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LONG-TERM CF6 ENGINE PERFORMANCE DETERIORATION - EVALUATION OF ENGINE S/N 451-380

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16. Abstract

This report summarizes the performance testing and analytical teardown of CF6-6D engine serial number 451-380 at the General Electric Aviation Service Operation, Ontario, California. This Western Airlines engine was a multiple build engine, most recently removed from DC-10 aircraft Number N902WA to participate in the NASA-Lewis Task IV Program. The investigative test program was conducted inbound prior to normal overhaul/refurbishment. The performance testing included an inbound test, a test following cleaning of the low pressure turbine airfoils, and a final test after leading edge rework and cleaning the stage one fan blades. The analytical teardown consisted of detailed disassembly inspection measurements and airfoil surface finish checks of the as received deteriorated hardware.

Included in this report is a detailed analysis of the test cell performance data, a complete analytical teardown report with a detailed description of all observed hardware distress, and an analytical assessment of the performance loss (deterioration) relating measured hardware conditions to losses in both sfc (specific fuel consumption) and EGT (exhaust gas temperature).

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1.0 INTRODUCTION

CF6-6D serial number 451-380 was selected to be the second of the Task IV (Long Term Performance Deterioration) engines in accordance with the requirements of the NASA-Lewis CF6 Jet Engine Diagnostics Program, Contract No. NAS3-20631. The rationale and justification for selection of this particular engine was submitted on June 17, 1977.

Background information had been supplied to NASA in two separate documents. "Potential Task IV Engines" compared 451-380 cruise trend data versus data for other Task IV engine candidates. The document also explained why a CF6-6D, rather than a CF6-50, engine was selected as the second Task IV engine. "Task IV Engine 451-380" presented detailed data on 451-380. This included module historical records, acceptance test data from the last outbound test cell run (at Ontario), and an update of the 451-380 cruise trend data.

The engine test plan was submitted on June 14, 1977. Included in that document was a list of test objectives, a description of the basic CF6-6 engine, an itemized test plan schedule, detailed instructions for the designated performance tests, analytical teardown, refurbishment and reassembly instructions, and an instrumentation and facilities description for the General Electric Aviation Service Operation (ASO) Ontario, California, CF6 test cell.

The instrumentation plan for this engine was submitted on June 14, 1977. This document described the instrumentation required for the performance testing of the engine. Standard airline instrumentation was requested and used to measure test cell engine performance. Additional LP turbine inlet pressure probes (P49) and HP compressor discharge temperatures (T_3 rake) were used to ensure data consistency and accuracy.

This report summarizes all of the pertinent data generated during the course of the test plan, together with an analytical assessment of the performance losses, as shown in Section 7.0.

2.0 OBJECTIVES

In accordance with the requirements outlined in the NASA-Lewis CF6 Jet Engine Diagnostic Program, Contract No. NAS3-20631, the following objectives were considered paramount for engine S/N 451-380, as one of the participants in the Task IV effort:

- Component Analyses of long-term performance deterioration with regard to deterioration magnitude and apportionment to individual components.
  - High Pressure (HP) Compressor Efficiency
  - High Pressure (HP) Turbine Efficiency
  - Parasitics
  - Low Pressure (LP) System Efficiency
  - Thrust at Fan Speed
- Evaluation of LP turbine (LPT) performance restoration with regard to LPT vane and blade surface finish.
- Evaluation of fan performance restoration with regard to blade leading edge quality and airfoil surface cleanliness.
- Analysis of HP core losses (HP compressor, HP turbine, and parasitics) for use in correlating analytical teardown inspection results
- Obtain data for the CF6 deterioration model in terms of both component and overall (EGT and sfc) performance.

3.0 ENGINE HISTORY

CF6-6D Serial No. 451-380 was delivered new to Western Airlines (WAL) on DC-10-10 aircraft (A/C) No. N902WA-1 (left wing location) on June 14, 1973 (see "Engine Historical Record," Table I). During the period of revenue service up to installation on A/C N901WA-3 (right wing location) on May 24, 1976, the engine composition had undergone a number of changes necessitated by distress, updating and/or convenience of the operator.

As is common practice at the airline shops during overhaul, modules are interchanged between engines to facilitate a particular engine's buildup cycle. Consequently, after the last shop visit, 451-380 was composed of modules from several different engines. Table II is a listing of -380's engine module units (EMU), including the source engine, and the hours (TSN) and cycles (CSN) since new at the time of this teardown. There had been some compressor damage in the past history of 451-380, so some of the compressor blades and vanes had been replaced. The combustor liner (G44) was replaced during the last build, as were the high pressure turbine (HPT) blades and vanes and the turbine midframe (TMF) liner. The low pressure turbine (LPT) had not been serviced since it was purchased as a spare module. The Stage 1 fan blades were originally from ESN 451-436 and, of particular interest, was the fact that the leading edges had never been recontoured.

This build of 451-380 was per the "Phase III Upgrade Program," which included a number of performance and ruggedization improvements. The primary modifications included elliptical grinding of the HPT shrouds, shimming of the Stage 1 HPT nozzle, and increased cooling holes in the Stage 2 HP turbine nozzle support.

The engine was removed from the aircraft on June 19, 1977, to participate in the NASA-Lewis Diagnostics Program as the second Task IV engine. At that time, it had accumulated 12,189 hours (TSN) and 3741 cycles (CSN) since new. This included 4594 hours (TSO) and 1270 cycles (CSO) since the last overhaul. The engine was delivered to the General Electric Aircraft Service Operation (ASO) located in Ontario, California, on June 20, 1977.

Table I. ESN 451-380 Historical Record.

Aircraft No.	Installed	Removed	TSN	CSN	TSI	CSI	Reason for Removal
902WA-1	6/14/73	10/16/73	1300	570	1300	570	Inlet Gearbox Horizontal Duplex Bearing Spalled
904WA-3	1/2/74	6/6/74	2882	1061	1582	491	Combustor Liner Crack
904WA-1	6/21/74	8/1/74	3273	1213	391	152	Vibrations in HP Turbine Rotor
901WA-2	10/12/74	7/15/75	5794	1973	2521	760	Turbine Midframe Liner Failure
905WA-1	9/14/75	2/26/76	7594	2471	1800	498	Stage 10 Blade Failure
901WA-3	5/24/76	6/19/77	12189	3741	4595	1270	Removed for NASA - Task IV

Table II. ESN 451-380 Modules.

EMU	Source	TSN	CSN
Fan Rotor	451-380	12189	3741
- Stage 1 Blades	-436	11408	3462
Fan Stator	-380	12189	3741
Fan Frame	-380	12189	3741
Midshaft	-380	12189	3741
Compressor Rotor	-380	12189	3741
Compressor Front Stator	-380	12189	3741
Compressor Rear Stator	-380	12189	3741
Compressor Rear Frame	-402	10618	3157
Combustor	-388	10363	3028
- Liner	New	4594	1270
HPT Stage 1 Nozzle	-330	12435	4554
- Vanes	New	4594	1270
HPT Stage 2 Nozzle	-384	12597	3777
- Vanes	New	4594	1270
HPT Rotor	-384	12597	3777
- Blades	New	4594	1270
Turbine Midframe	-491	7167	2034
- Liner	New	4594	1270
LPT Stage 1 Nozzle	-491	7167	2034
LPT Stator	Spare	7717	2179
LPT Rotor	Spare	7717	2179
Turbine Rear Frame	-393	12125	3576
Inlet Gearbox	-380	12189	3741
Transfer Gearbox	-385	12111	3484
Accessory Gearbox	-380	12189	3741

4.0 SUMMARY OF EVENTS

Work Order No. 181650 was prepared and issued to the shop by ASO/Ontario to accomplish the requirements of the Task IV Test Plan. The program objectives were met in the following sequence of events:

Date	Event
6/19/77	Engine S/N 451-380 was removed from WAL Aircraft S/N 901-3 at Los Angeles. Prepared for shipment to ASO/Ontario.
6/20/77	Engine arrived in Ontario late second shift. Incoming inspections performed and slave hardware installed for test cell run. Suspected faulty EGT harness (upper right) accepted for the test.
6/22/77	Engine delivered to the test cell at 1630 hours. Test personnel setting up and instrumenting per the Test Plan.
6/23/77	Initiated test at 0900 hours. Difficulties with the cell fuel system necessitated an additional calibration run.
6/24/77	Made another calibration run to substantiate the data obtained during the previous day's testing. Engine returned to Hanger No. 1 at the end of second shift for analytical inspection and refurbishment of the low pressure turbine (LPT) section.
7/1/77	LPT EMU removed and delivered to Hanger No. 2.
7/5/77	Initiated LPT disassembly and inspection checks.
7/18/77	Completed inspections and SWECO cleaning of LPT blades and vanes.
7/28/77	Completed engine rebuild. Waiting for test cell to become available.
8/2/77	Engine installed in cell. Conducted the calibration runs prior to the end of second shift. Computer nonoperational throughout the tests.
8/3/77	Computer printout showed faulty T3 readings and the fuel flow ratio was out-of-limits. Corrections made and performance runs repeated. Spent remainder of day trouble shooting fuel system (ratio between main and verification sensors still out-of-limits).

Date	Event
8/4/77	Most of the day spent on fuel system. Completed rerun of test at 2300 hours. Initiated removal of Stage 1 fan blades for recontouring and cleaning, per Test Plan.
8/6/77	Fan blades completed and reinstalled. Test runs completed at 2300 hours. Replaced suspected faulty EGT harness (upper right).
8/7/77	Completed testing with replacement harness at 0900. No effect on EGT indication. Engine removed from cell and delivered to Hanger No. 1 for core analytical teardown.
8/11/77	Initiated engine disassembly into major EMU's.
8/12/77	Core delivered to Hanger No. 2.
8/21/77	Initiated core analytical teardown.
8/29/77	Completed core engine inspections.
8/31/77	Decision made to rebuild engine at WAL. Initiated removal of HPC blades and vanes for SWECO cleaning. Also, removal of Stage 1 fan blades for fluorescent penetrant inspection (FPI) per S/B 72-653. Preparing all other hardware for return to WAL "as-is".

5.0 451-380 PERFORMANCE SUMMARY

Performance testing of engine 451-380 consisted of four separate double-power calibrations, including an inbound test, a test following cleaning of the LP turbine airfoils, a test following Stage 1 fan blade cleaning and leading edge rework, and a final outbound test following partial refurbishment at Western Airlines. The data were reasonably consistent and repeatable, with the exception of a shift in core engine (HP compressor, HP turbine, and parasitics) performance following cleaning of the LP turbine airfoils. Detailed inspections during the core engine teardown revealed no evidence of any recent hardware distress which could have caused the performance shift.

The inbound test consisted of four down-power calibrations. A section of the EGT harness (upper right) tested bad (grounded) prior to running the inbound test, but was not replaced until the completion of the NASA program. Changing this segment and retesting (following the fan test) resulted in a negligible impact on the measured EGT. The inbound calculated T5X minus indicated EGT (ΔT5X) was +28° F, as compared to +25° F for the previous outbound test conducted at ASO/Ontario on April 30, 1976. This excellent agreement confirmed that the grounded harness segment had little effect on the indicated EGT readout.

The inbound performance level (EGT) was in excellent agreement with that projected by the cruise trend data. The total sea level deterioration since the last engine build (4594 hours TSI) was 37° C EGT and 3.2 percent sfc. The cruise data projected a value of 35° C using an 80 percent sea level to altitude EGT deterioration correlation. The inbound data are summarized in Table III.

The following component deterioration (inbound versus April 30, 1976 outbound) was measured. Note that almost all the loss was in the core engine (HP compressor, HP turbine, and parasitics):

-0.7%	ΔETAC (HP Compressor Efficiency)
-2.6%	ΔETAT (HP Turbine Efficiency)
+1.1%	ΔPARAS (Core Engine Internal Leakages and Cooling Flows)
-0.8%	ΔETALPS (LP System Efficiency)
+0.7%	FN at N1 (Thrust at Fan Speed)
+67° F	EGT at N1 (EGT at Fan Speed)
+71° F	T5X at N1 (Calculated EGT at Fan Speed)
+3.2%	sfc at FN (sfc at Thrust)

The performance stackup is presented using the measured inbound A4 of 54.045 square inches. The 1976 outbound test data were reduced assuming an A4 of 52.843 square inches since the HP turbine Stage 1 nozzle area was not measured at that time. The value is the average of the CF6-6 Shop Manual

Table III. Average of Takeoff and Maximum Continuous Data.

