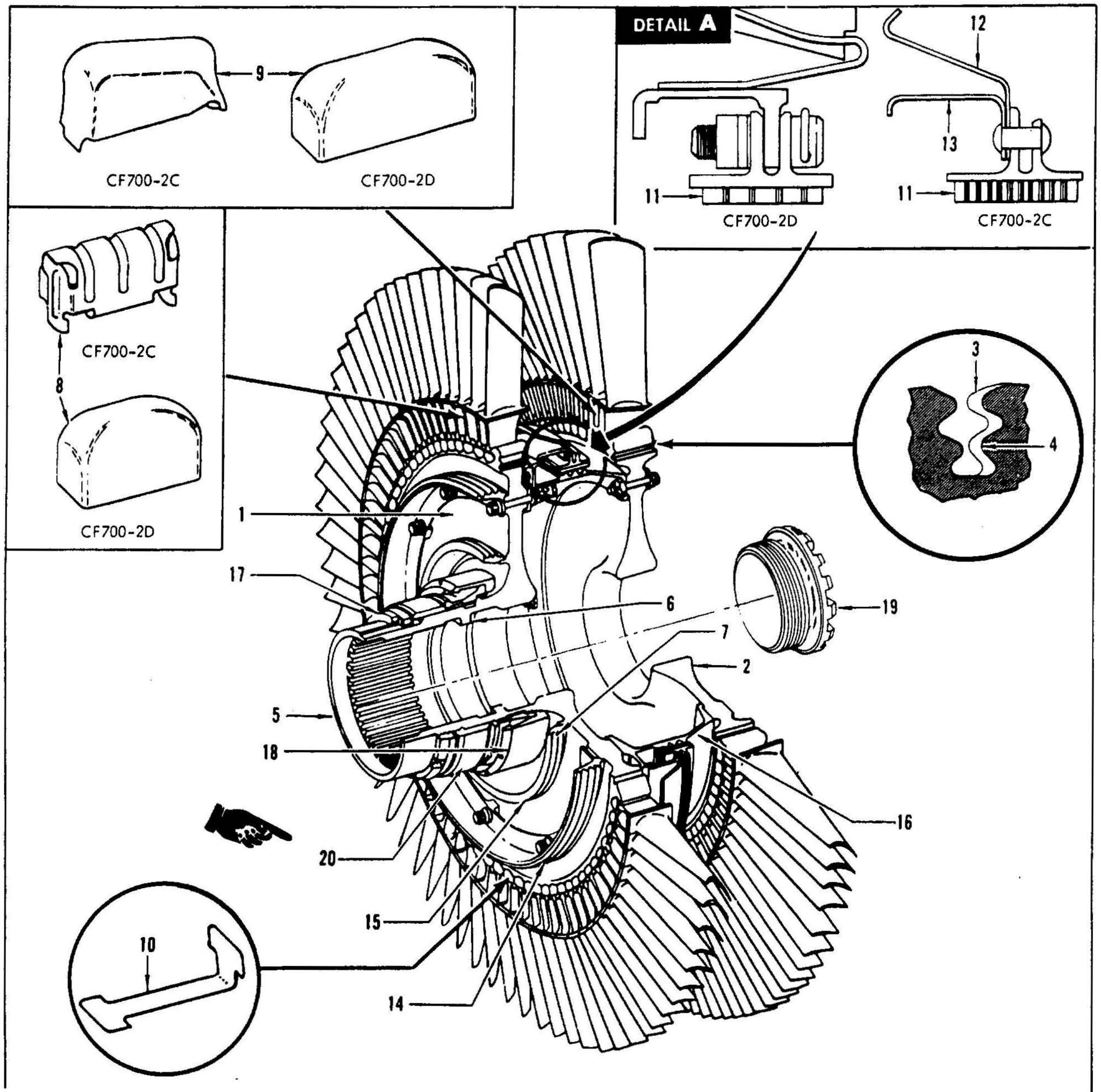
THE BLADE TIME, PART NUMBER, HEAT LOT, AND ENGINE OF ORIGIN MUST BE ENTERED IN THE APPROPRIATE SECTION OF THE ENGINE LOG BOOK.

(1) Overall blade for:

CAUTION: REPLACE THE ENTIRE STAGE OF BLADES IF ONE OR MORE BLADES IS CRACKED. IF IT CAN BE DETERMINED POSITIVELY THAT THE CRACKS ARE DUE TO FAULTY PROCESSING OR FOD, THEN ONLY THE DAMAGED BLADES NEED TO BE REPLACED.

CRACKS IN THE NON-CRITICAL AREAS ON THE LEADING AND TRAILING EDGES MUST BE COMPLETELY REMOVED BY BLENDING AND VALIDATED BY FLUORESCENT-PENETRANT INSPECTION.

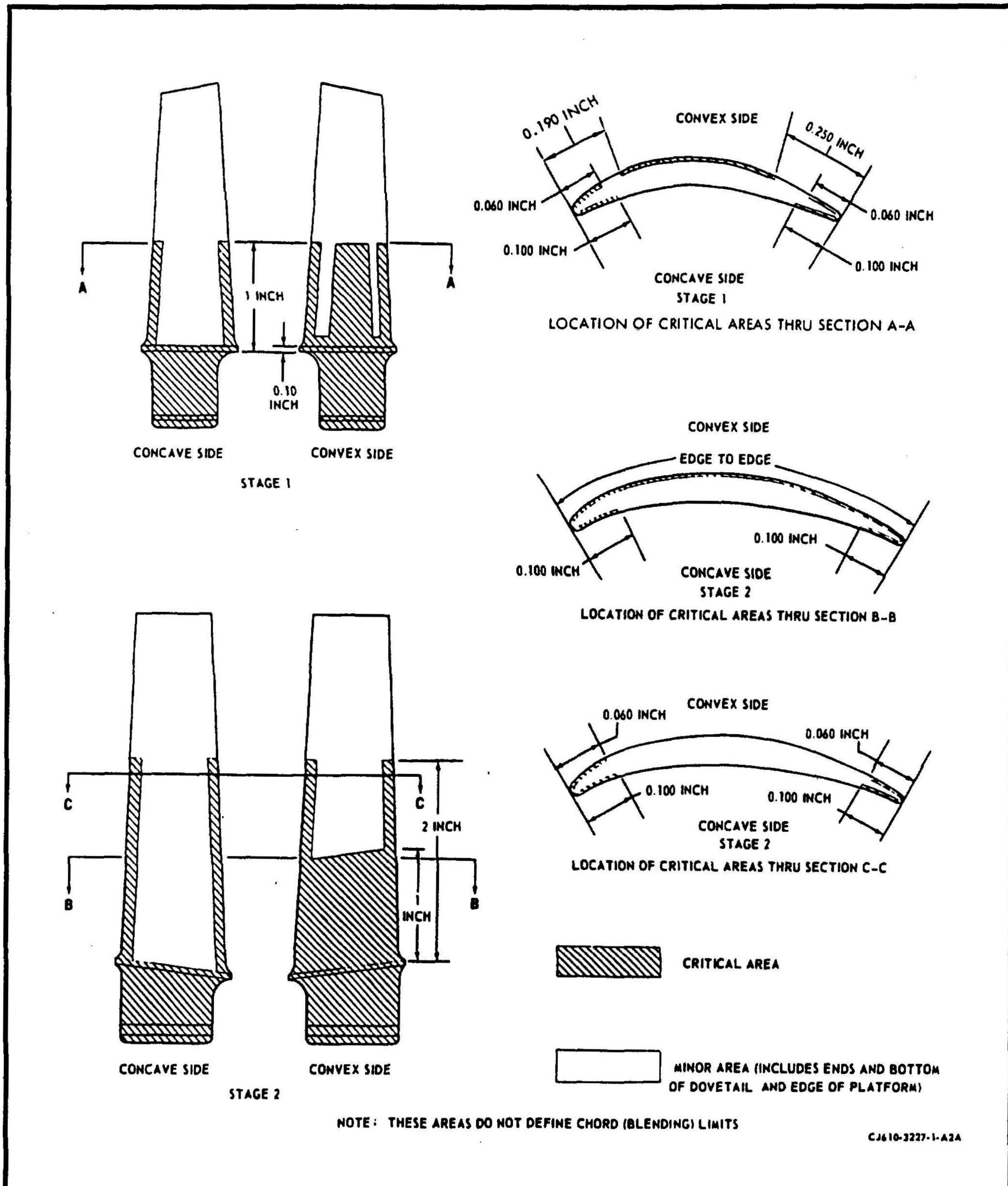
(a) Cracks.	Not serviceable.	Remove FOD cracks only in the non-critical areas on leading and trailing edges. Blend per repair paragraph 4.



1. FIRST-STAGE WHEEL	8. FIRST-STAGE BAFFLE	15. INNER ROTARY SEAL
2. SECOND-STAGE WHEEL	9. SECOND-STAGE BAFFLE	16. TORQUE RING
3. DOVETAIL SERRATION	10. LOCKING STRIP	17. NO. 3 BEARING LOCKNUT
4. DOVETAIL EDGES	11. INTERSTAGE SEAL	18. NO. 3 SEAL RUNNER
5. FIRST-STAGE WHEEL SHAFT	12. INTERSTAGE SEAL OUTER BAFFLE	19. TURBINE LOCKNUT
6. ROTOR BORE AND PULLER GROOVE	13. INTERSTAGE SEAL INNER BAFFLE	20. NO. 3 BEARING INNER RACE
7. RIVETS	14. OUTER ROTARY SEAL	

CF700-6049-1-A2A

Turbine Rotor Assembly
Figure 201

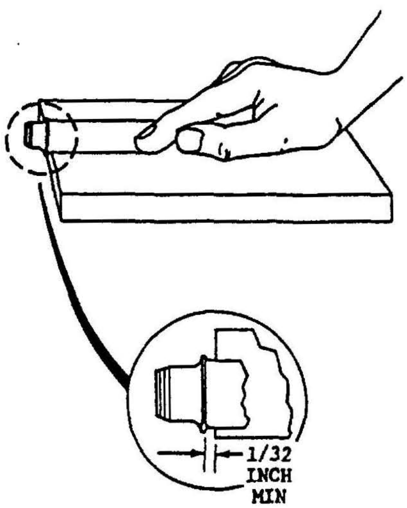


Turbine Blade Inspection Areas
Figure 201A

Inspection/Check	Maximum Serviceable Limits	Remarks
CAUTION: BLADES ARE TO BE VISUALLY INSPECTED ON THE LEADING AND TRAILING EDGES WHILE ASSEMBLED IN THE TURBINE WHEEL. REPLACE BLADES WITH DEFECTS THAT EXCEED 0.046 INCH FROM TRUE NORMAL SHAPE OF BLADE.		
(b) Bends, twists, and bowing (figure 202).	Leading and trailing edges within 0.046 inch from true nominal shape of blade.	Replace blade.
(c) Tip rub.	Tip rub and scoring allowed without high metal.	Remove high metal up to 0.020 inch from tip.

1 VISUALLY INSPECT BLADES IN EACH STAGE FOR BOWING. REMOVE 2 WORST BLADES IN EACH STAGE AND INSPECT THEM, ONE AT A TIME.

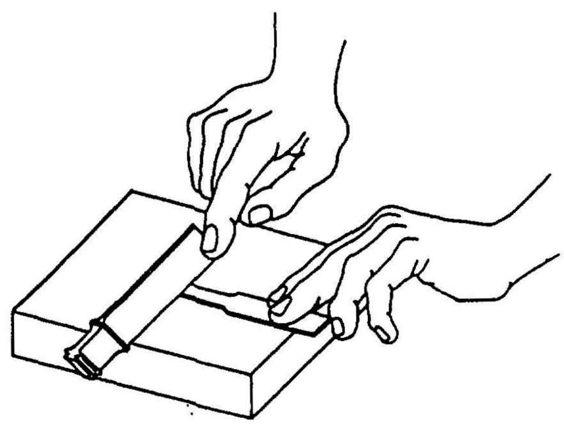
2 PLACE BLADE ON A FLAT SURFACE SO THAT CONCAVE SIDE OF BLADE IS FACING UP. HOLD BLADE IN PLACE WITH FINGER-PRESSURE.



3 BLADE PLATFORM SHALL EXTEND AT LEAST 1/32 INCH BEYOND EDGE OF FLAT SURFACE SO THAT READING WILL NOT BE AFFECTED BY PLATFORM RADIUS.

4 GET A THICKNESS GAGE THAT IS 1/4 INCH MAXIMUM WIDE AND 0.046 INCH THICK. A WIRE THICKNESS GAGE THAT IS 0.046 INCH THICK MAY BE USED AS AN ALTERNATE.

5 TRY TO INSERT GAGE BETWEEN EDGE OF BLADE AND FLAT SURFACE. IF GAGE ENTERS, BLADE IS OUT-OF-LIMITS AND SHALL BE REPLACED.

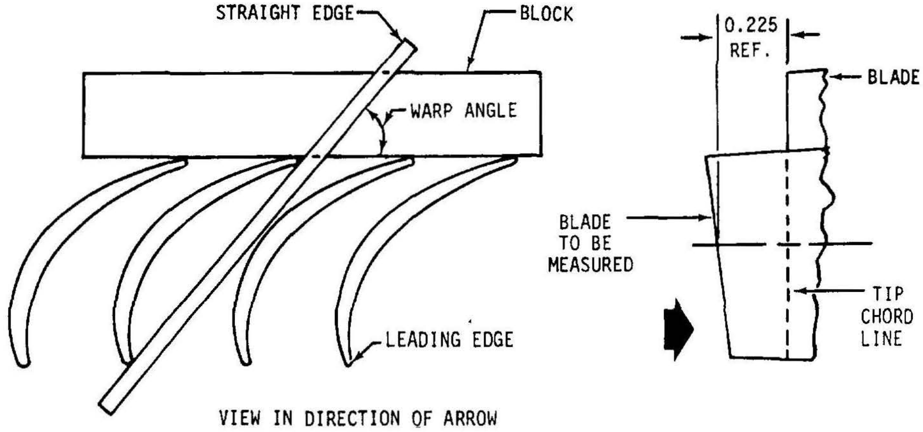


6 REPEAT PROCEDURE FOR SECOND BLADE.

7 IF EITHER BLADE IN A STAGE IS OUT-OF-LIMITS, REMOVE REMAINING BLADES IN THAT STAGE AND INSPECT THEM, USING THIS PROCEDURE.

C
000CF7-890403

Bowing of Turbine Blades - Inspection
Figure 202



FIRST-STAGE BLADE TIP CHORD			
FIRST-STAGE BLADE PART NUMBER	MAXIMUM WARP ANGLE	MARGINAL WARP ANGLE	APPLICABLE NOTES
5008T30P01	58°		1 THRU 4
5039T11P01	58°		1 THRU 4
6009T97P01	61°		1 THRU 4
6009T97P03	61°		1 THRU 4
ALL OTHER PART NUMBERS	55°	53°	1 THRU 5

1. MEASURE TIP CHORD WARP ANGLE WITH BLADES INSTALLED IN THE FIRST-STAGE TURBINE WHEEL OR EQUIVALENT.

2. *DO NOT MEASURE A BLADE IF DEFECTS HAVE BEEN BLENDED OUT OF THE* LEADING AND/OR TRAILING EDGE AT THE TIP CHORD.

3 MAKE SURE THAT BLOCK RESTS ON BLADES HAVING THEIR ORIGINAL TRAILING EDGE CONTOUR.

4. REPLACE BLADES IF TIP CHORD EXCEEDS MAXIMUM WARP ANGLE LIMIT.

5. NO MORE THAN 25 BLADES IN A WHEEL ASSEMBLY SHALL BE IN EXCESS OF THE MARGINAL WARP ANGLE LIMIT.

ALL DIMENSIONS ARE IN INCHES

000CJF-019902

Inspection of First-Stage Turbine Blade Tip Chord Warp Angle
Figure 202A

Inspection/Check	Maximum Serviceable Limits	Remarks
(d) First-stage blade tip chord warp angle (see figure 202A).	See maximum warp angle limits specified in figure 202A.	Replace blade.

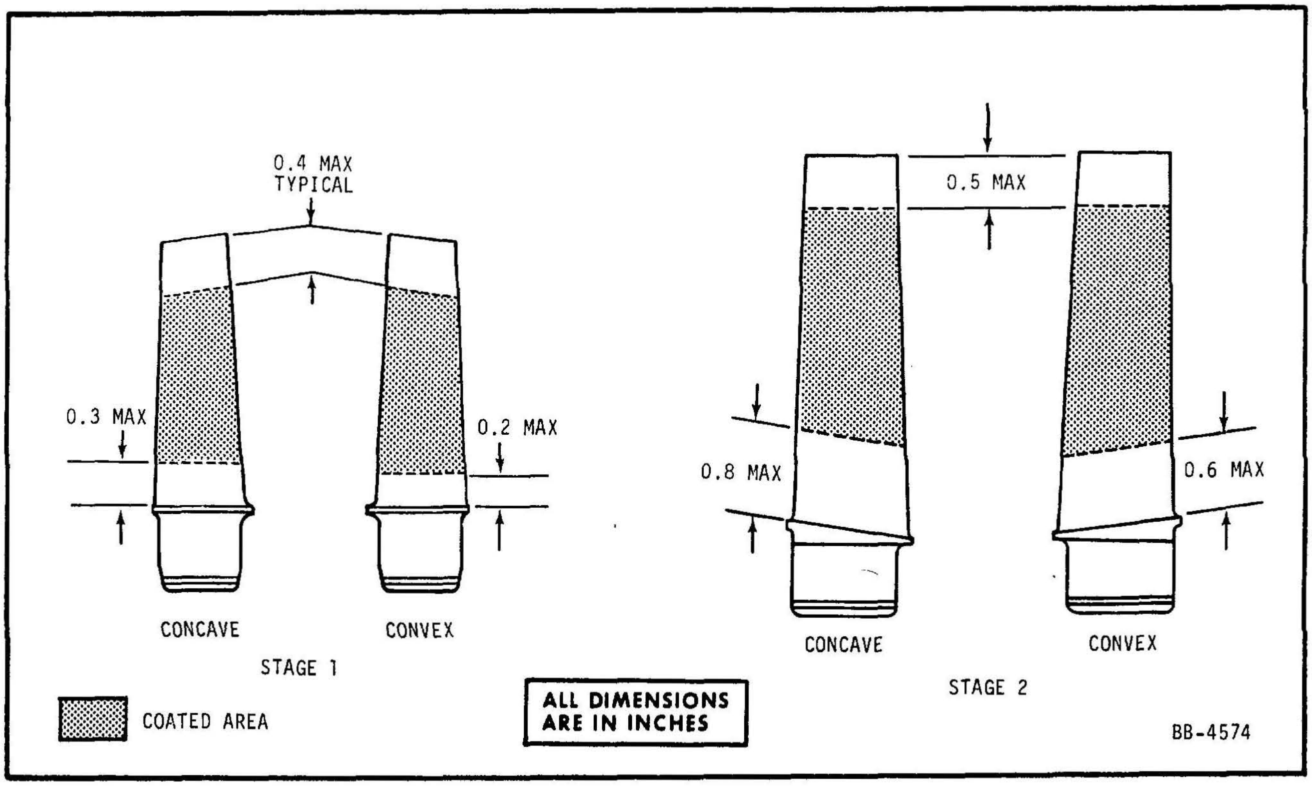
NOTES: 1. Inspection of all blades in the first-stage turbine wheel assembly (as shown in figure 202A) is necessary only on engines that have performance problems.

2. Inspection of the warp angle shall be made with blades installed in the first-stage turbine wheel or equivalent.

(2) Airfoil for:

(a) Nicks, pits, dents, or scratches in critical areas.	Any number, 0.010 inch deep.	Blend per paragraph 4.D.
(b) Deleted.		
(c) Nicks, pits, dents, or scratches in minor areas.	Any number, 0.020 inch deep.	Blend per paragraph 4.D.
(d) Corrosion (swelling, flaking, chipping,(etc.).	Not serviceable.	On leading and trailing edges only, remove corrosion to bright metal by blending per paragraph 4.D.
(e) Hot environmental attack (hot gas corrosion on diffusion coated blades).		
1 All blades identified as HP, HR, HS, HT, and HW.		

Inspection/Check	Maximum Serviceable Limits	Remarks
a Shaded areas only. (See figure 202B.)	Any amount of discoloration with no surface roughness, blistering or separation of airfoil surface.	
b Unshaded areas. (See figure 202B.)	Any amount of discoloration, surface roughness, or missing coating with no blistering or separation of airfoil surface.	
2 All other blades. (Shaded and unshaded areas.)	Any amount of discoloration with no surface roughness, blistering or separation of airfoil surface.	
(3) Visible areas of dovetail for nicks, pits, dents and scratches in:		
(a) Critical areas.	Any number 0.005 inch deep after removal of high metal.	Replace blade.
(b) Minor area.	Any number 0.010 inch deep after removal of high metal.	
(4) Blade tips for curled corners.	Within 0.025 of true position.	
(5) Platform, shank, and dovetail for hot environmental attack (hot gas corrosion) and sulfidation (diffusion coated blades):		
(a) All blades identified as HP, HR, HS, HT, and HW.	Any amount of discoloration, surface roughness, or missing coating with no blistering or separation of parent metal.	Replace blades.



Turbine Blades - Inspection for Hot Gas Corrosion
Figure 202B

Inspection/Check	Maximum Serviceable Limits	Remarks
(b) All other blades.	Any amount of discoloration, with no surface roughness, blistering or separation of parent metal.	

B. Baffles for:

CAUTION: THE TURBINE ROTOR BAFFLES USED ON THE CF700-2C FIRST-STAGE TURBINE WHEELS, AND THE BAFFLES USED ON CF700-2C SECOND-STAGE WHEELS MUST BE REPLACED WHENEVER THEY ARE DISASSEMBLED. ALL OTHER BAFFLES MUST BE FLUORESCENT PENETRANT-INSPECTED.

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Cracks in first-stage (8, figure 201).	Not serviceable.	Replace all baffles in stage and balance rotor if one baffle is found cracked.

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Cracks in second-stage (9, figure 201).	Not serviceable.	Replace all baffles in stage and balance rotor if one baffle is found cracked.

C. Locking strips for: (10, figure 201)

<u>CAUTION</u>: LOCKING STRIPS MUST BE REPLACED WHENEVER THE TAB IS UNBENT. DO NOT BEND THE TAB MORE THAN ONCE.

(1) Cracks at radius of bend.	Not serviceable.	Replace locking strips per paragraph 4.B.
(2) Axial looseness.	0.010 inch.	Replace locking strips per paragraph 4.B.
D. Inner labyrinth seal for missing or loose rivets (15, figure 201).	Not serviceable.	Replace rivet.

E. Inner and outer labyrinth seals for: (14 and 15, figure 201)

(1) Cracks.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Nicks and dents on seal teeth.	Any number, 0.005 inch deep. A maximum of 6 per tooth not to exceed 0.030 inch deep. A maximum of 6 per seal not to exceed 0.060 inch deep. However, the total cumulative length of all dents, nicks and blends per teeth shall not exceed 10% of the circumference of the seal. There shall be no high metal or sharp edges.	Blend to smooth contour removing all sharp edges and high metal.
F. Turbine rotor locknut and No. 3 bearing locknut for cracks (17, 19, figure 201).	Not serviceable.	

G. No. 3 bearing inner race (20, figure 201)

NOTE: Refer to 72-02-3 for inspection.

H. Interstage seal for: (Detail A, figure 201.)

(1) CF700-2C seal:

Inspection/Check	Maximum Serviceable Limits	Remarks
(a) Missing rivets.	Not serviceable.	
(b) Worn rivets.	Any amount provided the shank diameter is not below 0.070 inch at any one point.	
(c) Cracks in seal supports.	Not serviceable.	
(d) Inner and outer baffles for: (12, 13, figure 201)		
1 Separation (broken away from rivets).	Not serviceable.	
2 Warpage and dents.	Any amount to rear; 0.030 inch forward.	
3 Cracks.	Not serviceable.	
(e) Outer baffle for burned out sections.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) CF700-2D seal:		
(a) Missing honeycomb.	10 percent in any one segment.	Replace segment.
(b) Grooves in honeycomb.	Any number 1/8 inch wide by 0.070 inch deep with a min. thickness of honeycomb wall between any 2 grooves of 1/32 inch, measured at 1/2 of the groove depth. No rubs allowed into parent metal of seal support.	
(c) Broken lockwire.	Not serviceable.	Re-safety bolts per 72-52-0.
I. No. 3 bearing carbon seal runner (18, figure 201)		
NOTE: Refer to 72-02-2 for inspection.		
J. Turbine wheels: (1, 2, figure 201)		
(1) Cracks in any area.	Not serviceable.	
(2) Dovetail slots (if blades are removed) for:		
(a) Scratches.	Any amount that cannot be felt with a 0.030 inch radius scribe.	Replace wheel.
(b) Nicks, dents, or mars.	Not serviceable.	
(c) Wear or galling.	Slight wear or galling, uniform throughout full length of dovetail.	
(d) Dovetail edges for scratches, nicks, and dents.	Any number 0.005 inch deep.	Any defect can be removed by increasing the edge radius up to 0.040 inch.
(3) Front shaft of first-stage wheel for: (5, figure 201)		
(a) Bore and puller groove, scratches, nicks, and dents.	Any number, 0.015 inch, any length after removal of high metal.	Defects up to 0.050 inch may be blended out.
(b) Threads for damage.	Not serviceable.	One complete defective thread can be removed and the thread chased.

Inspection/Check	Maximum Serviceable Limits	Remarks
(c) Spline, lands and journals for nicks, scratches, and dents.	Any number, 0.010 inch deep, any length after removal of high metal.	Defects up to 0.050 inch may be blended out.

K. Torque ring for: (16, figure 201)

NOTE: Visible areas only.

(1) Cracks.	Not servicable.	
(2) Labyrinth seal teeth for nicks and dents.	Any number, 0.005 inch deep. A maximum of 6 per tooth not to exceed 0.030 inch deep. A maximum of 6 per seal not to exceed 0.060 inch deep. However, the total cumulative length of all dents, nicks, and blends per tooth shall not exceed 10 percent of the seal. There shall be no high metal or sharp edges.	Blend to a smooth contour, removing all sharp edges and high metal.

4. Repair.

CAUTION: USED, SERVICEABLE BLADES CAN BE INSTALLED IN ENGINES OTHER THAN THE ENGINE FROM WHICH THEY WERE REMOVED, WITH THE FOLLOWING RESTRICTIONS:

CONVENTIONALLY CAST R80 AND R100 MATERIAL BLADES, P/N 5008T30P01, 5039T11P01, AND 6009T97P01, REMOVED FROM CF700-2D AND -2D2 ENGINES MUST BE REINSTALLED BACK INTO THE ENGINE FROM WHICH THEY WERE REMOVED.

USED, SERVICEABLE BLADES MAY BE MOVED FROM ENGINE TO ENGINE ONLY IN COMPLETE SETS. IF A SET IS INCOMPLETE, THE SET SHOULD BE COMPLETED USING NEW BLADES.

THE BLADE TIME, PART NUMBER, HEAT LOT, AND ENGINE OF ORIGIN MUST BE ENTERED IN THE APPROPRIATE SECTION OF THE ENGINE LOG BOOK.

A. Turbine Blade Replacement. (See figure 203.) Whenever turbine blades are replaced, the tip clearance checks specified in 72-50, paragraph 2.G. must be made. Also record the blade marking on the dovetail base except for the engine project letter and the blade moment weight. Also record the number of blades with the same marking. Record the operating time for each group of blades (see figure 203A for sample record form). Blades will assume the operating time of their respective turbine wheels. Previous engine buildup records must be searched to provide as accurate a blade time as possible. For example, the respective turbine wheels may have been replaced and the blades retained and vice versa. The total actual blade operating time thus determined must be entered in the engine log book.

1st. STAGE WHEEL P/N & S/N ______ TSN ____ CSN ____

2nd. STAGE WHEEL P/N & S/N TSN ____ CSN ____

Note: This form to accompany turbine blades. Replacement turbine blades must not exceed the time (hrs) of the highest timed blade listed below:

ENGINE MODEL ________
ENGINE S/N ________
ENGINE TSN ____ TSO ____

1ST STAGE AT REMOVAL			1ST STAGE AT BUILD-UP			2ND STAGE AT REMOVAL			2ND STAGE AT BUILD-UP		
BLADE MARKING	NO.	TIME	BLADE MARKING	NO.	TIME	BLADE MARKING	NO.	TIME	BLADE MARKING	NO.	TIME
TOTAL MUST =	75		TOTAL MUST =	75		TOTAL MUST =	55		TOTAL MUST =	55	

NOTE: BLADES WITH THE SAME MARKING SHALL ASSUME THE TIME OF THE HIGHEST TIME BLADES OF THAT GROUP.

Disassembly Insp. & Date ____________
Assembly Insp. & Date ____________

REMARKS: ____________

ENGINE MODEL	CODE	STG. 1 TURBINE BLADES	CODE	STG. 2 TURBINE BLADES
CF700-2C	BT	5002T10P01	BG	37E501526P101
CF700-2C			BH	37E501526P102
CF700-2C	HJ	5002T10P03	HK	37E501526P103
CF700-2D, -2D2	HB	5008T30P01	HC	5008T31P01
CF700-2D, -2D2	HT	5039T11P01	—	—

F
BC-0113-2

Turbine Wheel Blade Position and Time Record - Sample Form
Figure 203A

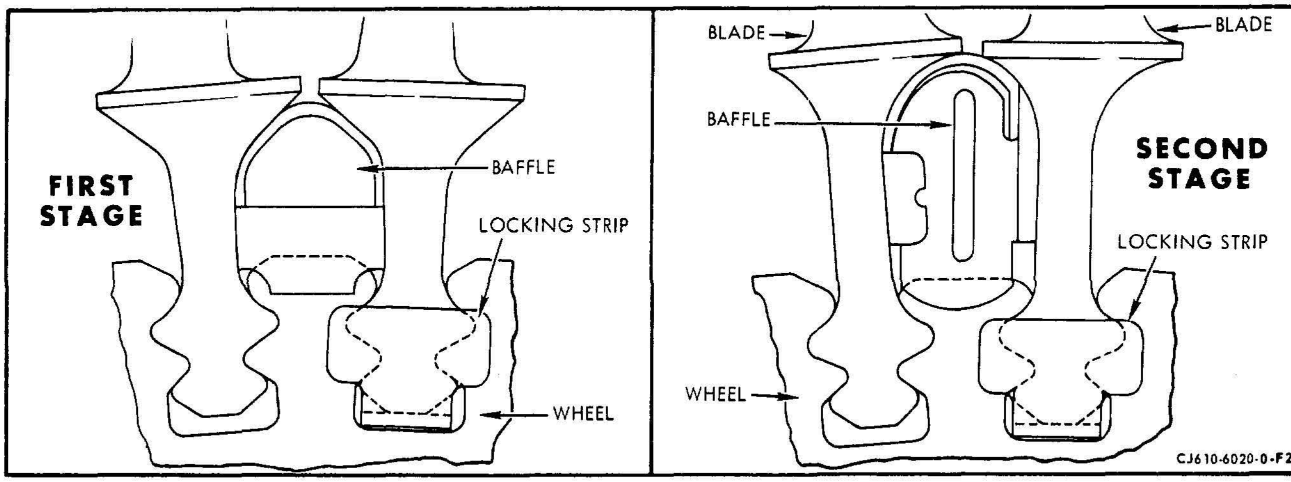
Example of what must be recorded:

Marking on dovetail base (typical): BT H15BP 190

Record only this group: TH15BP

NOTES: 1. On CF700-2D and -2D-2 engines, blade tips are ground after installation in the turbine wheel. Replacement blades may be ground to the length of adjacent blades, prior to installation, using holding fixture, 2C5377, or equivalent.

2. Blades which have been replaced with new ones and are still serviceable must have their time recorded and attached to the blade.



Turbine Blade Replacement
Figure 203

(1) Remove either the first- or second stage turbine blades as follows:

(a) Straighten the tab of the locking strip. Forward tab on first-stage, aft tab on second.

CAUTION: DO NOT USE SHARP TOOL TO STRAIGHTEN THE TABS.

(b) Remove the baffles, blade and locking strip. First-stage blades with interlocking steps on the platform edges (CF700-2D and -2D-2) cannot be removed individually. Remove these blades as follows:

1 Straighten lockstrip tabs on several adjacent blades. Slide blades axially as far as possible out of the dovetail slots. Alternately straighten additional tabs and slide blades axially until one blade can be completely removed. The remaining blades with straightened tabs can then be tilted circumferentially to clear the steps and removed from the slots.

2 Second-stage blades with interlocking steps (CF700-2 and -2D-2) have sufficient circumferential movement that individual removal is possible.

(2) Install replacement blade in either the first- or second-stage turbine wheel as follows: (Selected per paragraph 4.B.)

(a) Insert the locking strip in the dovetails on the rim of the wheel. On the first-stage the pre-bent tab end of the strip goes on the aft side of the wheel, on the second-stage the pre-bent tab goes to the forward side.

(b) Assemble the turbine blade in the dovetail slot and install the baffle to the left side of the turbine blade shank.

(c) Check the blade for proper looseness by pushing circumferentially on the blade tip. There must be noticeable motion.

(d) Bend the unbent tab of the locking strip radially outward to secure the turbine blade. Use tool 2C5302G2 to bend first-stage tabs and tool 2C5301G2 to bend second-stage tabs.

(e) Apply pressure against the pre-bent tab of the lockstrip to hold it snug to the aft side of the turbine wheel. Check the space between the bent tab and the wheel face with a 0.005 inch shim. If the space is greater than 0.005 inch, bend the tab further by striking the anvil head of the bending pliers with a hard fiber mallet.

CAUTION: IF IT IS NECESSARY TO UNBEND THE LOCKSTRIP TAB, REPLACE THE LOCKSTRIP. END TABS OF LOCKSTRIPS ARE NOT TO BE FULLY BENT MORE THAN ONCE.

(f) Blades that have been operating in the CF700-2D and -2D-2 engines are shorter than replacement blades due to assembly grinding and tip rub. Grind replacement blades as follows:

1 Install replacement blade and compare with adjacent blades that have been operating in the engine.

WARNING: WHEN POWER GRINDING AVOID PROLONGED OR REPEATED CONTACT WITH DUST. INHALATION OF DUST MAY CAUSE TEMPORARY COUGHING AND WHEEZING, RESPIRATORY TRACT IRRITATION, AND PERMANENT LUNG PROBLEMS. IF COUGHING OR WHEEZING PERSISTS, GET MEDICAL HELP.

IF DUST CONTACTS EYES, FLUSH THEM THOROUGHLY WITH WATER.

WHEN USING AN AIR-EXHAUSTED GRINDING WHEEL, WEAR APPROVED RESPIRATOR, GOGGLES, OR FACE SHIELD.

IF GRINDER IS NOT EQUIPPED WITH LOCAL EXHAUST VENTILATION, WEAR AN APPROPRIATE RESPIRATOR AND GOGGLES OR FACE SHIELD.

2 Grind tip to obtain same blade length and tip angle as adjacent blades.

B. Methods of Blade Substitution.

NOTE: First-stage turbine blades Pt No. 5008T30 and 5039T11 are interchangeable and may be used in mixed lots.

(1) The moment-weighted turbine blade numbers run in 1 gram-inch increments from 175 to 225 for the first-stage turbine wheel and from 265 to 330 for the second-stage wheel. The moment weight is stamped on the base of the blade dovetail (see figure 204).

(2) Replace blades using Method One. If a replacement blade of the same moment weight is not available use Method Two or Three.

(3) Replacement Method One.

(a) Replace each blade with one of the same moment weight number, if available. A maximum of 10 blades may be replaced using this method.

(4) Replacement Method Two. (See figure 205.)

(a) Remove the damaged blade and one adjacent on each side.

(b) Total the moment weight numbers and select 3 replacement blades having the same total moment weight.

(c) Install the 3 replacement blades in the dovetail slots, retaining the same respective weights in the same relative location in the wheel as those removed (the heaviest replacement blade replacing the heaviest blade in the group of 3 removed). A maximum of 3 sets may be replaced using this method.

(d) If the two adjacent blades of each set removed are still serviceable, identify them by inking the engine model and part number on the convex side of the airfoil, using semi-permanent black ink ("Easy-mark" No. 2120, Easymark Ink Co., Lowell, Mass.) or equivalent and return them to stock for re-use.

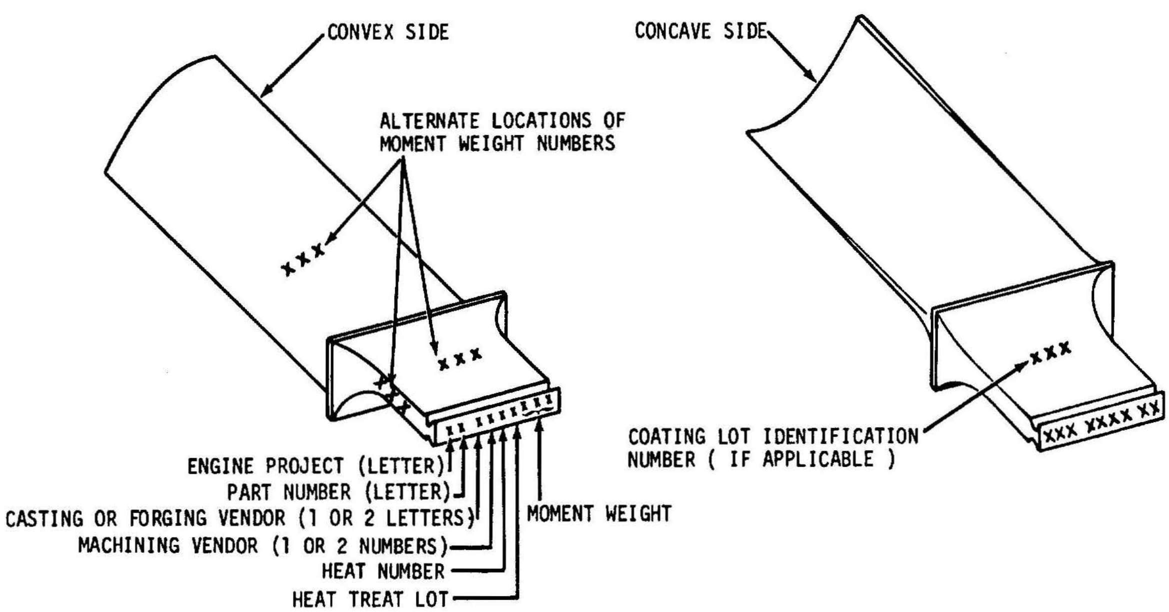
(5) Replacement Method Three. (See figure 205.)