	Inbound	After LPT	Before Fan	After Fan	Refurbished Outbound
Date	6/23/77	8/3/77	8/4/77	8/6/77	11/2/77
Δsfc Margin	-3.2%	-4.1%	-4.3%	-3.8%	-1.4%
ΔT/O EGT	+67° F	+80° F	+93° F	+95° F	+40° F
ΔM/C EGT	+68° F	+79° F	+88° F	+88° F	+40° F
ΔT/O T5X	+71° F	+98° F	+109° F	+110° F	+41° F
ΔM/C T5X	+70° F	+92° F	+99° F	+103° F	+40° F
%ΔETAC ↑	-0.7%	-1.3%	-1.4%	-1.3%	+0.2%
%ΔETAT	-2.8%	-3.6%	-4.4%	-4.4%	-1.9%
%ΔPARAS T5X	-1.1%	-1.3%	-1.7%	-1.7%	-0.5%
%ΔETALPS	-0.8%	-0.5%	-0.3%	+0.3%	-0.1%
%ΔFN1 ↓	+0.7%	+0.5%	+0.6%	+1.5%	+1.5%
%ΔETAC ↑	-0.7%	-1.3%	-1.4%	-1.3%	+0.2%
%ΔETAT	-2.4%	-2.7%	-3.5%	-3.4%	-1.8%
%ΔPARAS EGT	-1.1%	-1.2%	-1.6%	-1.6%	-0.6%
%ΔETALPS	-0.7%	-0.1%	+0.1%	+0.8%	-0.1%
%ΔFN1 ↓	+0.7%	+0.5%	+0.6%	+1.5%	+1.5%
%ΔA4	+2.3%	+2.3%	+2.3%	+2.3%	0

Note: All parameters tabulated versus the April 30, 1976 outbound level.

limits (Section 72-51-00). This assumed value is probably too small, since the calculated value for parasitics decreased by 1.1 percent, while, in reality, this value should either stay constant or increase with time.

The test following cleaning of the LP turbine airfoils consisted of several power calibrations. The core engine (HPC, HPT, and parasitics) performance level deteriorated during the testing sequence. As noted earlier, the analytical teardown hardware inspections revealed no indication of any recent hardware distress. The magnitude of the core deterioration (+26° F EGT and +1.1 percent sfc) concealed any measured LPT improvement due to the airfoil cleaning. The calculated LP system efficiency, however, indicated there may have been as much as a 0.5 percent improvement in the LP turbine.

In addition to the core engine shift, there was a problem with an erratic facility fuel flow measurement (main to verification ratio). This problem appeared to be position-related, as the main (upstream) fuel meter always indicated a higher reading than the verification (downstream) meter. A complete investigation of the fuel flow system resulted in the erratic nature of the fuel flow ratio being eliminated. The main fuel flow, although within limits, continued to read approximately 0.3 percent higher. The performance data are summarized in Table III. The two columns of past LP turbine data (Table III) are the first and last power calibrations recorded during this testing sequence. The following component differences were measured relative to the inbound test (average of EGT and T5X):

-0.6% ΔETAC
-0.5% ΔETAT
-0.2% ΔPARAS
+0.5% ΔETALPS
-0.2% FN at N1
+13° F EGT at N1
+27° F T5X at N1
+0.9% sfc at FN

Two power calibrations were run following the Stage 1 fan blade cleaning and leading edge recontouring. The back-to-back test data indicated a significant improvement in both sfc (0.5% sfc at FN) and thrust (+0.9% FN at N1). There was no improvement in EGT at N1, since both fan airflow and efficiency increased. The performance data are summarized in Table III. The following component differences were determined from the back-to-back tests involving the fan blade refurbishment:

+0.1% ΔETAC
0 ΔETAT
0 ΔPARAS
+0.7% ΔETALPS
+0.9% FN at N1
+2° F EGT at N1
+1° F T5X at N1
-0.5% sfc at FN

Following completion of the NASA program workscope, Western Airlines (WAL) elected to perform a minimum workscope to make 451-380 a serviceable engine. Included in this workscope was SWECO cleaning of the HP compressor airfoils in order to demonstrate the potential gains resulting from this cleaning process.

The rebuild of 451-380 took place at WAL and included replacement Stage 1 fan blades, the original HP compressor with SWECO cleaned airfoils, a new rotating forward CDP seal, a serviceable combustor, mini-nozzle, HP turbine Stage 1 nozzle module, and HP turbine module, and the original LP turbine module. The outbound performance test indicated a 55° F EGT and 2.4 percent sfc improvement over the prerefurbished levels. Included was a 1.5 percent increase in measured HPC efficiency resulting from SWECO cleaning of the HPC airfoils. The performance data are summarized in Table III.

6.0 POSTTEST TEARDOWN RESULTS

Following the testing on 8/7/77, engine 451-380 was returned to the shop for an analytical teardown inspection of the core engine. Earlier in the program, the low pressure system had likewise been subjected to an analytical teardown. The results of the various inspection checks are presented in this section. An assessment of the hardware with regard to performance losses appears in Section 7.0. The inspection results include observations concerning the hardware which were performance-related, and do not imply that no other discrepancies existed.

6.1 HIGH PRESSURE COMPRESSOR SECTION

6.1.1 HP Compressor Rotor Assembly

6.1.1.1 General

Except for the normal accumulation of dirt on the blades and spool, the high pressure compressor rotor assembly was in very good condition. Blades in Stages 15 and 16 were very rusty in appearance, probably due to being outside the hanger during a very heavy rain storm, prior to the teardown. The rain was also responsible for the powdery substance noted throughout the compressor, on blades and spool parts, as well as on vanes and cases. Figure 1 is a photograph of the rotor. (Note: There was no evidence of any aluminum deposits. The splatter observed on the blades in the photograph is the powdery substance mentioned above.)

6.1.1.2 Rotor Land Rubs

There were no vane-to-spool rubs on any rotor land. However, there was a heavy scratch on the Stage 4 land, more than likely caused by an end vane being out of position when the cases were removed (a common disassembly fault).

6.1.1.3 Rotor Land Coating Condition

Inspection of the aluminum coating on the compressor rotor lands revealed discrepancies as noted below. (See Figure 1.)

Stage	Land Condition
14 and 15	100 percent missing
12 and 13	Approximately 50 percent missing
10 and 11	Intermittent chipping, aft end of land
7 - 9	Intermittent chipping, forward end of land
3 - 6	Satisfactory

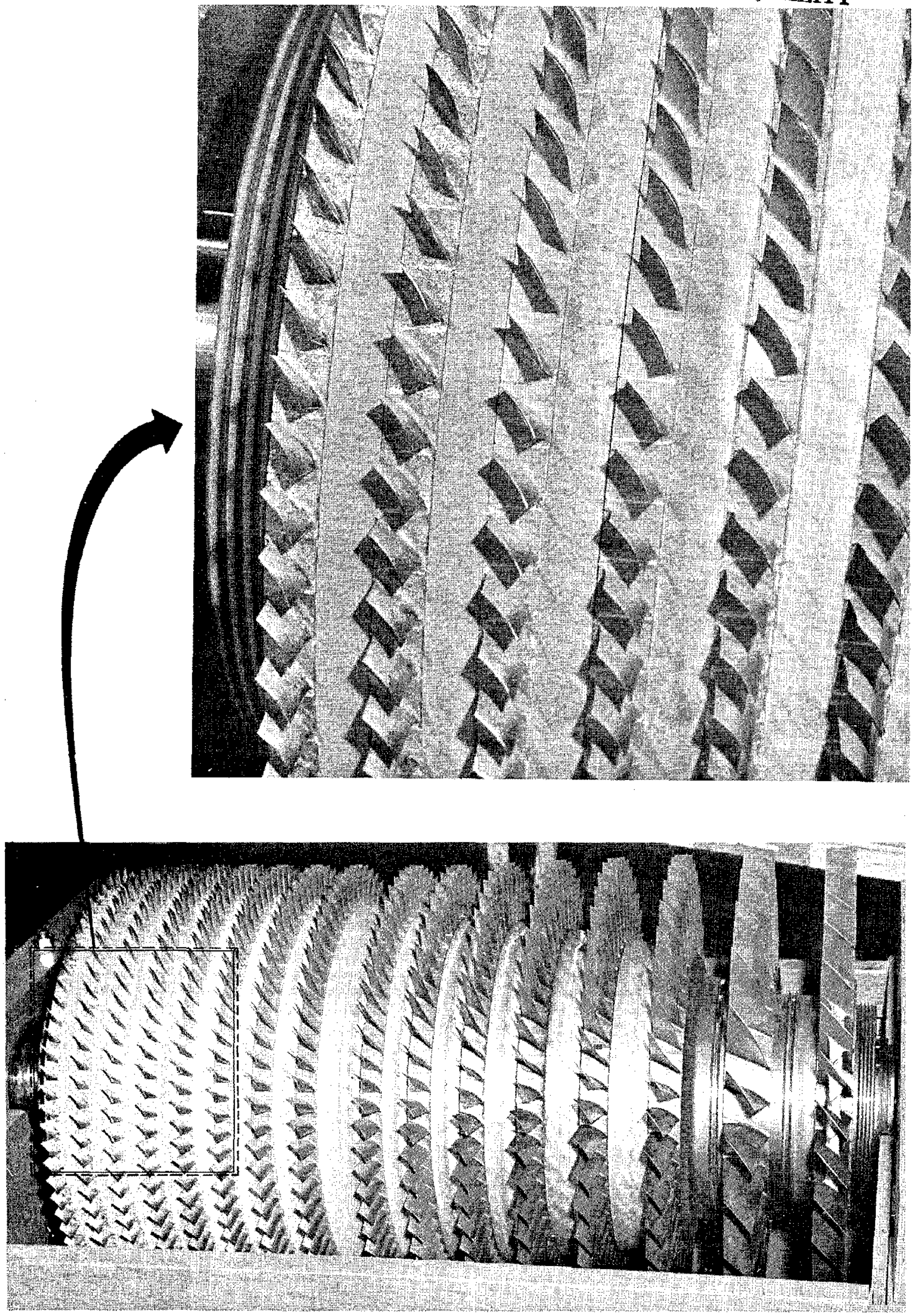

Figure 1. HP Compressor Rotor Coating.

6.1.1.4 Blade Airfoil Condition

The airfoils were in excellent condition, except for the dirt and the oxidized appearance of the Stage 15 and 16 blades. The blades contained no nicks (FOD) or other damage. Stage 15 blades exhibited a very mild tip rub which was substantiated by the rub noted on the compressor stator land, lower case (See Section 6.1.2.4).

The Stage 1 blade midspan shrouds were visually inspected, as assembled, and were found to be in excellent condition.

6.1.1.5 Blade Surface Finish

Two blades per stage were removed from the rotor to measure the airfoil surface finish by means of a profilometer supplied by Airline Support Engineering, Evendale. The measurements were taken at 15, 50 and 85 percent of blade height at:

1. 10 to 15 percent of chord from leading edge on the suction side.
2. 10 to 15 percent of chord from trailing edge on the pressure side.

Results (RMS μ inch) are presented in Table IV.

6.1.1.6 Rotating CDP Seal

A visual inspection of the CDP seal showed it to be in excellent condition. However, measurements revealed the teeth diameters to be slightly under the shop manual serviceable limits. It had already been planned to replace this seal with an updated part prior to the inspection checks.

Results of the measurements of each of the CDP seal teeth are shown in Table V. (Note: 12 o'clock position arbitrarily chosen to establish a base point and all measurements are relative to that point. Runout data are recorded in mils and are positive, unless otherwise indicated. Diameters are recorded in inches.)

6.1.2 High Pressure Compressor Stator Assembly

6.1.2.1 General

Inspection of the HP compressor stator assembly showed it to be in very good condition, except for the normal dirt buildup on the vanes. A mixture of oil and dirt was noted on the IGV's and the IGV inner shroud. There was no trace of aluminum splatter on any of the vanes. Photographs of the stator assembly, Figures 2 and 3, give the appearance of aluminum splatter, but this is some type of powdery substance presumed to be caused by allowing the engine to sit outside during a heavy rain storm.

Table IV. HP Compressor Rotor Airfoil Surface Finish Inspection Results.

Stage	Position No.	Convex					Concave					Stage Overall Avg.
		Tip	Pitch	Root	Avg.	Stg. Avg.	Tip	Pitch	Root	Avg.	Stg. Avg.	
1	1	10	12	15	12		63	70	44	59		
	3	13	13	10	12	12	66	70	55	64	61	37
2	1	23	30	25	26		72	35	43	50		
	2	30	30	33	31	28	70	38	33	47	48	38
3	5	27	27	33	29		63	27	29	40		
	6	27	29	27	28	28	67	30	38	45	42	35
4	5	30	29	48	36		55	38	38	44		
	4	30	37	40	36	36	46	39	40	42	43	39
5	5	27	30	46	34		47	38	48	44		
	6	25	33	50	36	35	42	39	45	42	43	39
6	6	35	37	51	41		37	53	53	48		
	5	35	42	60	46	43	48	55	83	62	55	49
7	5	27	37	44	36		38	45	42	42		
	6	30	32	60	41	38	44	42	53	46	44	41
8	5	43	40	54	46		46	42	50	46		
	6	38	42	60	47	46	48	43	58	50	48	47
9	5	33	45	58	45		41	25	64	43		
	6	30	40	50	40	43	35	42	57	45	44	43
10	5	30	42	40	37		51	40	40	44		
	6	25	42	48	38	38	42	47	43	44	44	42
11	5	36	42	61	46		43	50	63	52		
	6	32	46	60	46	46	38	48	62	49	51	48
12	5	42	47	65	51		34	36	45	38		
	6	33	45	60	46	49	40	60	58	53	45	47
13	6	47	47	73	56		47	50	53	50		
	5	37	47	45	43	49	50	42	57	50	50	50
14	6	47	67	62	59		35	37	80	51		
	5	34	47	55	45	52	44	60	70	58	54	53
15	6	38	51	54	48		42	40	65	49		
	5	53	55	60	56	52	68	57	60	62	55	54
16	6	40	40	55	45		35	48	63	49		
	4	37	46	50	44	45	51	45	90	62	55	50
Average blade surface finish = 45 RMS µ inches. (Average when new = 15 RMS µ inches)												

Table V. CDP Seal Tooth Inspection Results.