(a) Remove the damaged blade and the two adjacent blades on either side; a total of five blades.

(b) Total the moment weight numbers, and select 5 replacement blades having the same total moment weight.

(c) Install the 5 replacement blades in the dovetail slots, retaining the same respective weights in the same relative location in the wheel as those removed (the heaviest replacement blade replacing the heaviest blade in the group of 5 removed).

STAGE	ENGINE PROJECT CODE LETTER	BLADE PART NO. CODE LETTER	BLADE PART NO.
1	B	T	5002T10P01
1	H	J	5002T10P03
1	H	B	5008T30P01
1	H	T	5039T11P01
2	B	G	37E501526P101
2	B	H	37E501526P102
2	H	K	37E501526P103
2	H	C	5008T31P01



F
BC-0115-2

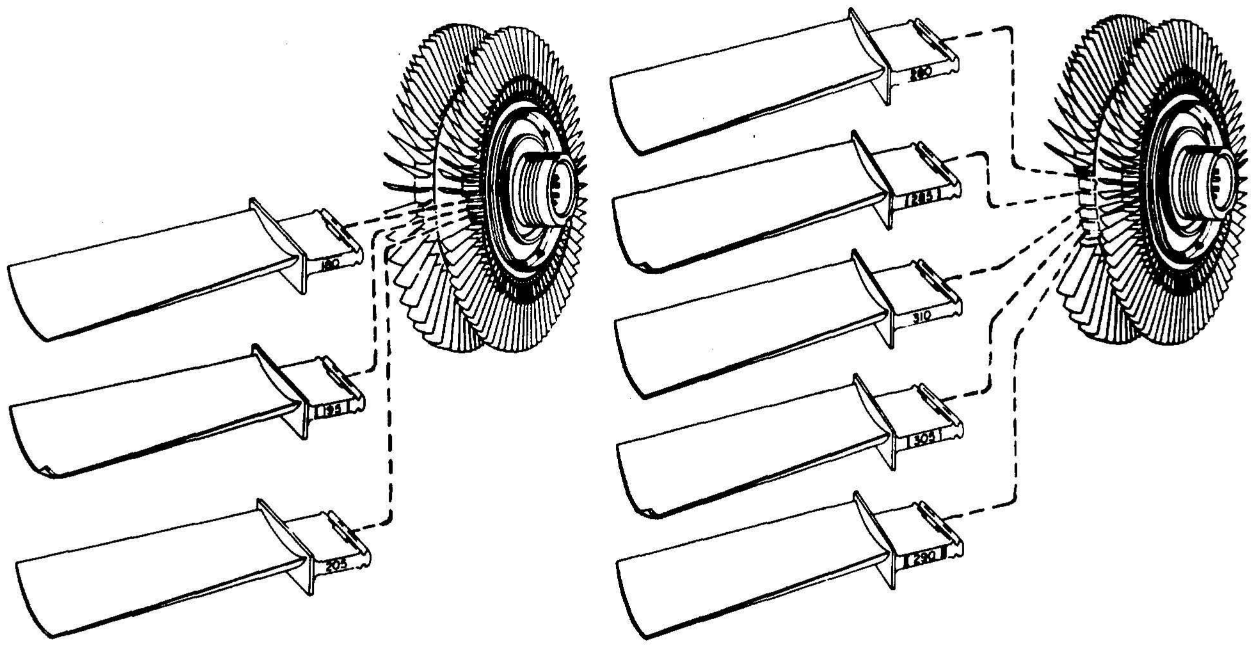
Moment Weight Location
Figure 204

(d) If any of the adjacent removed blades are serviceable, return them to stock for re-use as outlined in method two.

(e) A maximum of 1 set may be replaced using this method.

C. Replacement of No. 3 Bearing Inner Race and Seal Race.

<u>NOTE</u>: The inner and outer bearing races are matched sets and are not to be separated, if one race is replaced the other must also be replaced. Make certain replacements are a set. This replacement is accomplished with the turbine rotor removed.



REPLACEMENT METHOD TWO		
BLADE NO.	MOMENT WEIGHT NO. BEFORE REPAIR	AFTER REPAIR
1	180	187
2	*195	190
3	205	203
TOTAL	580	580

REPLACEMENT METHOD THREE		
BLADE NO.	MOMENT WEIGHT NO. BEFORE REPAIR	AFTER REPAIR
1	280 LIGHT	281
2	285	284
3	*310 HEAVY	308
4	305	304
5	*290	293
TOTAL	1470	1470

IN REPLACEMENT METHOD TWO AND THREE, IT IS ASSUMED THAT CERTAIN BLADES, MARKED (*) ARE NOT AVAILABLE (IN LH COLUMN) AND ARE REPLACED BY THE AVAILABLE SPARES INDICATED IN THE RH COLUMN.

CJ610-6110-0-B2

Blade Replacement Methods
Figure 205

(1) Removal.

(a) Place the turbine rotor in stand, 2C5303 with the front end facing up.

(b) Remove the No. 3 bearing locknut by straightening the tab on the lockwasher and using spanner wrench, 2C5304.

(c) Remove the inner race and seal runner using puller, 2C5306.

NOTE: The bearing race and seal runner are removed at the same time, since the pulling surface is on the forward side of the seal runner.

(2) Installation.

(a) Measure the distance from the first-stage turbine wheel shaft hub to the seal stop shoulder. Record reading.

(b) Measure the height of the seal runner from the counterbore to the top of the seal runner. Measure the bearing race height. Add the two together and record.

(c) Coat the inside diameter of the races with engine oil.

(d) Wrap both races in aluminum foil, place them in an oven and heat for 20 minutes at 250°F (121°C).

(e) Assemble the heated races onto the shaft. Seat the races against the shaft and hold with inner race holder of the fixture, 2C5303.

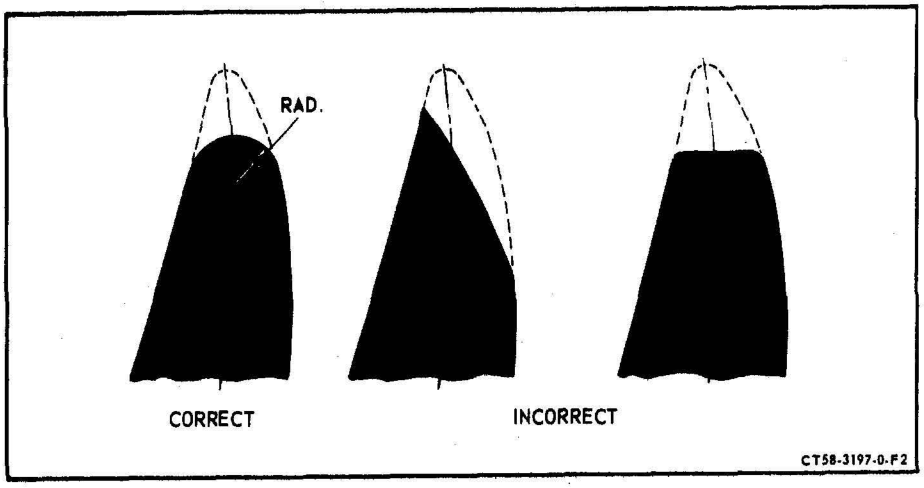
(f) After the parts have returned to room temperature, measure the distance from the end of the shaft to the seal race in four equally spaced places. The average of these readings must be within ±0.001 inch of the difference between the readings taken in step (a) and (b).

(g) Position the turbine rotor locking device of the fixture 2C5303 to keep rotor from turning.

(h) Assemble the lockwasher and locknut onto the shaft.

NOTE: Lubricate the threads of the shaft with engine oil.

(i) Tighten the nut, using spanner wrench, 2C5304, to 150-170 lb-in. Align the locknut and the lockwasher tab by increasing torque from the minimum value. Bend the tab of the lockwasher into the locknut slot.



Typical Leading Edge After Blending
Figure 206

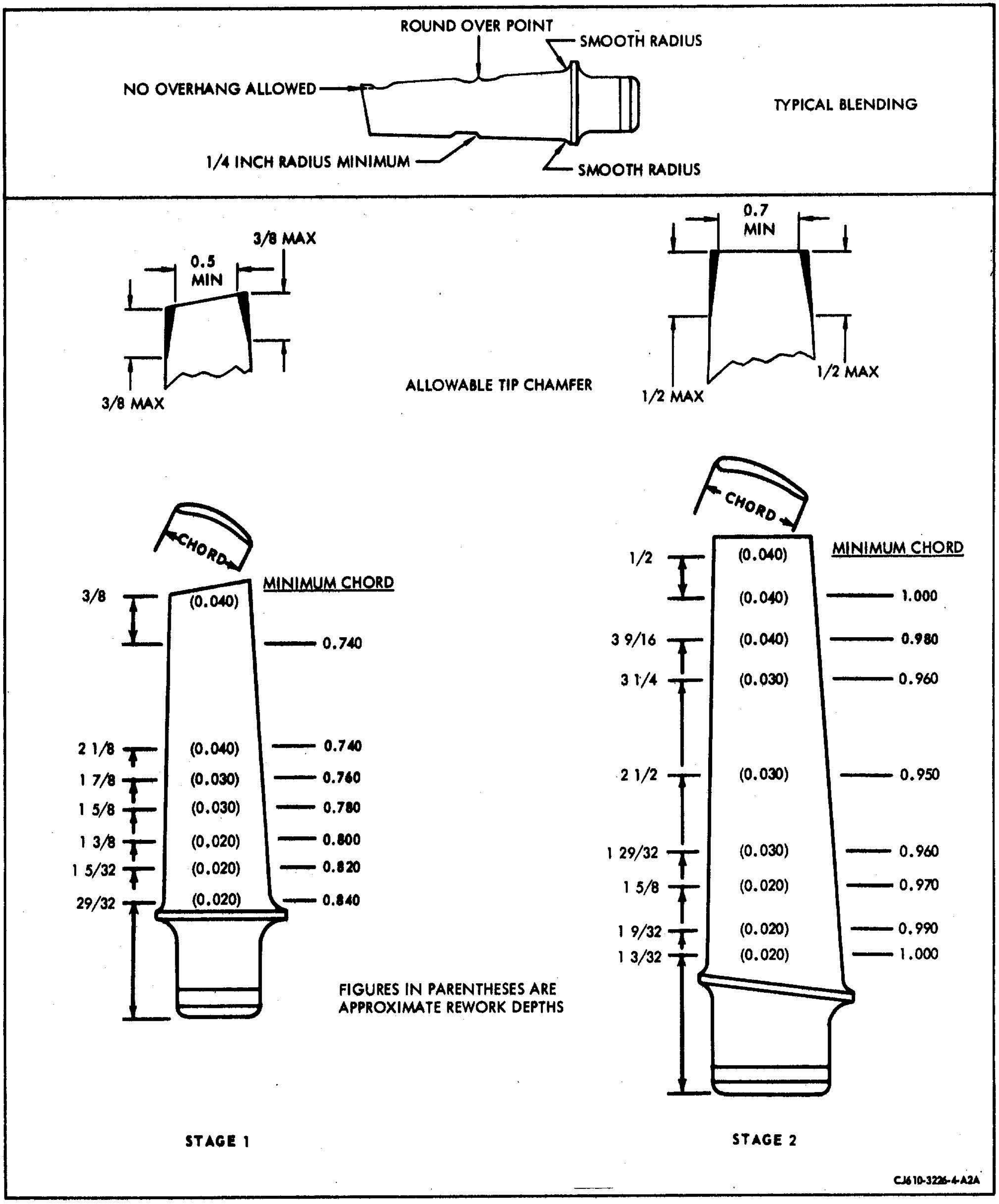
D. Turbine Blade Airfoil Blending Procedure.

NOTE: Blending is done to remove the stress concentration of nicks, pits, scratches, etc., to prevent blade failure. The removal of high metal, and radiusing of the leading edge is done to restore the airfoil to nearly its original aerodynamic shape. All blending should be done with a minimum of 1/4 in. radius. Blending close to the tip should be extended straight out so as not to leave a narrow projection at the corner. If the benching to remove two separate defects runs together, round over the point between them. Any blending near platform-to-airfoil radii must be such as to maintain the same smooth transition as on new parts. The shape of the airfoil leading edge is very important to maintain engine performance. They are not knife edges, but carefully radiused edges whose shape shall be maintained in the blended area. (See figure 206.)

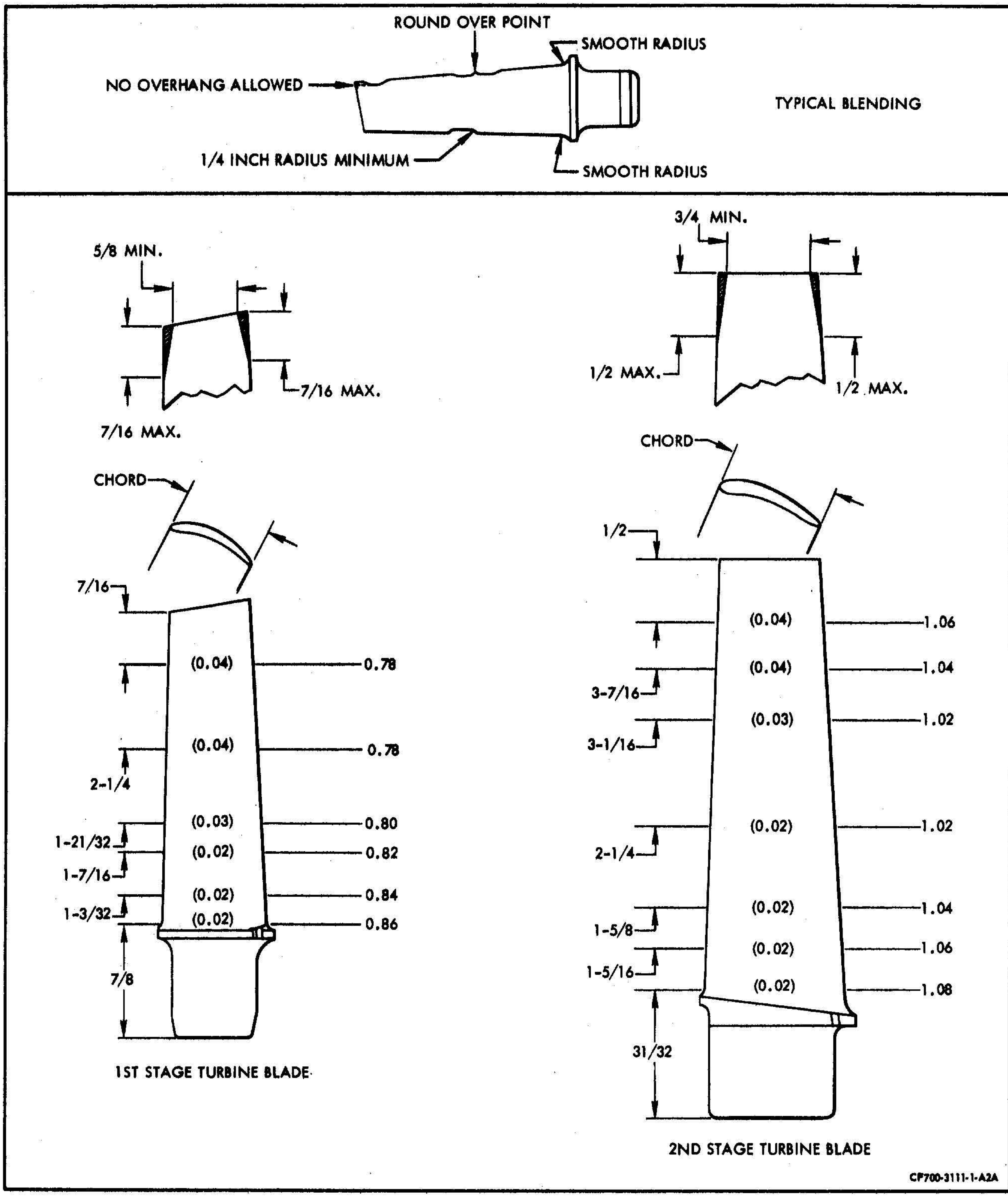
(1) Rough blend the damaged area with a file, emery cloth or equivalent tool.

(2) Finish blend the final .003-.005 inch with fine emery paper, a fine stone or equivalent tool. Always finish blend in a lengthwise direction, removing all evidence of crosswise marks that may have been made during rough blending. The final finish of the reworked area shall be as smooth as the undamaged area.

(3) The amount of repair is controlled by the minimum chord width. (See figure 207 or 208.) The total reduction in chord may be taken on either edge or divided between the edges at any given location. The tip chamfer shown allows a further reduction in chord at the tip only.



Turbine Blade Chord Limits - CF700-2C
Figure 207



Turbine Blade Chord Limits - CF700-2D and -2D-2
Figure 208

The minimum chords between points specified are proportional. Allowable depths of rework, shown in parentheses, are for convenience only. In the event of doubt or disagreement between depth and min chord, the min chord is the referee method.

CAUTION: BLENDING IS TO BE DONE ON LEADING AND TRAILING EDGES ONLY. BLENDING IS NOT ALLOWED ON AIRFOIL SURFACES.

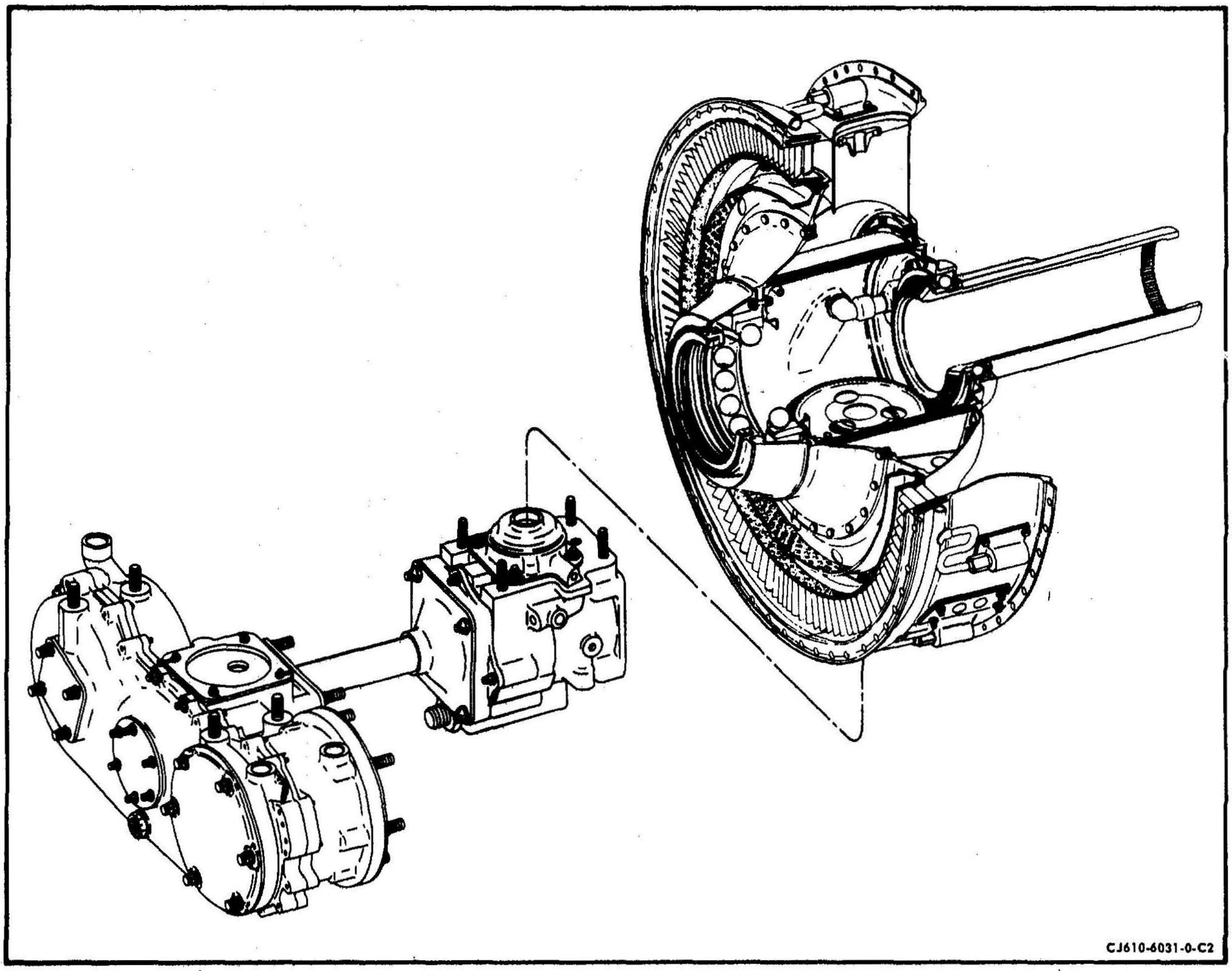
NOTE: The indicated minimum chord limits are not to be taken as permission to machine the entire edge off.

(4) Fluorescent-penetrant inspect per 72-03-1.

ACCESSORY DRIVE SECTION - DESCRIPTION AND OPERATION

1. General.

This section (figure 1) consists of the accessory power-takeoff drive assembly located within the compressor mainframe; transfer gearbox located on the bottom of the mainframe; and an accessory gearbox located on the compressor front frame. The horizontal drive shaft and cover connects the transfer gearbox to the accessory gearbox. The accessories are mounted on the pads of the accessory gearbox and transfer gearbox.



Accessory Drive Section
Figure 1

2. Description.

A. Accessory Power Takeoff (PTO).

(1) The accessory power takeoff drive assembly is located within the mainframe. Its purpose is to transmit power from the engine drive shaft to the engine accessories. This assembly consists of a housing which houses and supports the gears and their related components. It is secured at the forward end by bolts which pass through the No. 2 bearing support to the carbon seal support. At the aft end, it is supported by a collar which rests on the mainframe inner shell. The collar is attached to the PTO housing by bolts that also attach the shaft forward end to the PTO housing.

(2) The engine drive shaft passes through the power-takeoff assembly, through the driver shaftgear, and mates with the internal splines on the aft end of the driver shaftgear. The ball bearing and housing assembly supports the forward end of the shaftgear where it enters the PTO housing. The driven shaftgear is centrally located in the six o'clock position of the PTO housing. It is supported by a roller bearing at the gear end and by a ball bearing at the other end. The lube-IN line enters the PTO at the eight o'clock position, and is routed through lines which connect to the oil nozzles. These nozzles spray oil to the No. 3 bearing, No. 2 bearing, the shaftgear PTO ball bearing, and the contact point between the 2 bevel gears. A second connection at the eight o'clock location is for the PTO sump return. The 2 connections at the four o'clock position are for the No. 3 bearing sump scavenge line and the PTO sump vent line. All free oil in the PTO housing drains into the transfer gearbox, which acts as a sump.

(3) An insulation blanket covering the exterior of the PTO prevents the assembly from being overheated.

B. Transfer Gearbox. The transfer gearbox, mounted on an adapter at the bottom of the mainframe, consists of a beveled gear train enclosed in a casing. The gearbox, powered by the engine power takeoff assembly through the radial drive shaft, powers the accessory gearbox through the horizontal drive shaft. It also provides power to the accessory (if installed) mounted on its rear pad.

C. Accessory Gearbox. The accessory gearbox, mounted on a bracket under the front frame, consists of a gear train enclosed within a casing and cover. The gear train is powered by the transfer gearbox through the horizontal drive shaft. The fuel pump, oil pump, and overspeed governor are mounted on pads on the accessory gearbox. Two other pads are available for customer use.

D. Horizontal Drive Shaft and Cover. The horizontal drive shaft (enclosed in a cover) is splined at both ends and transmits power from the transfer gearbox to the accessory gearbox.

TRANSFER GEARBOX - MAINTENANCE PRACTICES

1. General. The maintenance of the transfer gearbox is limited to the external section except for carbon seal. If a problem concerning the interior of the gearbox arises the gearbox must be replaced.

2. Removal/Installation.

   A. Removal.

      (1) Remove the horizontal drive shaft per 72-63-0.

      (2) Remove the 4 nuts that secure the transfer gearbox to the mainframe adapter.

      (3) Carefully lower the transfer gearbox until it is free. Remove the gearbox and the radial drive shaft.

      CAUTION: DO NOT DROP THE RADIAL DRIVE SHAFT. DO NOT ATTEMPT TO ROTATE THE GEARBOX TO FREE IT FROM THE MOUNTING ADAPTER DURING REMOVAL AS IT IS POSITIONED BY A TIGHT-FITTING DOWEL PIN.

      (4) Remove guide cover, shaft shield guide and O-ring from the axis A housing (input drive). Discard the O-ring.

   B. Installation.

      (1) Install a new O-ring in the bore of the transfer gearbox axis A housing (input drive). Assemble shaft shield guide and guide cover over bearing housing.

      NOTE: The guide is a hand press fit and the cover fits over the guide.

WARNING: ENGINE OIL

IF OIL IS DECOMPOSED BY HEAT, TOXIC GASES ARE RELEASED.

PROLONGED CONTACT WITH LIQUID OR MIST MAY CAUSE DERMATITIS AND IRRITATION.

IF THERE IS ANY PROLONGED CONTACT WITH SKIN, WASH AREA WITH SOAP AND WATER. IF SOLUTION CONTACTS EYES, FLUSH EYES WITH WATER IMMEDIATELY. REMOVE SATURATED CLOTHING.

IF OIL IS SWALLOWED, DO NOT TRY TO VOMIT. GET IMMEDIATE MEDICAL ATTENTION.

WHEN HANDLING LIQUID, WEAR RUBBER GLOVES. IF PROLONGED CONTACT WITH MIST IS LIKELY, WEAR APPROVED RESPIRATOR.

(2) Lubricate both splined ends of the radial drive shaft with engine oil. Install the radial drive shaft and carefully position the transfer gearbox on the mainframe adapter. Secure the gearbox with 4 nuts. Torque the nuts to 10-30 lb-in.

(3) Check the alignment runout of the transfer gearbox with the accessory gearbox per section 72-64-0.

(4) Remove the alignment fixture.

(5) Replace the horizontal drive shaft per 72-63-0.

3. Inspection/Checks. When serviceable limits are exceeded, the parts may be repaired in accordance with the Overhaul Manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Visually inspect the transfer gearbox for:		
(1) Cracks.	None allowed.	
(2) Nicks and scratches.	Any number, 0.030 inch deep.	
(3) Evidence of leakage between cover and case.	None allowed.	
(4) Evidence of leakage at rear pad.	See Operating Limits, Adjustment/Test, 72-00.	Replace seal per paragraph 4.A.
B. At every exposure of transfer gearbox Axis B forward and aft female splines, clean thoroughly with a suitable solvent and using a bright light visually inspect splines for:		
NOTE: Deleted.		
(1) Wear at contact area.	0.005 inch (Approx. estimate can be made by visually comparing wear at contact point with a piece of 0.005 inch shim stock.)	If within Serviceable Limits lubricate aft spline with lubricant specified in Section 72-01-1; lubricate forward spline with engine oil.

NOTE: Replacement of the transfer gearbox Axis B gearshaft for forward end spline excessive wear also requires replacement of the accessory horizontal drive shaft.

4. Repair.

A. Rubbing Seal Replacement.

NOTE: For special tools use kits (Pt. Nos. 2C5334 and 2C5333).

(1) Remove the mounted accessory per the applicable paragraph.

(2) Bend the locking tabs away from the bolt heads. Discard the locking tabs.

CAUTION: REMOVE ONE RETAINING BOLT AT A TIME AND REPLACE WITH RETAINING PIN FROM TOOL KIT 2C5333 BEFORE PROCEEDING TO THE NEXT BOLT. IF ALL 3 RETAINING BOLTS ARE REMOVED WITHOUT THE USE OF RETAINING PINS, THE BEARING RETAINER INSIDE THE GEARBOX WILL BE DISLOCATED REQUIRING REMOVAL AND DISASSEMBLY OF THE GEARBOX TO PROPERLY ASSEMBLE THE BEARING RETAINER.

(3) Remove one of the retaining bolts and install a retaining pin from tool kit 2C5333 in its place. Remove the second retaining bolt and install a retaining pin in its place. Remove the third retaining bolt and install a retaining pin in its place. (By replacing retaining bolts with retaining pins the bearing retainer inside the gearbox will be held in position.)

(4) Remove the seal housing with the puller, 2C5333.

(5) Remove the O-ring; using the pusher, 2C5334, remove the rubbing seal from the seal housing.

(6) Remove the O-rings from the 3 bolt holes.

(7) Remove the mating ring and packing from the shaft.

(8) Replace defective part.

(9) Insert the mating ring packing into the mating ring.

CAUTION: USE EXTREME CARE WHEN HANDLING THE MATING RING. DO NOT ALLOW THE RUBBING FACE TO BE DAMAGED.

(10) Insert a seal guide, 2C5336, into the bore of the gearshaft.

(11) Assemble the mating ring and packing to the gearshaft, seating the mating ring (packing side) against the shaft shoulder, using inserter, 2C5335.

NOTE: Some mating rings have 2 tabs. These tabs must be aligned with slots in the spanner nut.

(12) Assemble the three O-rings to the 3 bolt hole O-ring grooves.

(13) Lubricate the OD of the rubbing seal with engine oil and assemble it to the seal housing with the pusher, 2C5334.

CAUTION: BE CAREFUL WHEN HANDLING RUBBING SEALS. THE CARBON SURFACES ARE EXTREMELY BRITTLE AND EASILY DAMAGED.

(14) Assemble the O-ring to the seal housing.

(15) Lubricate the OD of the seal housing with engine oil and assemble it to the gearbox housing. Use tool, 2C5334.

(16) Bend the washer tabs approximately 30 degrees. Lubricate the bolts with oil. Replace the retaining pins with the bolts and tab washers. Torque the bolts to 25-35 lb-in. Bend the tabs to secure the bolts.

NOTE: Bend one tab on washer to meet best aligned side of hex bolt.

B. Deleted.

Figure 201. DELETED

HORIZONTAL DRIVE SHAFT AND COVERS - MAINTENANCE PRACTICES

1. General. The drive shaft is inaccessible without removing the overspeed governor from the accessory gearbox.

2. Removal/Installation. (See figure 201.)

   A. Removal.

      (1) Remove the aircraft hydraulic pump per the aircraft manual.

      (2) Remove the overspeed governor from the middle front pad of the accessory gearbox per Section 73-22-0.

      NOTE: The thread in the plug (4) is 1/4-28. Thread a bolt of convenient length into the plug for ease of removal and replacement.

      (3) Remove the retaining ring (3), plug (4), O-ring (5), and second retaining ring (3) from the overspeed governor spline bore. This exposes the end of the horizontal drive shaft (13).

      (4) The splines of the drive shaft (13) must be reassembled to the same mating spline in the accessory and transfer gearbox from which it was removed. Match-mark drive shaft (13) and mating splines as follows:

      CAUTION: 1. DO NOT USE PUNCH TO MATCH-MARK THE PARTS. THE FORCE REQUIRED COULD DAMAGE THE GEARBOX BEARINGS.

      2. DO NOT PLACE MATCH-MARK ON CONTACT SURFACE OF SPLINE.

      NOTE: Gearshafts and drive shaft are made of hardened material and will require use of a diamond file or rotary burr for match-marking.

      (a) Rotate the compressor rotor until one of the spline teeth of the accessory gearbox axis B gearshaft forward spline is located at the 6 o'clock position.

      (b) Place a matchmark on the crown (tip) of the axis B gearshaft spline tooth and also on the forward end or chamfer of the drive shaft (13) bore. Do not mark the aft end of the drive shaft (13).

(c) Make certain the matchmarks on the accessory gearbox axis B gearshaft and drive shaft (13) are at exactly 6 o'clock position and then match-mark the transfer gearbox axis B gearshaft aft spline (customer PTO/hydraulic pump). The transfer gearbox axis B gearshaft will not necessarily have a spline tooth located at the 6 o'clock position so place the matchmark on the end of the axis B gearshaft outer diameter at exactly 6 o'clock.

(5) Remove the clamp, drain valve and tubes from the drive shaft cover (7).

(6) Remove 2 snaprings (6) from the drive shaft cover (7).

(7) Remove the 4 nuts and washers that secure the flanged cover (9) to the transfer gearbox. Slide the flanged cover (9) and drive shaft cover (7) forward as far as each will go.

(8) Slide the drive shaft (13) forward and remove it by pulling it forward through the accessory gearbox.

(9) Remove the drive shaft cover (7) and transfer gearbox flanged cover (9). Remove and discard three O-rings (8 and 10).

(10) Remove the accessory gearbox oil jet cover (12). Discard the O-rings (10 and 11).

B. Installation.

(1) Assemble accessory gearbox oil jet cover (12) with new O-rings (10 and 11). Torque the nuts to 60-90 lb-in.

<u>NOTE</u>: For ease of assembly it is recommended that clear plastic templates be locally manufactured to fit the stud pattern of the overspeed governor pad on the accessory gearbox and the customer PTO/hydraulic pump pad on the transfer gearbox. Scribe a line on the templates at the 6 o'clock position as an aid for lining up the matchmarks at exactly 6 o'clock.

(2) Rotate the accessory gearbox axis B gearshaft and transfer gearbox axis B gearshaft until the matchmarks on the end of gearshafts are at exactly 6 o'clock.

(3) Lubricate both splined ends of the horizontal drive shaft (13) with engine oil. Position the matchmark on the forward end of the drive shaft at 6 o'clock and insert the drive shaft through the middle front spline bore of the accessory gearbox so that approximately a 3-inch length of the shaft is visible at the rear of the gearbox.

(4) Install 2 new O-rings (8) on the drive shaft cover (7), then assemble the cover loosely over the drive shaft (13) and into the accessory gearbox oil jet cover (12) as far as it will go.

(5) Install a new O-ring (10) on the transfer gearbox flanged cover (9). Hang the flanged cover loosely on the drive shaft cover (7).

(6) Move drive shaft (13) toward the rear and align the matchmark on the forward end of the drive shaft with the matchmark on the forward end of accessory gearbox axis B gearshaft. With all 3 matchmarks (drive shaft, accessory gearbox axis B gearshaft and transfer gearbox axis B (aft end) gearshaft) aligned at 6 o'clock position engage and seat drive shaft (13) into transfer gearbox spline. Ensure that all 3 matchmarks are aligned at 6 o'clock position.

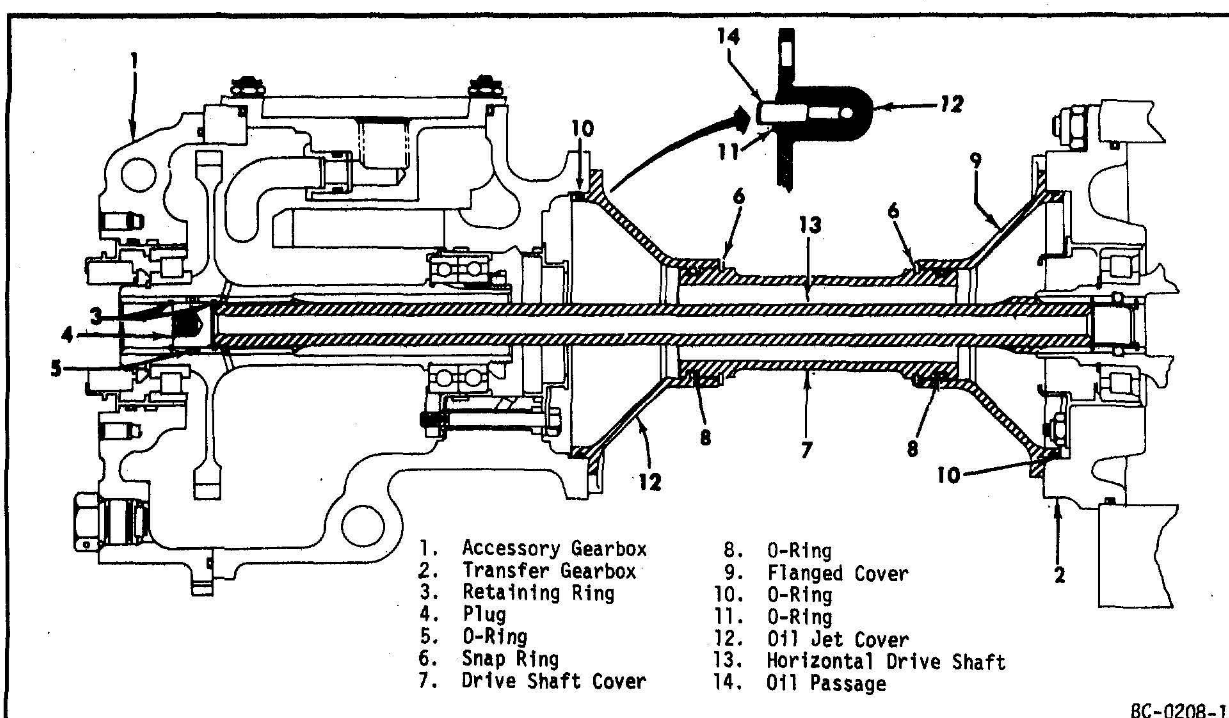
(7) Position and secure the flanged cover (9) to the transfer gearbox pad with 4 nuts and washers. Torque the nuts to 60-90 lb-in.

(8) Position the drive shaft cover (7) between the 2 covers (9 and 12) and install the 2 snaprings (6), using tool 2C5325.

(9) Connect and tighten the left and right manifold drain tubes (26, figure 2, Chapter 73-00) to the fuel manifold tees (25). Install the clamp on the drive shaft cover and tighten the bolt to secure the drain valve (27). Connect and tighten the hose to the drain valve.

(10) Install retaining ring (3, figure 201), O-ring (5), plug (4) and second retaining ring (3) in the middle front gearbox spline bore.

(11) Replace the overspeed governor per Section 73-22-0.



Accessory Drive Components
Figure 201

3. Inspection/Checks. When serviceable limits are exceeded, the parts may be repaired in accordance with the overhaul manual.

Inspection/Checks	Maximum Serviceable Limits	Remarks
A. At every exposure of drive shaft, clean thoroughly with a suitable solvent and using a bright light visually inspect for:		
(1) Cracks.	None allowed.	
(2) Nicks and scratches.	Any number, 0.030 inch deep.	
(3) Spline wear at contact area.	0.005 inch. (Approx. estimate can be made by visually comparing wear at contact point with a piece of 0.005 inch shim stock.)	Replace drive shaft if maximum serviceable limits are exceeded.

NOTE: Replacement of the horizontal drive shaft for excessive spline wear also requires replacement of the female spline which mated with the worn end of the drive shaft.

Inspection/Checks	Maximum Serviceable Limits	Remarks
B. Visually inspect the flanged cover, oil jet cover, and drive shaft cover for:		
(1) Cracks.	None allowed.	
(2) Oil passage blockage at every exposure of oil jet cover.	None allowed.	Check by blowing air or smoke or pumping oil through the oil passage. Clean as required to free the oil passage opening or replace cover.