Runout	D	E	F	G	H	I
12 o'clock	0.0	0.0	0.0	0.0	0.0	0.0
1 o'clock	-0.5	-0.5	0.0	0.0	0.5	0.0
2 o'clock	-0.5	-0.5	-0.5	0.0	-0.5	0.0
3 o'clock	-0.5	-0.5	-0.5	0.0	-0.5	1.0
4 o'clock	-0.5	-0.5	-0.5	0.0	-0.5	0.5
5 o'clock	0.0	0.0	0.0	0.5	-1.5	1.0
6 o'clock	0.5	0.0	0.5	0.5	-1.0	0.0
7 o'clock	0.0	0.0	0.5	0.5	0.5	1.0
8 o'clock	0.5	0.5	0.5	1.0	1.0	0.0
9 o'clock	0.5	0.5	0.5	0.5	1.0	1.5
10 o'clock	0.5	0.0	1.0	0.5	0.5	1.0
11 o'clock	0.0	0.0	1.0	0.5	-0.5	0.0
Diameter at 12 o'clock	17.130	17.329	17.525	17.729	17.926	18.122
FIR	0.001	0.001	0.0015	0.001	0.002	0.0015
Diameters were Calculated to be:						
Maximum	17.130	17.329	17.5255	17.7295	17.928	18.1245
Minimum	17.129	17.3285	17.5245	17.729	17.925	18.122
Average	17.129	17.329	17.525	17.729	17.927	18.123
Shop Manual Dimensions						
Maximum	17.134	17.334	17.534	17.734	17.934	18.134
Minimum	17.132	17.332	17.532	17.732	17.932	18.132
Serv. Limit	17.129	17.329	17.529	17.729	17.929	18.129

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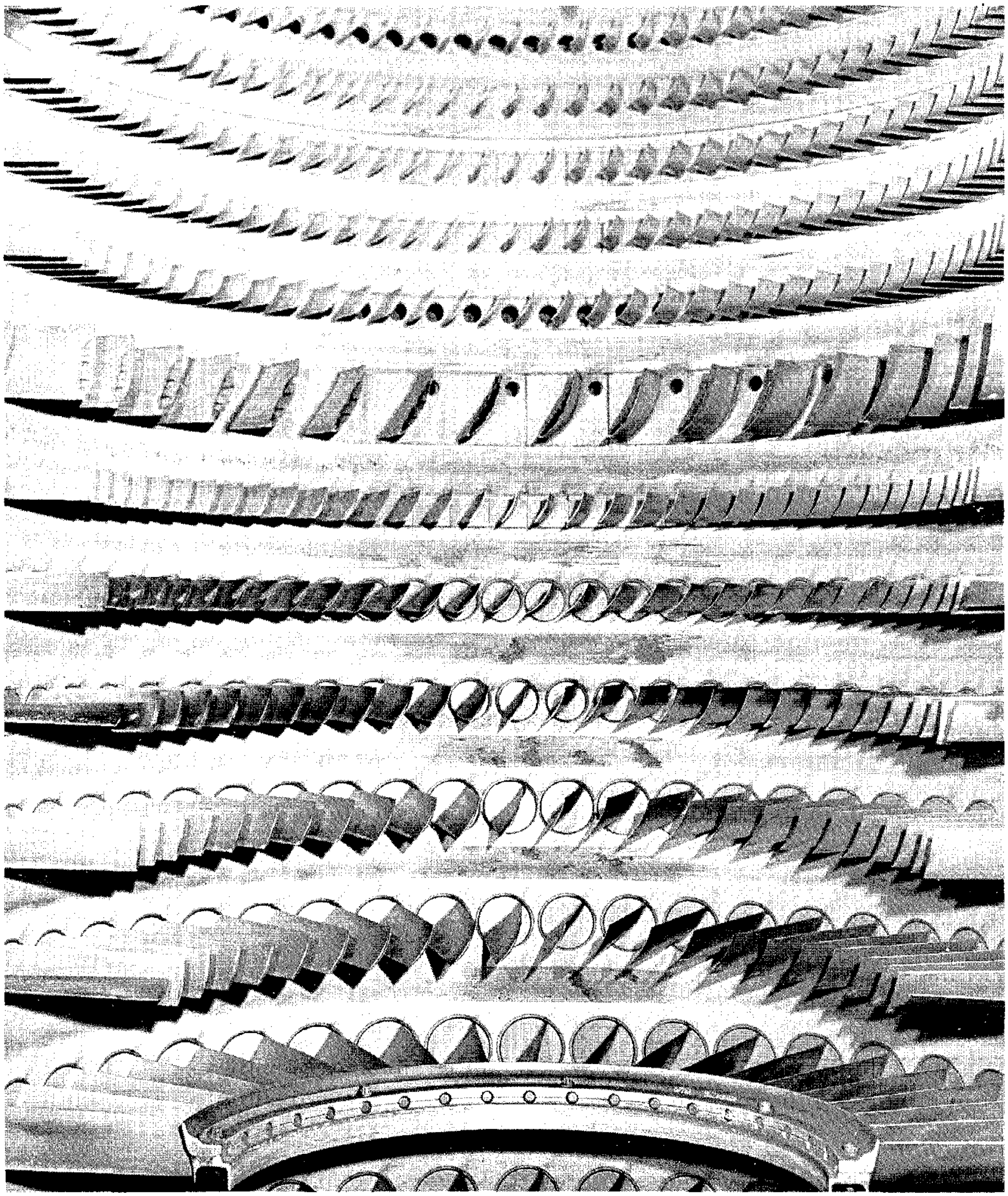

Figure 2. HP Compressor Stator Case, Upper Land Rubs.

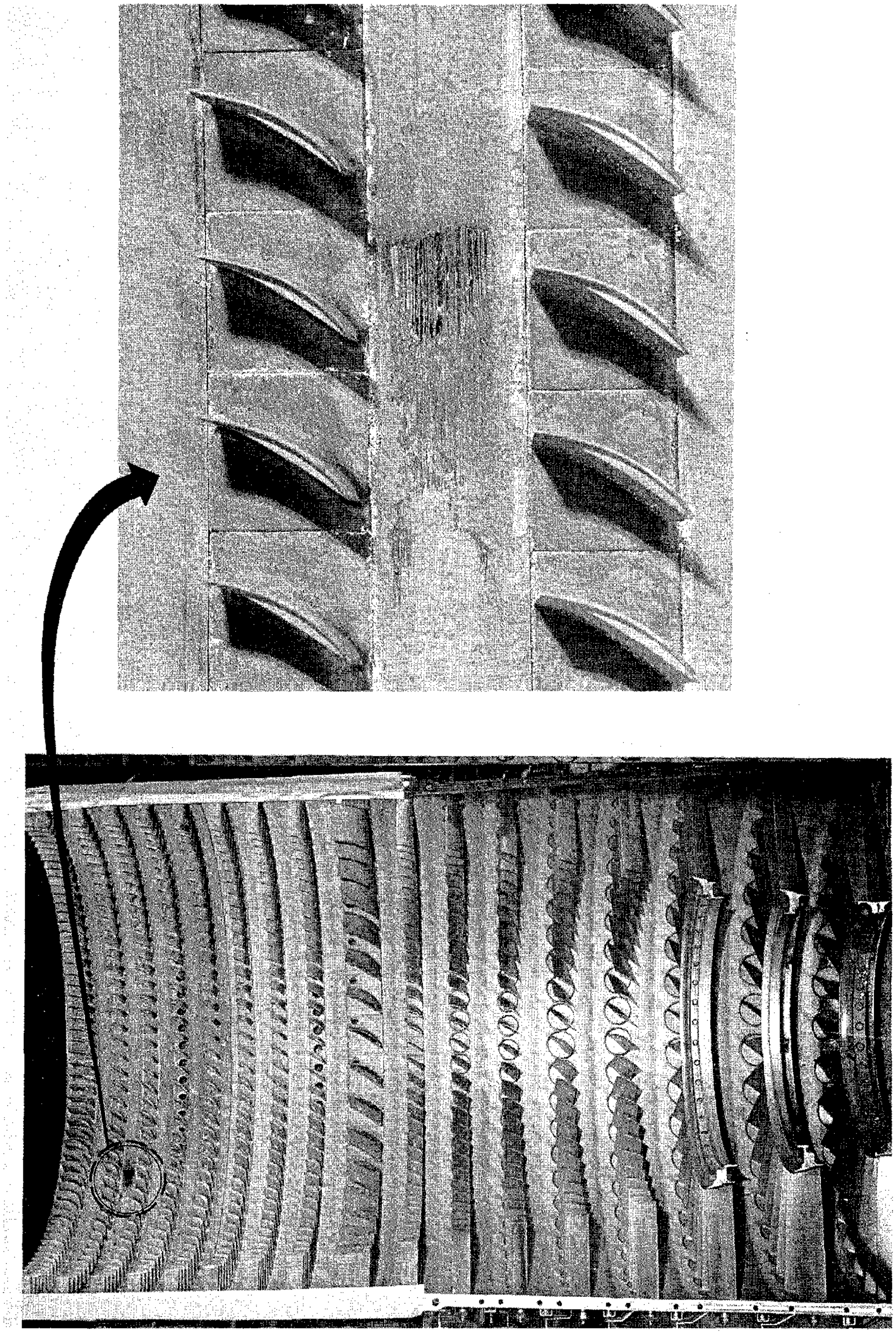

Figure 3. HP Compressor Stator Case, Lower 15th Stage Rub.

6.1.2.2 Condition of Variable Stator Bushings

Variable stator bushings were in excellent condition. Inspection checks revealed no loose vanes, with all appearing to have retained their normal torque.

6.1.2.3 Vane Airfoil Condition

Except for the dirt, the airfoils were in excellent condition. No nicks, dents or other discrepancies were noted on any vane.

6.1.2.4 Casing Rubs

Inspection of the lower stator case lands revealed a heavily rubbed area on Stage 15 at approximately the 8 o'clock position. The rub was only about 3/4 inch long and the full width of the blades, but appeared to have no depth, indicating that it must have been a high spot in the coating. No rubs were seen in any of the other stages in the lower case.

Inspection of the upper stator case lands revealed some very light blade tip-to-case rubs in Stages 1 through 11. The rubs were generally the full width of the blade and were confined, in most instances, to the area of the shadow-masking. Maximum depth of any of the rubs was approximately 0.003 inch. Figures 2 and 3 are detailed photographs depicting the case land rubs.

6.1.2.5 Vane Surface Finish

Two vanes per stage, Stage 7 through OGV's, were removed from the stator case to inspect the airfoil surface finish. Measurements were taken with a profilometer at 15, 50 and 85 percent of vane height at:

1. 10 to 15 percent of chord from the leading edge on the convex side.
2. 10 to 15 percent of chord from the trailing edge on the concave side.

Results (RMS μ inch) are presented in Table VI.

6.1.3 Compressor Rear Frame

6.1.3.1 General

A cursory inspection of the compressor rear frame (CRF) revealed no notable discrepancies. A visual inspection of the combustor and dimensional inspections of the CDP seal and the No. 4B pressure balance seal (mini-nozzle) were made. The results are presented in the following paragraphs.

Table VI. HP Compressor Stator Vane Surface Finish Inspection Results.

Stage	Position No.	Convex					Concave					Stage Overall Avg.
		Tip	Pitch	Root	Avg.	Stage Avg.	Tip	Pitch	Root	Avg.	Stage Avg.	
7	37	60	70	55	62		180	80	70	110		
	72	70	65	55	63	63	130	75	75	93	102	83
8	18	60	55	45	53		70	65	40	58		
	34	55	50	60	55	54	60	55	60	58	58	56
9	38	90	80	90	87		65	80	75	73		
	74	75	80	80	78	83	90	75	75	80	77	80
10	41	60	80	55	65		55	75	70	67		
	80	65	55	40	53	59	60	80	80	73	70	65
11	41	60	40	50	50		80	65	70	72		
	80	50	35	50	45	48	55	75	75	68	70	59
12	41	60	45	70	58		80	50	60	63		
	80	50	30	65	48	53	25	35	50	37	50	52
13	41	55	60	60	58		65	65	70	67		
	80	50	55	45	50	54	75	60	75	70	68	61
14	45	65	65	60	63		80	70	65	72		
	88	75	65	55	65	64	70	65	70	68	70	67
15	45	70	75	70	72		80	80	75	78		
	88	75	65	75	72	72	60	70	65	65	72	72
OGV	56	80	75	65	73		55	35	50	47		
	110	85	85	80	83	78	40	30	40	37	42	60

Average Surface Finish of Vanes = 66 RMS μ inches. (Average surface finish of vanes new = 15 RMS μ inches)

6.1.3.2 Combustor

A visual inspection of the combustor was made as-installed in the compressor rear frame. The most notable observation was the distress seen in the inner liner, which was the same condition noted in the previous Task IV engine, S/N 451-479; i.e., cracks originating at the aft thimble louvers. From the louver located at approximately 6 o'clock, a crack progressed aft approximately 2-1/4 inches, then circumferentially about 3/4 inch. Another crack, originating at the same louver, progressed circumferentially approximately 1-1/2 inches, then forward about 9/16 inch.

The louvers at 11 and 12 o'clock had circumferential cracks on each side ranging from 3/4 to 1 inch in length. Other louvers were similarly cracked, but to a lesser degree. Figure 4 shows a photograph of the combustor depicting the various cracks.