ACCESSORY DRIVE GEARBOX - MAINTENANCE PRACTICES

1. General. The maintenance of the accessory drive gearbox is limited to the external section except for carbon seals. If a problem concerning the interior of the gearbox arises the gearbox must be replaced.

2. Removal/Installation.

NOTE: Whenever front frame is removed, gearbox bracket must be aligned (see Section 72-30) prior to installation of the accessory gearbox.

A. Removal.

(1) Remove the following components per the referenced paragraphs:

(a) Starter (refer to the Aircraft Maintenance Manual).

(b) Customer component that is mounted on the accessory gearbox (refer to the Aircraft Maintenance Manual).

(c) Fuel pump and control (73-13-0).

(d) Overspeed governor (73-22-0).

(e) Horizontal drive shaft (72-63-0).

(f) Lube pump and oil tank (79-21-0).

(2) Disconnect 2 lube supply and 4 scavenge lines from the fittings on the accessory gearbox. (On engines with center vent, remove the vent line from the fitting on the accessory gearbox.) Note the locations of clamps and brackets.

NOTE: The front frame sump scavenge line may be removed more easily after the accessory gearbox mounting nuts have been removed.

(3) Remove the 4 accessory gearbox mounting nuts, and carefully remove the accessory gearbox and laminated shims. Use wrenches 2C5315 and 2C5316.

NOTE: Disconnect the front frame sump scavenge line as the gearbox is being removed.

CAUTION: THE LAMINATED SHIMS ARE USED TO ALIGN THE ACCESSORY GEARBOX WITH THE TRANSFER GEARBOX. BE SURE THE SHIMS ARE MARKED SO THAT THEY WILL BE IN THE SAME LOCATION WHEN THE ACCESSORY GEARBOX IS REPLACED.

(4) Remove the horizontal drive shaft end cap from the rear middle pad of the accessory gearbox. Discard two O-rings.

NOTE: The accessory gearbox mounting bracket was not removed or installed. If removal is necessary refer to 72-30, Maintenance Practices.

B. Installation. (Using gage 2C5324.) The purpose of the following procedure is to install the accessory gearbox so that its middle splined shaft axis is parallel to and concentric with the splined shaft axis of the transfer gearbox. Use alignment gage 2C5324 only to perform this alignment. The gage shall be equipped with the special eccentric ring as shown in figure 201. The eccentric ring is designed with the center mounting hole drilled 0.020 inch off-center. This eliminates the need for use of any thermal compensating shims under the transfer gearbox. It is necessary to set the low point of the eccentric at exactly 6 o'clock position.

NOTES: 1. In normal operation, the mainframe of the engine grows 0.020 inch more than the front frame because of thermal expansion. The alignment is set to provide proper alignment in the hot or running condition.

2. Since the alignment inspection and adjustment is made with the engine cold the transfer gearbox is 0.020 inch closer to the engine center line than is the accessory gearbox. The purpose of drilling the ID of the eccentric ring off-center 0.020 is to move the apparent location of the accessory gearbox female spline 0.020 inch closer to the engine center line. This would place both the accessory gearbox apparent spline and the transfer gearbox spline at the same distance from the engine center line. In this position the ideal alignment is to have a TIR of zero.

3. To allow for some variation, the limits of alignment are established to allow the accessory gearbox spline to be within 0.012 inch of the transfer gearbox spline. This 0.012 inch can be in any 360° direction. Since a dial indicator reads twice the displacement, the ideal alignment is 0.000 TIR and the max allowable misalignment is 2 x 0.012 inch = 0.024 inch TIR.

(1) Connect the front frame sump scavenge hose, and secure the accessory gearbox and shims to the mounting bracket with 4 nuts. Torque the nuts to 220-235 lb-in.

NOTE: On initial installation of the accessory gearbox, the use of 0.035 inch shims on the rear studs and 0.040 inch shims on the front studs is recommended as a starting point.

(2) Install the alignment gage as follows: (See figure 201.)

(a) With the transfer gearbox in its normal installed configuration (i.e., no thermal compensating shims) install the short arbor of the 2C5324 gage into the transfer gearbox by backing off the spreader screw. Insert the arbor until it bottoms against seal plug and secure in place by expanding the slotted end using the spreader screw and a 3/16 inch Allen screw.

(b) Install the long arbor of the 2C5324 gage into the accessory gearbox axis-B female spline by backing off the spreader screw in the arbor. Insert the long arbor into the accessory gearbox until it seats. Secure in place by expanding the slotted end using the spreader screw and a 3/16 inch Allen wrench. Install the eccentric ring by placing it on the stub shaft of the long arbor and secure by tightening the setscrew.

CAUTION: WHEN USING THE ECCENTRIC RING DO NOT INSTALL THE 0.020 INCH THERMAL COMPENSATING SHIMS UNDER THE TRANSFER GEARBOX.

(c) Install the dial indicator to the post on the short arbor installed in the transfer gearbox. Adjust the ball of the indicator so that it contacts the 6 o'clock position on the OD of the 1.50 inch diameter eccentric ring installed on the stub shaft of the long arbor.

(d) With the ball of the dial indicator contacting the OD of the eccentric ring at the 6 o'clock position rotate the accessory gearbox arbor including the eccentric ring and observe the runout. The runout should be twice the offset of 0.020 and give a TIR (Total Indicator Reading) of 0.040 inch. Because of tolerance in the tool and the spline, the reading may not be exactly 0.040. The readings can be varied slightly by removing the long arbor from the accessory gearbox and reinstalling it rotated 90°, 180° or 270° relative to its original position in the female spline. The long arbor should be rotated to these different locations until the TIR of the eccentric is 0.038 - 0.042 inch.

(e) Once the long arbor is located in the proper position relative to the female spline locate the minimum runout at exactly 6 o'clock position by placing the dial indicator at 6 o'clock position and rotating the accessory gearbox female spline including the long arbor and observing the runout. The minimum runout shall be located at 6 o'clock position. The arbor should be marked with a felt tip marker, or equivalent, at the 6 o'clock position.

NOTES: 1. The 6 o'clock mark shall be checked periodically to ensure that it has not rotated off the 6 o'clock position. It must remain in this position for the entire alignment procedure.

2. The face of the eccentric ring has a "V.T." (Vertical Top) stamped at the point of maximum eccentricity. This stamp should be at 12 o'clock position as a cross check.

(3) Check displacement of splines as follows: (See figure 201.)

(a) With the match mark on the long arbor located at 6 o'clock and the ball of the indicator contacting the OD of eccentric ring, rotate the transfer gearbox spline and short arbor and note the indicator reading as the indicator is rotated 360°. The TIR (Total Indicator Reading) must not exceed 0.024 inch.

(4) Check face alignment runout as follows: (See figure 202.)

(a) Place the ball of the dial indicator against the face of the long arbor. The ball should be located approximately 1-1/2 inch from the center of the arbor. The transfer gearbox spline should be rotated and the indicator readings noted as the indicator rotates through 360°. The max allowable face runout is 0.006 TIR.

(5) Alignment Procedure.

(a) Install and adjust the alignment gage per paragraph (2).

NOTE: The sequence of adjustments can be performed in any order convenient to the operator. Experience has shown that the following sequence will often reduce the time required.

(b) Record the face runout from 12 o'clock to 6 o'clock position and add or subtract shims as necessary on the front studs of the accessory gearbox to reduce the 12 o'clock to 6 o'clock runout to as close to zero as possible.

(c) The low point of the eccentric ring is to remain located at 6 o'clock position at all times. Record the eccentric ring runout from 12 o'clock to 6 o'clock position. Add or subtract equal amounts of shims to all four accessory gearbox studs to reduce the runout to as close to zero as possible.

(d) Record the eccentric ring runout from 9 o'clock to 3 o'clock position. Loosen the four nuts on the accessory gearbox studs and move the accessory gearbox laterally toward 9 or 3 o'clock to reduce the runout to as close to zero as possible. Retorque the four nuts to 220-235 lb-in.

(e) Record the face runout from 9 to 3 o'clock position and loosen the four nuts on the accessory gearbox and rotate the gearbox about its vertical axis. This will effect both the face runout and the eccentric ring runout. Adjust to obtain the minimum runout. Retorque the four nuts to 220-235 lb-in.

(f) Loosen the 4 nuts holding the transfer gearbox and rotate the transfer gearbox about the vertical axis. The transfer gearbox is located by a pin between the two rear studs. The amount of rotation should be limited to the amount of play between the locating pin and its hole. Do not force the box beyond this point. The use of this adjustment will change the 9 to 3 o'clock readings on both the face readings and the eccentric ring readings. Retorque the four nuts to 60-90 lb-in.

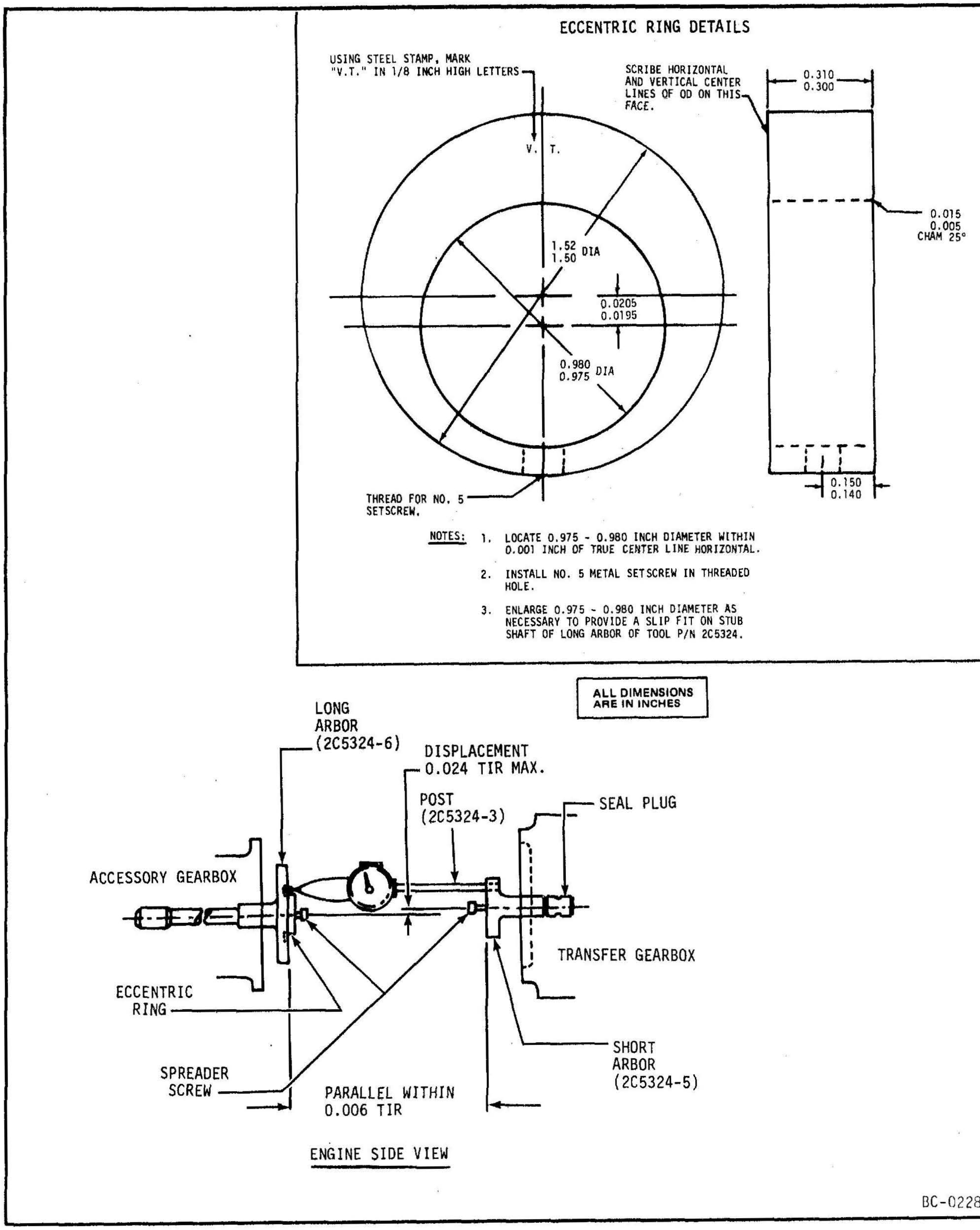
NOTES: 1. The use of steps (d), (e), and (f) used in combination is normally sufficient to bring the alignment within limits.

2. There are three additional adjustments but they are not normally required. One is to loosen the bolts holding the accessory gearbox bracket to the front frame and move the bracket right or left within the tolerance of the bolt diameter and the hole diameter. The second is to loosen the bolts holding the compressor casings to the mainframe. The compressor casing, front frame and accessory gearbox bracket, can then be rotated right or left about the engine center line within the limits of the tolerance of the bolt OD and the mainframe hole ID. The third, and seldom used, adjustment is to put unequal shims between the left hand studs and the right hand studs of the accessory gearbox.

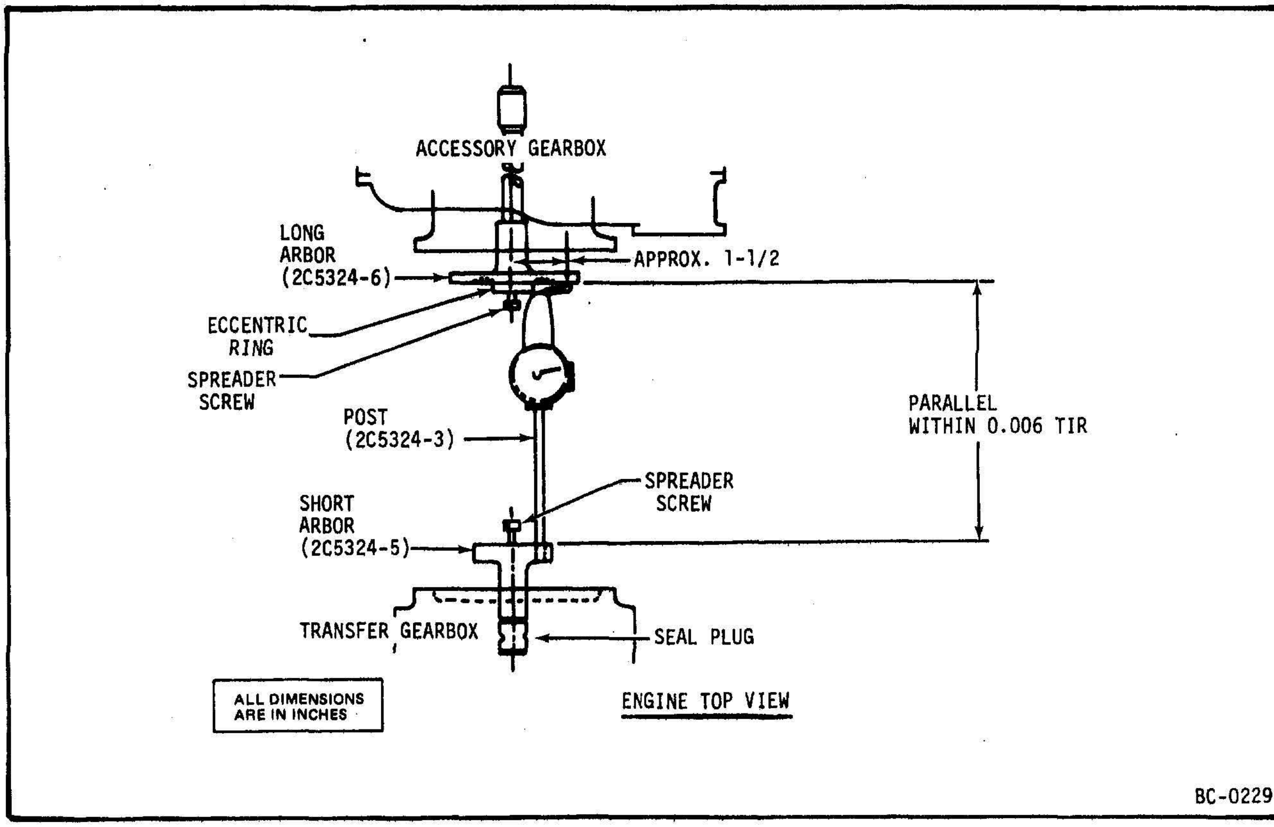
3. After all adjustments have been made and all mounting bolts have been torqued a final check of both the face runout and the eccentric ring runout is required. Recheck the low point of the eccentric ring to be certain it is still at 6 o'clock. The final limits are not to exceed the following:

a. Face Run Out - 0.006 inch TIR maximum.

b. Eccentric Ring Run Out - 0.024 inch TIR maximum.



Accessory Gearbox - Transfer Gearbox Spline Displacement
Figure 201



Accessory Gearbox - Transfer Gearbox Face Alignment
Figure 202

(6) Remove alignment gage 2C5324.

(7) Replace the accessory gearbox end cap and 2 new O-rings on the rear middle pad. Secure it with 4 nuts and washers. Torque the nuts to 60-90 lb-in. Secure the bracket on the upper left mounting stud also.

(8) Connect the 2 lube lines and the 3 remaining scavenge lines (with new O-rings installed where used) to the fittings on the accessory gearbox. Assemble clamps and brackets in locations previously noted.

(9) Install the following components per the referenced paragraphs:

(a) Lube pump and oil tank (79-21-0).

(b) Horizontal drive shaft (72-63-0).

(c) Fuel pump and control (73-13-0).

(d) Overspeed governor (73-22-0).

(e) Starter (refer to the Aircraft Maintenance Manual).

(f) Customer component that is mounted on the accessory gearbox (refer to Aircraft Maintenance Manual).

B1. Deleted.

3. Inspection/Checks. When serviceable limits are exceeded, the parts may be repaired in accordance with the Overhaul Manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Visually inspect the accessory gearbox for:		
(1) Cracks.	None allowed.	
(2) Nicks and scratches.	Any number, 0.030 inch deep.	
(3) Evidence of leakage between cover and case.	None allowed.	
(4) Evidence of seal leakage of pads.	See Operating Limits, Adjustment/Tests, 72-00.	Replace seal per paragraph 4.A.
(5) Stripped threads in drain plug holes.	One full entrance thread.	Substitute modified plug for drain plug per paragraph 4.B.

B. At every exposure of transfer gearbox Axis B forward and aft female splines, clean thoroughly with a suitable solvent and using a bright light visually inspect splines for:

NOTE: Deleted.

(1) Wear at contact area.	Approx. estimates can be made by visually comparing wear at contact points with pieces of shim stock, sized to the limits below.	
Axis B fwd (OSG).	0.007 inch.	If within Serviceable Limits lubricate all splines, except axis B aft, with lubricant specified in Section 72-01-1. Lubricate axis B aft spline with engine oil.
Axis B aft (Acces. Drive Shaft).	0.005 inch.	
NOTE: Replacement of the accessory gearbox axis B gearshaft for aft end spline excessive wear also requires replacement of the accessory horizontal drive shaft.		
Axis C fwd (Customer PTO).	0.006 inch.	
Axis C aft (Starter-Gen.).	0.008 inch.	
Axis D fwd (Fuel Pump).	0.006 inch.	

4. Repair.

A. Rubbing Seal Replacement. Axis "C" forward and aft, axis "B" forward (overspeed governor), axis "D" forward (fuel pump/main fuel control).

NOTE: For special tools, use kits (part Numbers 2C5333 and 2C5334).

(1) Remove the mounted accessory per the applicable paragraph.

(2) Remove the seal housing retainer nuts.

(3) Remove the seal housing with the puller.

NOTE: Axis "D" and "B" forward have combination seal and bearing housings. When the housing is removed the entire axis "D" ball bearing may be removed at the same time. The bearing must be disassembled from the housing before removing the seal. When the axis "B" housing is removed the bearing outer race may come out with the housing and must be pressed out of the housing before the seal is disassembled.

(4) Remove the O-ring, then remove the rubbing seal from the seal housing with the pusher.

(5) Remove the mating ring and packing ring.

(6) Replace defective part.

(7) Insert the mating ring packing into the mating ring.

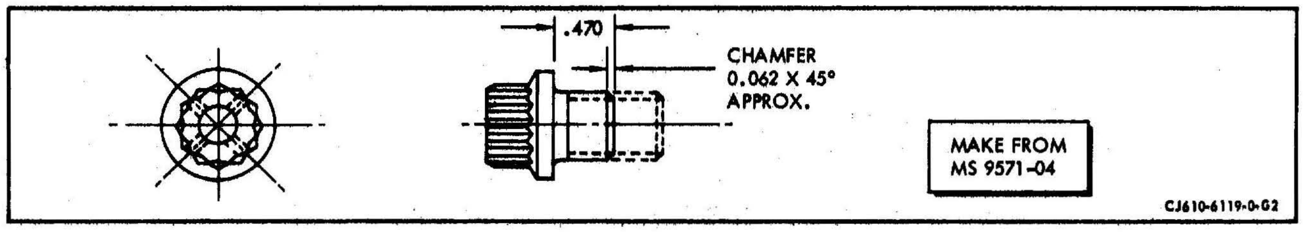
CAUTION: USE EXTREME CARE WHEN HANDLING THE MATING RING. DO NOT ALLOW THE RUBBING FACE TO BE DAMAGED.

(8) Assemble the mating ring and packing to the gearshaft, seating the mating ring (packing side) against the bearing face.

(9) Assemble the O-ring to the O-ring groove in either the seal housing or gearbox casing.

CAUTION: O-RING MUST BE INSTALLED IN FIRST (FORWARD) AXIS-B PORT RECESS IN COVER ASSEMBLY.

(10) Lubricate the OD of the rubbing seal with engine oil and assemble it to the seal housing.



Replacement Plug
Figure 203

(11) Lubricate the OD of the seal housing with engine oil and assemble it to the gearshaft, mounting studs, and seal housing bore in the gearbox casing with the pusher.

CAUTION: BE CAREFUL WHEN HANDLING RUBBING SEALS. THE CARBON SURFACES ARE EXTREMELY BRITTLE AND EASILY DAMAGED.

(12) Lubricate the studs with engine oil. Secure the seal housing with nuts; torque them to 10-15 lb-in.

B. Substituting Modified Plug for Drain Plug.

CAUTION: THIS REPAIR IS LIMITED TO 300 HOURS OF SERVICE AND MUST BE ENTERED IN THE ENGINE LOG BOOK.

(1) Clean drain hole to make sure it is free of foreign material.

(2) Fabricate a replacement plug per figure 203.

(3) Install O-ring onto the replacement plug and install plug into gearbox. Tighten plug to 60-80 lb-in. of torque and lockwire.

AFT FAN SECTION - DESCRIPTION AND OPERATION

1. General.

The aft fan section (figure 1) is flange-bolted to the turbine casing aft flange. The purpose of the aft fan is to increase engine thrust without increasing fuel consumption. Engine primary air enters the primary airflow inlet (1) and drives a single-stage free rotating rotor (2). Secondary air which enters through the secondary airflow inlet (3) is compressed by the outer portion of the aft fan rotor blades. The volume of secondary air is about twice that of the primary airflow through the engine.

The aft fan rotor is both a turbine and a compressor. By using rotor blades having both a turbine airfoil (4) and a compressor airfoil (5) separated by a sealing and dividing platform (6) a single stage rotor is used to separately handle the two airflows.

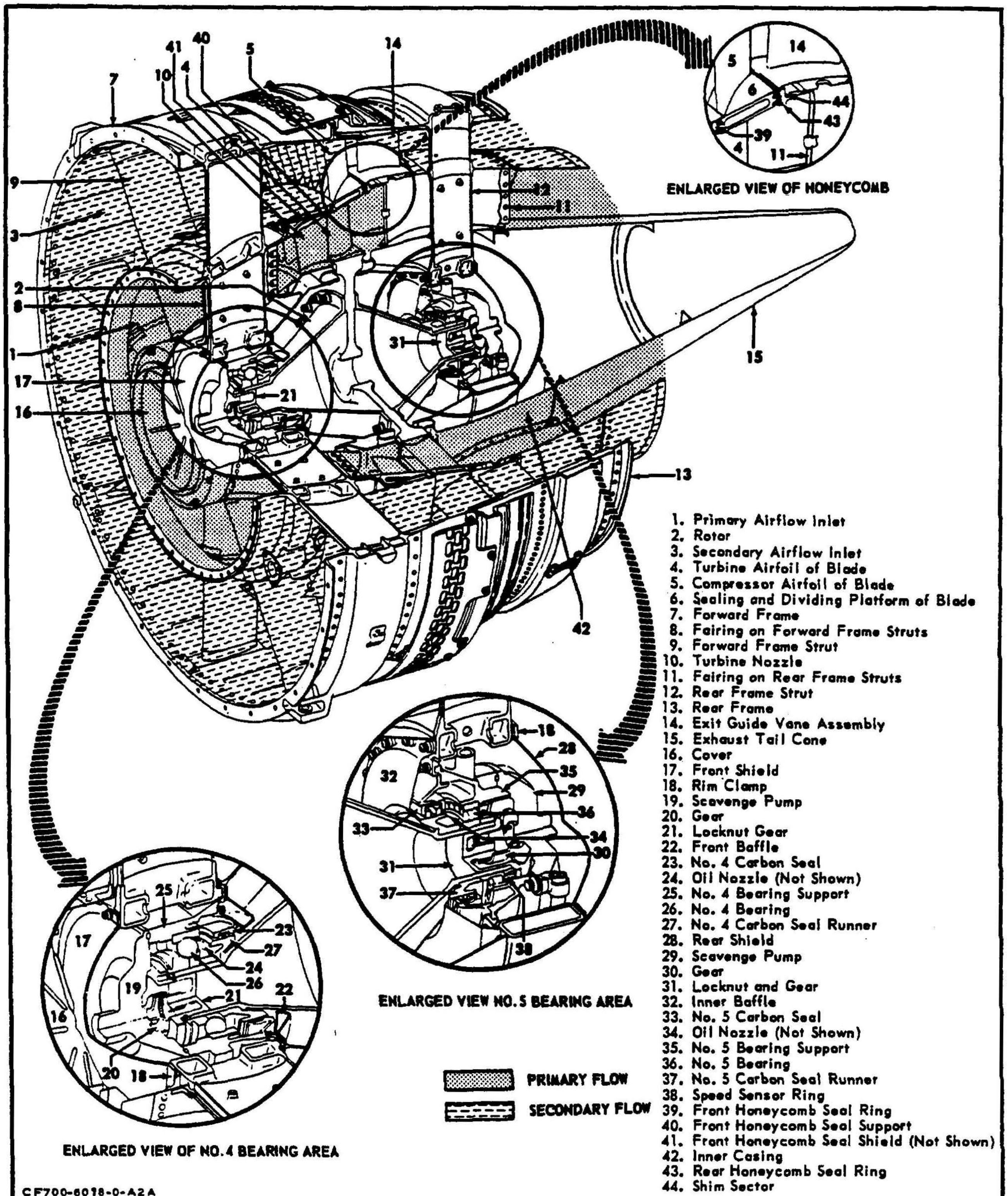
The primary air from the turbine section of the engine flows into the primary airflow inlet of the forward frame (7). The fairing (8) around the struts (9) in the forward frame causes the air to flow in an axial direction. The airflow then passes through the turbine nozzle (10) which directs the airflow at the proper angle and at the proper rate of flow onto the turbine airfoil of the blades, resulting in rotor rotation (power extraction). The fairing (11) around the rear frame struts (12) straightens the airflow as it leaves the turbine airfoils before it flows out of the aft end of the rear frame (13).

The secondary airflow enters the aft fan nacelle inlet and then flows through the nacelle inlet duct into the secondary inlet (3) of the forward frame. From there, the air flows through a converging area in the forward frame to the rotating compressor airfoils of the aft fan rotor blades which compress the secondary airflow. Exit guide vanes (14) straighten the airflow as it leaves the compressor airfoils before the airflow flows out the aft end of the rear frame.

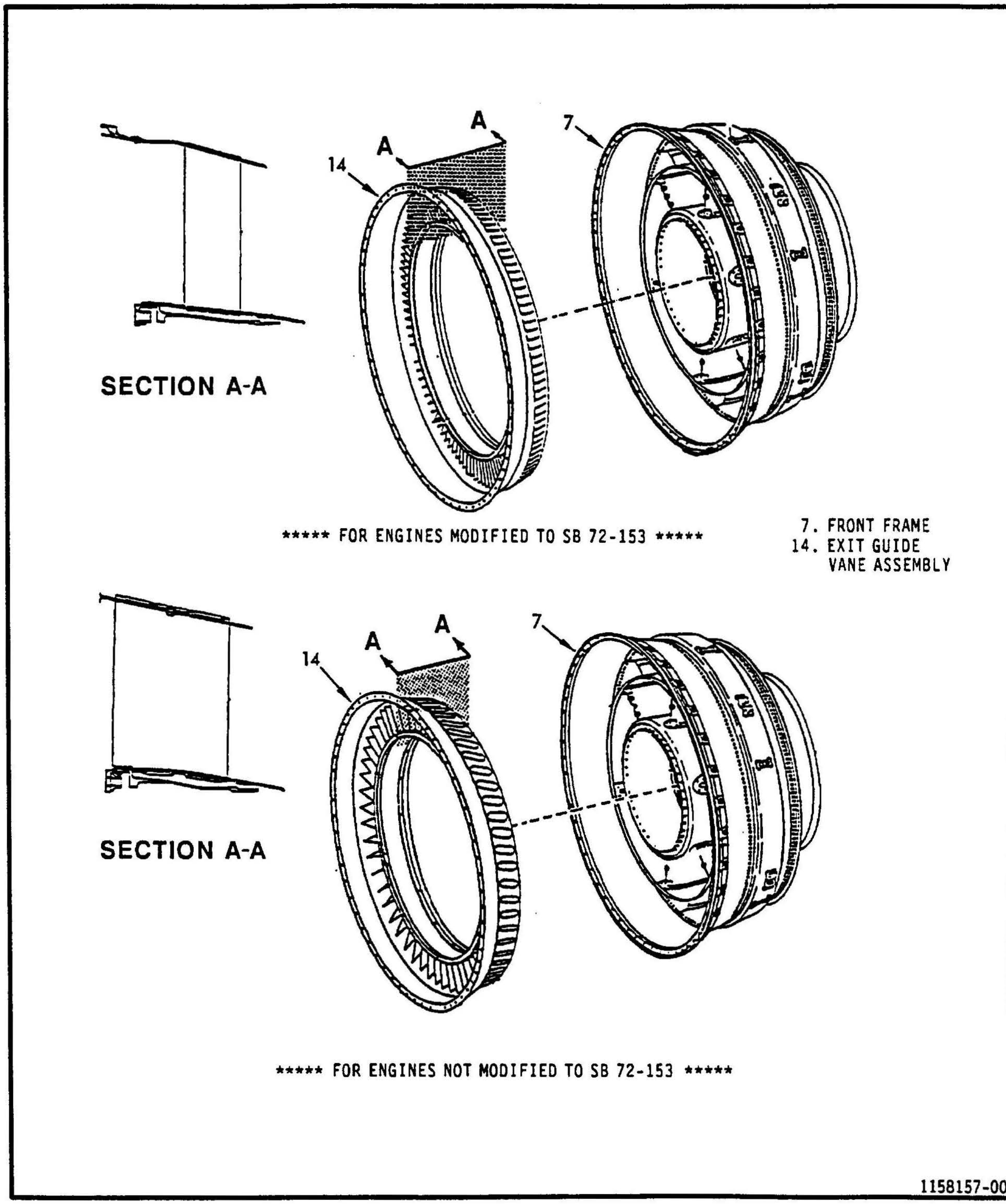
The aft fan assembly consists of the fan front frame (7), the turbine nozzle (10), the rotor (2); the parts needed to support and lubricate the rotor (see enlarged views of the No. 4 and No. 5 bearing areas in figure 1), the transition seals (39 and 43), the exit guide vane assembly (14), the fan rear frame (13) and the exhaust tail cone (15). A description of each of these parts is contained in the following paragraphs.

2. Fan Front Frame.

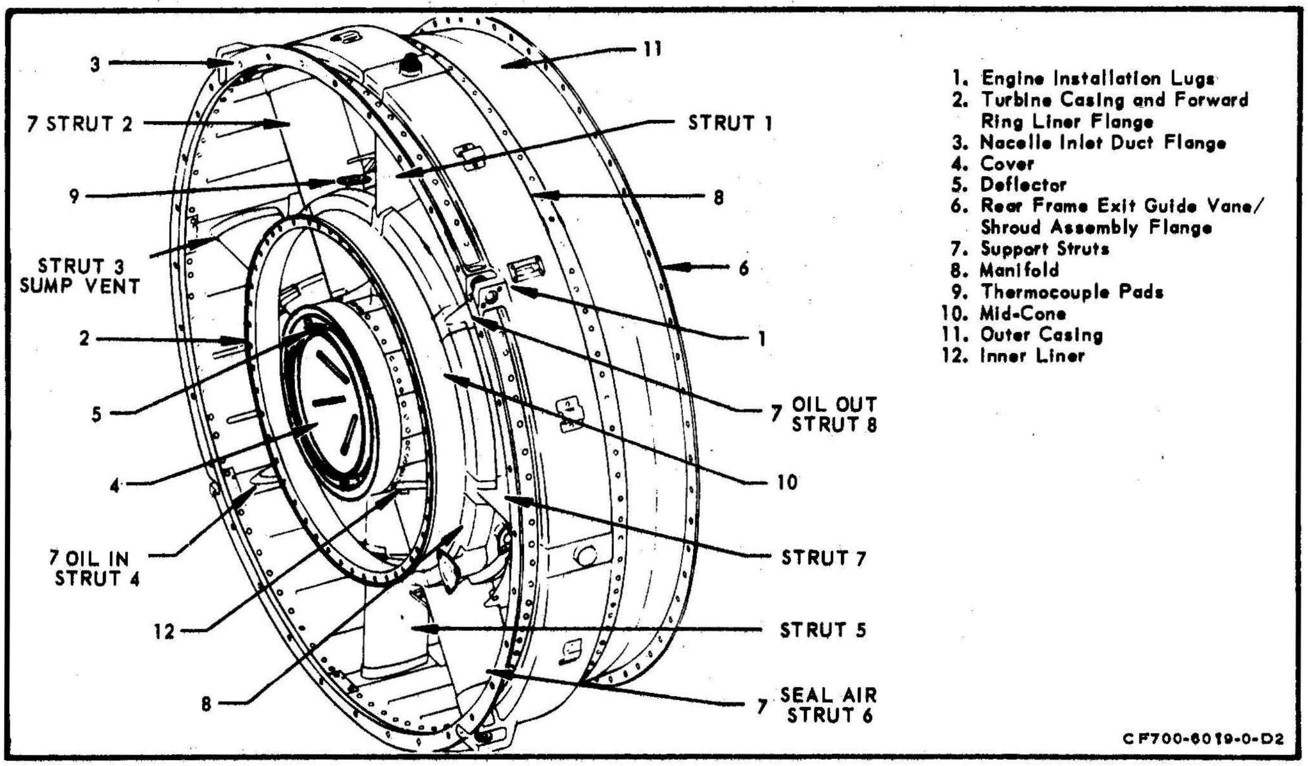
The fan front frame (figure 2) is a fabricated assembly containing separate inlets for the primary and secondary air flows. It also serves as the supporting structure for the forward end of the rotor. The forward flanges are



Aft Fan Section
Figure 1 (Sheet 1 of 2)



Aft Fan Section
Figure 1 (Sheet 2 of 2)

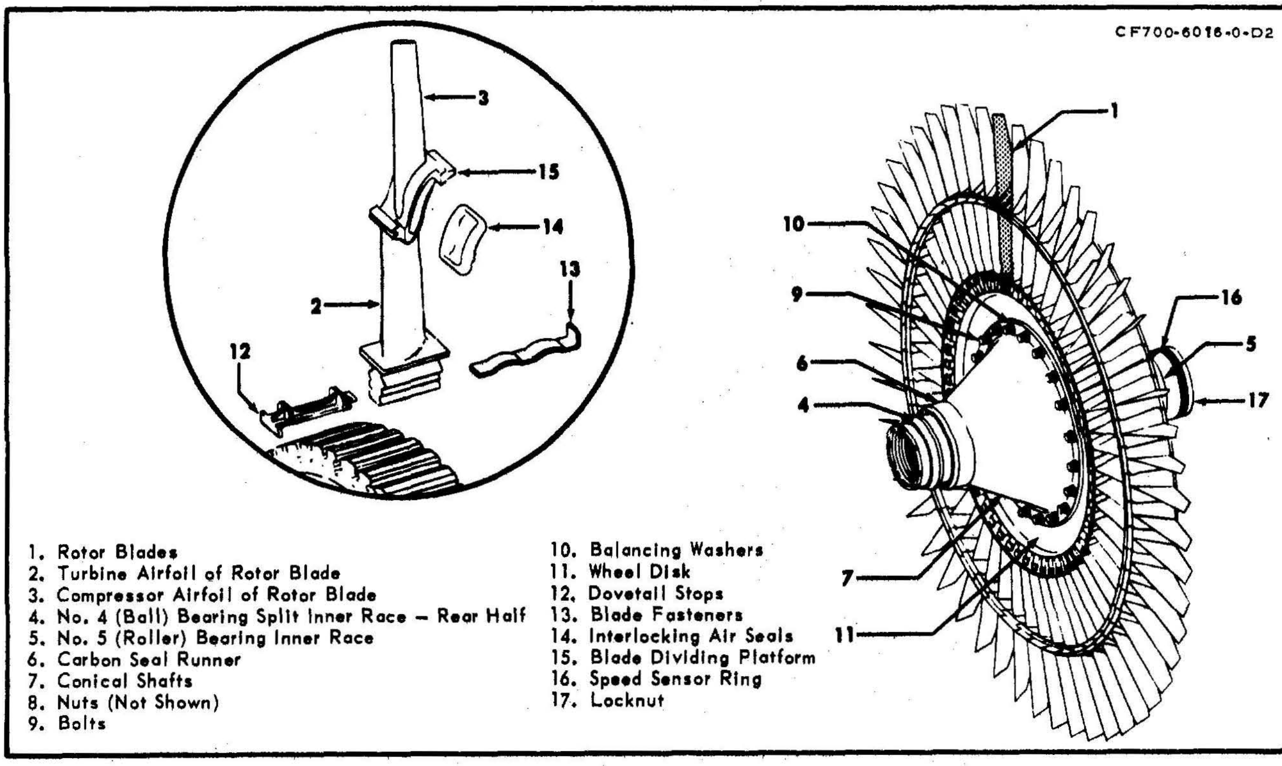


Fan Front Frame
Figure 2

used to attach the aft fan section to the engine and to attach the aft fan to the nacelle inlet duct. The rear flanges are used for attaching other aft fan parts to the front frame. Engine installation lugs (1) are located at the outer ends of the four hollow support struts. Tubes through the struts service the forward sump. Cooling air from the fifth-stage of the compressor flows through strut 2 (which does not carry eighth-stage leakage air) and into the inner manifold where it flows circumferentially around the manifold. Eighth-stage leakage air flows inward through 7 of the struts and out the vent holes in the side of the struts into a space between the strut fairing and the strut walls where it is heated. From this space the heated air flows outward through all the struts to the outer manifold where it flows out of the vent holes located in the manifold mid way between the struts. The mid-cone also has 8 pads (9) for attaching the thermocouples.

3. Fan Turbine Nozzle.

The fan turbine nozzle (10, figure 1) directs air onto the turbine airfoils of the fan rotor blades. The nozzle is a fabricated assembly made up of 51 partitions that are joined by outer and inner supports.



Fan Rotor
Figure 3

4. Fan Rotor.

The fan rotor (figure 3) is driven by the primary air flow which is directed by the turbine nozzle onto the turbine airfoil of the rotor blades (1). The rotor is made up of 2 conical shafts (7) attached to a wheel disc (11). Balancing washers (10) are used as required, depending upon the balancing requirements of the rotor. Fifty-four blades (1) are held in place by the dovetail stops (12) and blade fasteners (13). Interlocking air seals (14) are used at the blade dividing platforms (15) to prevent intermixing of the primary and secondary airflows. Included as parts of the turbine rotor are both carbon seal runners (6), the speed sensor ring (16) and rear locknut (17). The one-piece locknut and gear hold the seal runners, inner races and the speed sensor in place. A retaining ring locks the locknut in place. The gears on the locknuts drive the scavenge pumps.

5. Fan Rotor Components. (See figure 1.)

The fan rotor is supported at the forward end by a ball bearing (No. 4) and at the aft end by a roller bearing (No. 5). Both bearings (26 and 36) are lubricated by oil nozzles (24 and 34) that direct oil onto the bearing balls or rollers. Each bearing is housed in a bearing support (25, 35) which are attached to the forward and rear frames. Tubes, that pass through the forward and the rear frame struts and in the bearing housings, provide the sump areas with oil, seal air, sump venting, and sump scavenging. The two sump areas are sealed at both ends: at one end by a carbon seal and at the other end by a scavenge pump. Both the seal and the pump are attached to the bearing support. Each pump is driven by a one-piece locknut gear which is screwed in the end of the rotor shaft.

6. Fan Transition Seals. (See figure 1, sheet 1.)

Rear and front honeycomb seals (39, 43) mate with the forward and the rear edges of the sealing and dividing platforms of blade (6). The forward transition seal is held in place by a seal support, and the rear transition seal is attached to the exit guide vane assembly.

* * * * * FOR ENGINES NOT MODIFIED TO SB 72-153 * * * * *

7. Fan Exit Guide Vane Assembly. (See figure 1, sheet 2.)

The exit guide vane assembly (14) contains 57 vanes joined by an outer and an inner shroud. The vanes straighten the secondary air flow after it leaves the compressor airfoil of the rotor blades. The outer shroud contains an abradable material in the blade tip path that allows the blade tips to rub and wear-in. The exit guide vane assembly is attached to the front frame and the rear frame.

* * * * * FOR ENGINES MODIFIED TO SB 72-153 * * * * *

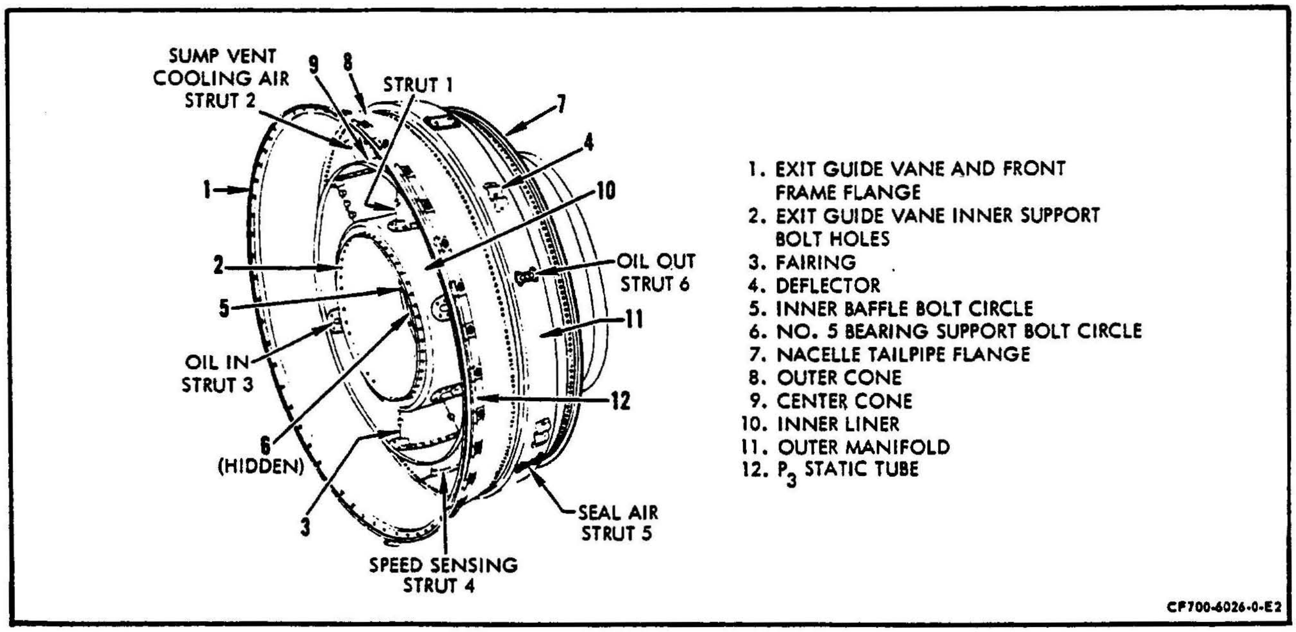
7. Fan Exit Guide Vane Assembly. (See figure 1, sheet 2.)

The exit guide vane assembly (14) contains 110 vanes joined by an outer and an inner shroud. The vanes straighten the secondary air flow after it leaves the compressor airfoil of the rotor blades. The outer shroud contains an abradable material in the blade tip path that allows the blade tips to rub and wear-in. The exit guide vane assembly is attached to the front frame and the rear frame.

* * * * * FOR ALL * * * * *

8. Fan Rear Frame. (See figure 4.)

The fan rear frame is a fabricated assembly that contains separate exhaust areas for the primary and secondary airflows. The rear frame also supports the aft end of the rotor. The forward flange (1) is used to attach the rear frame to the front frame. The rear flange (7) is used to attach the rear frame to the nacelle tail pipe. The rear frame has six struts: four struts service the No. 5 sump area; the speed sensing electrical lead of the aft fan passes through a fifth strut; cooling air from the fifth-stage of the compressor flows through the No. 1 strut in the inner manifold to cool the manifold and the No. 5 sump. Air from the primary airflow is directed outward through the struts and out through holes in the outer manifold to provide equal thermal expansion of the struts.



Fan Rear Frame
Figure 4

9. Fan Exhaust Tailcone.

The exhaust tailcone attaches to the rear frame. Its purpose is to maintain a smooth airflow as the primary and secondary airflows leave the rear of the engine.

AFT FAN SECTION - MAINTENANCE PRACTICES

1. General. This section covers Removal/Installation of the fan assembly as a unit with the engine in the horizontal position. Disassembly, Inspection/Check, Approved Repair and Assembly of the individual components of the assembly are covered in maintenance practices for each component.

WARNING: ASBESTOS

THIS ENGINE MAY CONTAIN SMALL AMOUNTS OF ASBESTOS. WHEN WORKING WITH THIS ENGINE, THE FOLLOWING PRECAUTIONS MUST BE RIGIDLY ADHERED TO:

BEFORE ANY MAINTENANCE ACTIVITIES ARE UNDERTAKEN, REVIEW THE ILLUSTRATED PARTS BREAKDOWN/CATALOG INDEX TO DETERMINE IF THE HARDWARE TO BE WORKED ON OR USED CONTAINS ASBESTOS.

WHENEVER MECHANICAL REMOVAL OF MATERIAL, SUCH AS MACHINING, GRINDING, BUFFING, DRILLING, SANDING OR ANY TYPE OF MATERIAL BUILD-UP ON PARTS THAT CONTAIN ASBESTOS IS NECESSARY, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT MUST BE WORN, AND NATIONAL ENVIRONMENTAL CONTROLS REQUIRED FOR THE HANDLING OF ASBESTOS-CONTAINING MATERIAL MUST BE COMPLIED WITH.

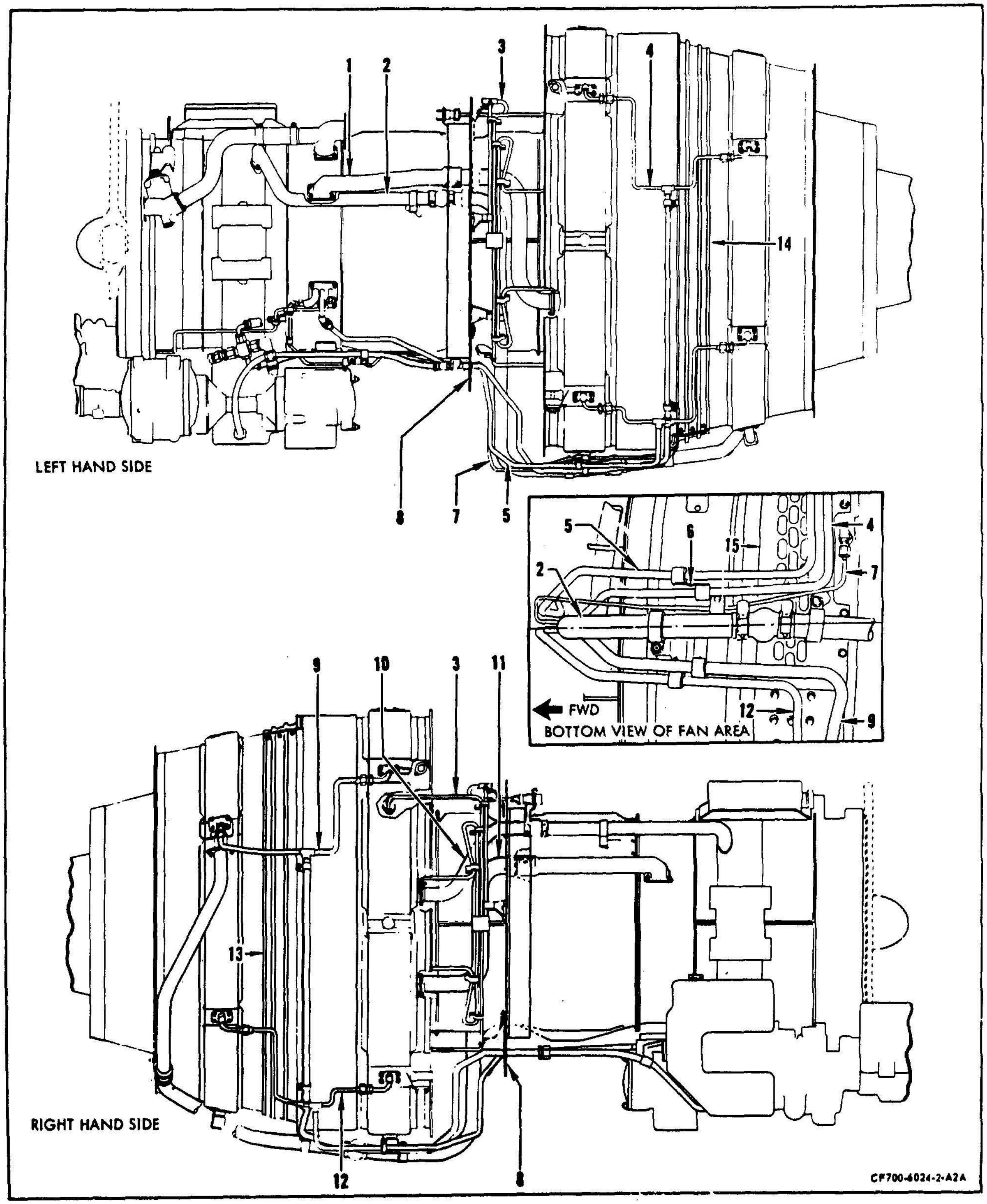
BEFORE HANDLING, REPLACING, OR DISPOSING OF ASBESTOS-CONTAINING HARDWARE, APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND NATIONAL ENVIRONMENTAL CONTROLS MUST BE STRICTLY ADHERED TO FOR HANDLING ASBESTOS-CONTAINING HARDWARE.

2. Removal/Installation. (See figure 201.)

A. Removal.

NOTE: This procedure is for complete removal of the fan section from the engine. When the section is being removed for a specific purpose, such as hot section inspection, remove the minimum amount of lines and tubing necessary to accomplish the fan section removal.

(1) Remove the T5 thermocouple harness (3) per 77-21-0.



Fan Section Removal/Installation
Figure 201

WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(2) Remove the 8th stage air tube assemblies (1, 11) per 75-21-0.

(3) Remove the 5th stage air tube assemblies (2, 10) per 75-22-0.

(4) Remove the air, vent and oil tubing from the aft fan and the engine. Remove the tubing as an assembly while still attached to the tube hanger (6) on the fan front frame.

NOTE: Replace the bolts and nuts on all clamps on the tubes and piping.

(5) Remove the firewall sections (8).

(6) Attach lift sling, 2C5345, to the fan assembly.

(7) Remove the bolts and nuts that secure the fan assembly to the turbine casing rear flange.

(8) Remove the fan assembly from teh engine.

(9) Place the fan assebmly in a stand using either of the following methods:

(a) If the tailpipe is attached to the assembly, place the assembly in stand, 2C5346.

(b) If the tailpipe is not attached to the assembly, remove 8 bolts from the blade guard, install trunnion adapters, 2C5344, and place the assembly in stand, 2C5332.

B. Installation. (See figure 201 unless otherwise indicated.)

WARNING: USING HOISTING DEVICES

HOISTING SHALL ONLY BE DONE BY DESIGNATED PERSONNEL.

DO NOT EXCEED LOAD CAPACITY RATING MARKED ON HOIST.

INSPECTION AND TESTING FOR CRACKS OR DEFECTS IN HOISTING SYSTEM SHALL BE PERFORMED ON A REGULAR BASIS.

USE ONLY PINS, LINKS, AND HOOKS RECOMMENDED FOR HOISTING SPECIFIC COMPONENTS.

BEFORE HOISTING, BALANCE THE LOAD.

DO NOT STAND UNDER LOAD WHILE IT IS BEING MOVED FROM ONE AREA TO ANOTHER ON A HOIST. DO NOT STAND UNDER LOAD TO DO MAINTENANCE WORK.

HOISTING DEVICES MADE OF NYLON, POLYESTER, POLYPROPYLENE, OR ALUMINUM SHALL NOT BE USED IN AREAS WHERE CAUSTICS ARE HANDLED.

WARNING: LUBRICATING OIL

IF OIL IS DECOMPOSED BY HEAT, TOXIC GASES ARE RELEASED.

PROLONGED CONTACT WITH LIQUID OR MIST MAY CAUSE DERMATITIS AND IRRITATION.

IF THERE IS ANY PROLONGED CONTACT WITH SKIN, WASH AREA WITH SOAP AND WATER. IF SOLUTION CONTACTS EYES, FLUSH EYES WITH WATER IMMEDIATELY. REMOVE SATURATED CLOTHING.

IF OIL IS SWALLOWED, DO NOT TRY TO VOMIT. GET IMMEDIATE MEDICAL ATTENTION.

WHEN HANDLING LIQUID, WEAR RUBBER GLOVES. IF PROLONGED CONTACT WITH MIST IS LIKELY, WEAR APPROVED RESPIRATOR.

(1) Using engine sling 2C5345, position the fan assembly on the turbine casing rear flange and secure with 48 bolts and nuts. Apply a light coat of engine oil to the bolts and install with bolt heads aft. Torque locknuts to 36-40 lb-in.

(2) Lubricate the threads of the plug (59, figure 202) with TEXACONE EASE OFF 990 (Texacone Co., Dallas, Texas) or equivalent; and install into the 12 o'clock pad. Torque to 30-35 lb-in. and lockwire.

(3) Install the blade guards as follows:

(a) Install the right-hand half of the rear blade guard (13). Do not tighten the bolts at this time. Leave bolt holes 14 and 25 (figure 203) open for the vent and oil tube brackets.

NOTE: The cutoff in thre rear blade guard is for the 90° elbow at the 5:30 o'clock position.

(b) Install the left-hand half of the rear blade guard (14) but do not tighten the bolts. Leave bolt holes 32, 37 and 48 (figure 203) open for the vent and oil tube brackets.

(c) Install the bolts at the rear blade guard split lines. Torque the 4 large split line bolts to 280-300 lb-in. Torque the 2 small split line bolts to 90-110 lb-in. Torque the blade guard-to-flange bolts to 30-35 lb-in.

(d) Place the front blade guard (15) on the fan assembly and push it forward to allow installation of the vent and oil tube brackets.

(4) Install the upper firewall onto the brackets on the turbine casing front flange with the slot for the T5 harness at the 12 o'clcok position. Install the bolts into the brackets but do not tighten.

<u>WARNING</u>: RTV 577, SILICONE RUBBER

COMBUSTIBLE NEAR SPARKS, OPEN FLAMES, WELDING AREAS, HOT SURFACES, OTHER SOURCES OF IGNITION, OR WHILE SMOKING.

CONTACT WITH EYES/FACE/SKIN MAY CAUSE IRRITATION OR BURNING.

INGESTION MAY CAUSE IRRITATION OR BURNING OF DIGESTIVE SYSTEM.

PERSONAL PROTECTIVE EQUIPMENT REQUIRED WHEN HANDLING OR USING THIS MATERIAL.

(5) Apply RTV 577 (General Electric Co., Silicone Products Business Dept., Hudson River Rd., Waterford, N.Y. 12188) to the forward side of the firewall at all joints, including splitline and tube passages. Light should not be visible through any part of the sealed surface.

(6) Install the lower firewall onto the brackets on the turbine casing front flange. Secure the bolts at the splitline first, then install the remaining bolts into the brackets. Torque the firewall bolts to 24-27 lb-in.

(7) Install the tube hanger (6) onto the fan front frame at the 6 o'clock position. Torque the bolt to 80-130 lb-in. and lockwire.

<u>WARNING</u>: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

(8) Install the 8th-stage air tube assemblies (1, 11) per 75-21-0. Install the 5th-stage air tube assemblies (2, 10) per 75-22-0.

(9) Install the clamps onto the P3 air tube (7). Secure to the fan elbow and to the P3 air connector on the mainframe pad at the 8 o'clock position. Torque the coupling nuts to 90-100 lb-in. and lockwire. Position the clamps and torque to 44-48 lb-in.

(10) Install the clamps on the vent tube assembly (9). Connect to the fan tube elbows and route forward to the universal connector on the accessory gearbox. Torque the coupling nuts at the fan tube elbows to 270-300 lb-in. and lockwire. Torque the coupling nut at the universal connector to 450-50 lb-in. Position the clamps on the hoses and tubes and tighten until the shanks of the clamps are parallel and touching each other.

CAUTION: CHECK FOR INTERFERENCE BETWEEN TUBES AT THE 6 O'CLOCK POSITION. SHIFT TUBES FOR A MINIMUM CLEARANCE OF 1/8 INCH BETWEEN TUBES. IF NECESSARY, LOOSEN THE ELBOW CONNECTORS ON THE FAN TUBES TO OBTAIN CLEARANCE.

(11) Install the clamps onto the oil tube assembly (12). Connect to the fan tube elbow and route the tube to the 45° connector on the oil hose at 6 o'clock. Connect the oil hose to the gearbox at the forward, left port. Torque the coupling nuts on the fan tube to 135-150 lb-in. and lockwire. Torque the hose connections to 135-150 lb-in. Position the clamps on the hoses and tubes and tighten until the shanks of the clmaps are parallel and touching each other.

(12) Install the clamps on the scavenge tube assembly (4). Connect to the fan tube elbow and route forward to the scavenge hose assembly. Connect the scavenge hose to the bulkhead fitting on the oil reservoir. Torque the coupling nuts on the fan tube to 135-150 lb-in. and lockwire. Torque the hose connections to 270-300 lb-in. Position the clamps.

CAUTION: CHECK FOR INTERFERENCE BETWEEN TUBES AT THE 6 O'CLOCK POSITION. SHIFT TUBES FOR A MINIMUM CLEARANCE OF 1/8 INCH BETWEEN THE TUBES. IF NECESSARY, LOOSEN THE ELBOW CONNECTORS ON THE FAN TUBES TO OBTAIN CLEARANCE.

(13) Install the clamps on the seal-air tube assebmly (5). Connect to the fan tube elbow and route forward to the center tube on the mainframe pad at 8 o'clock. Torque the coupling nuts on the fan tube to 135-150 lb-in. and lockwire; torque the tube at the mainframe pad to 270-300 lb-in. Position the clamps.

(14) Tighten the positioned clamps on the hoses and tubes until the shanks of the clamps are parallel and touching each other.

(15) Install the T5 thermocouple harness (3) per 77-21-0.

(16) Install the tailcone and torque the screws to 22-27 lb-in.

3. Disassembly/Assembly of the Fan Section.

A. Disassembly (see figure 202). This disassembly procedure applies to the fan assembly after it has been removed from the engine as a unit using fan assembly lift sling, (2c5327), and placed in fan assembly stand, (2C5332). With the fan blade guard installed on the assembly, use turnnion adapters (2C5344) attached to the blade guard at the 3 and 9 o'clock positions. With the fan blade guard removed from the assembly, use trunnion adapters (2C5328) attached to the front face of the front frame rear flange at the 3 and 9 o'clock positions. Disassemble as follows:

NOTE 1: If CF700 Service Bulletins 72-96 (Replacement of Viton A O-rings with Viton (Fluorel 2160) O-rings) and 79-8 (Fan Center Vent System) have been incorporated, it is only necessary to remove the front scavenge pump (see step (4) of this paragraph) and rear scavenge pump (see step (7) of this paragraph) and perform the Inspection/ Check of paragraph 5. Do not remove the oil-out and oil-in tubes unless required to do so in paragraph 5.

NOTE 2: The front liner ring (1) was removed when the fan assembly was disassembled from the turbine casing.

(1) Remove the tube assemblies from the fan rear frame as follows:

NOTE: Do not lose the washers when removing the brackets.

(a) Remove the bolts (18), tailcone (17), bolts (20, 21), brackets (19), washers (22) and rear shield (23).

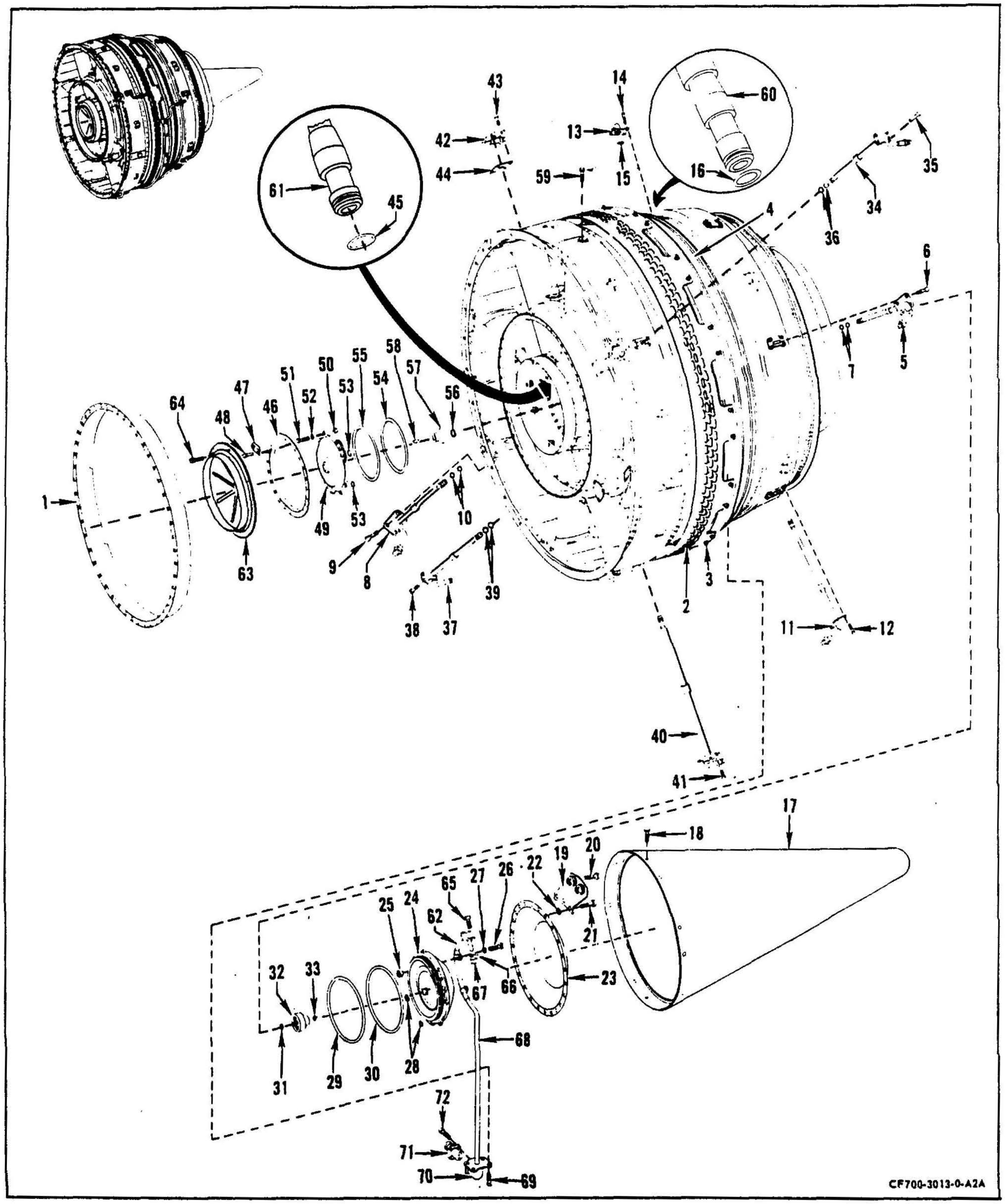
WARNING: ASBESTOS

THE FOLLOWING PROCEDURE MAY INVOLVE A PART THAT CONTAINS ASBESTOS, WHICH IS HIGHLY TOXIC TO SKIN, EYES, AND RESPIRATORY TRACT. READ GENERAL INFORMATION BEFORE PROCEEDING, AND ADHERE TO ALL SITE SAFETY AND ENVIRONMENTAL CONTROLS CONCERNING ASBESTOS. OTHERWISE, PERSONAL INJURY MAY RESULT.

CAUTION: THE FAN OIL SERVICE TUBE O-RINGS ARE EXTREMELY SENSITIVE TO BEING CUT ON INSTALLATION, AND TO FRETTING WEAR DURING SERVICE. INSPECT EACH TUBE, AS IT IS BEING REMOVED, FOR MISSING O-RING MATERIAL.

(b) Remove the bolts (6), oil-out tube (5) and O-rings (7) form the 10 o'clock pad. Pull the tube (5) out until the O-rings are just above the bearing housing port. Remove the O-rings (7) from the tube.

(c) Remove the bolts (9), oil-in tube (8) and O-rings (10) from the 4 o'clock pad. Pull the tube (8) out until the O-rings are just above the bearing housing port. Remove the O-rings (10) form the tube.



Fan Section - Disassembly
Figure 202

(d) Remove the bolts (12) and the seal air tube (11) from the 8 o'clock pad. Pull the tube (11) until the O-ring grooves are just above the bearing housing port.

NOTE: *The sump vent tube (60) and the O-ring (16) have been deleted by SB 79-8.*

(e) The center vent system has been incorporated on all engines per SB 79-8. Only the No. 5 bearing housing P/N 5001T96P13 should be used. If the service tube interferes with the installation of the bearing housing, cut the exposed end of the tube (do not contaminate the bearing area with metal chips).

(f) Inspect all O-rings for cut and missing material. If any material is missing from an O-ring and cannot be located, the bearing support must be removed and cleaned per paragraph 6.

(g) Clean the tubes (refer to SEI-133, Section 72-70).

(2) Remove the tube assemblies from the front frame as follows:

(a) Remove the bolts (64), cover (63), bolts (48), rim clamps (47), and front shield (46).

CAUTION: THE O-RINGS ON THE FAN OIL SERVICE TUBE ARE CAN BE DAMAGED (CUT) AT INSTALLATION, AND ARE SUBJECT TO FRETTING WEAR DURING SERVICE. INSPECT EACH TUBE AT REMOVAL FOR MISSING O-RING MATERIAL.

(b) Remove the bolts (35), oil-out tube (34), and O-rings (36) from the 10 o'clock pad. Pull the tube (34) until the O-ring grooves are just above the bearing housing port. Remove the O-rings (36).

(c) Remove the bolts (38), oil-in tube (37), and O-rings (39) from the 4 o'clock pad. Pull the tube (37) until the O-ring grooves are just above the bearing housing. Remove the O-rings (39).

(d) Remove the bolts (41) and seal-air tube (40) from the 8 o'clock pad. Pull the tube (40) out until the O-ring grooves are just above the bearing housing port.

NOTE: The sump vent tube (61) and the O-ring (45) have been deleted by SB 79-8.

(e) The center vent system has been incorporated on all engines per SB 79-8. Only the No. 4 bearing housing P/N 5001T98P02 should be used. If the service tube interferes with the installation of the bearing housing, cut the exposed end of the tube (do not contaminate the bearing area with metal chips).

(f) Inspect all O-rings for cut and missing material. If any material is missing from an O-ring and cannot be located, the bearing support must be removed and cleaned per paragraph 6.

(g) Clean the tubes (refer to SEI-133, Section 72-70).

(3) Remove the blade guards (2, 4).

(4) Remove the front scavenge pump as follows:

(a) Remove the bolts (51), washers (52), and nuts (50). Use two 1/4-28 inch jacking screws and remove the pump (49) from the bearing housing.

(b) Remove the O-rings (53, 54) and the O-ring retainer (55).

(5) Remove the front frame as follows:

(a) Remove the retaining ring from the forward end of the rotor shaft.

(b) Insert the spanner wrench 2C5462 in the rear locknut; then break the torque.

CAUTION: USE CARE WHEN YOU RESTRAIN THE ROTOR FROM TURNING. OTHERWISE, THE FAN BLADES CAN BEND.

(c) Remove the gear locknut; remove the packing.

(d) Attach the hydraulic puller 2C5379 to the front end of the rotor shaft, and remove the front half of the ball bearing inner race.

(e) Remove the bolts that attach the front and rear frames together.

(f) Use the sling 2C5468 that is attached to the front frame flange, and lift the frame slightly. Remove the ball bearing cage.

(g) Lower the fan frame and install the guide arbor 2C5466 to the rotor shaft, and install the guide arbor housing to the bearing housing.

(h) Hoist the front frame from the rotor and place on the frame rear flange.

CAUTION: PLACE BLOCKS UNDER FLANGE TO PROVENT DAMAGE TO TRANSITION SEAL.

(i) Remove the guide housing (2C5466) from the bearing housing.

(6) Remove rotor from rear frame as follows:

(a) Remove guide arbor (2C5466) from front end of rotor and install lifting eye (2C5469).

(b) Attach hoist to lifting eye and remove rotor.

CAUTION: ENSURE ROTOR IS LIFTED STRAIGHT UP SO AS NOT TO DAMAGE THE SEGMENTS IN THE CARBON SEAL.

(c) Remove the retaining ring from the gear locknut on the aft end of the fan rotor shaft and attach the jacking screw part of (2C5464) to the gear locknut using 5 screws.

(d) Lower the rotor into the outrigger plate assembly (2C5465) which is mounted in the stand (2C5332). This prepares rotor for re-assembly.

(7) Position the rear frame front flange down and remove the rear scavenge pump as follows:

(a) Free the speed sensor conduit (62) from the pump and push aside.

(b) Remove the nuts (25), bolts (26), washers (27) and pump (24) from the bearing housing with 2 jacking screws (1/4-28 thread).

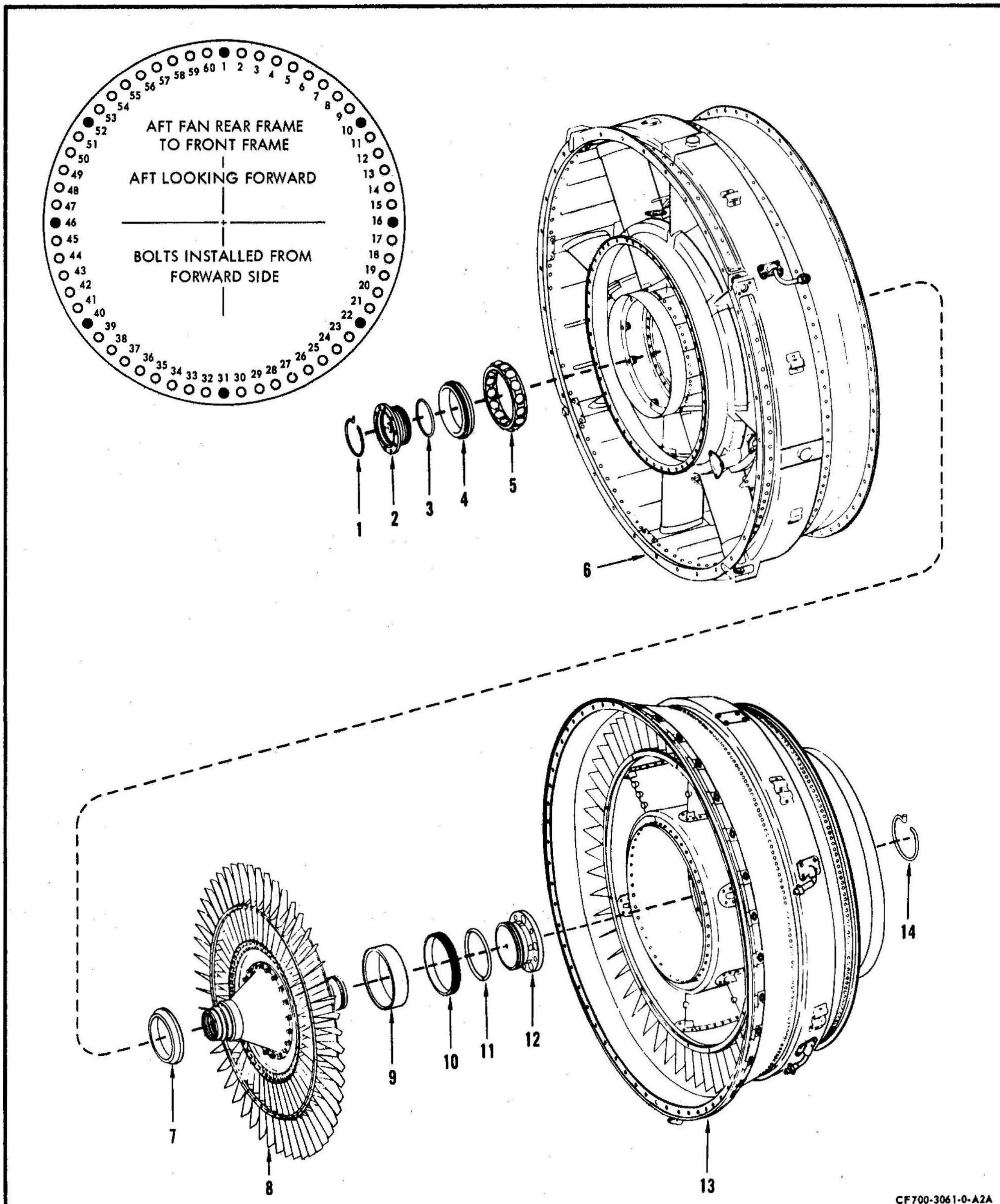
(c) Remove the O-rings (28, 29) and O-ring retainer (30).

(d) Remove the bolt (65) and remove the speed sensor block from the bearing housing. Retain the spacer shims.

B. Assembly. This procedure applies to the buildup of the aft fan assembly consisting of the fan front frame assembly, the fan rotor assembly and the fan rear frame assembly. The complete fan assembly is subsequently fitted to the engine.

(1) Install the fan front frame as follows: (See figure 203.)

(a) Measure and record the dimension from the front end of the rotor shaft to the front face of the rear half of the bearing inner race. Label this dimension V. Measure and record thickness of front half of bearing inner race. Label this dimension P. Subtract V from P and record this value as M.



Fan Section Assembly
Figure 203

(b) Install the lifting eye, 2C5469, to the rotor front shaft. Lift the rotor and place in the outrigger plate, 2C5464, if this was not accomplished at disassembly.

NOTE: Lower the rotor as far as possible into the fixture.

(c) Remove the lifting eye and install the guide arbor, 2C5466, into the rotor front shaft.

(d) Install the plate adapter of the guide arbor, 2C5466, to the bearing housing of the front frame.

(e) Take the fan front frame clearance checks as follows:

NOTE: It is only necessary to measure those clearances affected by any parts replaced.

1 Install proper thickness wax 60° apart circumferentially located to measure clearance Nos. 6, 7, 8, 9, 13 and 17, figure 204.

2 Lift the front frame using lift sling, 2C5468, and lower onto the rotor front shaft.

3 Remove the guide arbor and install the ball and cage assembly (5).

NOTE: Lift the front frame slightly to seat the ball and cage assembly against the inner race. Make sure front frame is all the way down to cut the wax to minimum thickness.

4 Remove the ball and cage assembly (5), and install the guide arbor, 2C5466.

5 Remove the front frame and check the wax thickness. Clearances must be within the limits specified in paragraph 4.

NOTE: If the limits are exceeded, an investigation must be conducted to determine the cause. Repair as necessary or replace part to obtain clearances.

(f) Reinstall the front frame on the rotor. Remove the guide arbor and reinstall the ball and cage assembly (5).

(g) Use the pusher, 2C5458, to install and seat the front half of the No. 4 bearing inner race (4) onto the rotor front shaft. Be sure the "O" matchmarks are aligned with the No. 1 dovetail slot on the rotor disc.

(h) Measure and record the dimension from the front face of the inner race (4) to the front end of the rotor shaft. This dimension must be within 0.001 inch of value M, recorded in step (1)(a).