The outer liner had its visual axial cracks at the aft end, the longest being approximately 2 inches. At the 6 o'clock position, there was a 6 inch circumferential crack through the band cooling holes in the forward end of the ring, immediately aft of the ring containing the thimble louvers. At the same axial location, there was a 1 inch crack through the cooling holes at the 1 o'clock circumferential position.

6.1.3.3 Stationary CDP Seal, Forward

Measurements of the stationary seal lands were inadvertently missed; therefore, the analytical assessment of losses for the forward CDP seal (see Section 7.0) is based entirely on the amount that the rotating seal was under nominal blueprint requirements (see Section 6.1.1.6). Although it is possible that there was some loss due to the stationary seal, none could be assessed. Normally, this would be a minimal amount, if any.

6.1.3.4 No. 4B Pressure Balance Seal

A visual inspection of the No. 4B pressure balance seal (mini-nozzle) revealed cracks at the aft inner edge of two vanes, each approximately 1 inch in length. Since the cracks had not opened, they would have no influence on performance.

Eight equally spaced diameters were measured and recorded for each land of each of the aft seals contained in the mini-nozzle. These seals mate with the seals on the forward shaft of the high pressure turbine rotor and are referred to as the aft CDP seal (shaft forward seal) and the HPT balance piston seal (shaft aft seal).

The dimensional inspection checks are recorded in Table VII and VIII. Seal clearances are contained in Section 6.2.3.6, "Forward Shaft Seals." All dimensions are in inches.

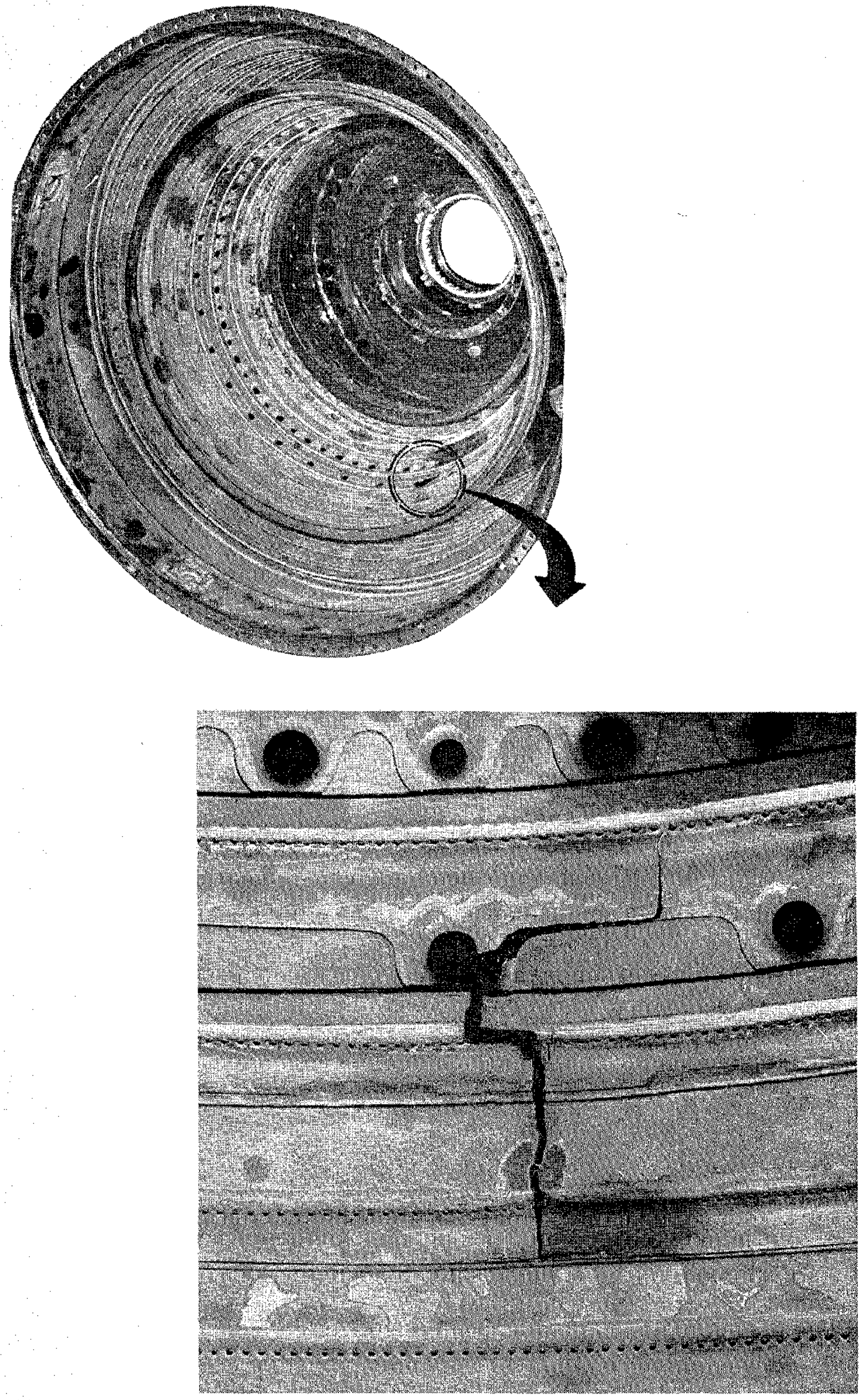

Figure 4. Combustor Inner Liner.

Table VII. No. 4B Pressure Balance Seal, Forward Seal (Aft CDP) Dimensional Inspection.

B70						
Diameter	F1	F2	F3	F4*	F5	F6
1	7.948	8.115	8.276	8.455	8.602	8.756
2	7.942	8.111	8.270	8.448	8.591	8.751
3	7.943	8.111	8.274	8.449	8.595	8.755
4	7.947	8.114	8.276	8.449	8.596	8.754
5	7.948	8.112	8.276	8.455	8.596	8.754
6	7.947	8.112	8.275	8.454	8.598	8.753
7	7.947	8.112	8.274	8.452	8.600	8.755
8	7.946	8.114	8.276	8.450	8.599	8.752
Minimum	7.942	8.111	8.270	8.448	8.591	8.751
Maximum	7.948	8.115	8.276	8.455	8.602	8.756
Average	7.946	8.113	8.275	8.452	8.597	8.754
	Shop Manual Dimensional Requirements					
Minimum	7.942	8.102	8.262	8.422	8.582	8.742
Maximum	7.945	8.105	8.265	8.425	8.585	8.745
Serv. Limit	7.947	8.107	8.267	8.427	8.587	8.747

*Note: In comparing the individual seal lands with the nominal Shop Manual Dimensional Requirements, land F4 shows a marked difference from that seen on the other lands. Therefore, F4 was omitted from the overall average that was used for the analytical assessments of performance loss for the seal in Section 7.0.

Table VIII. No. 4B Pressure Balance Seal, Aft Seal (HPT Balance Piston) Dimensional Inspection.

B71						
Diameter	F1	F2*	F3	F4	F5	F6
1	10.482	10.616	10.802	10.971	11.127	11.275
2	10.469	10.602	10.793	10.961	11.121	11.270
3	10.475	10.603	10.799	10.963	11.123	11.273
4	10.475	10.608	10.799	10.962	11.120	11.272
5	10.471	10.615	10.798	10.962	11.121	11.272
6	10.471	10.613	10.799	10.962	11.122	11.271
7	10.474	10.609	10.800	10.963	11.125	11.270
8	10.471	10.606	10.800	10.962	11.125	11.270
Minimum	10.469	10.602	10.793	10.961	11.121	11.270
Maximum	10.482	10.616	10.802	10.971	11.127	11.275
Average	10.474	10.609	10.799	10.963	11.123	11.272
	Shop Manual Dimensional Requirements					
Minimum	10.442	10.602	10.762	10.922	11.082	11.242
Maximum	10.446	10.606	10.766	10.926	11.086	11.246
Serv. Limit	10.448	10.608	10.768	10.928	11.088	11.248

*Note: Land F2 omitted from the average used for the analytical assessment of performance loss for this seal (see Section 7.0). F2 versus shop manual dimensions is quite different from the other lands on the seal.

6.2 HIGH PRESSURE TURBINE SECTION

6.2.1 Stage 1 High Pressure Turbine Nozzle Assembly

6.2.1.1 General

Visual inspection of the Stage 1 HPTN assembly showed it to be in a less deteriorated condition than the assembly from the first Task IV engine (NASA-CR-135381, "Long-Term CF6 Engine Performance Deterioration - Evaluation of Engine 451-479"). Photographs of the assembly are shown in Figures 5 and 6. No burning of the vane trailing edge was in evidence, which was in sharp contrast to what was seen on the previous engine, and, although there were 10 vanes which were bowed on the trailing edge, none were as severe as those seen on the 451-479. As before, the bowing caused radial cracks just forward of the aft cooling holes on the concave side. The lengths of the cracks were proportional to the severity of the bowing.

There were the normal minute cracks on the leading edge of the vanes, together with the common splatter buildup, but all cooling holes were open. Five vanes were mildly burned on the leading edge, but they had not burned through. One vane, vane No. 20, did burn through, leaving a hole approximately 7/16 inch x 1/4 inch. Its insert was exposed, but was intact with no signs of burning.

The concave side of the vane also had the normal splatter, causing them to be quite rough. The convex side was smooth, which is typical. The surface finish of the airfoils was measured on three vanes and the results are tabulated in Section 6.2.1.5, "Airfoil Surface Finish Checks."

The thermal shield located inside the vane platform ID was slightly warped, but, compared to 451-479, it was in very good condition.

The aft face of the Stage 1 vane outer hook showed 360° contact. However, similar to 451-479, the first vane of each segment (CW, ALF) appeared to be the heavier marred of the two vanes.

One outer fishmouth seal tab was burned to the point of not being useful, while four others had some degree of insignificant burning. Only one inner seal tab showed any signs of burning, and it was only about 10 percent. The tab discrepancies have no influence on performance and are mentioned only as casual observations.

6.2.1.2 Drop Dimension - CRF to Stage 1 Vanes

Drop dimensions from the compressor rear frame (CRF) aft flange to the aft face of the Stage 1 vane outer hook were taken at 16 equally spaced locations, starting at 12 o'clock and working clockwise. Upon completion, it was noted that only 15 readings had been recorded. The minor differences in the readings that were recorded did not warrant a repeat of all the measurements. The drop dimensions recorded were as follows:

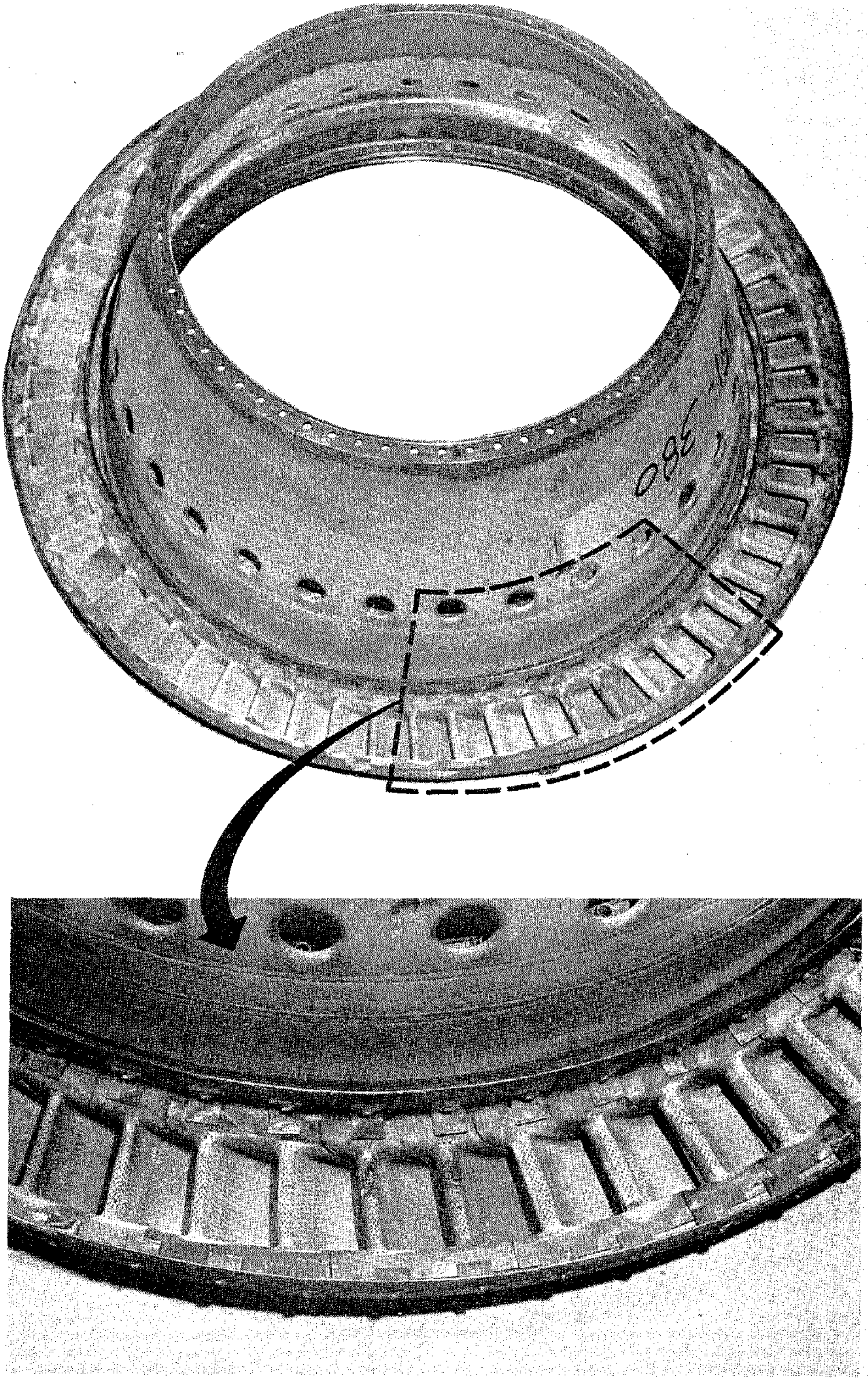

Figure 5. Stage 1 HPTN Vanes, Leading Edge.