(i) Install the O-ring (3) into the locknut (2). Install the locknut onto the rotor shaft. Use the spanner wrench, 2C5462, and torque the locknut to 165 lb-ft. Loosen and retorque to 150-165 lb-ft. Check to be sure one locknut hole is lined up with a slot in the rotor shaft for proper installation of the retaining ring.

(j) Install the retaining ring (1) and make certain it is fully seated into the groove in the locknut and the protruding end extends into a slot of the rotor shaft.

(k) Attach the lifting sling, 2C5327, to the trunnion adapters on the outrigger plate.

(l) Lift the front frame, turn it over, and place it on the front flange. Remove the outrigger, lifting yoke and jacking fixture.

(2) Install the fan rear frame as follows: (See figure 203.)

(a) Install the plate adapter of the guide arbor, 2C5466, to the No. 5 bearing housing.

(b) Install the guide arbor, 2C5466, to the rotor rear shaft.

(c) Take the fan rear frame clearance checks as follows:

NOTE: It is only necessary to measure those clearances affected by any parts replaced.

1 Install proper thickness wax 60° apart circumferentially located to measure clearance Nos. 10, 11, 12, 14, 15 and 18, figure 204.

2 Use lift sling, 2C5468, and lower the fan rear frame onto the rotor rear shaft.

3 Install 6 equally spaced bolts in the front and rear frame mating flanges and torque to 30-35 lb-in.

4 Remove the rear frame and check the wax thickness. Clearances must be within the limits specified in paragraph 4.

NOTE: If the limits are exceeded, an investigation must be conducted to determine the cause. Adjust or repair as necessary to obtain clearances. Adjust seal teeth shims as required.

(d) Re-install the fan rear frame.

(e) Remove the guide arbor, plate adapter and lift sling.

(f) Install the retaining ring (14) and make certain it is fully seated into the groove of the locknut and the protruding end extends into a slot of the rotor shaft.

(g) Install the lifting adapters, 2C5328, at the 3 and 9 o'clock positions.

(h) Install flange bolts and nuts Nos. 1, 10, 16, 22, 31, 40, 46 and 52 (shown in solid black in figure 203).

NOTE: The bolts will be torqued to 30-35 lb-in. when the remaining bolts are installed with the blade guard at engine assembly.

(3) Install the speed sensor as follows: (See figure 202.)

(a) Insert the probe end of the speed sensor (68) into the No. 5 bearing housing.

(b) Determine the shim thickness required to maintain a 0.005-0.008 inch clearance between the tip of the probe and the speed sensor ring on the shaft.

NOTE: It is recommended that the clearance be held as close as possible to the minimum limit when installing the speed sensor.

(c) Install the O-rings (67) onto the speed sensor; install the correct number of shims (66).

(d) Insert the probe end into the bearing housing and secure with the bolt (65). Torque the bolt to 18-22 lb-in.

(e) Make a shim check between the probe end and the sensor ring and record the clearance.

(4) Check the speed sensor as follows: (See figure 202.)

(a) Make a continuity check of the speed sensor at the receptacle (71). The resistance should read 123-183 ohms.

(b) Use a vacuum tube voltmeter in the microvolt range and connect the meter leads to the pins of the speed sensor connector. Do not allow the leads to touch.

(c) Hand rotate (spin) the fan rotor.

(d) An indication (needle deflection from zero) should appear on the meter scale.

(e) If an indication results in step (d), installation is probably good. If no indication appears, recheck for proper probe clearance (0.005-0.008 inch). Recheck solder joints, broken wiring, pins and insulation. Repeat steps (c) and (d).

(f) Check the torque (18-22 lb-in.) on the bolt (65) and lockwire.

(5) Install the rear scavenge pump as follows: (See figure 202.)

(a) Install the O-ring retainer (30) into the recess on the pump housing.

NOTE: Place the flat side of the retainer against the pump housing.

(b) Install the O-ring (29) against the O-ring retainer (30).

(c) Install the 2 O-rings (28) into the oil-in and oil-out ports.

(d) Install the pump (24) to the bearing housing and secure with 4 bolts (26), washers (27) and nuts (25). Cross-tighten until the pump is seated.

NOTE: If the O-ring retainer (30) shears, remove the sheared section and re-install the pump assembly.

(e) Align the speed sensor conduit (62) with the bolt holes at the 3 and 5 o'clock positions.

(f) Install the remaining bolts (26), washers (27) and nuts (25) to secure the speed sensor conduit and scavenge pump. Torque the bolts to 30-35 lb-in. and lockwire.

(6) Deleted.

(7) Using sling 2C5327 attached to the 2C5328 lifting adapters lift fan package into the 2C5332 assembly stand.

(8) Install the front scavenge pump (49) as follows: (See figure 202.)

(a) Install the O-ring retainer (55) into the recess on the pump housing.

NOTE: Place the flat side of the retainer against the pump housing.

(b) Install the O-ring (54) against the O-ring retainer (55).

(c) Install the 2 O-rings (53) into the oil-in and oil-out ports.

(d) Install the pump (49) to the bearing housing and secure with 4 bolts (51), washers (52) and nuts (50). Cross-tighten until the pump is seated. Install the remaining bolts, nuts and washers. Torque the bolts to 30-35 lb-in. and lockwire.

NOTE: If the O-ring retainer (55) shears, remove the sheared section and re-install the pump assembly.

(9) Deleted.

(10) Assemble the rear shield to the rear frame as follows: (See figure 202.)

(a) Install the rear shield (23) and secure in position with 2 bolts (21).

(b) Install the brackets (19) and secure with bolts (20) to the rear of the inner casing. Torque the bolts to 30-35 lb-in.

NOTE: Equally space the brackets around the OD of the casing.

(c) Remove the two bolts (21) installed in step (a) and install washers (22) between the rear shield (23) and the brackets (19). Secure the rear shield and the brackets to the rear frame with the bolts (21). Torque the bolts to 18-22 lb-in. and lock-wire, single-strand method, using 0.032 inch lockwire.

(11) Assemble the forward shield and forward frame cover to the front frame as follows: (See figure 202.)

(a) Install the forward shield (46) and rim clamps (47) to the front frame and secure with the bolts (48). Torque the bolts to 18-22 lb-in. and lock-wire, single-strand method, using 0.032 lockwire.

NOTE: Equally space the six rim clamps (47), using the 12 o'clock position as the starting point.

(b) Install the forward frame cover (63) and secure with the bolts (64). Torque the bolts to 22-27 lb-in. and lock-wire, single-strand method, using 0.032 inch lockwire.

NOTE: Assembly of the tailcone (17), blade guards (2 and 4), plug (59), and tubing will be accomplished at engine assembly.

4. Aft Fan Clearances. (See figure 204 and Table 201.) The following clearance limits apply to both the CF700-2C and CF700-2D engines unless otherwise indicated. They are not used for dimensional inspection of individual parts, but are used as guides when parts are replaced, or to verify serviceability of a new part. Inspection of clearances and dimensions need only be performed when it is specifically required in the text.

TABLE 201. AFT FAN CLEARANCES
(Refer to figure 204.)

Clearance No.	Description	Direction Measured	Operating Limits Min.	Max.
1.	Second-Stage Blade Platform to Fan Front Frame.			
	CF700-2C Engine.	A	0.210	
	CF700-2D Engine.	A	0.120	
2.	Second-Stage Blade Locking Strip to Fan Front Frame.			
	CF700-2C Engine.	A	0.210	
	CF700-2D Engine.	A	0.120	
3.	Second-Stage Turbine Wheel to Fan Front Frame.			
	CF700-2C Engine.	A	0.210	
	CF700-2D Engine.	A	0.130	
4.	Bearing to Oil Nozzle.	A	0.030	
5.	Rubbing Seal Runner to Oil Nozzle.	A	0.100	
6.	Rotor Shaft to Front Baffle.	A	0.070	
7.	Blade Retainer to Nozzle.	A	0.120	0.200
8.	Blade to Nozzle.	A	0.120	0.200
9.	Rotor Disk to Nozzle.	R	0.090	0.185
10.	Blade to Frame.	A	0.130	0.250
11.	Rotor Disk to Frame.	R	0.070	0.200
12.	Blade Platform to Rear Frame.	A	0.150	0.310
13.	Blade Tooth to Front Transition Seal.	A	0.035	
14.	Aft Platform Face to Rear Transition Seal.	A	0.060	0.130

Clearance No.	Description	Direction Measured	Operating Limits Min.	Max.
15.	Blade Tooth to Rear Transition Seal.			
	CF700-2C Engine.	R		0.070
	CF700-2D Engine.	R		0.030
16.	Blade Tip to Shroud.			
	CF700-2C Engine.	R	0.065	0.130
	CF700-2D Engine.	R	0.065	0.100
17.	Blade Tooth to Front Transition Seal.			
	CF700-2C Engine.	R		0.040
	CF700-2D Engine.	R		0.030

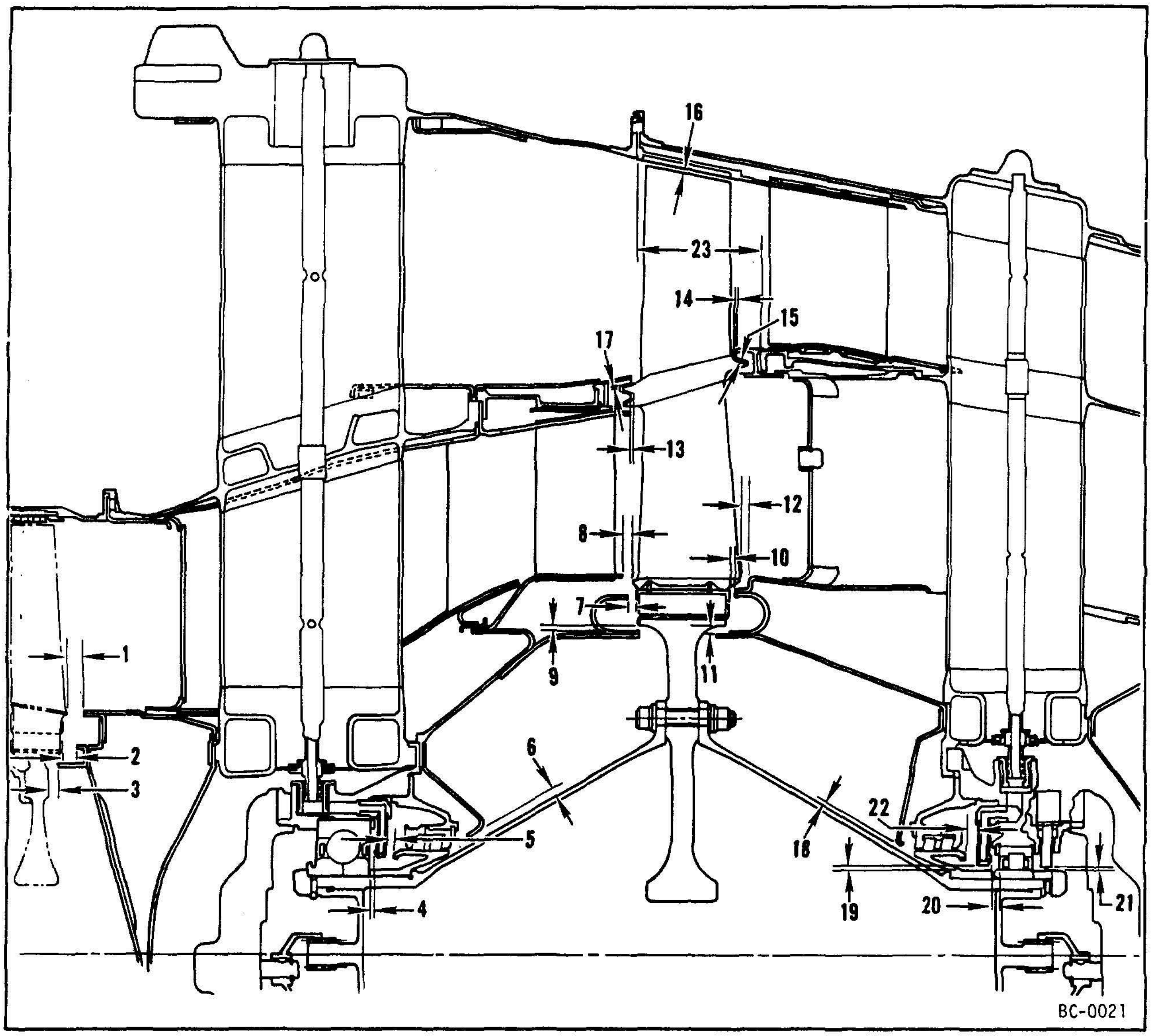
Clearance No.	Description	Direction Measured	Operating Limits Min.	Operating Limits Max.
18.	Rotor Shaft to Rear Baffle	R	0.070	
19.	Oil Nozzle to Seal Runner	R	0.020	
20.	Oil Nozzle to Rear Bearing	A	0.030	
21.	Speed Sensor Probe to Sensor Ring	R	0.005	0.008
22.	Rubbing Seal Runner to Oil Nozzle	A	0.100	
23.	Forward Surface Outer Flange to Forward Surface Inner Support	A	2.292	2.302

5. **Inspection/Check. If CF700 Service Bulletins (Replacement of Viton A O-rings with Viton (Fluorel 2160) O-rings) 72-96 and 79-8 (Fan Center Vent System) have been incorporated, remove the front and rear scavenge pumps (see paragraph 3.A.) and inspect the No. 4 and 5 sump area as follows:**

NOTE: This inspection requirement is applicable during every other Hot Section Inspection.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Oil leaks past No. 4 and 5 carbon seals. (Identified by oil around blades at 6 o'clock position)	Any amount provided the engine oil consumption limits are not exceeded.	Replace seals.
B. Oil leaks past scavenge pumps or oil tubes.	None allowed.	Replace O-rings.

C. Deleted.



Fan Section Clearances
Figure 204

Inspection/Check	Maximum Serviceable Limits	Remarks
D. Lube system contamination.		
(1) Metallic particles	None allowed.	Flush lube system. Remove, clean and inspect No. 4 and 5 bearings per 72-02-3.
(2) Non-metallic particles		
(a) Particles in lube filter and sump.	None allowed.	Flush lube system. Remove and clean oil tubes, No. 4 and 5, bearing housing, oil nozzle and carbon seals per paragraph 6. Remove, clean and inspect No. 4 and 5 bearings per 72-02-3.
(b) Particles only in sump area.	None allowed.	Remove and clean oil tubes per paragraph 6. Pressure flow check oil nozzle per 72-73-0, paragraph 2.B.(8).

6. Cleaning.

NOTE: If overhaul shop cleaning facilities are available they shall be used in place of the following procedures.

A. Cleaning of No. 4 and 5 Bearing Housing and Oil Nozzle.

(1) Soak part in trichloroethylene, or equivalent, for at least 15 minutes.

(2) Blow out all oil passages, in a direction opposite to normal oil flow, with clean filtered air.

(3) Rinse in clean trichloroethylene, or equivalent, drain and blow dry using clean filtered air. If part is not to be immediately used, place in clean polyethylene bag.

B. Cleaning of No. 4 and 5 Oil Tubes.

NOTE: This procedure shall be used on only the oil-in and oil-out tubes.

(1) Soak part in trichloroethylene, or equivalent, for at least 15 minutes.

(2) Use a 22 caliber bore cleaning brush to scrub the straight portion of the tube.

(3) Blow the tube out with clean filtered air.

(4) Bend a piece of 1/16 inch diameter steel wire approximately 17 inches long so as to form a hook, approximately 1/8 inch long, on the end of it and cut off with a pair of side cutters leaving a sharp point on the hook.

(5) Run the sharp point of the wire over the inside length of the tube. If any black particles appear on the point of the wire, repeat steps (1), (2) and (3) until the tube is clean.

(6) If part is not to be immediately used, place in clean polyethylene bag.

FAN FRONT FRAME - MAINTENANCE PRACTICES

1. General. At first hot section inspection maintenance of the fan front frame consists of Inspection/Check and Approved Repair of the frame with the aft fan section assembled.

2. Disassembly/Assembly. This procedure is performed only when required and pertains to the fan front frame after it has been removed from the aft fan assembly per 72-70.

   A. Disassembly. (See figure 201 unless otherwise indicated.)

      (1) Position the frame with the front flange up. Remove the bolts (1) that secure the spacers (2) and remove the spacers.

      NOTE: Matchmark parts in order to reassemble in same position (or rotated 180° in the case of the fan nozzle).

      (2) Position the frame with the rear flange up and remove the bolts (22) from the fan nozzle (23) and front baffle (21). Remove the front baffle.

      (3) Remove the fan turbine nozzle (23) with the transition seal (16), inner heat shield (17) and transition seal support (18).

      (4) Remove the nozzle (23) and visually inspect per paragraph 2 for cracked partitions only.

      NOTE: Removal of the front baffle and fan nozzle releases the No. 4 bearing housing (5).

      (5) Remove the bearing housing and disassemble as follows:

      NOTE: Sump vent tube (35) at the 2 o'clock pad must be retracted in the outboard direction to allow removal of the bearing housing.

         (a) Remove the bolts (15) and use the seal puller, 2C5351, to remove the oil seal (14) from the bearing housing.

         CAUTION: DO NOT USE SCREWDRIVERS TO PRY THE OIL SEAL HOUSING FROM THE BEARING HOUSING.

         (b) Remove the O-ring retainer (13) and O-ring (12).

         (c) Remove the bolts (11), oil nozzle (9) and O-ring (10).

(6) Wash bearing housing and oil nozzle in a suitable solvent and ultrasonically clean per 72-70, paragraph 5 (Cleaning of No. 4 and No. 5 Bearing Housings.) of the Overhaul Manual.

(7) Recondition the oil seal (14) by replacing the carbon segments per the Overhaul Manual or replace the carbon seal assembly with a new or overhauled assembly with zero time.

(8) If the facilities are available, clean the fan frame per Section 72-70 of the Overhaul Manual. If the bearing housings are in place, inspect the area between the bearing housing and fan frame for manufacturing chips which were trapped in the frame and have shifted during engine operation.

B. Assembly. (See figure 201.)

(1) Assemble the front (No. 4) bearing housing as follows:

(a) Install the O-ring (10) onto the oil nozzle (9) and secure to the housing with the bolts (11). Torque the bolts to 22-27 lb-in. and lockwire.

NOTE: The oil nozzle is in the 4 o'clock position viewed aft looking forward.

(2) Install the O-ring (36) onto the sump vent tube (35). Push the tube radially outward to allow clearance for installation of the bearing housing.

(3) Install the bearing housing (5) into the front frame (3) with the oil nozzle in the 4 o'clock position. Install 2 bolts (15) finger-tight.

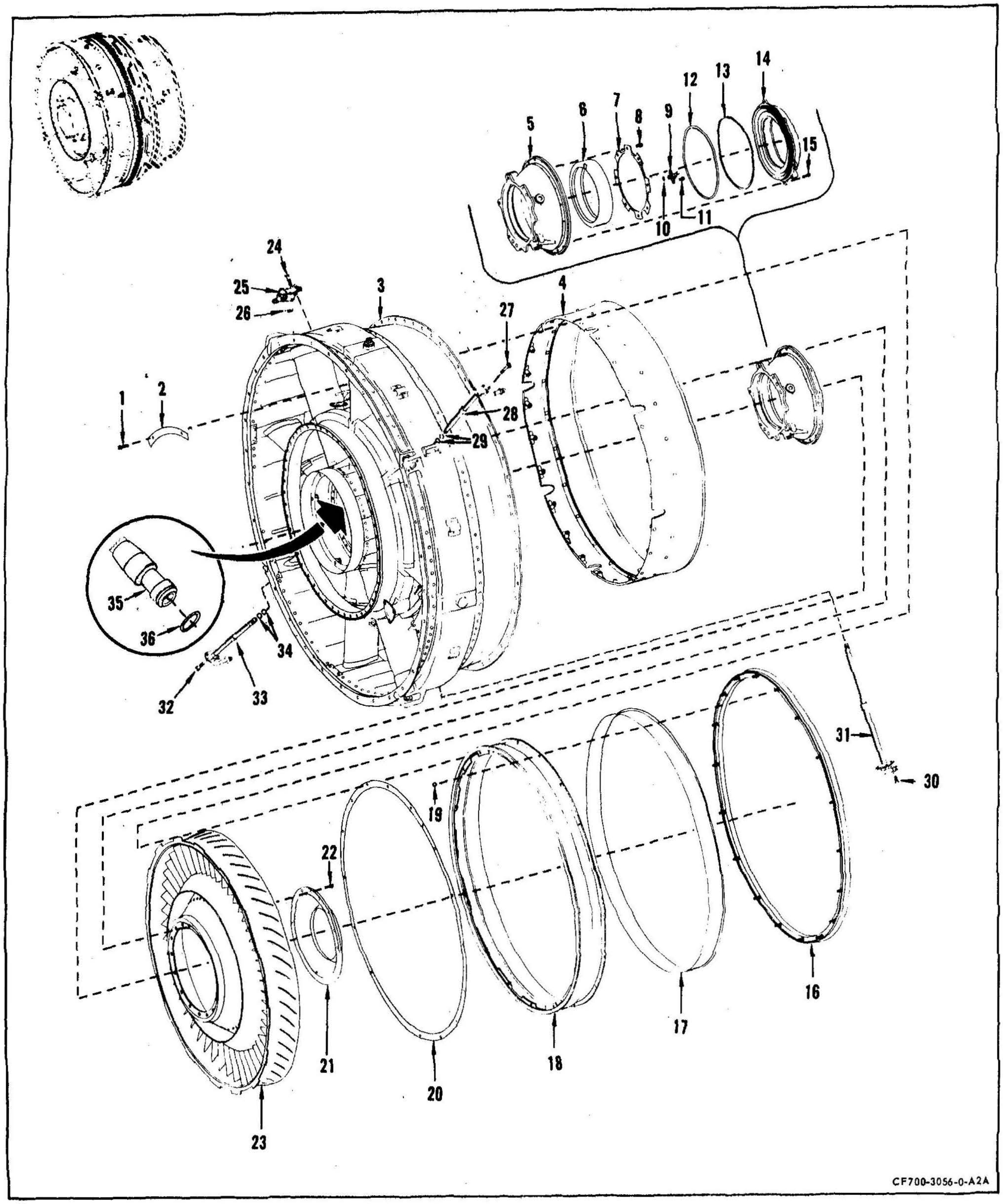
NOTE: The bearing housing is not secured at this time to allow alignment of air and oil tubes into housing.

(4) Install the elbow fitting (25) and gasket (26). Lubricate the bolts (24) with engine oil. Install the bolts and torque 45-50 lb-in. and lockwire.

NOTE: Deleted.

NOTE: All tube assemblies on the fan front frame are installed with the elbow pointing aft.

CAUTION: BE SURE THAT ALL TUBES ARE CENTRALIZED AT THE MID POINT OF THE STRUTS TO PREVENT DAMAGE TO THE TUBES AND PREVENT KNOCKING CONTAMINATION FROM THE TUBE PASSAGE INTO THE BEARING HOUSING WHEN INSERTING THE TUBE.



Fan Front Frame Assembly
Figure 201

(5) Install the O-rings (29) onto the oil scavenge tube (28) and insert the tube down the passage until it is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from the bearing housing and insert the tube. Secure with bolts (27). Torque to 22-27 lb-in. and lockwire.

(6) Insert the seal-air tube (31) down the passage until it is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from from the bearing housing and insert the tube. Secure with bolts (30), torque to 22-27 lb-in. and lockwire.

(7) Install the O-rings (34) onto the oil supply tube (33) and insert the tube down the passage until it is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from the bearing housing and insert the tube. Secure with bolts (32) and torque to 22-27 lb-in. and lockwire.

(8) Apply a pressure of 8-12 PSIG to the oil supply tube, using engine oil, for 1 minute. Increase the pressure to 48-52 PSIG and hold for 2 minutes. Reduce the pressure to 8-12 PSIG and hold for 1 minute. A clean, continuous stream shall come from the oil nozzle and the seal nozzle. If any restriction of the nozzle is indicated clean per 72-70, paragraph 5 of the Overhaul Manual.

(9) Install the transition seal support and seal assembly onto the fan turbine nozzle (23).

(10) Lift the seal support assembly and install the locking ring (20) between the nozzle and the seal support. Return the seal to original position.

CAUTION: INSTALL THE LOCKING RING CAREFULLY AROUND THE OD OF THE NOZZLE IN A CLOCKWISE DIRECTION WITH THE LOCKING RING HOLES APPROXIMATELY 1/2 INCH FROM THE TABS.

(11) Remove the 2 bolts (15) securing the bearing housing.

(12) Insert the nozzle assembly into the front frame with the nozzle rotated 180° from its position at disassembly. If the nozzle lugs do not fit into the slots in the frame, lug width may be reduced to 1.418 inch with a file or by machining. Remove only required amount for assembly. Align the bolt holes in the nozzle and bearing housing and install 4 bolts (22) to support the 2 assemblies.

NOTE: To allow the rotational capability the nozzle must have been modified per S/B CF72-75.

CAUTION: BEFORE TIGHTENING BOLTS (22), LIFT THE CASING AND SEAL SUPPORT AND USING A MIRROR AT 4 STRUT SLOTS 90° APART CHECK THE LUG ENGAGEMENT OF THE FAN TURBINE NOZZLE TO THE CASING. ROTATE NOZZLE CLOCKWISE SO NOZZLE FLANGE LUGS ARE UP AGAINST SIDES OF FRONT FRAME FLANGE BOSSES.

(13) Position the fan frame with the front flange up. Place blocks under the rear outer flange to prevent damage to the transition seal.

(14) Align the holes of the fan nozzle locking ring and seal support. Working in a clockwise direction install the 8 split sector rings (2). Secure with the bolts (1). Torque the bolts to 30-35 lb-in.

NOTE: Push all the sectors radially outward as far as possible while tightening the bolts. When all sectors are in place, check the inner casing (4) for radial play. Move segments where necessary to eliminate radial movement.

(15) Install the O-ring retainer (13) into the groove on the carbon seal (14). Install with the flat side of the retainer against the carbon seal housing.

(16) Install the O-ring (12) into the groove of the carbon seal (14) and against the O-ring retainer (13).

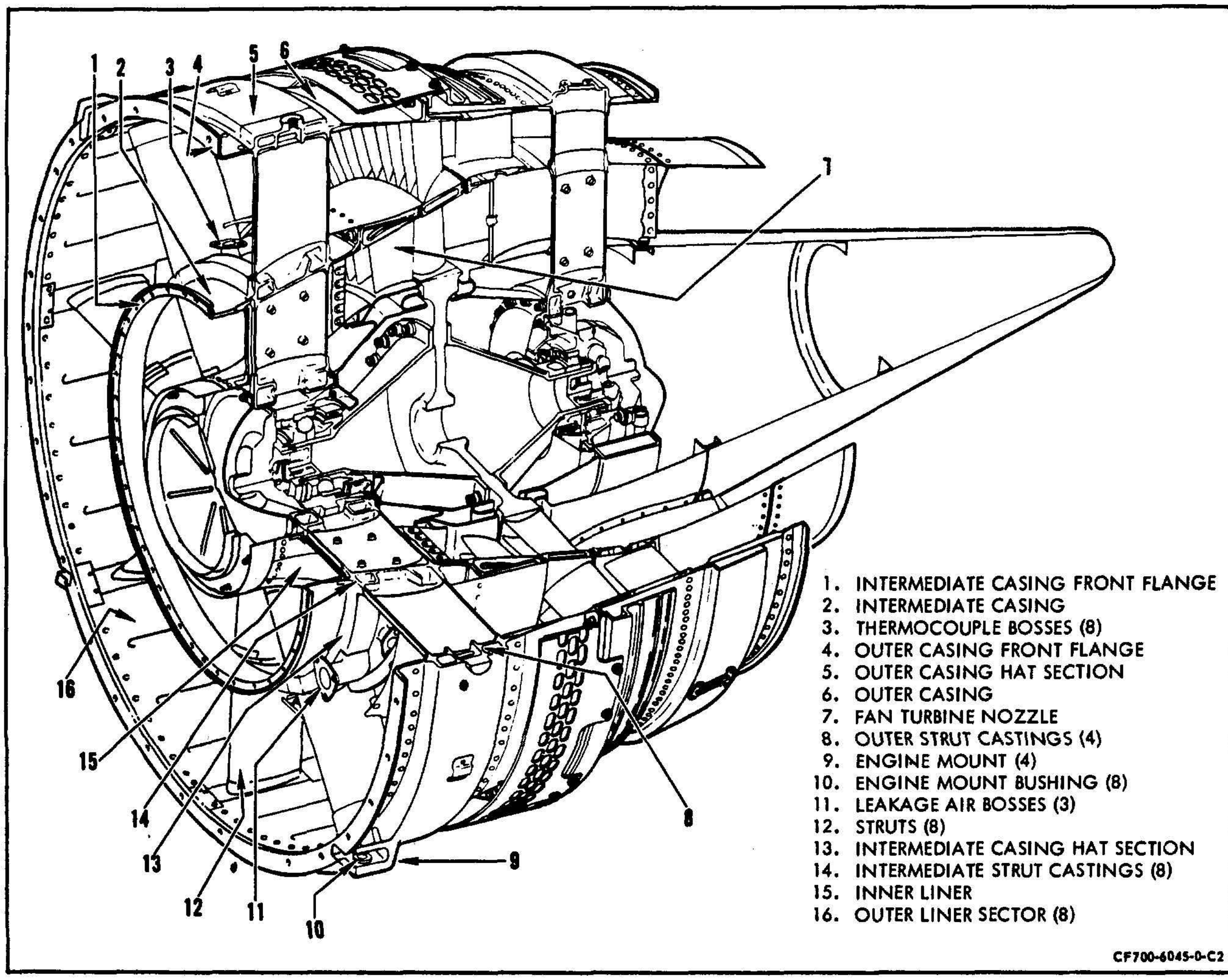
(17) Install the carbon seal into the bearing housing (5). Position the seal and seat with 3 bolts (15).

(18) Install the remaining bolts (15). Torque the bolts to 18-22 lb-in. and lock-wire.

(19) Remove the 4 bolts (22) that secure the fan turbine nozzle and bearing housing.

(20) Install the front baffle (21) and secure with the bolts (22). Torque the bolts to 22-27 lb-in and lock-wire.

3. Inspection/Check. (See figure 202.) Visually inspect the fan front frame. When serviceable limits are exceeded, the frame may be repaired in accordance with the overhaul manual, unless noted otherwise.



Fan Section - Front Frame Inspection
Figure 202

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Outer casing (6) for:		
(1) Parent metal cracks.	Nine, 3/8 inch long, no closer together than 3 inches.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	
(3) Dents and bulges.	2 between adjacent struts, 1/8 inch deep, with no sharp edges.	
(4) Thread damage in holes at end of struts.	One thread (cumulative) damaged or missing per hole, provided threads can be used without danger of cross threading.	
B. The outer casing forward mounting flange (4) for:		
(1) Cracks in bolt holes.	One per bolt hole extending radially outward, provided cracked holes are separated by one uncracked hole. Six cracked holes maximum.	
(2) Circumferential weld cracks (flange-to-casing).	3 per weld, 3/8 inch long, no closer together than 1 inch.	
(3) Transverse weld cracks (flange-to-casing).	4 per weld not extending into parent metal, no closer together than 1 inch.	
C. Engine mounts (9) for:		
(1) Parent metal cracks.	Not serviceable.	
(2) Weld cracks.	Not serviceable.	
D. Main mount bushings (10) for:		
(1) Cracks.	One crack per bushing in the shoulder not extending into the bushing bore.	
(2) Wear.	ID not more than 0.4387 inch diameter.	
(3) Looseness in housing.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(4) Galling in ID.	30 percent of bearing area inner and outer bushings with no apparent depth.	
E. Mounting bolt for:		
(1) Bearing diameter wear.	Not less than 0.4365 diameter.	Replace bolt.
(2) Bearing diameter scoring (galling).	Not more than 30% of bearing area with no apparent depth. No high metal.	Replace bolt.
(3) Nicks and scratches.	No apparent depth.	Replace bolt.
(4) Cracks.	Not serviceable.	Replace bolt.
(5) Damaged threads.	One thread (cumulative) provided there is no interference with seating of bolt.	Replace bolt.
(6) Bent bolt.	Not serviceable.	Replace bolt.
F. Outer casing hat section (5) for:		
(1) Parent metal cracks.	Not serviceable.	
(2) Attaching seam-weld cracks.	3 between adjacent struts, 3/8 inch long.	
(3) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(4) Dents and bulges.	2 between adjacent struts, 1/4 inch deep, with no sharp edges.	
G. Intermediate casing (2) for:		
(1) Cracks.	Nine, 3/8 inch long, no closer together than 2 inches.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Dents and bulges.	One between adjacent struts, 1/8 inch deep, with no sharp edges.	
H. Intermediate casing forward mounting flange (1) for:		
(1) Cracks in the bolt holes.	Not serviceable.	
(2) Circumferential weld cracks (flange-to casing).	3 per weld, 3/8 inch long, no closer than 1 inch.	
(3) Transverse weld cracks (flange-to casing).	4 per weld not extending into parent metal, no closer together than 1 inch.	
I. Thermocouple and leakage air bosses (3, 11) for:		
(1) Parent metal cracks.	Not serviceable.	
(2) Weld cracks.	One, 1/8 inch long.	
J. Intermediate casing hat section (13) for:		
(1) Parent metal cracks.	Not serviceable.	
(2) Attaching seam weld cracks.	Two between adjacent struts, 3/8 inch long.	
(3) Nicks and gouges.	Any number, .015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(4) Dents and bulges.	2 between adjacent struts, 1/8 inch deep, with no sharp edges.	Cold work to adjacent contour. Spot fluorescent-penetrant inspect per 72-03-1. No cracks allowed.
K. Strut castings (8, 14) for:		
(1) Parent metal cracks.	Any number, 1/8 inch long, no closer than 1 inch.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Strut-to-casting welds for cracks.	Not serviceable.	
(3) All other casting welds for cracks.	2 cracks running transversely to the weldment and one running along the weldment, 1/8 inch long per casting.	
L. Struts (12) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(3) Dents.	Any number, 1/16 inch deep; 3 per strut 1/8 inch deep. Diameter of defect no more than 1/2 inch.	
M. Each sector of the outer casing liner (16) for:		
(1) Cracks.	Two 1/2 inch long, no closer together than 1/2 inch provided cracks are stop-drilled.	Replace aluminum panel per paragraph 4.B. Replace steel panel per paragraph 4.C.
(2) Dents from foreign object damage.	Any number, 1/8 inch deep. Diameter of defect no more than 1 inch with 0.015 inch gouge at bottom of dent.	Replace aluminum panel per paragraph 4.B. Replace steel panel per paragraph 4.C.
(3) Bulges and dents from other causes.	Two, 1/8 inch deep.	Replace aluminum panel per paragraph 4.B. Replace steel panel per paragraph 4.C.
(4) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Replace aluminum panel per paragraph 4.B. Replace steel panel per paragraph 4.C.

Inspection/Check	Maximum Serviceable Limits	Remarks
(5) Pierced areas.	2 pierced areas, 1/16 inch wide, 3/8 inch long, no closer together than 1 inch.	Replace aluminum panel per paragraph 4.B. Replace steel panel per paragraph 4.C.
(6) Loose or missing rivets.	One missing rivet per row in each panel except no rivets missing in joint plates or joint strips at strut leading or trailing edge.	Remove loose rivets. Replace rivets per paragraph 4.B.
(7) Aluminum panel oil canning.	0.050 inch deflection when depressed by finger pressure.	Replace panel per paragraph 4.B.
N. Inner liner (15)		
(1) Outer and inner skin for:		
(a) Cracks per skin.	2 between adjacent struts, 3/8 inch long, no closer together than 1/2 inch.	
(b) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	

Inspection/Check	Maximum Serviceable Limits	Remarks

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN..

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

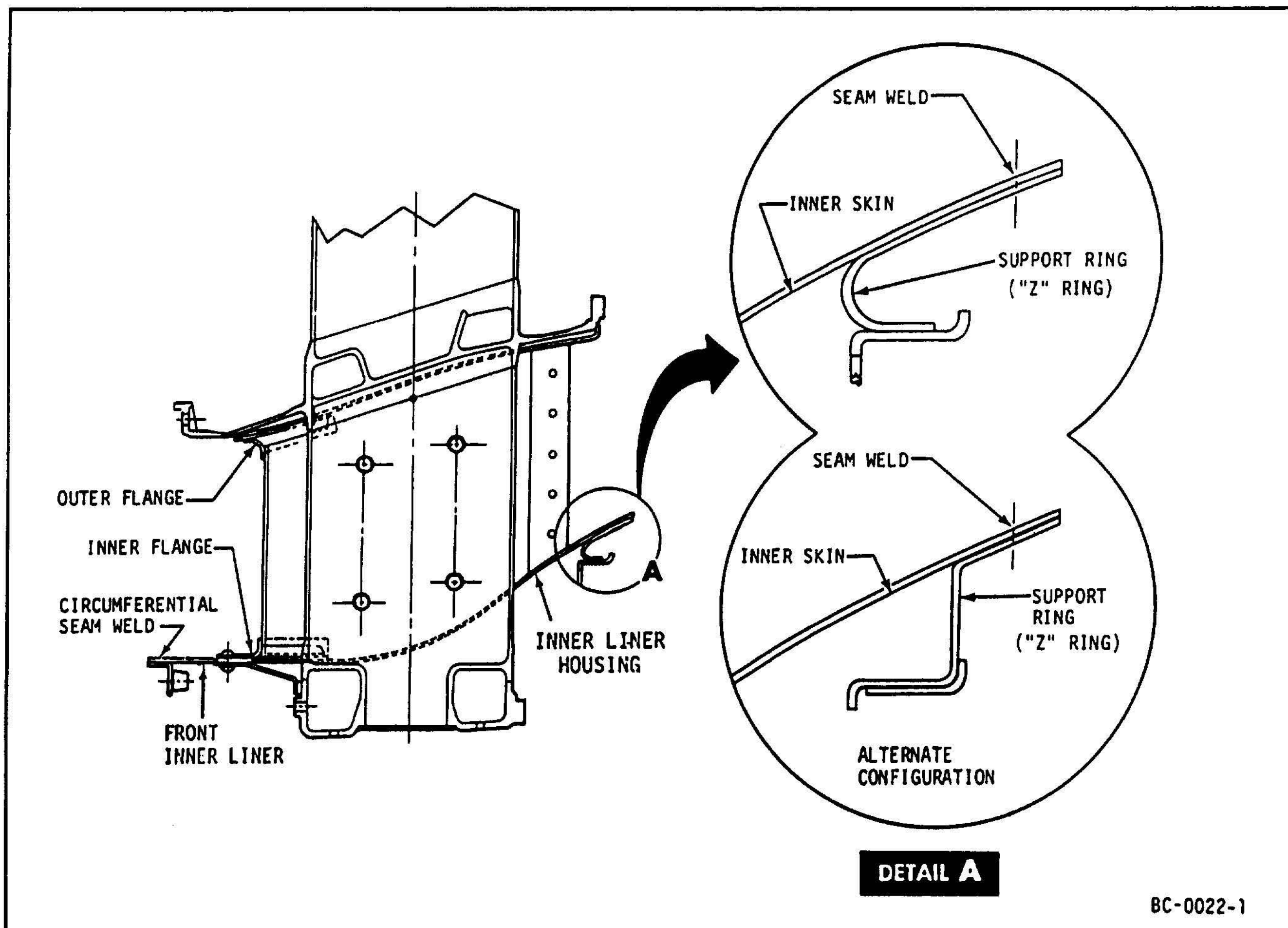
WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

Inspection/Check	Maximum Serviceable Limits	Remarks
(c) Cracks in seam weld joining Z-ring to inner skin (See figure 202A).	4 inches long, separated by at least 4 inches; maximum cumulative length 8 inches.	Weld using AMS 5794 filler and argon 2-10 CFH gas backup or copper backup. Spot fluorescent-penetrant inspect.
(d) Cracks at circumferential seam weld on Front Inner Liner (see figure 202A). Spot fluorescent-penetrant inspect and visual inspect using a 5-power, or higher, glass.	Not serviceable.	Repair per paragraph 4.E.

(2) Each strut fairing and nose fairing for:

Inspection/Check	Maximum Serviceable Limits	Remarks
(a) Cracks in the fillet radius atthe inner and outer skin.	One crack per radius, 3/8 inch long.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(b) Cracks in the leading edge radius (outer and inner flange, see figure 202A).	Any amount provided no material is in danger of falling out.	
(c) Cracks starting at rivet holes.	One crack per rivet hole, 1/4 inch long.	
(d) All other parent metal cracks.	One, 3/4 inch long.	
(e) Weld cracks.	Any number, 1/8 inch long, cumulative length not to exceed 1/2 inch.	



Fan Front Frame Inner Liner
Figure 202A

Inspection/Check	Maximum Serviceable Limits	Remarks
(f) Bulges or dents.	Any number, 3/16 inch deep.	
(g) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	
(h) Loose or missing rivets.	One either side of fairing at inner and outer skin.	
O. Front liner ring for:		
(1) Cracks.		
(a) Axial.	Two per cutout, 1/2 inch long after stop-drilling. Stop-drilled ends of cracks must be no closer than 0.9 inch. 1 crack per cut-out extending to within 1/4 inch of flange after stop-drilling.	Stop-drill per paragraph 4.A.
(b) Circumferential.	Not serviceable.	
(2) Wear in cutouts.	Not serviceable.	Bench or cold-work to avoid interference with nose fairing.
(3) Deformation in bolt-holes.	Three serviceable bolt-holes between broken-out holes.	Remove high metal.
P. Fan turbine nozzle.		

NOTE: A nozzle showing localized distress in the lower half, but still within serviceable limits, may be rotated 180 degrees by maintenance facilities that have teardown/buildup capability. CEB (CF700) 72-75 must have been complied with prior to nozzle rotation.

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Partitions for:		
(a) Cracks.	Any combination of the following cracks not to exceed a cumulative total of 50 cracks per nozzle.	

Inspection/Check	Maximum Serviceable Limits	Remarks
- Axial cracks:		
	1/8 inch long, 40 per nozzle, 6 per partition. 1/4 inch long, 10 per nozzle, 2 per partition. 3/8 inch long, 3 per nozzle, 1 per partition.	
- Radial cracks:		
	1/4 inch long, 10 per nozzle, 2 per partition.	
NOTE: Axial and radial cracks in same partition must be separated by at least 3/4 inch of undamaged material.		
(b) Burns and erosion.	1/8 inch from leading or trailing edge over a distance of 3/4 inch, 10 partitions per nozzle.	
(c) Dents.	Any number 0.040 inch deep with smooth deformation.	
(d) Nicks and gouges.	Any number 0.015 inch deep after removal of high metal.	
(2) Partition weld joints for:		
(a) Cracks.	One crack 5/8 inch long per partition, 5 partitions per nozzle.	
(3) Inner and outer band for:		
(a) Buckling or distortion.	Any amount 0.060 inch deep.	
(b) Cracks extending from the partition slot to the leading or trailing edge of band.	9 cracks in each band (inner and outer), with not more than 3 adjacent partition slots affected.	
(c) Circumferential cracks.	10 cracks 1/2 inch long in each band of the support structure with a minimum of 1-1/2 inches between cracks.	
(4) Burnouts.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
Q. Sump vent tube as follows:		
NOTE: The sump vent tube cannot be removed but can be retracted in the outboard direction far enough (approximately 5/8 inch) to allow removal of the bearing housing or replacement of the O-ring on the vent tube.		
(1) Braze cracks.	Not serviceable.	Repair per paragraph 4.D.
(2) Parent metal cracks.	None allowed.	Replace affected part.
(3) Distortion.	Any amount, provided system does not leak.	Replace affected part.
R. Air and oil tubes (if removed) for:		
(1) Damage to wear sleeve at middle of tube.	Any amount no deeper than 0.010 inch from original contour.	Replace part.
(2) Dents in heat shield.	Any number not exceeding 0.020 inch.	Replace part.
(3) Nicks or dents in bottom or edge of O-ring groove.	Not serviceable.	Blend sharp edges smoothly into original surface.

Inspection/Check	Maximum Serviceable Limits	Remarks
(4) Fitting thread damage.	One full thread damaged, cumulative.	Chase threads.

4. Approved Repair.

A. Minor Repair Procedures.

(1) Remove high metal from external tube flanges, exposed tubes, all areas in the secondary air-stream passage and the fan turbine nozzle.

(2) Chase threads as required to repair thread damage.

(3) Tighten or replace loose or missing rivets.

(4) Stop-drill cracks at each growing end. Use a drill not over 0.040 inch in diameter. Carefully center the drill on the last trace of the crack and drill through the material. Deburr edges of holes on both sides.

B. Aluminum Panel Replacement.

(1) Position the new panel and check fit to the casing.

(2) Clamp the panel in place.

(3) Using the rivet holes in the casing as a guide, drill through the panel with a No. 30 drill (0.128-0.132 inch dia) starting at the mid-point of each row and drilling 6 holes (3 on each side of the mid-point).

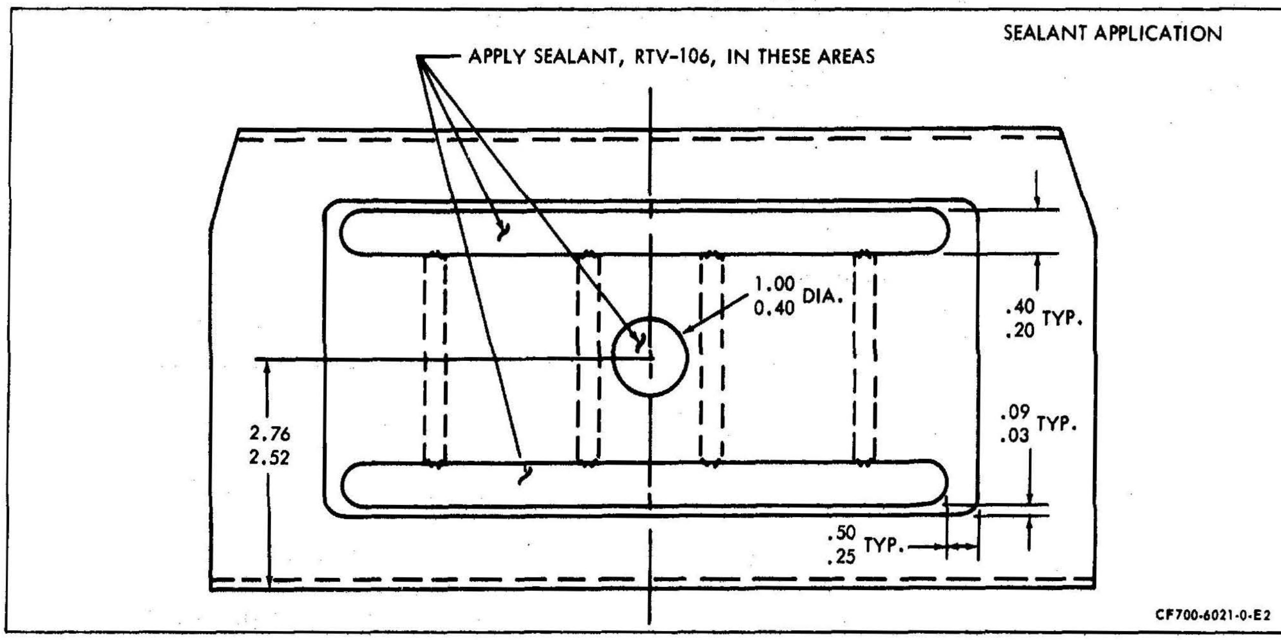
CAUTION: DO NOT USE EXCESSIVE FORCE WHEN DRILLING THROUGH THE PANEL AND DO NOT DRILL INTO THE SIDE OF THE CASING RIVET HOLE.

(4) Remove any burrs from the drilled holes.

(5) Apply Silicone Rubber Sealant as follows:

(a) Clean the panel sealing area (see figure 203) with acetone or trichloroethylene.

WARNING: PERFORM THIS OPERATION IN AN APPROVED CLEANING CABINET OR WELL VENTILATED AREA. TAKE PRECAUTIONS TO PREVENT INHALATION OF VAPORS AND TO MINIMIZE FIRE HAZARDS. REPEATED OR PROLONGED CONTACT OF SOME CLEANING MATERIALS WITH THE SKIN WILL REMOVE SKIN OILS AND MAY CAUSE SEVERE DERMATITIS.



Sealant Application Areas
Figure 203

NOTE: Mating seal areas on the frame must be free of oxides and foreign material before assembling panel. Use No. 20 grit sandpaper or equivalent.

(b) Apply silicone rubber sealant RTV-106 (General Electric Co., Silicone Products Dept., Waterford, New York) or equivalent, to the panel in the areas indicated in figure 203.

WARNING: UNCURED RUBBER IRRITATES EYES. IN CASE OF CONTACT IMMEDIATELY FLUSH EYES FOR AT LEAST 15 MINUTES. NOTIFY PHYSICIAN.

NOTE: Sealant to be used must not exceed shelf life limit of 12 months.

Apply the sealant through a spout with a 3/16 inch diameter in a single pass. The height of the sealant must not be less than 1/8 inch to assure contact with frame at assembly.

CAUTION: THE MAXIMUM ELAPSED TIME BETWEEN APPLICATION OF SEALANT AND POSITIONING OF PANEL SHALL NOT EXCEED 5 MINUTES.

(c) Cure parts at 70°F or higher (up to 120°F) for a minimum of 24 hours after assembly is completed.

(6) Use blind, self-plugging rivets (Townsend Co., Cherry Rivet Division, Santa Ana, California) or equivalent, in the following sizes:

Present Number	MS Number	Cherry Rivet Equiv.
R1220P56	MS20600-MP4K3	CR563-4-6
R1220P58	MS20600-MP4K4	CR563-4-8
R1220P62	MS20600-MP4K6	CR563-4-12
R1220P64	MS20600-MP5K7	CR563-5-14

(7) Install 12 rivets into the drilled holes from the inside of the casing. Use washer 2002T30P01 on the casing ID and washer 2002T30P02 on the casing OD, on each rivet.

(8) Use appropriate size rivet gun and pulling heads specified in Cherry Rivet Process Manual for series 100, 200, 300, 500 Cherry Rivets. Pull stems through and cut flush with rivet head. Stem ends should be shaved or filed to form smooth contour with rivet manufactured head.

(9) Drill the remaining holes as described in step (3) except one hole located in the center of the joint plate (if removed) behind the strut should be drilled through with No. 20 drill (.160-.164 diameter). Ream the spacer used between the liner panel and the casing in this location to .160-.164 diameter.

(10) Install the proper size rivets in the remaining holes using spacers (2002T16P01, P02) at proper locations under joint plate, if removed. Rivet CR563-5-14 is used in the .160-.164 diameter hole.

(11) Inspect for loose rivets or defective heads. Maximum acceptable clearance under rivet head on any one side .004 inch. Replace all defective rivets.

(12) Inspect the panel for "oil canning" after the panel is installed. The maximum deflection is 0.050 inch when finger pressure is applied.

C. Steel Panel Replacement.

(1) Remove the panel by removing 2 bolts.

(2) Fit up and install replacement panel.

(3) Install 2 bolts and torque to 30-35 lb-in.

D. Sump Vent Tube Braze Repair.

(1) Pull the vent tube plate out as far as possible. Unbraze the plate from the tube and discard the plate. Thoroughly clean the tube end and the surface of the replacement plate to be brazed. Do not remove parent metal. Vapor degrease area to be brazed.

(2) Apply AMS 3410 flux to the surfaces to be brazed.

(3) Braze the tube to the new plate as follows:

(a) Braze Data:

Torch tip size	-	No. 3 or No. 4
Torch gas pressure	-	Oxygen, 5 psig - hydrogen, 5 psig
Filler material	-	AMS 4770 wire, 0.030-0.062 inch diameter
Braze flux	-	AMS 3410

(b) Adjust the torch so that a neutral-to-a-slightly-reducing flame (yellowish blue) is produced.

(c) Insert the new plate over the tube with the counter bore surface outward from the frame so that the tube end is flush with counterbore surface.

(d) Carefully push the tube and plate assembly into the frame until the plate is against the pad. Measure the distance from the frame centerline to the inner end of the tube as shown in figure 204. Adjust the tube in the new plate until this measurement is 2.96-3.00 inch. Scribe the location of the tube in the plate.

(e) Pull the tube and plate assembly out to the end of its travel and heat the area to be brazed when it is assured the tube and plate are in correct relative location as measured in step (d).

(f) Heat the area to be brazed to approximately 1200°F (650°C).

NOTE: Check part temperature by touching the repair area with the filler wire. If the part is at temperature, the braze will flow.

(g) Manually feed a small amount of filler wire into the joint being repaired. Use only a minimum amount of filler wire.

(h) Direct the torch flame so that the tube gets a minimum amount of heat in the non-repair area.

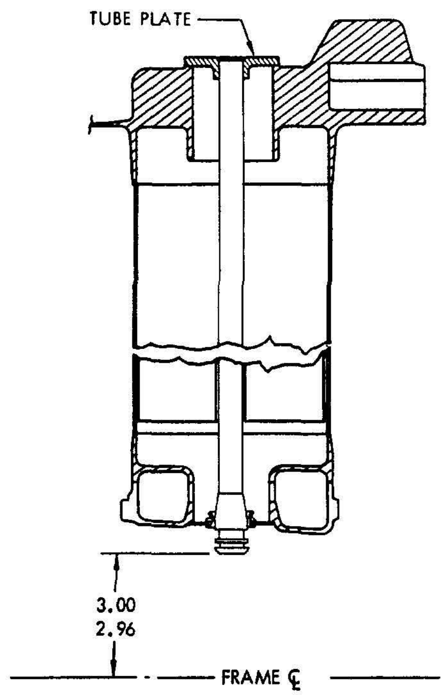
CAUTION: DO NOT HEAT THE REPAIR JOINT OR THE FILLER BRAZE TO A TEMPERATURE GREATER THAN 1300°F (705°C). TEMPERATURES *ABOVE 1300°F WILL CAUSE A CHANGE IN THE PROPERTIES OF* THE FILLER BRAZE. THE CAUSE MATERIAL WILL START TO FLOW AT 1160°F (625°C).

(i) Allow the repaired joint to air cool.

(4) Pour boiling water over the repaired joint and brush to remove the flux residue. Bench the plate flat if braze protrudes.

(5) Lower the tube in the frame until the plate seats. Check for flatness and perpendicularity by use of feeler gauge. If a gap exceeds 0.01 inch, repeat the braze procedure.

(6) Pressure-check the repaired area by pressurizing the tube assembly to an air pressure of 90-100 psig and immersing the joint in water. If bubbles appear in the repaired area, repeat this braze procedure.



Sump Vent Tube Plate Replacement
Figure 204

E. Inner Liner Repair.

(1) Match-mark inner liner to frame to reinstall in the correct radial position.

WARNING: GRINDING OR CHIPPING

GRINDING OR CHIPPING OPERATIONS CREATE PARTICLES WHICH MAY ENTER THE EYE. WEARING OR GOGGLES OR FACESHIELD IS REQUIRED.

VENTILATION REQUIREMENTS AND RESPIRATORY PROTECTION WILL BE DETERMINED BY THE BASE BIOENVIRONMENTAL ENGINEER.

(2) Using a hand-held grinder with a cutoff wheel, grind off rivet heads flush with skin (32 places). See figure 204.

(3) With a 1/16 inch diameter punch and a small ball peen hammer, remove the remaining portion of all the rivets. To minimize distortion, back up the remaining upset head. See figure 204.

(4) Separate inner liner from front frame. Cold-work rivet holes back to contour if distorted when removing rivets with a small ball peen hammer and anvil.

WARNING: BLASTING WITH ALUMINUM OXIDE MIL-A-21380, TYPE I

WHEN HANDLING MATERIAL IN AIR-EXHAUSTED, ENCLOSED CABINET, BE SURE THAT VENTILATION IS IN OPERATION AND THAT DOORS ARE PROPERLY SEALED.

WHEN HANDLING MATERIAL IN A PARTIALLY ENCLOSED, AIR-EXHAUSTED CABINET, OR IN OPEN WORK AREA, WEAR APPROVED RESPIRATOR, GLOVES, GOGGLES, AND LONG-SLEEVED CLOTHING.

SPILLED MATERIAL SHOULD NOT BE DRY-SWEPT. WET DOWN SPILLAGE AND PLACE IT IN A SEALED CONTAINER.

(5) Gritblast per SEI-133, Section 70-20-5 around the crack area to remove any surface oxides. Be sure to clean the crevice behind the nut flange. Mask nuts with masking tape.

(6) If required, use a hand grinder and abrasive point to remove any oxides in the crack area that remain.

(7) Degrease inner liner per SEI-133, Section 70-20-1.

(8) Assemble inner liner in fixture, LMT 9043-1, see figure 205 and bolt cover plate over the top. Center liner in fixture by using shims around base.

(9) Using 3M brand No. 443 metallic tape, or equivalent, cover all holes on the outside of the inner liner. Leave one of the 0.170-0.200 inch diameter holes uncovered closest to the crack area for gas hose. Insert argon gas hose in hole and tape in place. Put a small hole opposite gas hose. Purge inner liner for 10 minutes at 25 CFH.

WARNING: WELDING HASTELLOY W - AMS 5786

CONTACT WITH FUMES MAY CAUSE SKIN IRRITATION, DERMATITIS, AND EYE IRRITATION. REPEATED INHALATION OF FUMES CAN CAUSE COUGHING, WHEEZING, AND PERMANENT LUNG DAMAGE. ULTRAVIOLET LIGHT FROM WELDING ARC MAY CAUSE PERMANENT EYE DAMAGE. SPARKS MAY CAUSE SKIN BURNS.

IF FUMES CAUSE IRRITATION, GO TO FRESH AIR. IF COUGHING OR WHEEZING PERSISTS, GET MEDICAL ATTENTION.

WELDING SHOULD BE PERFORMED ONLY AT AIR-EXHAUSTED, ENCLOSED WORK AREA. WEAR APPROVED GLOVES, APRON, GOGGLES (OR HELMET), AND APPROVED RESPIRATOR IF CONTACT WITH FUMES IS LIKELY.

(10) Using Hastelloy W, AMS 5786, TIG tackweld the crack 1 inch apart along the entire length of the crack to hold edges together. Gas backing required.

(11) TIG weld crack completely. If crack is over 1 inch long, weld short portions, move to another area, and weld. Keep part cool to avoid distortion.

TIG WELD DATA TABLE

NOTES: 1. Read welding instructions before using this table.

2. Fluorescent-penetrant inspect all repair welds for cracks unless otherwise noted.

3. Use a 1/16 inch diameter, pointed, 1 percent thoriated tungsten electrode.

4. Use 1/32-1/16 inch diameter filler wire, 1/32 inch preferred for most repairs.

5. See end of Data Table for filler wire material designation.

Item	Component to be Welded	Material(s) to be Welded	Filler Wire Material	Machine Current (Amperes)	Torch Gas Flow (C.F.H.)	Backup Gas Flow (C.F.H.)	Weld Contour
1	Inner Liner	N-155	Hastelloy W AMS 5786	20-30 DC STRT. POLARITY	10-25	10-25	Butt

(12) Remove inner liner from fixture and remove tape. Bench weld to remove any oxides both sides and any high metal flush to 0.005 inch above parent metal.

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN.

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

(13) Fluorescent-penetrant inspect. No through indications allowed.

(14) Vapor-degrease inner liner per SEI-133, Section 70-20-1.

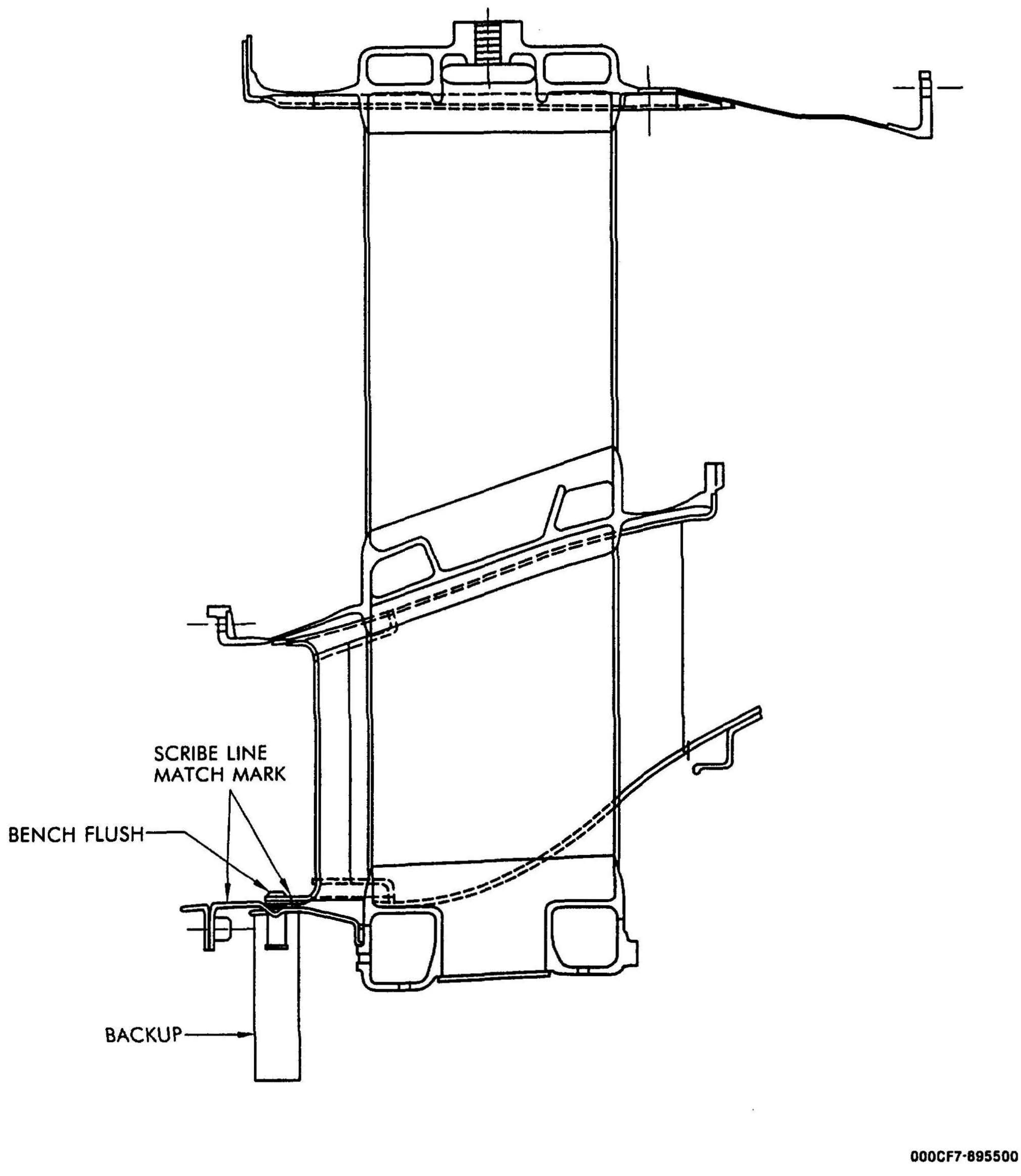
(15) Assemble inner liner in front frame, and line up matchmarks. Clamp in position using cleco clamps (8 places).

(16) Install rivet, AN123170, in hole from the outer surface. Place washers, AN960C3L, on the rivet flush to the surface on the opposite side.

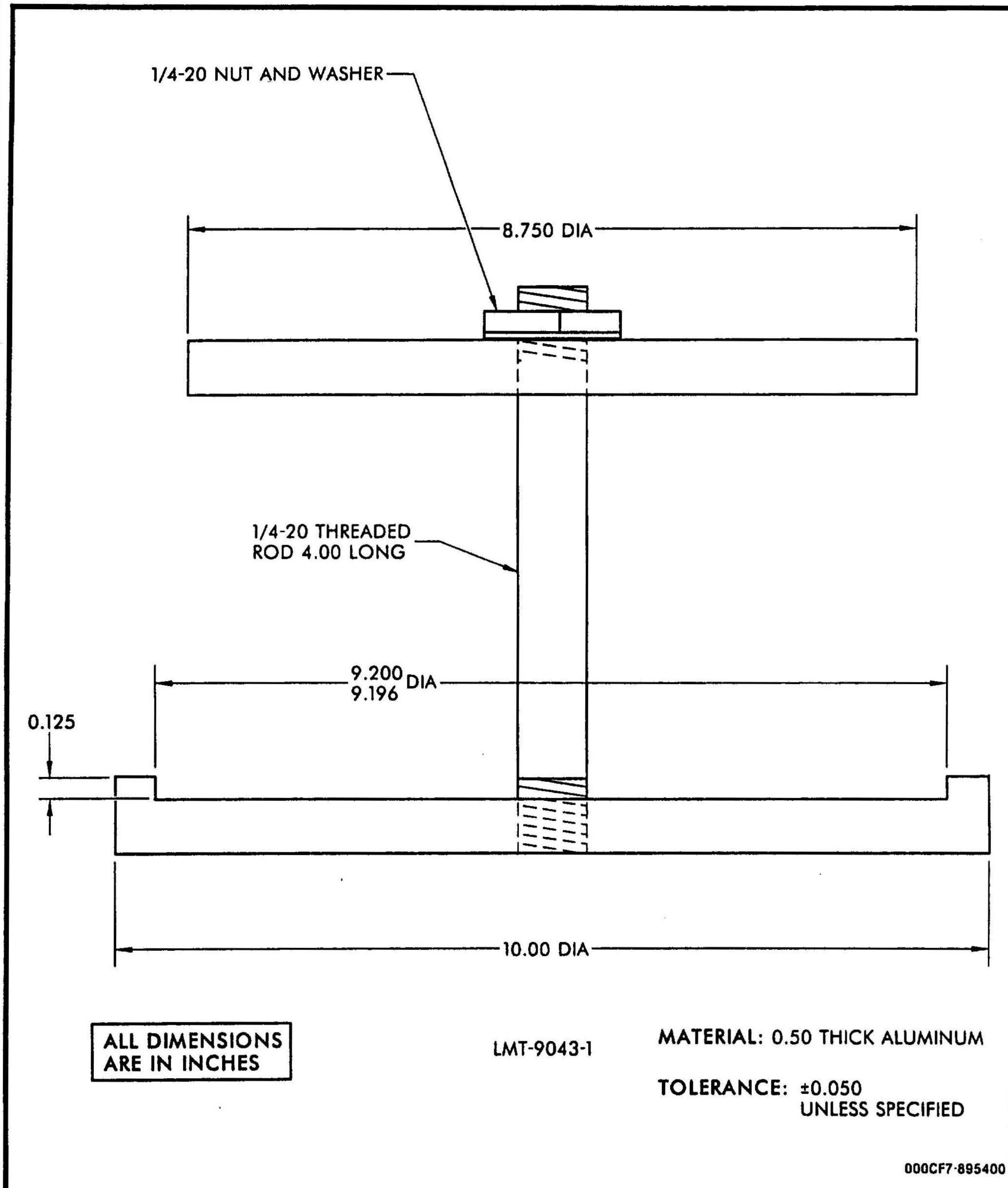
(17) Rivet upset head on the inside surface of the assembly per standard riveting practices.

(18) Repeat steps (16) and (17) until all rivets are installed. Rivet approximately 180 degrees apart to insure even spacing and reduce distortion.

(19) Vapor-degrease front frame per SEI-133, Section 70-20-1.



Inner Liner Repair
Figure 204



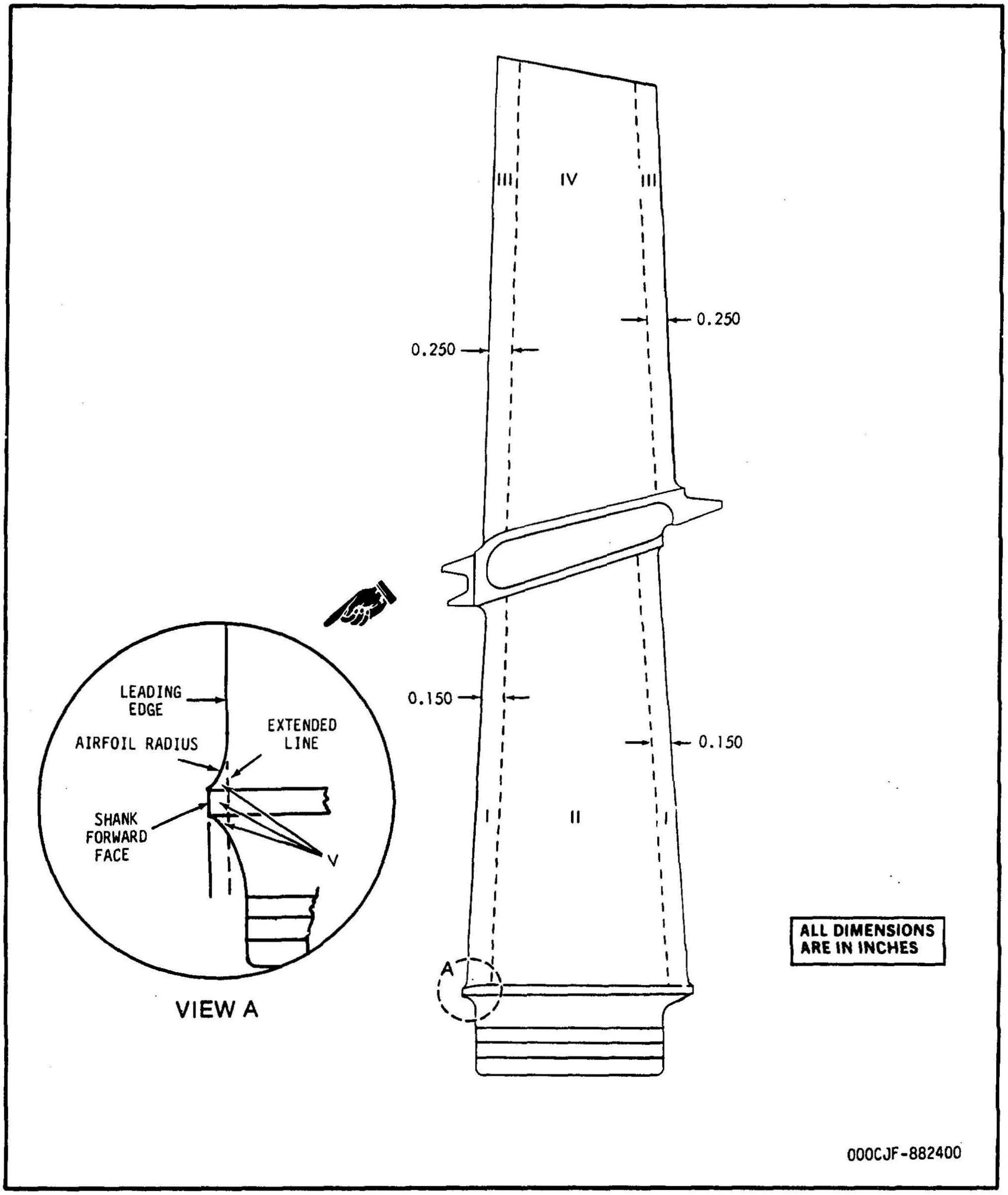
LMT-9043-1 Fixture
Figure 205

FAN ROTOR ASSEMBLY - MAINTENANCE PRACTICES

1. General. At first hot section inspection the maintenance of the fan rotor assembly is limited to those portions of the primary and secondary airfoil sections of the fan blades which can be reached through the fan frame openings.

2. Inspection/Check. (See figure 201.) Inspect visually. When serviceable limits are exceeded, the aft fan may be repaired in accordance with the Overhaul Manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Zone III (leading and trailing edges of fan portion) for:		
(1) Cracks.	Not serviceable.	Replace blade.
(2) Nicks, pits, and scratches.	Any number, 0.015 inch deep.	Blend per paragraph 4.A.
(3) Dents (smooth deformation) or edge waviness.	1/16 inch from original contour.	Blend per paragraph 4.A.
(4) Curled corners.	1/4 inch from original shape if within 1/2 inch of original corner with no sharp bends.	Blend per paragraph 4.A.



Fan Rotor Blade Inspection
Figure 201

Inspection/Check	Maximum Serviceable Limits	Remarks

WARNING: PENETRANT METHOD OF INSPECTION

PROLONGED OR REPEATED INHALATION OF POWDERS AND VAPORS OF CLEANING SOLVENTS, DEVELOPERS, AND EMULSIFIERS USED IN FLUORESCENT PENETRANT INSPECTION CAN IRRITATE MUCOUS MEMBRANE AREAS OF THE BODY.

CONTINUAL EXPOSURE TO PENETRANT INSPECTION MATERIALS CAN IRRITATE THE SKIN. DIRECT EXPOSURE OF EYES TO BLACK LIGHT AND PROLONGED EXPOSURE OF SKIN TO BLACK LIGHT CAN INFLAME AND DAMAGE EYES AND SKIN.

WEAR NEOPRENE GLOVES WHEN HANDLING PENETRANT INSPECTION MATERIALS. KEEP INSIDES OF GLOVES CLEAN.

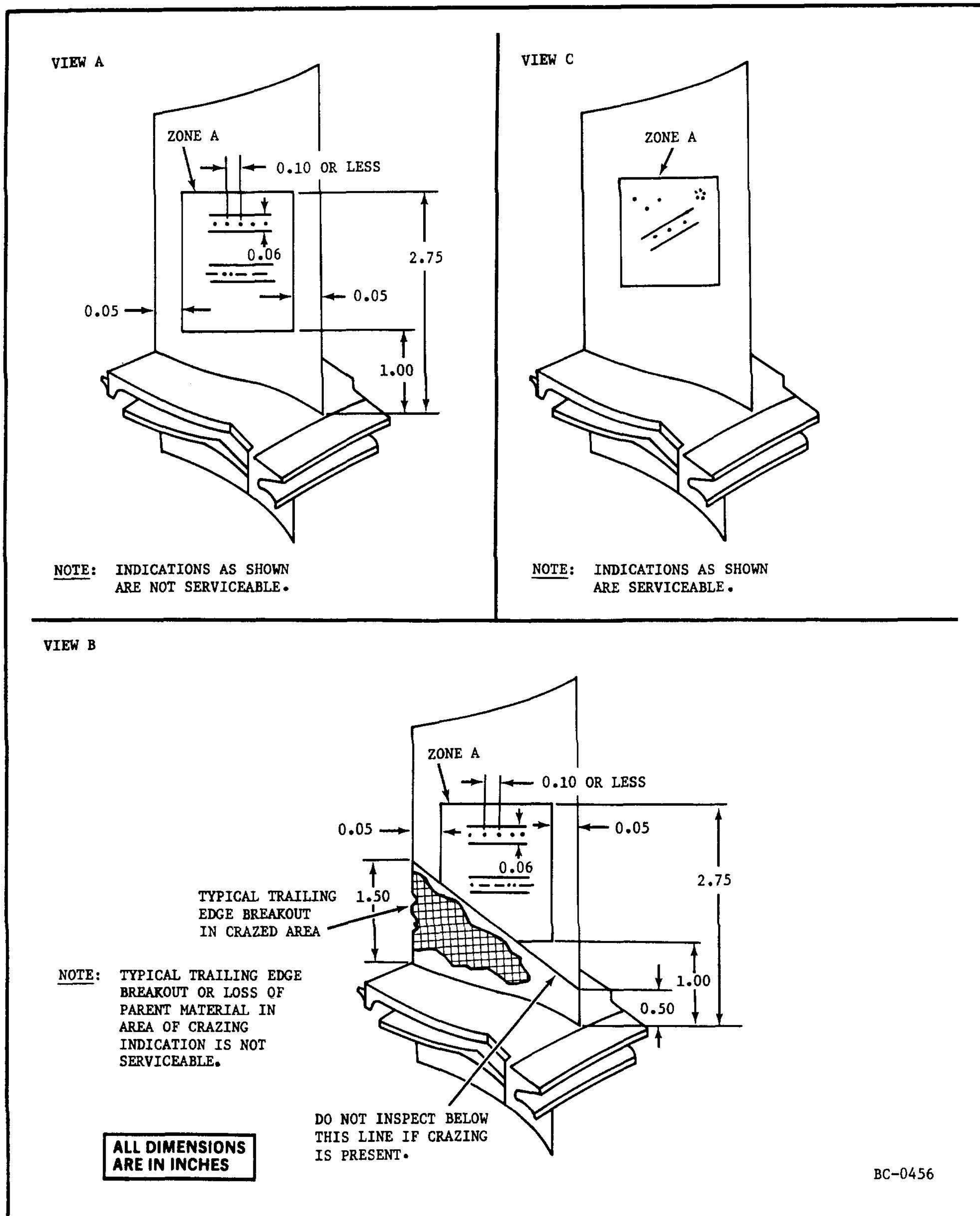
STORE ALL PRESSURIZED SPRAY CANS CONTAINING PENETRANTS, DEVELOPERS, AND EMULSIFIERS IN A COOL, DRY AREA PROTECTED FROM DIRECT SUNLIGHT, HEAT, AND OPEN FLAMES. TEMPERATURES HIGHER THAN 120°F (49°C) MAY CAUSE PRESSURIZED CAN TO BURST AND CAUSE INJURY.