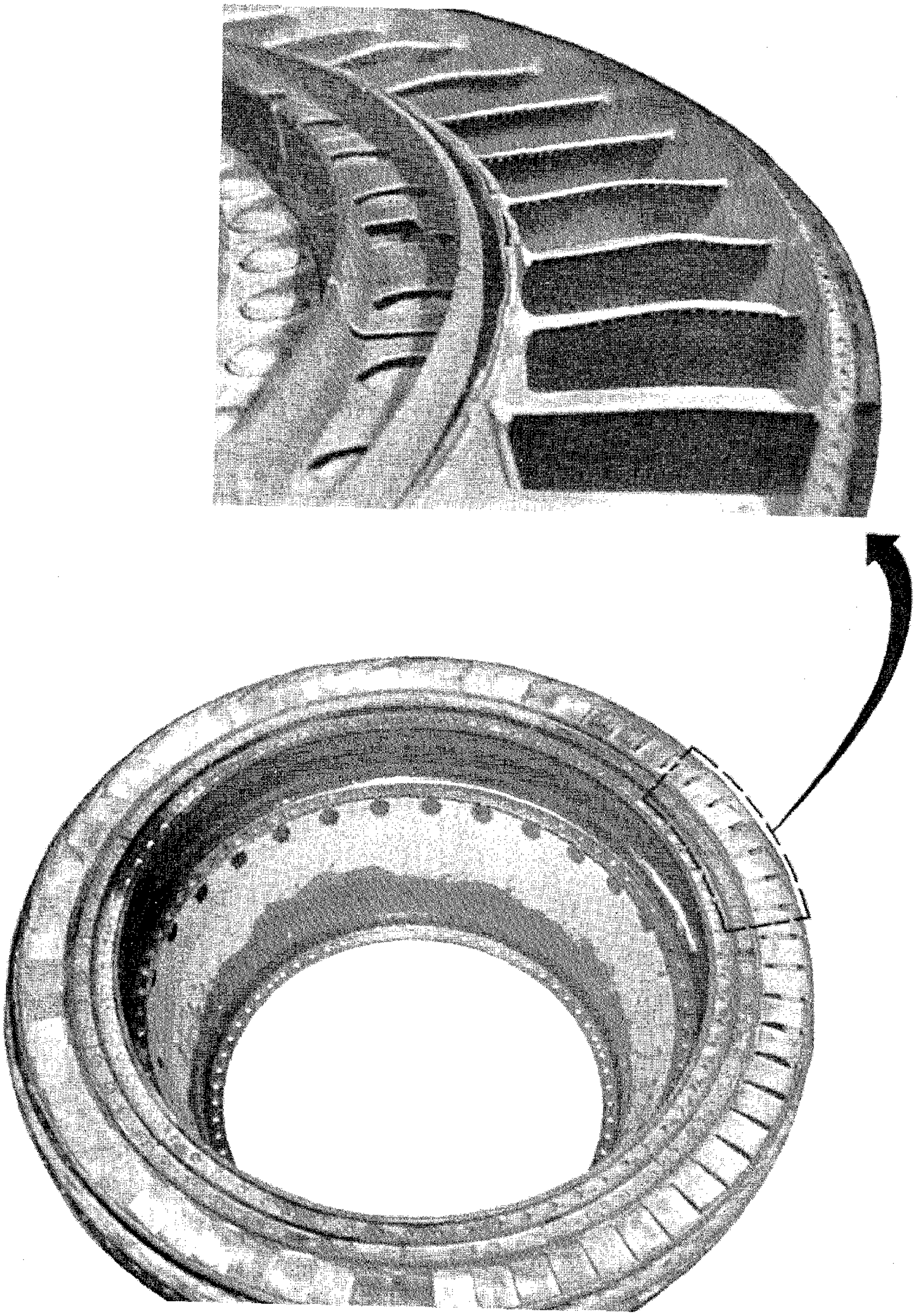

Figure 6. Stage 1 HPTN Vanes, Trailing Edge.

1.	4.855	9.	4.860
2.	4.848	10.	4.857
3.	4.846	11.	4.859
4.	4.852	12.	4.861
5.	4.860	13.	4.857
6.	4.856	14.	4.848
7.	4.855	15.	4.856
8.	4.853	16.	---

Average = 4.855 inches

Note: Stackup of the mating parts is contained in Section 6.2.2.5, "Nozzle Support."

6.2.1.3 Vane Outer Platform Gap Measurements

The gaps between the outer platforms on adjacent vane segments were measured at 16 places (every other segment) at the aft end of the vanes and were as follows:

1.	0.035	9.	0.004
2.	0.012	10.	0.013
3.	0.018	11.	0.014
4.	0.009	12.	0.015
5.	0.016	13.	0.035
6.	0.003	14.	0.030
7.	0.010	15.	0.000
8.	0.012	16.	0.014

Average Gap = 0.015

Shop Manual Limits = 0.015/0.045

Note: All readings are in inches.

6.2.1.4 Stage 1 HPTN Area Check (A4)

Area measurements of each of the individual vanes were made using Tool 2C6505 and the total area (A4) calculated as shown in Table IX. When using this tool, a correction factor of 0.366 must be added to the sum of the individual vane measurements to produce the actual area of the assembly.

Table IX. Stage 1 HPT Nozzle Area Measurements.

Nozzle No.	Area	Nozzle No.	Area	Nozzle No.	Area	Nozzle No.	Area
1	0.833	17	0.891	33	0.835	49	0.812
2	0.897	18	0.787	34	0.837	50	0.824
3	0.844	19	0.828	35	0.841	51	0.824
4	0.834	20	0.828	36	0.833	52	0.872
5	0.875	21	0.864	37	0.840	53	0.842
6	0.850	22	0.838	38	0.905	54	0.820
7	0.928	23	0.847	39	0.833	55	0.844
8	0.864	24	0.882	40	0.794	56	0.851
9	0.850	25	0.815	41	0.846	57	0.773
10	0.817	26	0.830	42	0.840	58	0.763
11	0.887	27	0.806	43	0.851	59	0.852
12	0.855	28	0.817	44	0.821	60	0.878
13	0.902	29	0.780	45	0.880	61	0.814
14	0.858	30	0.866	46	0.874	62	0.843
15	0.808	31	0.799	47	0.838	63	0.827
16	0.797	32	0.788	48	0.794	64	0.815

Total = 53.681 square inches
Corr. Factor = 0.366
Actual A4 = 54.045 square inches

Shop Manual Limits = 52.313/53.373 square inches.

6.2.1.5 Airfoil Surface Finish Checks

Three vane segments were removed from the assembly to check the airfoil surface finish. Measurements were taken at the pitchline at 10, 50 and 90 percent chord, each side. Following are the results of these measurements (RMS μ inch):

	Convex				Concave			
Vane No.	Fwd	Mid	Aft	Avg	Fwd	Mid	Aft	Avg
1	85	30	60	58	120	130	650	300
2	100	50	45	65	80	85	200	122
3	100	65	60	75	120	290	600	337
Overall Average				66				253

6.2.2 Stage 2 High Pressure Turbine Nozzle Assembly

6.2.2.1 General

The Stage 2 high pressure turbine nozzle assembly was in relatively good condition, considering the amount of running time on the parts. The results of an overall visual inspection are discussed in the following paragraphs. Related photographs are shown in Figures 7 through 10.

6.2.2.2 Shroud Rubs and Condition of Bradelloy

The Stage 1 shrouds were very rough due to oxidation/erosion. The majority of the shrouds revealed local hot spots with a considerable amount of Bradelloy missing between the pins which were recessed, probably due to pin oxidation.

The Stage 2 shrouds were slightly eroded with a moderate rub at the 4 o'clock position (see Figure 8.)

6.2.2.3 Vane Condition

Overall, the vanes were in good condition. There were six vanes with minor leading edge burning, but none burned through. Six other vanes exhibited small cracks just below the outer platforms on the trailing edge.

6.2.2.4 Filter Screen

The filter screen had no discrepancies, other than being extremely dirty.

6.2.2.5 Nozzle Support

A visual inspection of the forward flange that supports the Stage 1 HP turbine nozzle vanes revealed contact throughout the full 360° circumference. However, in many instances, the first vane of each segment (CW,ALF) produced heavier markings than the other. All of the support cooling holes were open.

Drop checks from the forward face of the aft flange to the forward face of the flange that supports the Stage 1 vane outer hook (Dimension "K" in the Shop Manual) were taken at 16 equally spaced locations. Following are the results of these measurements (all readings are in inches):

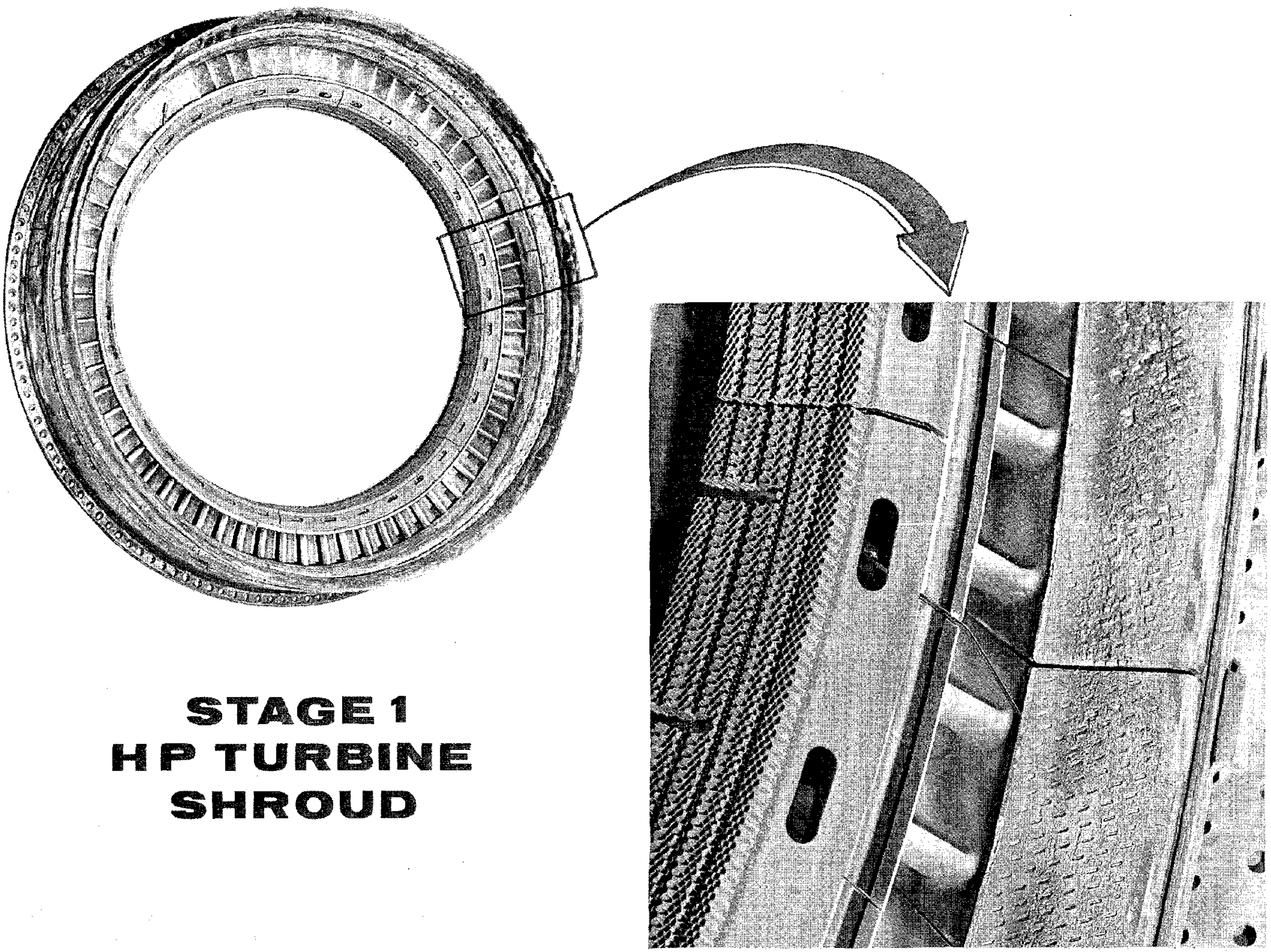

Figure 7. Stage 1 HP Turbine Shroud.