IF DIRECT EYE CONTACT WITH BLACK LIGHT CAUSES EYE PROBLEMS, IMMEDIATELY GET MEDICAL HELP.

WHEN USING BLACK LIGHT FOR FLUORESCENT INSPECTIONS, WEAR SAFETY GLASSES.

(5) Piece missing from trailing edge in area of crazing. (See figure 202, view B.)	Not serviceable.	Replace blade. Fluorescent penetrant-inspect remainder of blades; no cracks allowed.
(6) Missing Sermetel W coating.	Any amount is allowed.	
B. Zone IV (airfoil surfaces, fan portion, figure 201) for:		
(1) Cracks.	None allowed.	Replace blade.
(2) Nicks, pits, and scratches.	Any number, 0.015 inch deep.	Blend per paragraph 4.A.
(3) Dents.	1/8 inch deep separated by 6 times the depth.	
(4) Missing Sermetel W coating.	Any amount is allowed.	
C. Blade tip for burrs due to rubs.	0.010 inch high.	Remove high metal.

Inspection/Check	Maximum Serviceable Limits	Remarks
D. Zone I (leading and trailing edge of turbine portion) for:		
(1) Cracks.	Not serviceable.	Replace blade.
NOTE: At intervals of every 1000 hours of operation, all fan blades must be inspected per paragraph 3.A.		
(2) Nicks, dents, pits, and scratches.	Any number, 0.015 inch deep.	Blend per paragraph 4.A.



Inspection of Concave Side of Airfoil of Fan Rotor Blade
Figure 202

Inspection/Check	Maximum Serviceable Limits	Remarks
E. Zone II (airfoil surfaces, turbine portion) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks, dents, pits, and scratches.	Any number, 0.030 inch deep except fillet radii between airfoil and platform not over 0.020 inch deep.	
F. Zone V (shank leading edge) for:		
(1) Wear.	Any amount up to leading edge of blade.	Replace blade.

3. Deleted.

3A. Eddy Current (Defectometer) Inspection for Leading and Trailing Edges of Hot Section Fan Blades. (See figure 204A.) This inspection must be done at intervals of every 1000 hours of operation for all fan blades. Prepare for inspection as follows:

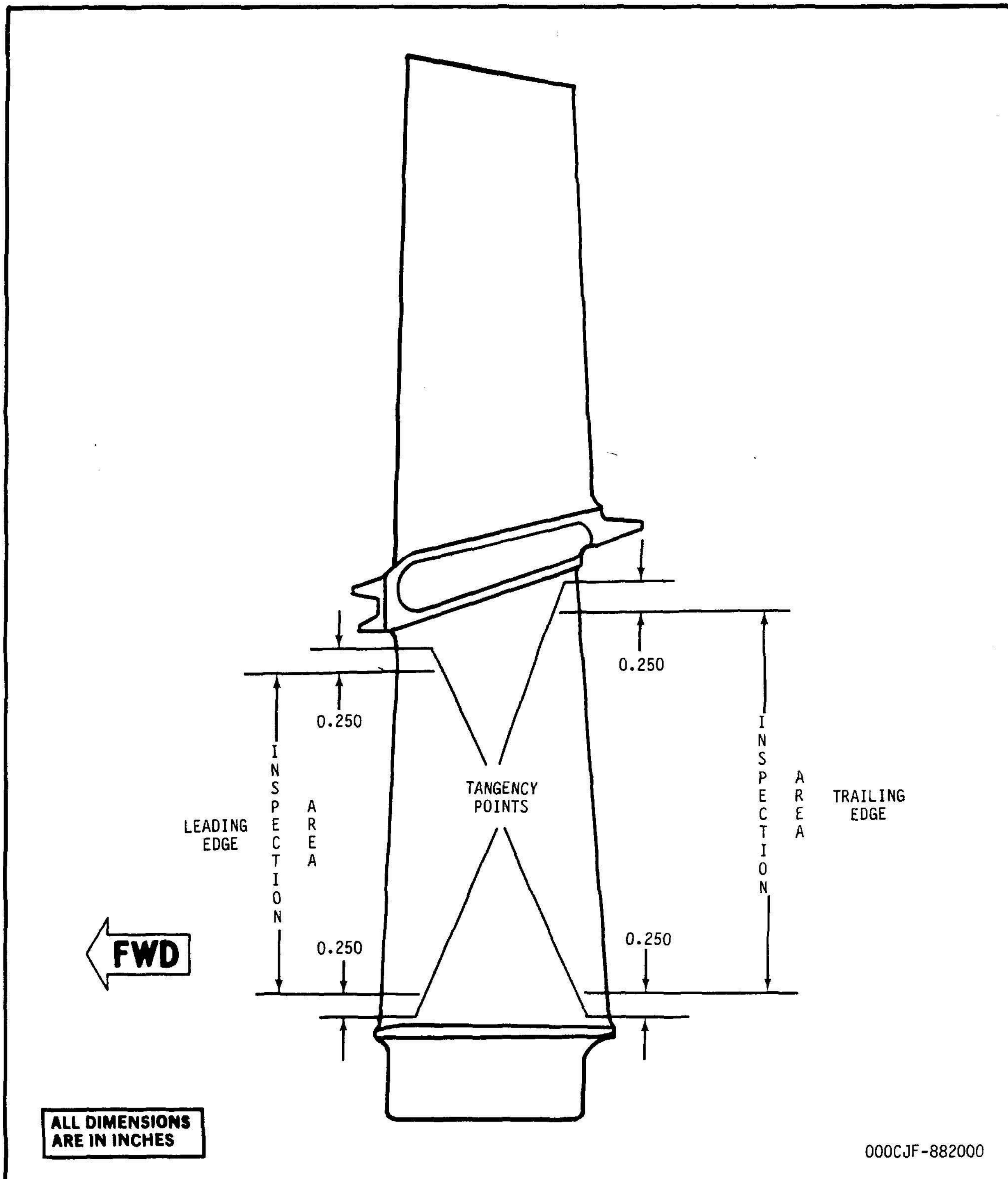
A. At option of inspector, remove exhaust nozzle (tail pipe) or thrust reverser (if so equipped) from engine.

CAUTION: SELECT AND CONNECT THE EDDY CURRENT DETECTOR TO THE POWER SOURCE DESIRED. IF POWER SOURCE IS ON LINE WITH LARGE POWER CONSUMERS (SUCH AS RESISTANCE WELDERS OR OTHER POWER TOOLS), A VOLTAGE REGULATOR IS REQUIRED. IF THE BATTERY POWER SOURCE IS TO BE USED, BE SURE THAT THERE IS SUFFICIENT BATTERY STRENGTH. (SEE DEFECTOMETER INSTRUCTION MANUAL).

NOTE: If the tail pipe is not removed, an additional man is required to assist the inspector.

B. Prepare eddy current crack detector, Defectometer Models 2.164, 2.835, or 2.836 with special probe for calibration as follows:

(1) Connect defectometer to power source. Turn on instrument and allow it to warm-up per the manufacturer's specifications.



Fan Rotor Blade Inspection
Figure 204A

(2) Preset defectometer as follows:

(a) Models No. 2.835 and No. 2.836

Sensitivity	5.0 dB
Material	Fe

(b) Model No. 2.164

Sensitivity	5.0
Material	Fe
Zero	5
Lift-Off Compensation	5

(3) Connect probe PN 66500 to defectometer probe socket.

(4) Apply teflon tape maximum thickness 0.0035 inch, 1/4 inch wide No. 5490 (3M Company, Building Services, Cleaning Products, St. Paul, MN 55144) to toroid coil (see figure 204B). Be sure there are no wrinkles or exposed areas of the toroid coil.

(5) Fold both edges of tape against coil.

C. Calibrate defectometer with probe as follows:

NOTE: Use trailing edge notch on calibration standard only to calibrate. (See figure 204C.)

(1) Set Lift-Off Compensation on Defectometer Models No. 2.835 and No. 2.836 as follows:

(a) Hold probe in air, away from any conducting surfaces and press and release L (Lift-Off) button.

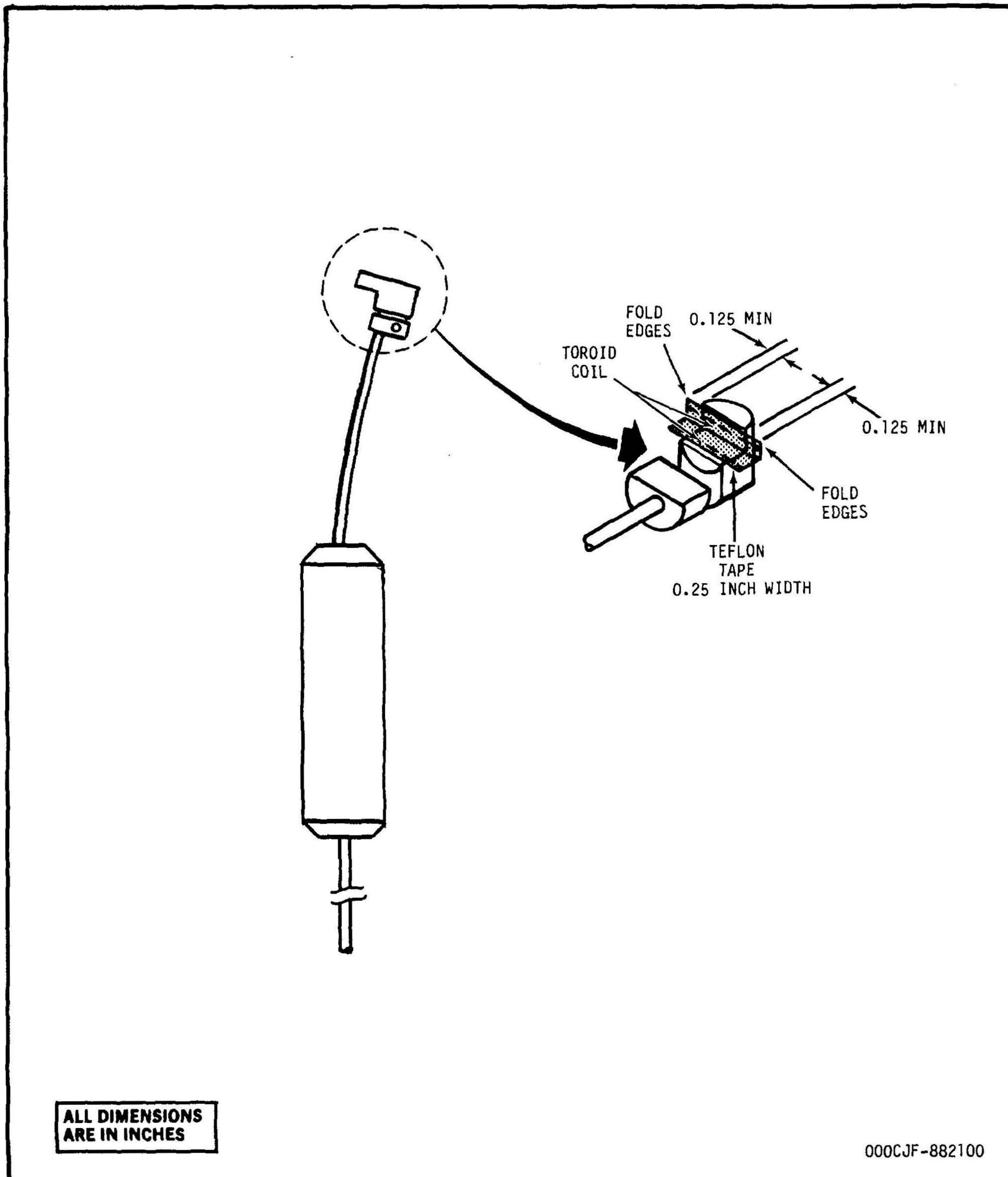
(b) When ZERO light begins flashing, position probe on a clean unnotched area of the calibration standard (see View A, figure 204D).

(c) Press and release the ZERO button. READY message will appear on the display.

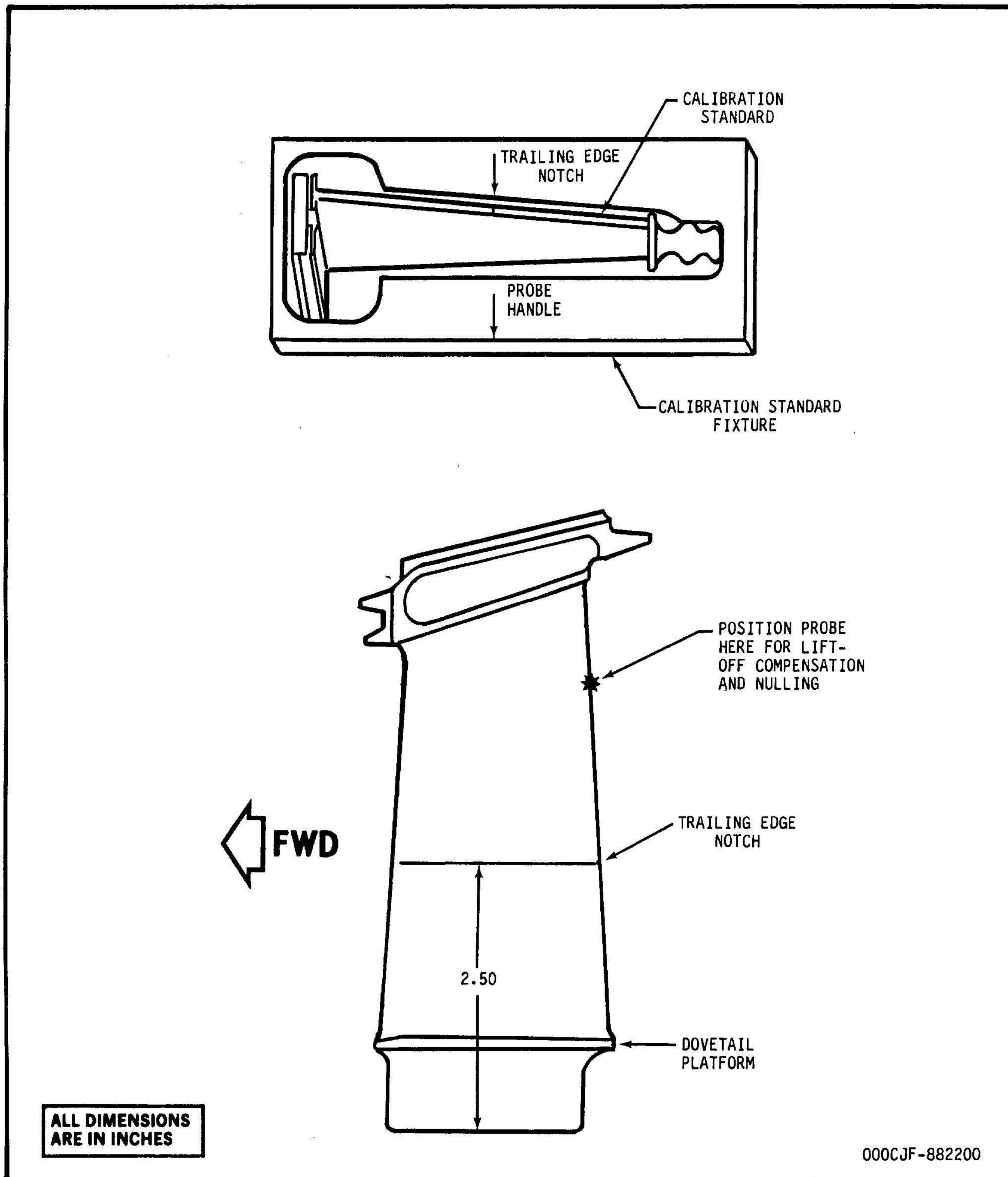
(2) Set Lift-Off Compensation on Defectometer Model No. 2.164 as follows:

(a) Position probe on a clean unnotched area of the calibration standard (see View A, figure 204D).

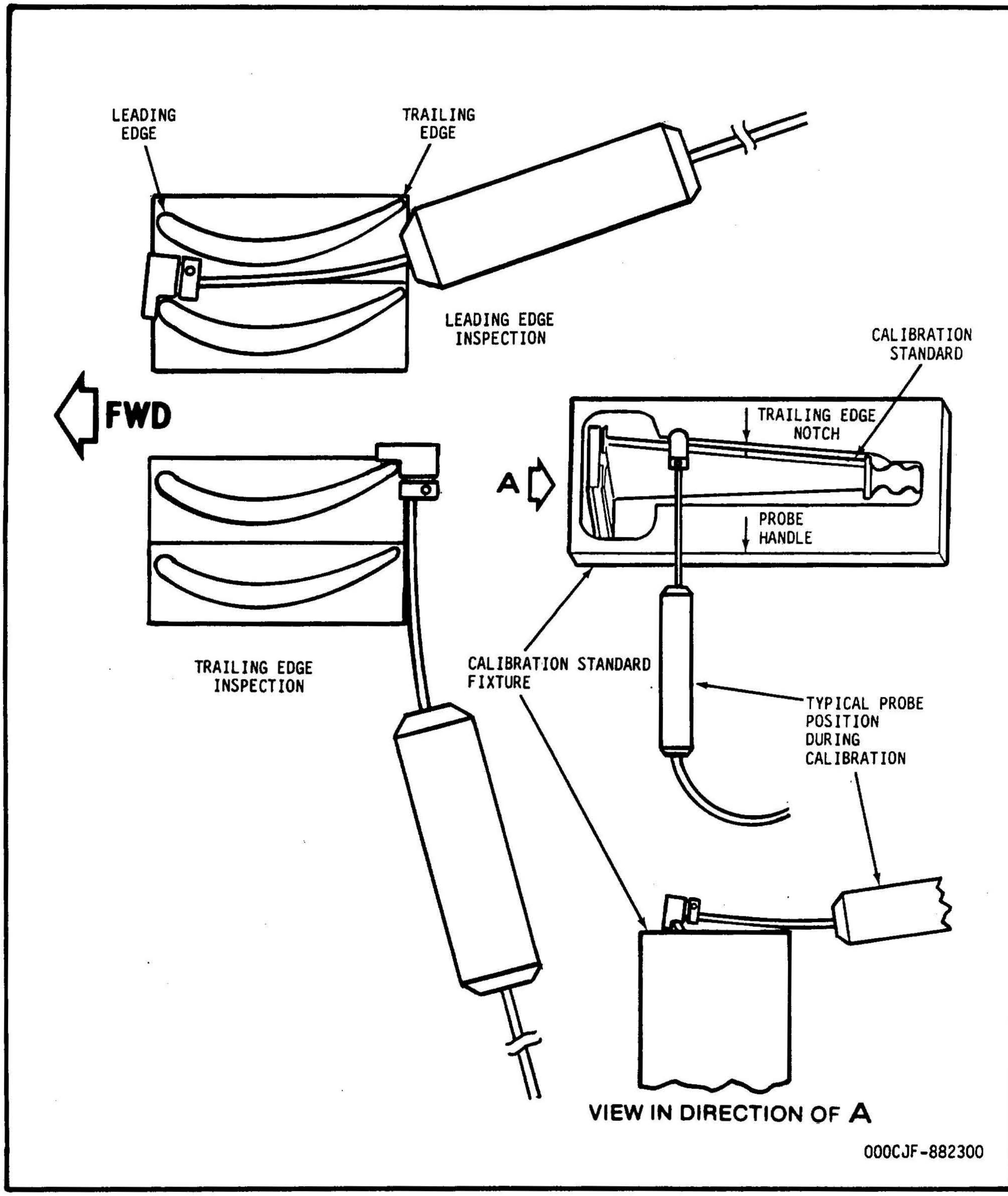
(b) Adjust ZERO control knob to bring needle to ZERO.



Probe PN 66500 - Eddy Current
Figure 204B



Calibration Standard
Figure 204C



Probe Position On Fan Blade
Figure 204D

(c) Lift probe off calibration standard while observing needle movement. If needle deflects to right, adjust Lift-Off Compensation knob clockwise to zero. If needle moves to left, adjust Lift-Off Compensation knob counterclockwise to zero.

(d) Repeat steps (a) and (b) until needle does not move more than plus or minus one graduation when probe is properly positioned or removed from the calibration standard.

(3) Adjust sensitivity on Defectometer Models No. 2.835, 2.836 and 2.164 as follows:

CAUTION: CLEAN, CALIBRATION STANDARD AND NOTCHES ONLY WITH NONMETALLIC SOFT MATERIALS. AVOID SOLVENTS. AVOID METAL-TO-METAL CONTACT, EXPOSURE TO HIGH TEMPERATURES AND CONTAMINATION FROM FOREIGN MATERIAL. WHEN NOT IN USE, STORE IN A PROTECTIVE CONTAINER.

(a) Place probe onto a clean unnotched area of the calibration standard (see View A, figure 204D), needle shall move to ZERO. If it does not, recalibrate per steps (1), and (2).

(b) Slowly scan the trailing edge to detect notch using a uniform speed not to exceed one half inch per second.

(c) Adjust sensitivity of the defectometer until a 95-99 percent reading is obtained when passing over notch. Adjust as follows:

1 On Defectometer Models 2.835, 2.836, press push button "↑" to increase sensitivity, or press push button "↓" to reduce sensitivity.

2 On Defectometer Model 2.164, turn sensitivity knob clockwise to increase sensitivity, or turn sensitivity knob counterclockwise to reduce sensitivity.

(d) Needle shall return to ZERO (±5 percent) when placed over an unnotched area of standard. If it does not, recalibrate per steps or (2).

(e) Record all calibration information on an inspection report form.

D. Clean the fan blades, if required, as follows:

NOTE 1: Feel the leading edge of (10) fan blades; if the convex side feels rough to the finger, it is recommended that the blades be cleaned to the following procedure prior to inspection with the Defectometer.

NOTE 2: It is recommended that blade cleaning and inspection be accomplished at the 2 o'clock to 4 o'clock positions with the engine horizontal.

(1) Obtain the following cleaning materials.

- String, 6 inches long with a loop tied on one end.
- Wire, 1/16 diameter 16-18 inches long with a small loop on one end.
- Crocus Cloth (400 grit), Rolls 1 inch wide cut to 3 foot lengths.
- Tape, adhesive.

(2) Feel the convex side of all the blades. If there are any deposits that feel rougher than 400 grit sand paper, continue with the cleaning process; otherwise, proceed to step E.

(3) Tape the straight end of the string to a length of crocus cloth overlapping them by about 2 inches.

(4) Push the crocus cloth, string end first, over the convex side of the blade to be cleaned, so that the string passes into the fan nozzle.

(5) Rotate the fan counterclockwise until the string droops over the leading edge of the blade to be cleaned.

(6) Hook the string with the wire and pull it back toward the trailing edge of the blade until both ends are even.

(7) Hold one end of the crocus cloth in each hand and slowly work from the transition seal to the root of the blade airfoil using a "shoeshine" motion.

NOTE: The convex side and the leading and trailing edges should feel smooth. It is not necessary to clean the blade to bright metal.

(8) Blow the loosened particles from the blades using low pressure air.

E. Inspect fan blade leading edge as follows:

CAUTION: DO NOT INSPECT IF BLADES TEMPERATURE EXCEEDS 100°F (38°C). HIGHER TEMPERATURE CAN DAMAGE THE INSPECTION PROBE.

(1) Check fan blade temperature using a thermometer with a minimum of 6 inch reach. The maximum allowable temperature for eddy current inspection is 100°F (38°C).

(2) Identify and mark a start reference position on first fan blade to be inspected using a Colorbrite silver marker 2101 or an approved silver marker or equivalent.

(3) Inspect teflon tape on probe for wrinkles, wear or exposure of coil (see figure 204B). If any of these conditions exist, replace tape and recalibrate per step C.

NOTE: Probe position during inspection shall be the same as during calibration (step C).

(4) Position probe on blade leading edge (near the midpoint), see figure 204D. Adjust ZERO control on defectometer to set the meter needle to zero.

(5) Pull on probe handle, a small amount to maintain proper position. Apply slight finger pressure at point where shaft and handle meet. This will ensure probe is seated properly.

CAUTION: MAINTAIN CONTACT/PRESSURE AND MINIMIZE PROBE WOBBLE TO GET CORRECT EDDY CURRENT READINGS.

NOTE 1: Needle movement at beginning or end of each scan might indicate probe is in a radius and is lifting off.

NOTE 2: Minor needle fluctuations while scanning may be caused by improper probe placement or wobble.

(6) Inspect blade leading edge (see figure 204A) using a uniform speed not to exceed one half inch per second.

(7) If a gradual shift of needle position, exceeding ±20 percent of scale, is observed, readjust defectometer ZERO control to zero.

(8) Any indications in excess of 49 percent of scale reading shall be identified for further inspection. If no indications are present, rotate fan rotor to next blade.

(9) Recheck the calibration per step C after each hour or at the completion of inspection of all blade leading edges if less than one hour. Proceed as follows:

(a) The inspection is acceptable if the calibration repeats within ±10 percent full scale.

(b) If deflection of needle has decreased more than 10 percent full scale, repeat calibration and reinspect all parts inspected since last valid calibration.

(c) If deflection of needle has increased by more than 10 percent full scale, only blades found to exceed 49 percent must be reinspected.

(10) Repeat steps (6), through (9) until leading edges of all blades have been inspected.

(11) Inspect trailing edge of all blades per steps (1) thru (9).

(12) Reinspect all suspect blades as follows:

(a) Recheck notch response on calibration standard per step C.

(b) Inspect blade leading edge by positioning probe on blade next to the suspect area. Readjust the zero control to bring needle to zero.

(c) If indication is above 49 percent, clean blade suspect area per step D. and reinspect per step (b).

(d) If indication is still above 49 percent, mark suspect blade per STANDARD PRACTICES, Section 70-30, paragraph 3 of overhaul manual (SEI-133) using Colorbrite silver marker or equivalent.

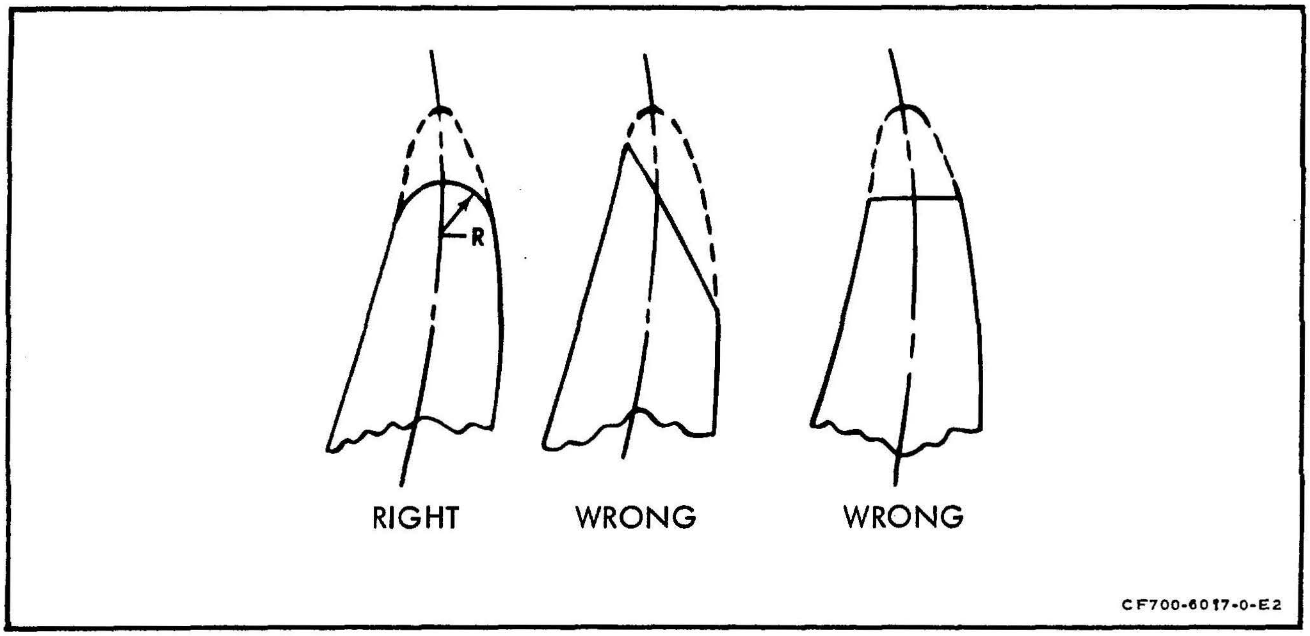
(e) Inspect the fan blade trailing edge as described in steps (b), through (d).

(f) Remove all suspect blades from fan rotor per overhaul manual (SEI-133) and inspect them at a GE authorized overhaul shop to confirm indicated turbine airfoil cracks.

(g) Replace all cracked fan blades, per overhaul manual (SEI-133).

4. Repair.

A. Fan Rotor Blade Blending. Blending is done to remove the stress concentration of nicks, pits, scratches, etc. to prevent blade failure by radiusing of the leading edge to restore the airfoil to nearly its original aerodynamic shape. All blending should be done with a minimum of 1/2 inch on each fan blade. Blending close to the tip should be extended straight out so as not to leave a narrow projection at the corner. If the benching to remove two separate defects runs together, round over the point between them. Any blending near the platform-to-airfoil radii must be such as to maintain the same smooth transition as on new parts. The shape of the airfoil leading edge is very important for prevention of engine stalls. They are not knife edges, but carefully radiused edges whose shape shall be maintained in the blended area (see figure 205). When material is removed from the fan portion of a blade, a similar amount of material must be



Airfoil Leading Edge Blending
Figure 205

removed from an opposite blade (within ± 5 blades) in order to maintain balance of the rotor assembly except that:

- Any one blade can be reworked to 50% of the Zone III leading or trailing edge limit without equivalent blade rework to maintain balance.

- If two blades are reworked to 50% of the Zone III leading or trailing edge limit, they must be separated by at least a 110° span, or else equivalent rework must be done on blades 180° opposite.

- Any number of blades may be reworked on the leading or trailing edges without equivalent rework provided the total material removed does not exceed 50% of the full limit of Zone III for any one blade leading or trailing edge. When field blade rework is required which exceeds the limits in the above three paragraphs, equivalent rework must be performed on blades 180° opposite in order to maintain dynamic balance.

(1) Hand Blending Method.

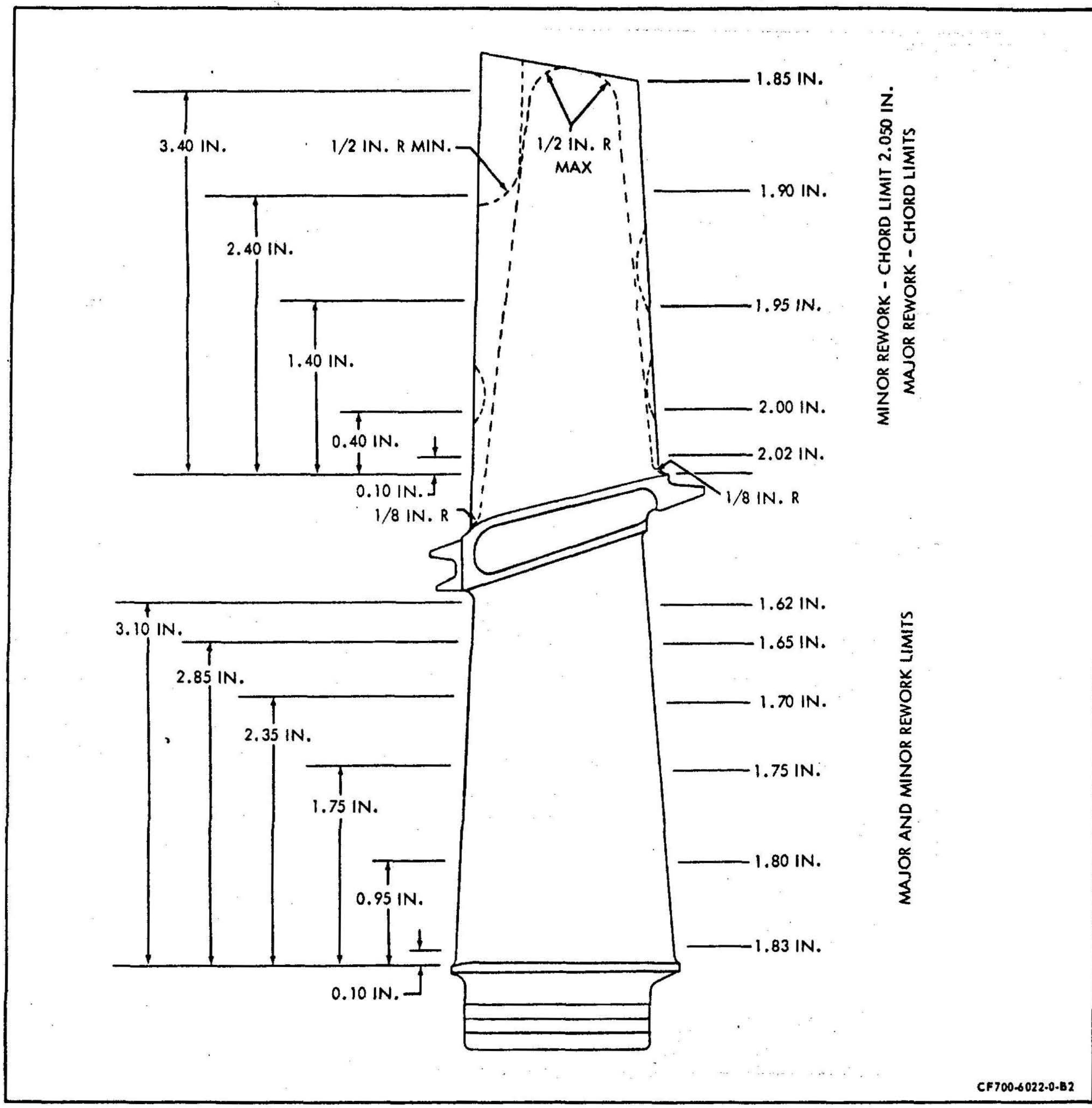
(a) Rough-blend the damaged area using a fine file, emery cloth, a fine abrasive stone, or equivalent tool.

(b) Finish blend using a fine emery paper, a fine stone, or equivalent tool. Always finish blend in a lengthwise direction, removing all evidence of crosswise marks that may have been made during rough blending. The final finish of the reworked area shall be as smooth as the undamaged area.

(2) Power Blending Method. The "Pencil Grinder", Part No. D-03E, used with a 1/8 inch Collet Insert, Part No. 1233-1317C, and Filter-Regulator Lubricator, Part No. MFRL-212-2 (available from Rotor Tool Co., 36300 Lakeland Blvd., Cleveland, Ohio) or approved equivalent may be used as a portable tool for reworking or blending while the blades are assembled in the rotor. Extra precaution must be used and simple masking of the adjacent blades is recommended to prevent damage to adjacent blades.

(a) Use the "Pencil Grinder" with an adequate supply of shop air at 35-50 CFM, 90 psig minimum, with the air being filtered through the filter-regulator and lubricator.

WARNING: THE MAXIMUM SAFE SPEED OF 25,000 RPM FOR SMALL WHEELS AND POINTS MUST NOT BE EXCEEDED AND ALL ESTABLISHED SAFETY RULES MUST BE STRICTLY OBSERVED.



Fan Blade Chord Limits
Figure 206

ORIGINAL
As Received By
ATP

(b) Rough out the blending of defects with the coarse grade silicon carbide impregnated rubber wheels and points. (Cratex Tool and Diemakers' Kit No. 777, Cratex Manufacturing Co., 1600 Rollins Road, Burlingame, California or equivalent.)

(c) Finish blend using the fine and extra-fine grade rubberized abrasives.

(3) The amount of repair is controlled by the minimum chord width. (See figure 206.) The total reduction in chord may be taken on either edge or divided between the edges at any given location. The tip radius shown allows a further reduction in chord at the tip only. The minimum chords between points specified are proportional.

(4) Limits for both major and minor rework are shown in figure 206. Major rework can be performed on 6 blades, minor rework can be performed on all blades.

CAUTION: BLENDING IS TO BE DONE ON LEADING AND TRAILING EDGE ONLY. BLENDING IS NOT ALLOWED ON AIRFOIL SURFACES. THE INDICATED MINIMUM CHORD LIMITS ARE NOT TO BE TAKEN AS PERMISSION TO MACHINE THE ENTIRE EDGE OFF UNLESS THIS IS REQUIRED TO REMOVE DAMAGE.

(5) Spot fluorescent penetrant-inspect the blended areas per 72-03-1.

FAN REAR FRAME - MAINTENANCE PRACTICES

1. General. At first hot section inspection maintenance of the fan rear frame consists of Inspection/Check and Approved Repair of the rear frame with the aft fan section assembled.

2. Disassembly/Assembly. This procedure is performed only when required and pertains to the fan rear frame after it has been removed from the aft fan assembly per 72-70.

   A. Disassembly. (See figure 201 unless otherwise indicated.)

      (1) Position the frame on a bench, front flange down. Remove the bolts (13) and remove the No. 5 bearing housing (14).

      NOTE: Sump vent tube (24, figure 202) at the 2 o'clock pad must be retracted in the outboard direction far enough to allow removal of the bearing housing.

      (2) Disassemble the No. 5 bearing housing as follows:

         (a) Remove the bolts (23) and use the oil seal puller, 2C5351, to remove the oil seal (22) from the No. 5 bearing housing (14).

         CAUTION: DO NOT USE SCREW DRIVERS TO PRY THE OIL SEAL HOUSING FROM THE BEARING HOUSING.