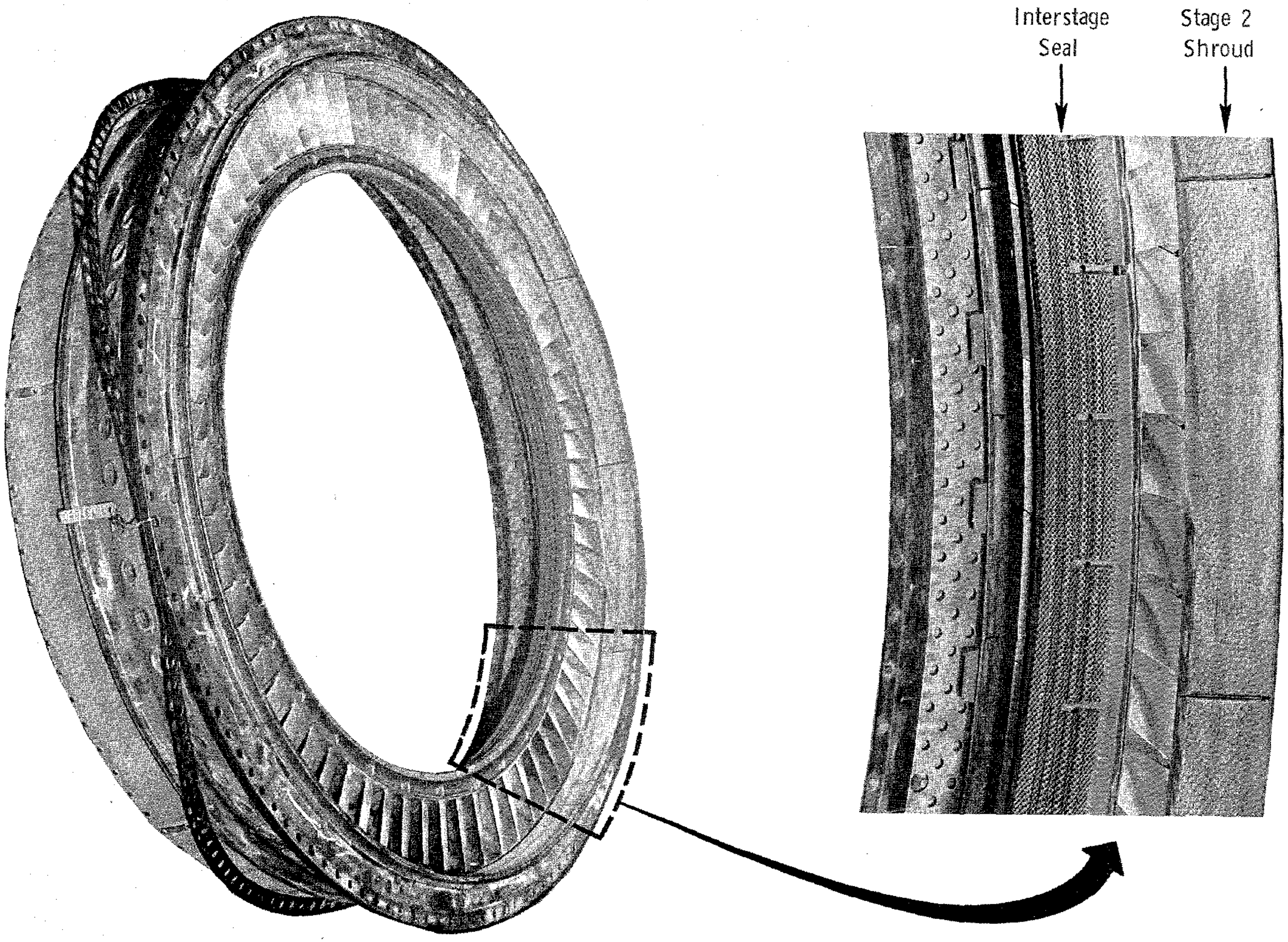

Figure 8. Stage 2 HP Turbine Nozzle Assembly.

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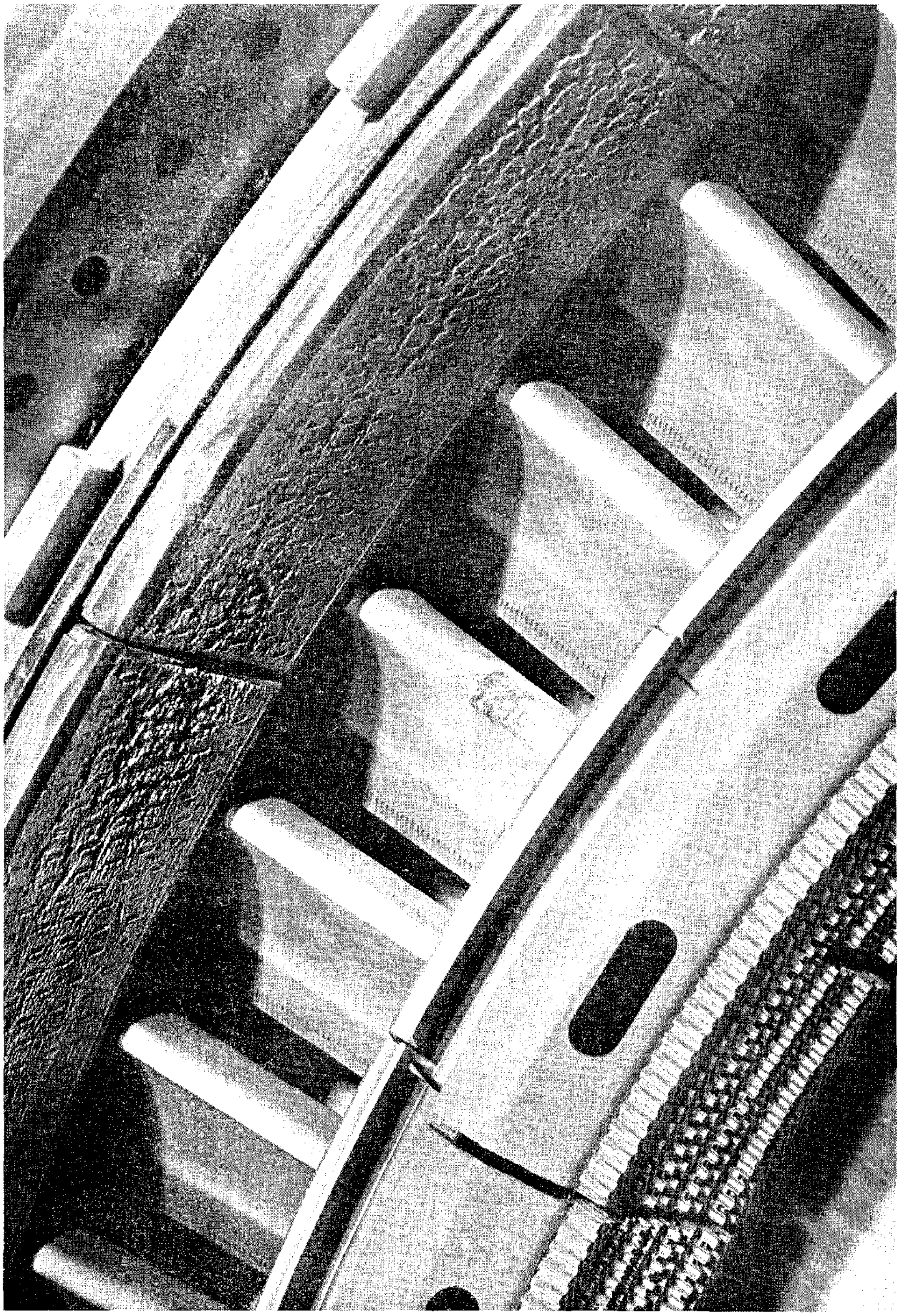


Figure 9. Stage 2 HP Turbine Nozzle Vane, Leading Edge Damage.

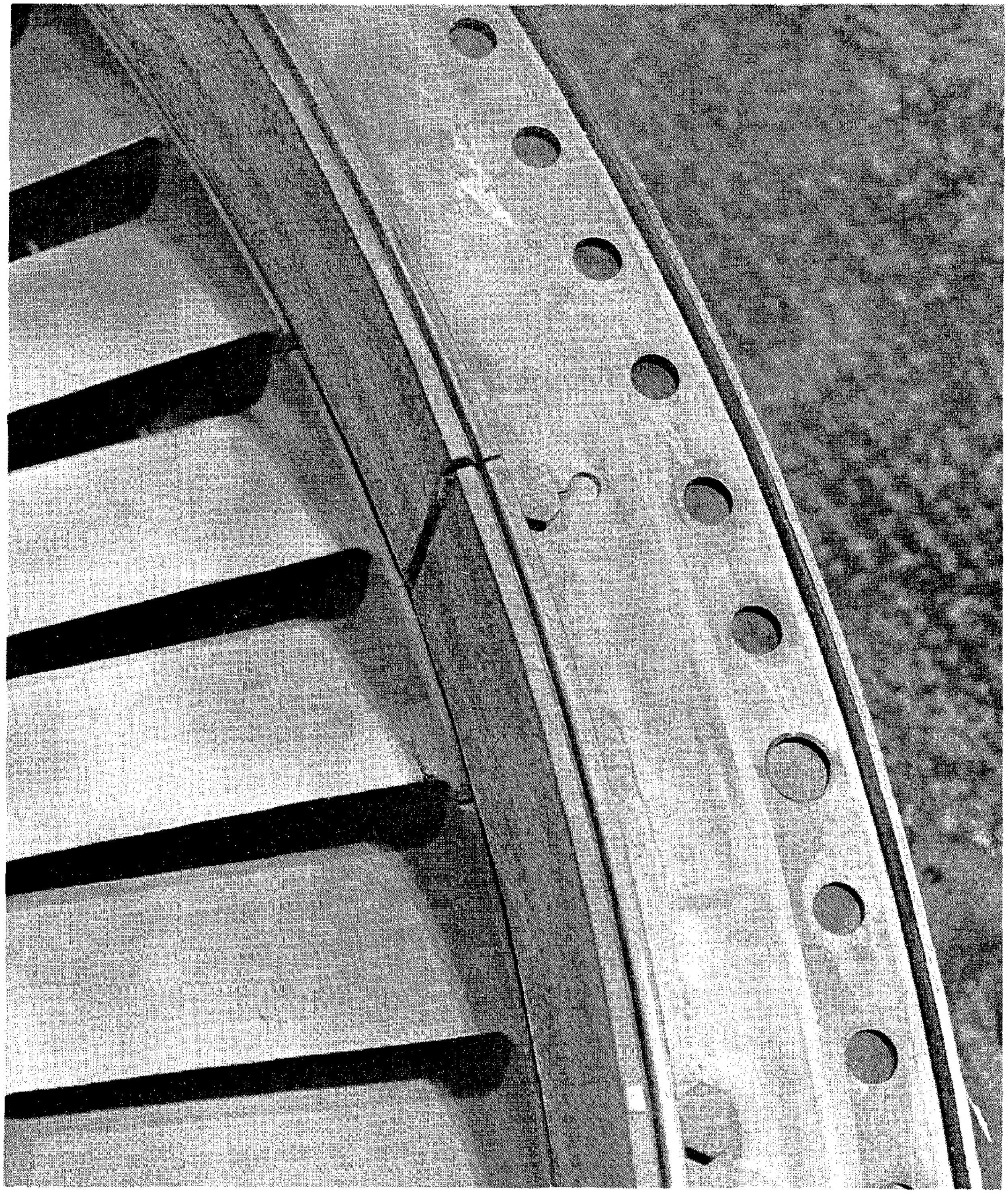


Figure 10. Stage 2 HP Turbine Nozzle Vane, Trailing Edge Crack.

1.	4.853	9.	4.845
2.	4.854	10.	4.846
3.	4.851	11.	4.851
4.	4.847	12.	4.853
5.	4.851	13.	4.852
6.	4.852	14.	4.853
7.	4.849	15.	4.851
8.	4.839	16.	4.850

Average	4.850
Shop Dimensions	4.857/4.861
Serviceable Limits	4.853/4.865

Corresponding dimensions from the CRF aft flange to the aft face of the Stage 1 vane outer hook averaged 4.855 in. (see 6.2.1.2 "Drop Dimensions - CRF to Stage 1 Vanes"). The shim that mounts between the nozzle support/CRF flanges measured 0.022 inch average. Therefore, the gap between the Stage 1 outer hook and the support's forward flange calculates to be 0.027 inch average. When the shims were originally introduced, it was the intent of the design to produce a gap of 0.042 inch to an interference of 0.012 inch.

6.2.2.6 Interstage Seal Grooves

The grooves worn into the interstage seal lands were measured at four equally spaced positions for each land. The results are shown in Table X.

Table X. Stage 2 HPT Nozzle Interstage Seal Groove Measurements.

	1		2		3		4	
Location	Width	Depth	Width	Depth	Width	Depth	Width	Depth
12 o'clock	0.100	0.055	0.100	0.040	0.103	0.048	0.090	0.030
3 o'clock	0.085	0.057	0.102	0.060	0.105	0.054	0.097	0.045
6 o'clock	0.100	0.044	0.100	0.050	0.102	0.037	0.075	0.032
9 o'clock	0.110	0.050	0.110	0.070	0.105	0.057	0.095	0.030
Average	0.099	0.052	0.103	0.055	0.104	0.049	0.089	0.034
Note: All readings are in inches.								

6.2.2.7 Stage 1 and Stage 2 Shroud Radii

The Stage 2 high pressure turbine nozzle assembly was restrained on the shroud grind fixture and the entire combination centered on the machine. Each stage of shrouds was measured at axial locations approximately 1/2 inch from the leading edge and 1/4 inch from the trailing edge at each end, and at the center of each shroud. Measurements at each of the axial locations consisted of a diameter recording at the 12 o'clock position and runouts relative to this point at each of the other positions (see Tables XI and XII).

6.2.3 High Pressure Turbine Rotor Assembly

6.2.3.1 General

Except for the Stage 1 blades, a visual inspection of the high pressure turbine rotor assembly revealed it to be in good condition. Most of the Stage 1 blades exhibited tip cracks and burning, as depicted in Figure 11. The concave surface of the airfoils revealed heavy deposits and roughness, while the convex sides were smooth.

The Stage 2 blade airfoils were very smooth on both surfaces. A heavy rub, at some time, was indicated by the slight discoloration noted at the blade tips, convex side, together with very mild burrs across the full blade width.

The visual inspection revealed no discrepancies in any of the spool parts (disks, shafts, seals, etc.). However, dimensional checks showed some hardware to be beyond the serviceable limits. These inspection checks are recorded later in this report.

The Stage 1 forward and Stage 2 aft blade retainer wires were removed (typically, in very small pieces) and returned to Evendale. Inspection of the pieces revealed good contact between the seals and the blades. In fact, after the retainers were removed, the seals were, for the most part, stuck to the blades and disk and had to be pried off.

6.2.3.2 HP Turbine Rotor Airfoil Surface Finish

Three blades were removed from each stage and measurements of the airfoil surface finish were obtained. Measurements were taken on each side at 10, 50 and 90 percent of the blade chord. The results, (RMS μ inch) are shown in Table XIII.

Table XI. HP Turbine Stage 1 Shroud Runout Data.

	1/2 in. From Leading Edge			1/4 in. From Trailing Edge		
Shroud No.	1	2	3	1	2	3
1	-2	0	3	3	0	-2
2	8	11	14	6	12	12
3	14	13	15	13	16	15
4	13	11	10	11	11	5
5	11	14	12	4	11	8
6	7	11	8	8	8	4
7	8	12	13	3	(46)[1]	9
8	18	17	20	8	15	13
9	14	13	11	11	9	9
10	9	10	7	8	11	14
11	5	7	12	13	6	4
12	9	13	13	8	8	4
13	11	11	11	6	9	8
14	9	11	16	1	11	11
15	14	18	15	10	16	16
16	12	16	8	13	11	12
17	13	15	17	6	10	8
18	14	15	11	14	16	8
19	5	17	18	8	13	16
20	20	18	16	12	9	14
21	10	15	11	3	11	11
22	10	6	9	8	6	10
23	10	8	2	10	6	3
24	3	7	6	-4	-2	0

All readings above are in mils and are positive, unless otherwise indicated. (1) Reading taken into eroded area, not included in average.

	Leading	Trailing
Diameter at 12 o'clock	33.241 in.	33.237 in.
Radius at 12 o'clock	16.615 in.	16.614 in.
Minimum Radius	16.613 in.	16.610 in.
Maximum Radius	16.635 in.	16.630 in.
Average Radius	16.626 in.	16.623 in.

Table XII. HP Turbine Stage 2 Shroud Runout Data.

	1/2 in. From Leading Edge			1/4 in. From Trailing Edge		
Shroud No.	1	2	3	1	2	3
1	-7	0	8	-12	0	-7
2	5	2	-7	-11	-8	-15
3	-4	-3	-3	-16	-7	-13
4	-5	2	-2	-15	-9	-15
5	-2	2	-2	-14	-6	-14
6	-4	-10	-13	-16	-14	-22
7	-17	-19	-10	-25	-25	-23
8	-13	-10	-5	-26	-12	-12
9	-6	-2	-3	-15	-4	-15
10	3	-8	0	-16	-13	-8
11	0	3	-5	-9	-1	-11

All readings above are in mils and are positive, unless otherwise indicated.

	Leading	Trailing
Diameter at 12 o'clock	34.551 inches	34.554 inches
Radius at 12 o'clock	17.282 inches	17.288 inches
Minimum Radius	17.263 inches	17.262 inches
Maximum Radius	17.290 inches	17,288 inches
Average Radius	17.278 inches	17.275 inches

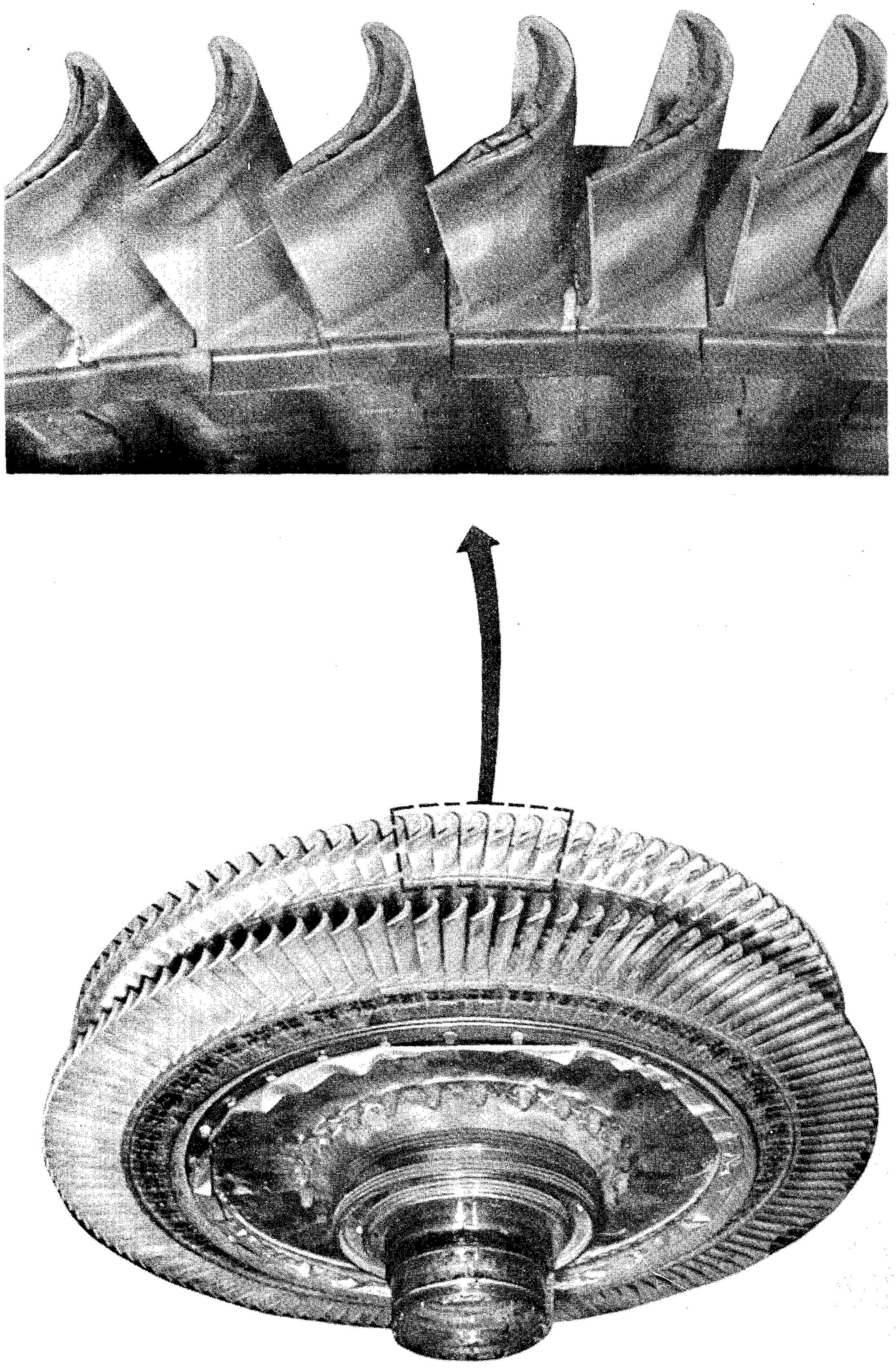


Figure 11. HP Turbine, Stage 1 Blade Tip Cracks and Tip Burning.

Table XIII. HPT Rotor Airfoil Surface Measurements.

		Convex				Concave			
Stage	Blade No.	FWD	MID	Aft	Avg	Fwd	Mid	Aft	Avg
1	1	90	63	40	64	450	450	250	383
	2	75	130	35	80	190	430	110	243
	3	110	43	42	65	180	550	140	290
Average					70				306
2	1	60	37	46	48	43	50	48	47
	2	70	28	35	44	38	45	53	45
	3	45	38	70	51	40	37	55	44
Average					48				45

6.2.3.3 Rotor Blade Tip Measurements

The HP turbine rotor was setup in a lathe bed and the blades shimmed per the shop manual. Runouts at two axial locations (0.100 in. from both the leading edge and from the trailing edge) of each blade, together with the maximum blade radius of each stage, were taken and recorded as shown in Tables XIV and XV.

6.2.3.4 HP Turbine Blade Clearances

Calculated clearances, as derived from blade tip measurements and shroud dimensions (Section 6.2.2.7), were as follows:

Stage No.	B/P (in.)	Min (in.)	Max (in.)	Avg (in.)	ΔB/P (in.)
1 (Leading Edge)	0.072	0.070	0.107	0.087	0.015
(Trailing Edge)	0.072	0.067	0.109	0.087	0.015
(Average)	0.072	0.069	0.108	0.087	0.015
2 (Leading Edge)	0.075	0.074	0.101	0.095	0.020
(Trailing Edge)	0.075	0.063	0.101	0.081	0.006
(Average)	0.075	0.068	0.101	0.088	0.013

Table XIV. Stage 1 HPTR Blade Runout Data.

No.	Fwd	Aft	No.	Fwd	Aft	No.	Fwd	Aft	No.	Fwd	Aft
1	4	2	28	11	9	55	3	8	82	9	2
2	4	4	29	3	3	56	6	8	83	1	1
3	1	0	30	9	12	57	2	9	84	7	14
4	5	17	31	3	11	58	6	8	85	2	4
5	1	10	32	15	17	59	2	11	86	10	10
6	4	2	33	6	5	60	6	12	87	3	3
7	4	7	34	8	14	61	3	7	88	9	8
8	1	1	35	3	4	62	6	10	89	2	9
9	6	5	36	7	10	63	2	14	90	8	7
10	2	0	37	2	8	64	4	11	91	3	16
11	4	20	38	7	14	65	3	22	92	6	6
12	1	10	39	3	6	66	4	9	93	1	3
13	5	12	40	6	6	67	2	11	94	5	5
14	1	2	41	3	10	68	3	7	95	2	9
15	5	13	42	4	9	69	3	14	96	4	11
16	2	3	43	2	8	70	7	10	97	0	3
17	0	7	44	5	6	71	3	4	98	6	6
18	5	5	45	4	14	72	6	19	99	2	2
19	1	0	46	5	10	73	4	10	100	7	6
20	8	13	47	3	9	74	6	3	101	2	5
21	2	5	48	2	12	75	2	6	102	3	4
22	7	9	49	0	9	76	3	10	103	0	11
23	1	10	50	3	7	77	2	20	104	5	*
24	9	16	51	1	9	78	6	7	105	1	*
25	3	3	52	5	7	79	3	5	106	6	*
26	9	16	53	2	19	80	6	2	107	1	*
27	0	3	54	9	9	81	3	7	108	5	*

* - Trailing edge measurements of five blades not recorded.

0 = 16.543 inches = maximum blade radius

Runouts are in mils and are negative.

	Forward	Aft
Maximum Radius (inches)	16.543	16.543
Minimum Radius (inches)	16.528	16.521
Average Radius (inches)	16.539	16.535

Table XV. Stage 2 HPTR Blade Runout Data.

No.	Fwd	Aft	No.	Fwd	Aft	No.	Fwd	Aft	No.	Fwd	Aft
1	12	3	30	14	7	59	17	7	88	13	5
2	12	3	31	15	5	60	16	9	89	16	5
3	12	1	32	15	9	61	18	7	90	13	5
4	11	2	33	15	8	62	18	9	91	17	6
5	11	1	34	19	8	63	18	8	92	13	5
6	12	2	35	16	8	64	17	7	93	16	5
7	10	1	36	18	10	65	19	8	94	13	3
8	12	2	37	17	9	66	17	8	95	18	6
9	11	1	38	22	9	67	22	8	96	12	2
10	12	4	39	20	12	68	19	7	97	15	3
11	12	4	40	22	8	69	22	9	98	12	3
12	16	5	41	17	11	70	17	6	99	15	3
13	14	2	42	20	8	71	21	7	100	12	2
14	17	2	43	21	9	72	19	7	101	14	2
15	14	3	44	17	7	73	23	10	102	12	3
16	15	2	45	20	8	74	17	6	103	15	3
17	12	4	46	17	8	75	22	11	104	13	3
18	14	3	47	23	10	76	16	7	105	13	2
19	12	3	48	20	10	77	22	8	106	12	2
20	11	4	49	19	6	78	15	5	107	16	2
21	13	3	50	18	7	79	19	8	108	12	1
22	14	5	51	18	5	80	14	3	109	12	2
23	14	3	52	18	8	81	18	6	110	12	3
24	14	5	53	18	7	82	14	5	111	11	1
25	14	4	54	18	9	83	20	6	112	11	2
26	14	6	55	15	5	84	15	3	113	12	0
27	14	5	56	16	8	85	18	6	114	12	2
28	14	6	57	16	6	86	14	4	115	13	0
29	15	4	58	19	11	87	17	6	116	11	2

0 = 17.199 inches = maximum blade radius

Runouts are in mils and are negative.