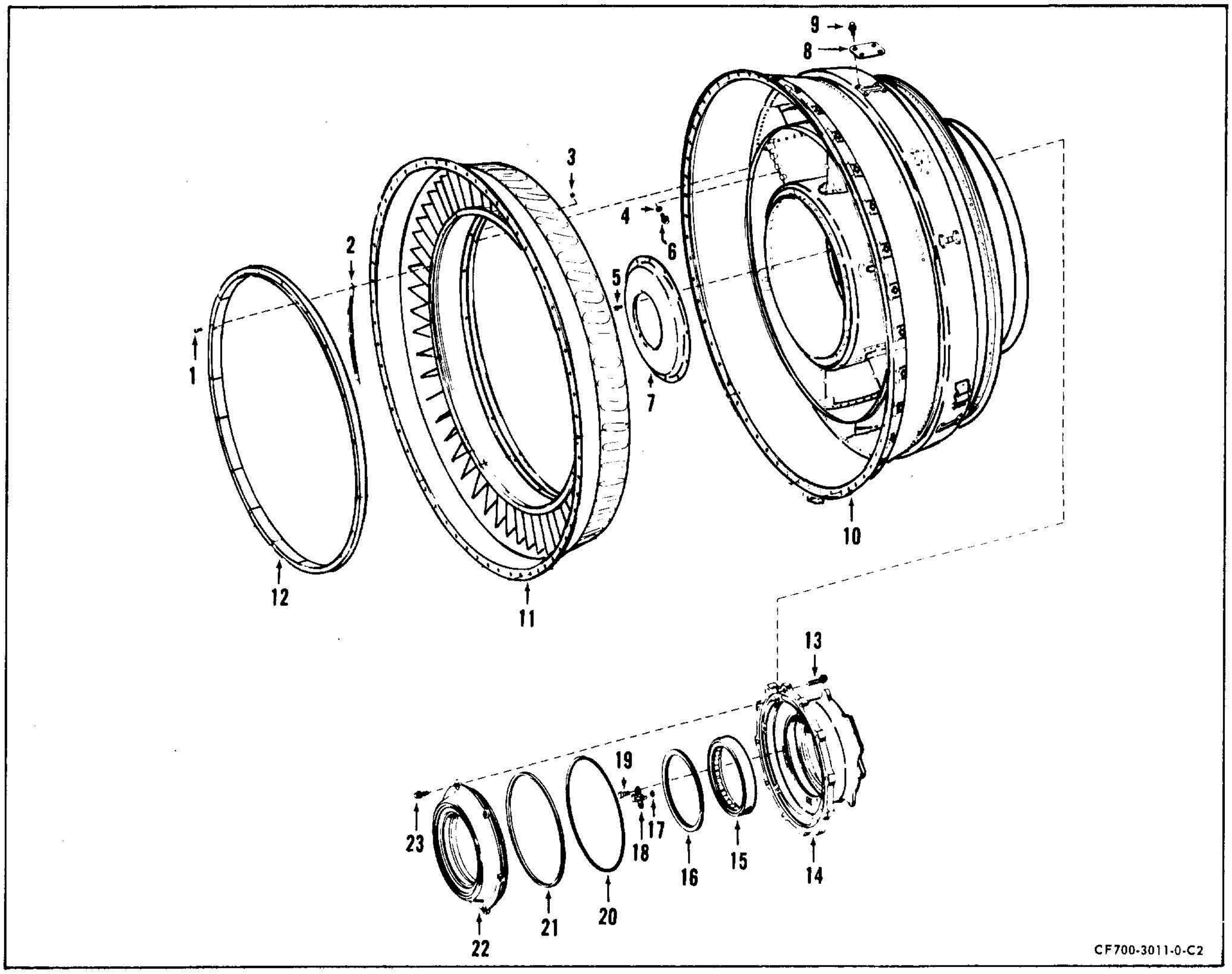
         (b) Remove the O-ring retainer (20) and O-ring (21).

         (c) Remove the bolts (19), oil nozzle (18) and O-ring (17).

         (d) Wash bearing housing and oil nozzle in a suitable solvent and ultrasonically clean per 72-70, paragraph 5 (Cleaning of No. 4 and No. 5 Bearing Housings.) of the Overhaul Manual.

         (e) Recondition the oil seal (22) by replacing the carbon segments per the Overhaul Manual or replace seal assembly with a new or overhauled assembly with zero time.

         (f) If the facilities are available, clean the fan frame per Section 72-70 of the Overhaul Manual. If the bearing housings are in place, inspect the area between the bearing housing and fan frame for manufacturing chips which were trapped in the frame and have shifted during engine operation.



Fan Rear Frame Disassembly
Figure 201

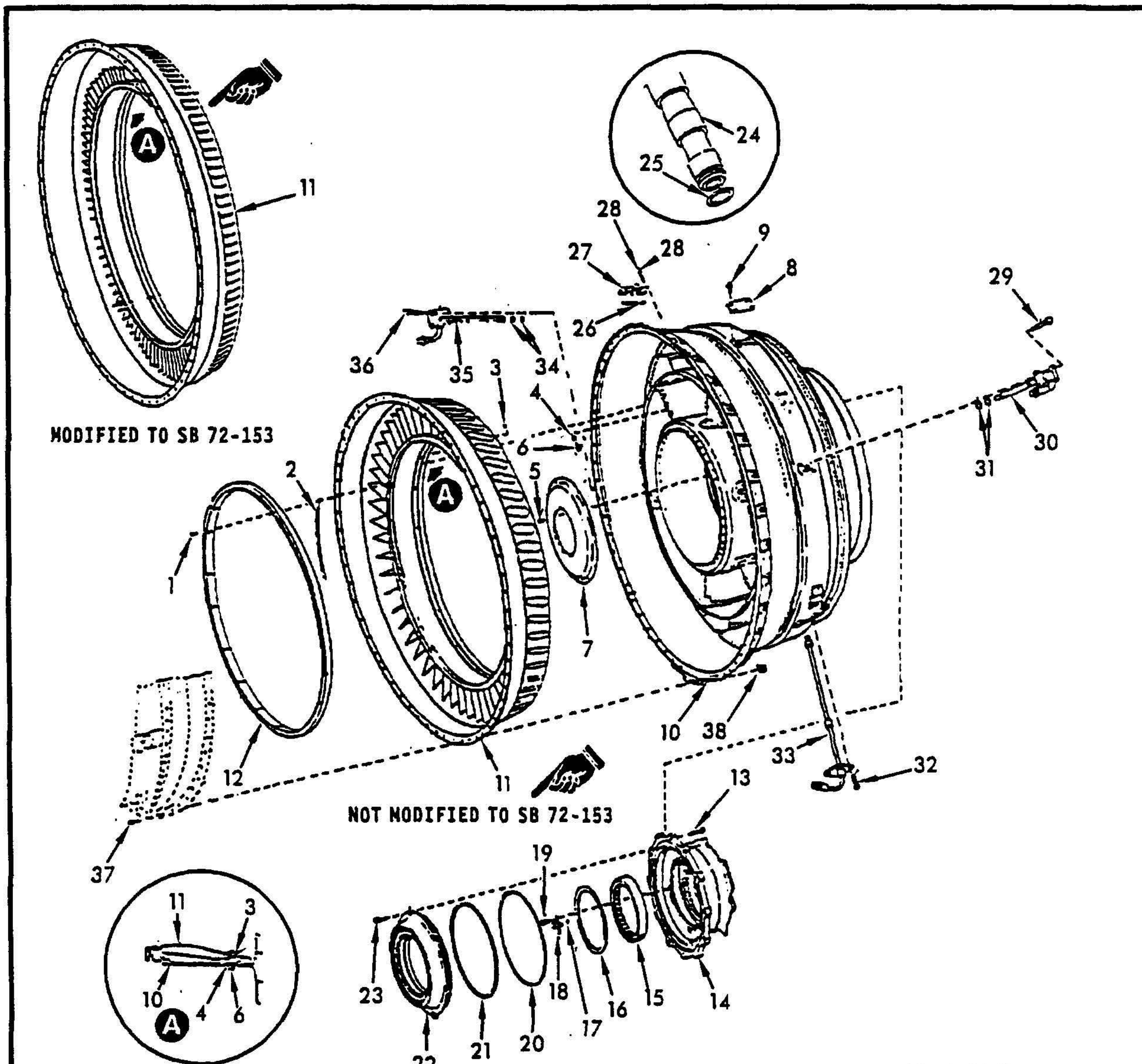
B. Assembly. (See figure 202.)

(1) Assemble the rear (No. 5) bearing housing as follows:

(a) Install the O-ring (17) onto the oil nozzle (18) and secure to the housing with the bolts (19). Torque the bolts to 22-27 lb-in. and lockwire.

NOTE: The oil nozzle is in the 4 o'clock position viewed aft looking forward.

(b) Install the O-ring retainer (21) into the groove on the carbon seal (22) with the flat side of the retainer against the carbon seal housing.



1. SCREW
2. SHIMS
3. NUT
4. WASHER
5. BOLT
6. BOLT
7. BAFFLE
8. STRUT COVER
9. BOLT
10. REAR FRAME
11. EXIT GUIDE VANE ASSEMBLY
12. TRANSITION SEAL
13. BOLTS
14. NO. 5 BEARING HOUSING
15. NO. 5 BEARING OUTER RACE
16. RETAINING RING
17. O-RING
18. OIL NOZZLE
19. BOLTS
20. O-RING
21. O-RING RETAINER
22. CARBON SEAL
23. BOLT
24. TUBE
25. O-RING
26. O-RING
27. ELBOW FITTING
28. BOLTS
29. BOLTS
30. OIL-OUT TUBE
31. O-RINGS
32. BOLTS
33. SEAL-AIR TUBE
34. O-RINGS
35. OIL SUPPLY TUBE
36. BOLTS
37. BOLT
38. NUT

1158162-00

Fan Rear Frame Assembly
Figure 202

(c) Install the O-ring (20) in the groove of the carbon seal (22) and against the O-ring retainer (21).

(d) Install the carbon seal (22) in the bearing housing (14). Position and attach the carbon seal with three bolts (23).

(e) Install the remaining bolts (23) and secure the carbon seal (22). Torque the bolts to 18-22 lb-in. Safetywire the bolts.

(2) Install the O-ring (25) on the tube (24). Push the tube radially outward to allow clearance for installation of the bearing housing.

(3) Install the bearing housing (14) on the rear frame (10). Attach the rear frame with two bolts (13) finger tight.

NOTE: The bearing housing is not secured at this time to allow alignment of the air and oil tubes.

(4) Install the O-ring (26) on the elbow fitting (27) and secure it to the sump vent tube port with bolts (28). Torque the bolts to 22-27 lb-in. Safetywire the bolts.

CAUTION: BE SURE THAT ALL TUBES ARE CENTRALIZED AT THE MIDPOINT OF THE STRUT TO PREVENT DAMAGE TO THE TUBES AND TO PREVENT ANY CONTAMINATION FROM THE TUBE PASSAGE IN THE BEARING HOUSING WHEN INSERTING THE TUBE.

NOTE: Install all tubes in the ports of the fan rear frame with the tube opening pointing forward.

(5) Insert the seal-air tube (33) down the passage until it is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from the bearing housing and insert the tube. Secure with bolts (32). Torque the bolts to 22-27 lb-in. Safetywire the bolts.

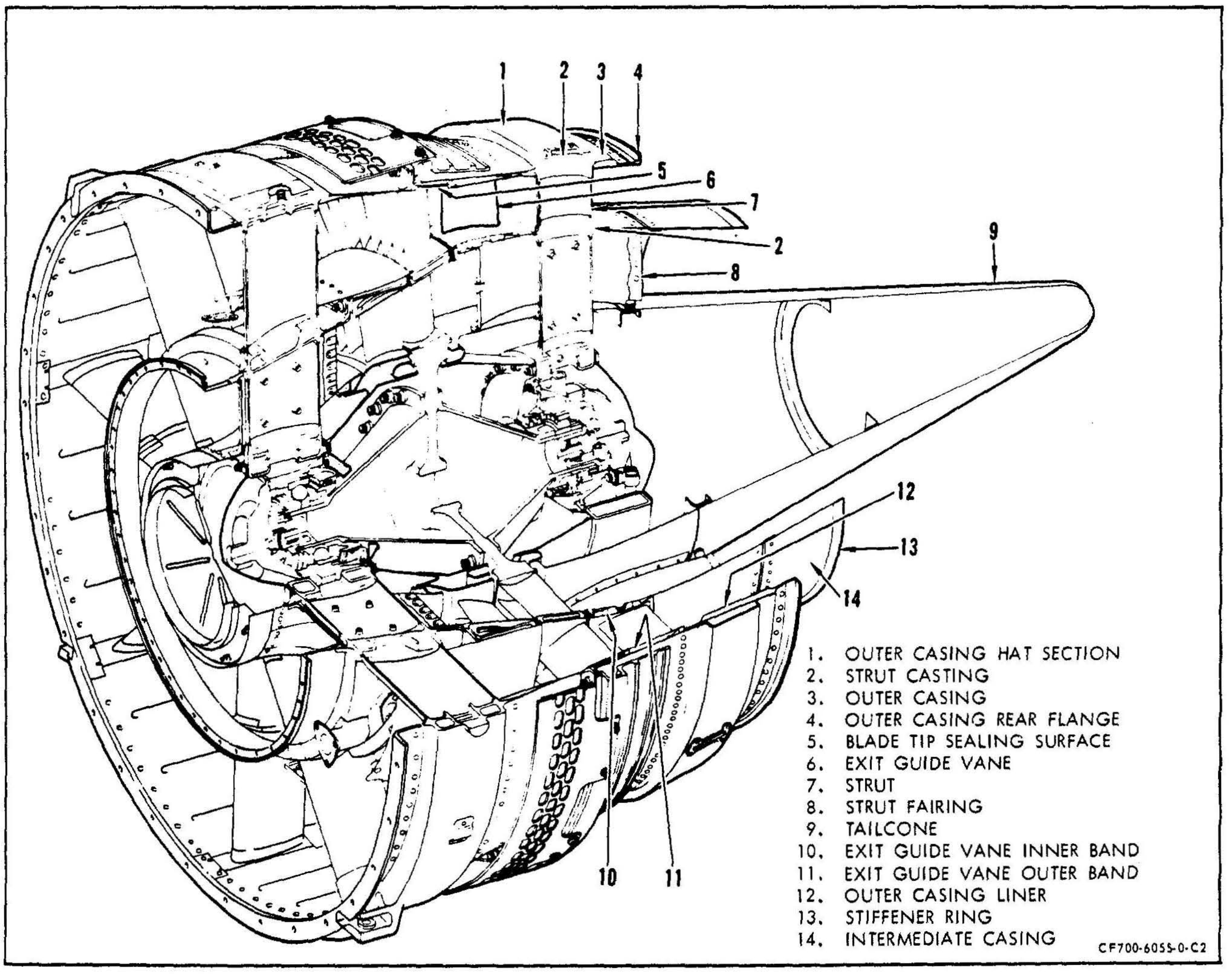
NOTE: The seal-air tube fits on a pin.

(6) Install the O-rings (31) on the oil scavenge tube (30) and insert the tube down the passage until the tube is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from the bearing housing and insert the tube. Secure with bolts (29). Torque the bolts to 22-27 lb-in. Safetywire the bolts.

(7) Install the O-rings (34) onto the oil supply tube (35) and insert the tube down the passage until it is just above the protective cover on the bearing housing. Inspect for, and remove, any dirt from the end of the tube. Remove the protective cover from the bearing housing and insert the tube. Secure with bolts (32), torque to 22-27 lb in., and lock-wire.

(8) Apply a pressure of 8-12 PSIG to the oil supply tube, using engine oil, for 1 minute. Increase the pressure to 48-52 PSIG and hold for 2 minutes. Reduce the pressure to 8-12 PSIG and hold for 1 minute. A clean continuous stream shall come from the oil nozzle and the seal nozzle. If any restriction of the nozzle is indicated clean per paragraph 72-70.

(9) Secure the No. 5 bearing housing (14) with the remaining bolts (13). Torque the bolts to 30-35 lb in.



Fan Section - Rear Frame Inspection
Figure 203

3. Inspection/Check. (See figure 203.) Inspect visually. Confirm suspected cracks using spot fluorescent-penetrant inspection per 72-03-1. When serviceable limits are exceeded the frame may be repaired in accordance with the overhaul manual.

Inspection/Check	Maximum Serviceable Limits	Remarks
A. Outer casing (3) for:		
(1) Parent metal cracks.	Nine, 3/8 inch long, no closer together than 3 inches.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(3) Dents and bulges.	2 between adjacent struts, 1/8 inch deep, with no sharp edges.	Cold work to adjacent contour. Spot fluorescent-penetrant inspect per 72-03-1. No cracks allowed.
(4) Thread damage in holes at end of struts. (5 holes in strut No. 3; 4 holes in all other struts).	One thread (cumulative) damaged or missing per hole, provided threads can be used without danger of cross threading.	Chase threads.
B. Outer casing rear mounting flange (4) for:		
(1) Cracks in the bolt holes.	One per bolt hole extending radially outward, provided cracked holes are separated by one uncracked hole, 5 holes maximum.	
(2) Circumferential weld cracks (flange-to-casing).	3 per weld, 3/8 inch long, no closer together than 1 inch.	
(3) Transverse weld cracks (flange-to-casing).	4 per weld not extending into parent metal, no closer together than 1 inch.	
C. Outer casing hat section (1) for:		
(1) Parent metal cracks.	Not serviceable.	
(2) Attaching seam-weld cracks.	3 between adjacent struts, 3/8 inch long.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(3) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(4) Dents and bulges.	2 between adjacent struts, 1/4 inch deep, with no sharp edges.	
D. Intermediate casing (14) and stiffener ring (13) for:		
(1) Cracks.	Six, 3/8 inch long, no closer together than 1 inch.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(3) Dents and bulges.	One between adjacent struts, 1/8 inch deep with no sharp edges.	
(4) Seam-weld cracks (casing-to-stiffener ring).	Any number, 3/8 inch long.	
E. Strut castings (2) for:		
(1) Parent metal cracks.	Any number, 1/8 inch long, no closer than 1 inch.	
(2) Strut-to-casting weld cracks.	Not serviceable.	
(3) All other casting welds for cracks.	2 cracks running transverse to the weldment and one running along the weldment, 1/8 inch long per casting.	
F. Struts (7) for:		
(1) Cracks.	Not serviceable.	
(2) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	
(3) Dents.	Any number, 1/16 inch deep, 3 per strut 1/8 inch deep; diameter of defect not more than 1/2 inch.	

Inspection/Check	Maximum Serviceable Limits	Remarks

G. Each sector of the outer casing liner (12) for:

WARNING: RTV SILICONE RUBBER ADHESIVE/SEALANT MIL-A-46106 OR MIL-A-46106A RTV-60 SILICONE RUBBER POTTING COMPOUND MIL-I-46838B

VAPOR RELEASED DURING CURING IS COMBUSTIBLE. DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.

VAPOR IS CORROSIVE. CONTACT OF VAPOR WITH SKIN OR EYES WILL CAUSE BURNS. INHALATION OF VAPOR MAY CAUSE SEVERE NOSE AND THROAT IRRITATION; REPEATED INHALATION MAY RESULT IN CHRONIC BRONCHITIS.

IF ANY VAPOR CONTACTS SKIN OR EYES, IMMEDIATELY FLUSH AFFECTED AREA THOROUGHLY WITH WATER. IF VAPORS CAUSE IRRITATION, GO TO FRESH AIR. GET MEDICAL ATTENTION.

WHEN MIXING UNCURED RUBBER, AND DURING CURING OF RUBBER WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES OR FACE SHIELD.

Inspection/Check	Maximum Serviceable Limits	Remarks
(1) Cracks.	Two, 1.0 inch long, not less than 1.0 inch apart if stop drilled.	Trim off damaged area and fill with RTV-106 (red). Blend to adjacent contour.
(2) Dents from foreign object damage (FOD).	Any number, 0.100 inch deep, diameter of defect no more than 1 inch, width gouge 0.015 inch at bottom of dent.	
(3) Bulges and dents from causes other than FOD.	Any number, 0.050 inch deep and 1.0 inch diameter.	
(4) Nicks, scratches and gouges.	Any number, 0.020 inch deep.	
(5) Pierced areas.	Two pierced areas, 1/16 inch wide, 3/8 inch long, no less than 1 inch apart.	
(6) Missing or loose rivets.	Not more than one loose or missing in the forward and/or aft band of rivets.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(7) Damaged rivet heads in the forward band and aft band of rivets.	Any number, provided head height is not less than 1/32 inch.	
H. Visible areas of strut fairings (8) for:		
(1) Parent metal cracks in the blend radius at the intermediate casing and at the inner liner.	One per radius, 3/8 inch long.	
(2) Parent metal cracks in the leading edge radius at the intermediate casing and at the inner liner.	Not serviceable.	
(3) Cracks emanating from rivet holes.	One per hole, 1/4 inch long. from rivet holes.	
(4) All other parent metal cracks.	One, 1 inch long.	
(5) Weld cracks (inner and outer fairing flange section-to-fairing).	One per flange section, 1/16 inch long.	
(6) Weld cracks, (air tube-to-fairing).	One per tube, 1/16 inch long.	
(7) Dents from foreign object damage.	Six, 1/16 inch deep. Diameter of defect no more than 1/4 inch, with 0.015 inch gouge at bottom of dent.	
(8) All other dents and bulges.	Any number, 1/16 inch deep, diameter of defect no more than 1/4 inch.	
(9) Nicks and gouges.	Any number, 0.015 inch deep, with no high metal.	Blend high metal to adjacent contour.
(10) Loose or missing rivets.	One at each strut.	

Inspection/Check	Maximum Serviceable Limits	Remarks
I. Exit guide vane assembly.		
(1) Exit guide vanes (6) on P/N 5002T53 for:		
(a) Cracks.	Any number 1/8 inch long, 5 trailing edge axial cracks 3/8 inch long, maximum 20 vanes.	
(b) Nicks at leading edge.	1/8 by 1/8 inch, 4 per vane, 20 vanes total.	Cold-work and blend nicks.
(c) Dents.	1/16 inch deviation from normal contour concave side, 4 per vane, 10 vanes total.	
(d) Tears.	Not serviceable.	Repair per paragraph 4.C.
(1A) Exit guide vanes (6) on P/N 6078T73 for:		
(a) Cracks.	Any number 1/8 inch long, 5 trailing edge axial cracks 3/8 inch long, maximum 40 vanes.	
(b) Nicks at leading edge.	1/4 by 1/4 inch, 4 per vane, 40 vanes total.	Cold-work and blend nicks.
(c) Dents.	1/4 inch deviation from normal contour concave side, 4 per vane, 20 vanes total.	
(d) Tears.	Not serviceable.	

Inspection/Check	Maximum Serviceable Limits	Remarks
(2) Inner and outer band (10, 11) for:		
(a) Axial and circumferential cracks.	Ten per band, 1/2 inch long, minimum separation of 1-1/2 inches.	
(b) Cracks extending from slot trailing edge.	5 per assembly, 1/8 inch long.	
(3) Outer band abradable coating (rotor blade tip sealing surface, 5) for:		
(a) Gouges, nicks, scratches, or missing patches.	Any number less than 0.050 inch deep. Defects deeper than 0.050 inch must not be larger than 3 inches by 1.75 inches in size and must not have a cumulative area exceeding 15 square inches.	Not repairable. Replace entire coating per paragraph 4.B.
J. Air and oil tubes (if removed) for:		
(1) Damage to wear sleeve at middle of tube.	Any amount no deeper than 0.010 inch from original contour.	Replace tube.
(2) Dents in heat shield.	Any number not exceeding 0.020 inch.	Replace tube.
(3) Nicks or dents in bottom or edge of O-ring groove.	Not serviceable.	Blend sharp edges smoothly into original surface.
(4) Fitting thread damage.	One full thread damaged, cumulative.	Chase threads.
K. Extension tailcone (9) for:		
(1) Cracks.	4 cracks, 0.50 inch long, minimum separation of 2 inches.	

4. Approved Repair.

A. Minor Repair Procedures.

(1) Remove high metal from external tube flanges, all areas in the primary and secondary air stream passages, and the outlet guide vane assembly.

(2) Chase threads as required to repair thread damage.

(3) Tighten or replace loose or missing rivets.

(4) Stop-drill cracks at each growing end. Use a drill not over 0.040 inch in diameter. Carefully center the drill on the last trace of the crack and drill through the material. Deburr edges of holes on both sides.

B. Abradable Coating Replacement.

(1) Using a putty knife or equivalent, remove the remaining fan shroud material. Use an 80-grit flapper wheel and stainless steel brush to remove all material from the shroud cavity. Removed material may be red or blue filler, fiber honeycomb core or epoxy-impregnated glass cloth.

WARNING: WHEN GRIT-BLASTING WITH ALUMINUM OXIDE (MIL-A-21380) IN AIR-EXHAUSTED, ENCLOSED CABINET, BE SURE THAT VENTILATION IS IN OPERATION AND THAT DOORS ARE PROPERLY SEALED.

WHEN GRIT-BLASTING WITH ALUMINUM OXIDE (MIL-A-21380) IN A PARTIALLY ENCLOSED, AIR-EXHAUSTED CABINET, OR IN OPEN WORK AREA, WEAR APPROVED RESPIRATOR, GLOVES, GOGGLES, AND LONG-SLEEVED CLOTHING.

(2) Roughen the shroud cavity surfaces uniformly with a stainless steel wire brush or gritblast with aluminum oxide. When grit-blasting use No. 220 or 240 aluminum oxide grit applied at a pressure of 70-90 psig and hold the nozzle at least 2 inches from the surface of part.

WARNING: TRICHLOROETHANE, O-T-620 IS TOXIC.

REPEATED OR PROLONGED CONTACT WITH LIQUID OR INHALATION OF VAPOR CAN CAUSE SKIN AND EYE IRRITATION, DERMATITIS, NARCOTIC EFFECTS, AND HEART DAMAGE.

AFTER PROLONGED SKIN CONTACT, WASH CONTACTED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. IF VAPORS CAUSE IRRITATION, GO TO FRESH AIR. GET MEDICAL ATTENTION FOR OVEREXPOSURE OF SKIN AND EYES.

WHEN HANDLING LIQUID IN VAPOR-DEGREASING TANK WITH HINGED COVER AND AIR EXHAUST, OR AT AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GLOVES AND GOGGLES IF CONTACT WITH LIQUID IS LIKELY.

WHEN HANDLING LIQUID AT OPEN, UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR, GLOVES, AND GOGGLES.

DISPOSE OF LIQUID-SOAKED RAGS IN APPROVED METAL CONTAINER.

(3) Degrease the cavity using trichloroethane, or equivalent.

WARNING: HOT STEAM CAN BURN EXPOSED TISSUE. DRY MATERIAL REMOVED BY STEAM SPRAY CAN INJURE EYES.

IF DRY MATERIAL CONTACTS EYES, FLUSH AFFECTED AREA THOROUGHLY WITH WATER. IF STEAM CONTACTS SKIN OR EYES, IMMERSE AFFECTED AREA IN COLD WATER FOR 10 MINUTES. IF BLISTERING OCCURS, IMMEDIATELY GET MEDICAL HELP.

WHEN STEAM-CLEANING, WEAR APPROVED GLOVES, APRON, AND FACE SHIELD.

(4) Steam clean the fan shroud cavity with detergent. Direct the steam with a constant sweeping motion to prevent localized heat buildup. Make a final steam pass without detergent.

(5) Visually inspect the cavity for cleanliness. No traces of shroud filler material allowed. Immediately check for water breaks indicated by water not flowing over the cleaned surface in a smooth continuous sheet. Check at several shroud circumferential locations. If traces of filler material are observed or if water breaks occur, repeat cleaning per steps (3) and (4).

WARNING: WHEN USING COMPRESSED AIR FOR ANY CLEANING OR DRYING OPERATION, DO NOT EXCEED 30 PSIG AT THE NOZZLE.

EYES CAN BE PERMANENTLY DAMAGED BY CONTACT WITH LIQUID OR LARGE PARTICLES PROPELLED BY COMPRESSED AIR. INHALATION OF AIR-BLOWN PARTICLES OR SOLVENT VAPOR CAN DAMAGE LUNGS.

WHEN USING AIR FOR DRYING OR CLEANING AT AN AIR-EXHAUSTED WORKBENCH, WEAR APPROVED GOGGLES OR FACE SHIELD.

WHEN USING AIR FOR DRYING OR CLEANING AT AN UNEXHAUSTED WORKBENCH, WEAR APPROVED RESPIRATOR AND GOGGLES.

(6) Thoroughly dry fan shroud, using clean, dry shop air. To maintain shroud cleanliness, do not use shop rags or paper wiping towels. Do not touch or handle shroud area with bare hands. Wear clean white cotton gloves when handling.

(7) Cover fan exit nozzle guide vanes with masking tape. To maintain shroud cleanliness, do not allow the masking tape to contact the shroud cavity surfaces.

(8) Install coating guide ring (figure 204) to the forward flange of the fan shroud. When applying coating, ring will guide and contain coating. The ring should be carefully positioned so that the shroud abradable material thickness will be uniform 360 degrees around.

WARNING: 3M BRAND VOID-FILLING COMPOUND MAY BE IRRITATING TO THE EYES UPON CONTACT. IF CONTACT IS MADE, FLUSH EYES WITH PLENTY OF WATER AND GET IMMEDIATE MEDICAL ATTENTION.

PROLONGED OR REPEATED SKIN CONTACT WITH COMPOUND MAY IRRITATE SKIN AND MAKE IT SENSITIVE. IF PROLONGED OR REPEATED CONTACT IS MADE, WASH CONTACT AREA THOROUGHLY WITH SOAP AND WATER.

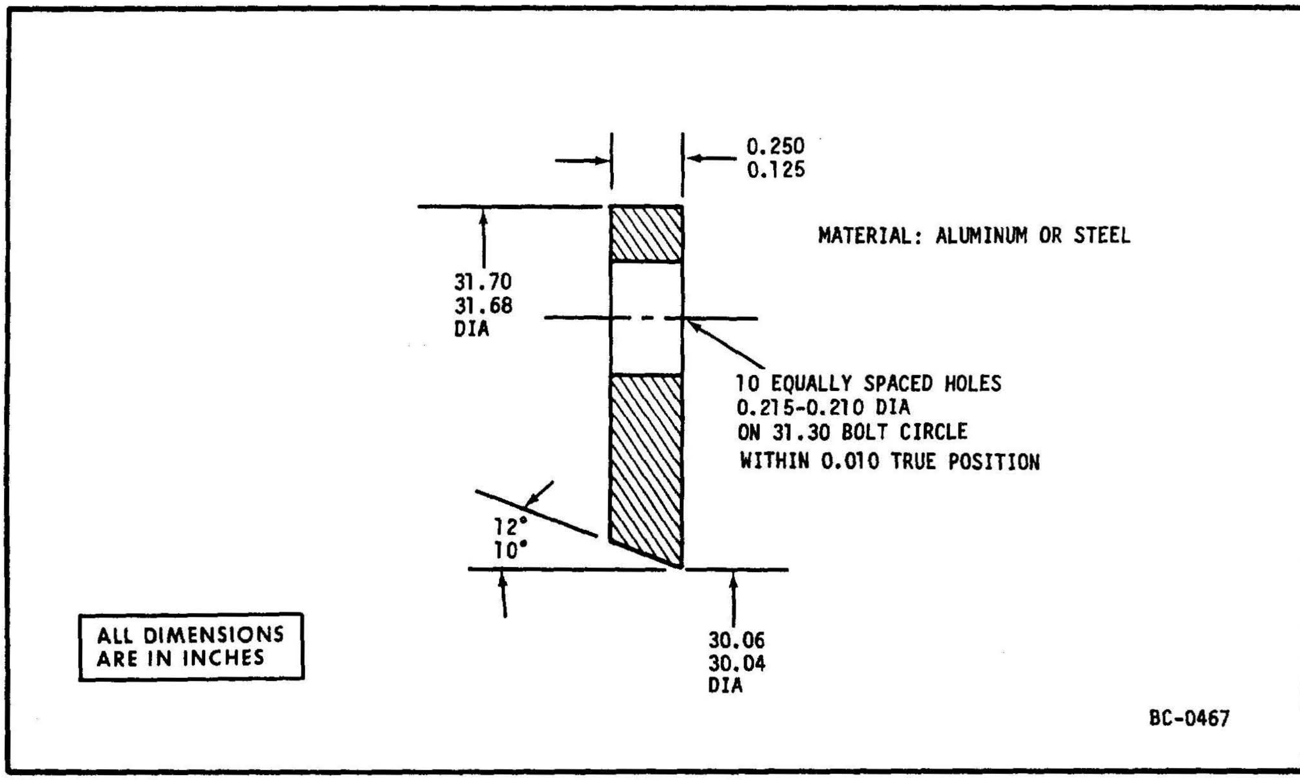
VAPORS OF HEATED COMPOUND MAY BE IRRITATING TO THE RESPIRATORY SYSTEM. IF VAPORS ARE INHALED, GO TO FRESH AIR.

WASH CONTAMINATED CLOTHING BEFORE REUSE.

AFTER USING COMPOUND, WASH HANDS THOROUGHLY BEFORE EATING OR SMOKING.

COMPOUND (OR VAPORS) MAY CAUSE ALLERGIES OR ASTHMA-TYPE SYMPTOMS, PARTICULARLY IN PERSONS ALREADY HAVING ALLERGIES OR ASTHMA.

NOTE: Before mixing, check expiration date on packet(s).



Coating Guide Ring
Figure 204

(9) Prepare the abradable coating (3M Void Filling Compound EC-3524 B/A, 3M Center, Saint Paul, MN 55101). Measure out the filler material (EC 3524 B and A) by weight as follows (100 parts base/94 part accelerator ratio):

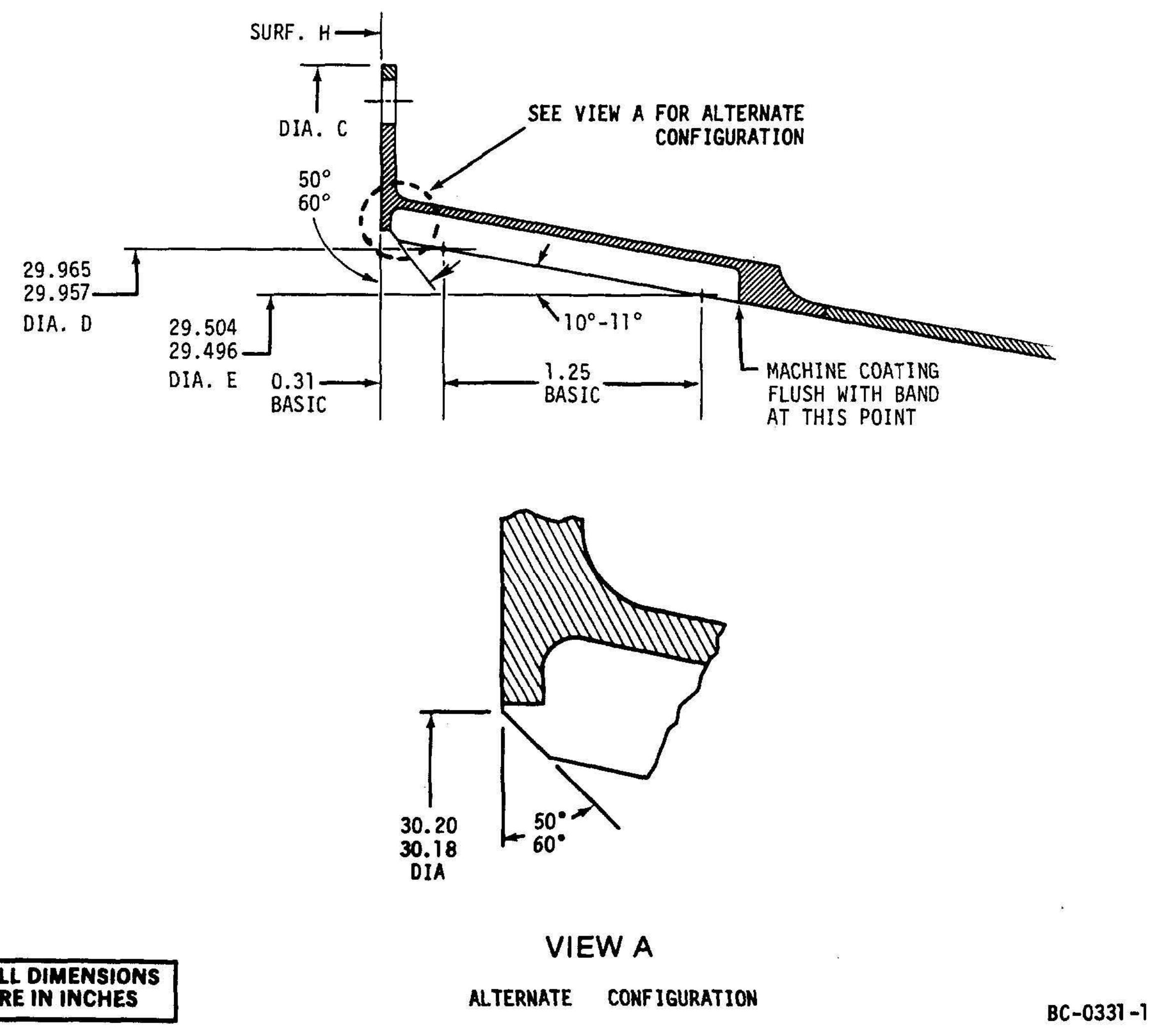
(a) Combine 200 grams of EC 3524 B (blue) base with 188 grams of EC 3524 A (white) accelerator.

(b) Mix the material by kneading it until a uniform pale blue color (without streaks) is obtained. Mixed material is to be used within 45 minutes.

(10) Apply the compound to the cleaned part. Wear clean white cotton gloves, if available. Apply sufficient pressure so that the mixture directly contacts the entire part and so that very few air bubbles form in the mixture. Trowel the exposed surface of the compound to form a truncated cone between the aft edge of the shroud cavity in front of the vanes and the edge of the installed ring.

(11) Cure the shroud for 24 hours at room temperature, 65°F (18°C) minimum.

(12) After curing, remove the guide ring from the shroud forward flange. Install the EGV in the fan rear frame and secure with at least six equally spaced bolts. Establish the best possible runout on the rear frame bore and machine the abradable coating to the dimensions shown in figure 205.



EGV Outer Shroud Rework Dimensions
Figure 205

C. Repair of Tears in Exit Guide Vanes.

WARNING: PERFORM THE CLEANING AND DEGREASING OPERATIONS IN AN APPROVED CLEANING CABINET OR WELL VENTILATED AREA. TAKE PRECAUTIONS TO PREVENT INHALATION OF VAPORS AND TO MINIMIZE FIRE HAZARDS. REPEATED OR PROLONGED CONTACT OF SOME CLEANING MATERIALS WITH THE SKIN WILL REMOVE SKIN OILS AND MAY CAUSE SEVERE DERMATITIS.

NOTE: This repair may be performed on tears a maximum of 1/2 inch long and 1/4 inch wide, at least 1/16 inch either side of a vertical centerline through the vane, and not closer than 5/8 inch to the leading edge and 1/4 inch from the trailing edge of the vane.

(1) Degrease in trichloroethylene, or equivalent.

(2) Clean the area to be repaired with clean acetone or methyl ethyl ketone solvent applied from a plastic squeeze bottle. Do not apply the solvent with a brush or cloth.

NOTE: After cleaning, do not handle the part or allow it to contact any foreign matter.

(3) Mix the compound (Kit No. 80055-674, Fenwal Inc., Ashland, Mass., or equivalent) and apply to the damaged area with a trowel allowing some of the compound to flow in between the vane walls. Trowel the compound from flush to slightly above the outer surface of the vane.

(4) Allow to cure for 24 hours at 70°F or for one hour at 100°-130°F.

(5) Sand the compound to the original contour of the vane using emery cloth or equivalent.