	Forward	Aft
Maximum Radius (inches)	17.189	17.199
Minimum Radius (inches)	17.176	17.187
Average Radius (inches)	17.183	17.194

It is estimated that there was an additional increase of 0.010 inch in Stage 1 clearances due to shroud erosion/oxidation. Therefore, the Stage 1 average clearance was calculated to be approximately 0.097 inch, or 0.025 inch over blueprint.

6.2.3.5 Thermal Shield Seal Teeth

While the HP turbine rotor was in the runout fixture, measurements of the thermal shield seal teeth were made. To accomplish this, a position, designated as 12 o'clock, was arbitrarily selected and marked on each tooth. The diameters were taken and recorded at these positions, together with runouts at 12 equally spaced locations relative to these positions. Results are shown in Table XVI.

6.2.3.6 Forward Shaft Seals

Measurements of the teeth of the HP turbine rotor forward shaft seals were accomplished in the same manner as the thermal shield teeth; i.e., a diameter and 12 equally spaced runouts for each tooth.

During these inspections, it was noted that the attachment of each of the seals to the shaft had not been updated to the six-pin configuration; rather, they were still the original three-pin retention design.

A review of the dimensional inspection checks revealed a large amount of circumferential warping of the aft air seal (see Figure 12 which depicts the runout of the seal teeth, H1, H3 and H6). Experience has shown that this condition is the result of thermal ratcheting caused by nonuniform heating of the seal journal, resulting in distortion of the seal teeth diameters, unequal wear, increased seal leakage and, therefore, reduced performance. To alleviate this condition, a six-pin retention system was introduced for each of the seals, but rework of existing hardware was left to the convenience of the operators.

Table XVII shows the results of the measurements of the forward shaft seals. The runouts are recorded in mils and are positive, unless otherwise indicated. Diameters are recorded in inches.

6.3 LOW PRESSURE TURBINE SECTION

As previously stated, one of the prime objectives of the NASA-Engine Diagnostics Program is to evaluate low pressure turbine (LPT) performance restoration. As done on the previous Task IV Engine, S/N 451-479, immediately after the inbound performance test, the LPT EMU was removed from the engine and disassembled into its major components for various inspection checks and for cleaning of the blades and vanes.

Table XVI. HPTR Thermal Shield Seal Teeth Measurements.

Runout	VI	V2	V3	V4
12 o'clock	0.0	0.0	0.0	0.0
1	1.0	-0.5	1.5	2.0
2	2.0	1.5	2.5	3.5
3	1.0	2.0	2.0	4.0
4	1.0	1.5	3.0	4.0
5	1.0	1.0	1.5	1.5
6	0.5	-0.5	1.0	2.5
7	0.5	0.0	0.5	1.0
8	0.0	0.0	1.0	2.0
9	2.0	1.0	2.0	1.5
10	2.0	1.0	2.5	3.0
11	0.5	0.5	-0.5	1.0
Diameter at 12 o'clock	26.616	26.443	26.298	26.047
Maximum Diameter	26.619	26.446	26.303	26.052
Minimum Diameter	26.616	26.443	26.298	26.047
Average Diameter	26.618	26.445	26.300	26.049
Shop Manual Dimensional Requirements.				
Maximum Diameter	26.630	26.470	26.308	26.058
Minimum Diameter	26.622	26.462	26.300	26.050
Serv. Limit	26.615	26.455	26.293	26.043

Note: Runout readings are in mils and are positive, unless otherwise indicated. Diameters are in inches.

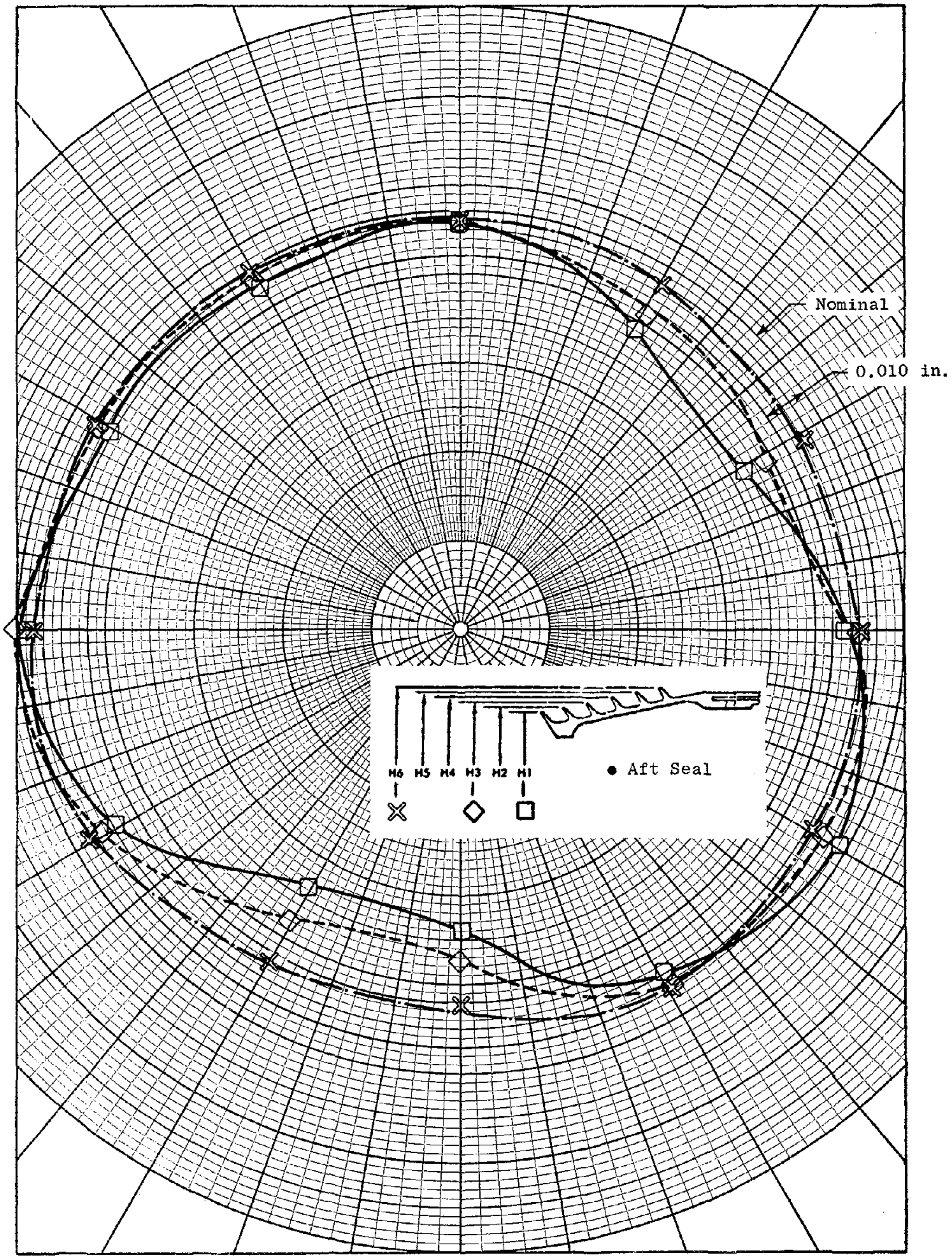


Figure 12. HPTR Forward Shaft Aft Seal Teeth Runout.

Table XVII. HPTR Forward Shaft Seal Measurements.

Forward Seal

Runout	G1	G2	G3	G4	G5	G6
12	0.0	0.0	0.0	0.0	0.0	0.0
1	0.5	-1.0	1.0	0.0	1.5	-0.5
2	0.5	-0.5	0.5	1.0	1.0	-0.5
3	1.5	0.0	-0.5	-0.5	0.0	0.0
4	0.5	-1.0	-3.0	-1.0	1.0	1.0
5	-0.5	-3.0	-1.0	-0.5	1.0	1.0
6	-1.0	-1.0	0.5	0.0	2.0	0.5
7	0.0	-1.0	0.5	0.5	1.5	0.0
8	2.0	2.0	0.5	0.5	0.5	0.5
9	2.5	1.0	1.0	1.0	2.0	1.0
10	2.0	0.0	2.0	1.5	2.0	0.5
11	1.0	-0.5	2.0	0.5	1.5	0.5
Diameter at 12 o'clock	7.901	8.080	8.242	8.403	8.563	8.720
Maximum Diameter	7.906	8.082	8.243	8.405	8.564	8.721
Minimum Diameter	7.901	8.078	8.241	8.403	8.562	8.719
Average Diameter	7.904	8.080	8.242	8.404	8.563	8.720

Shop Manual Dimensional Requirements

	G1	G2	G3	G4	G5	G6
Maximum	7.909	8.087	8.250	8.410	8.570	8.730
Minimum	7.899	8.083	8.246	8.406	8.566	8.726
MRL*	7.864	8.048	8.211	8.371	8.531	8.691

*MRL = Maximum Repairable Limit

With stationary seal data from 6.1.3.4, clearances were determined to be:

B70

	1	2	3	4	5	6
Maximum	0.024	0.019	0.018	0.026	0.020	0.019
Minimum	0.018	0.015	0.014	0.022	0.014	0.015
Average	0.021	0.017	0.016	0.024	0.017	0.017

Overall average clearance = 0.017 inch. Stackup of production new hardware = 0.010 in. nominal.

(Note: Land No. 4 omitted from overall average)

Table XVII. HPTR Forward Shaft Seal Measurements (Concluded).

Aft Seal

Runout	H1	H2	H3	H4	H5	H6
12	0.0	0.0	0.0	0.0	0.0	0.0
1	-13.0	-9.5	-9.0	-7.0	-4.0	-2.0
2	-19.0	-18.0	-14.0	-13.0	-10.0	-6.0
3	-7.0	-6.0	-5.0	-5.0	-4.0	-3.0
4	3.0	-2.0	-0.5	-6.0	-5.0	-1.5
5	-2.0	-1.0	1.0	0.5	1.5	1.0
6	-23.0	-23.0	-17.0	-15.0	-10.0	-7.0
7	-24.0	-22.0	-16.0	-14.0	-10.5	-6.0
8	-3.0	-2.0	0.0	1.0	0.0	1.5
9	5.0	5.0	6.0	5.0	5.0	3.0
10	-2.0	-0.5	0.0	0.0	1.5	0.5
11	-1.5	-2.0	0.5	0.0	0.5	1.0
Diameter at 12 o'clock	10.3985	10.567	10.728	10.8904	11.053	11.2134
Maximum	10.423	10.589	10.747	10.906	11.065	11.222
Minimum	10.385	10.559	10.720	10.884	11.049	11.212
Average	10.407	10.577	10.736	10.896	11.057	11.217

Shop Manual Dimensional Requirements

	H1	H2	H3	H4	H5	H6
Maximum	10.417	10.587	10.747	10.907	11.067	11.227
Minimum	10.413	10.583	10.743	10.903	11.063	11.223
MRL*	10.378	10.548	10.708	10.868	11.028	11.188

*MRL = Maximum Repairable Limit

With stationary seal data from 6.1.3.4 clearances were determined to be:

B71

	1	2	3	4	5	6
Maximum	0.049	0.029	0.041	0.044	0.039	0.032
Minimum	0.023	0.007	0.023	0.028	0.028	0.024
Average	0.034	0.016	0.031	0.034	0.033	0.027

Overall average clearance = 0.031 inch. Stackup of production new hardware = 0.010 inch nominal.

(Note): Land No. 2 omitted from overall average)

When this work was completed, the module was rebuilt and installed on the engine. Another test cell run was then conducted to measure any change in engine and component performance. During the period of LPT refurbishment and subsequent testing, the rest of the engine was purposely not disturbed in order that any changes in performance levels could be attributed only to the refurbishment of the LPT blade and vane surface finish, rather than to some unrelated activity. After all testing was completed, the LPT EMU was removed from the engine and set aside. Following the core analytical teardown investigation, the module was returned to Western Airlines, together with all the other engine modules. The results of the LPT module analytical teardown and the extent of the refurbishments are discussed in the following paragraphs.

6.3.1 Turbine Midframe

6.3.1.1 General

Early CF6-6 engines were besieged with problems involving turbine midframe (TMF) liner cracks, resulting in many unscheduled removals. To improve TMF durability, the material of the liner was changed from Hastelloy X to HS188, accompanied with an increase in thickness.

ESN 451-380 was equipped with this improved design liner. A visual inspection of the TMF, following the initial test, showed it to be in excellent condition, with no distress noted either in the liner or in the rest of the frame. All welds in the liner were thoroughly inspected, with no discrepancies noted.

6.3.1.2 TMF Forward Flange (Diameter U)

The TMF forward flange outer diameter (Diameter U) serves as the primary control of concentricity of the Stage 2 HPT nozzle support, affecting HPT blade-to-shroud clearances. Diameter U was measured at the 12 o'clock position, together with runouts of the flange in relation to the Number 5 bearing. The results (inches) were as follows:

12 o'clock	0.000	6 o'clock	- 0.006
1 "	- 0.002	7 "	- 0.009
2 "	- 0.007	8 "	- 0.007
3 "	- 0.006	9 "	- 0.008
4 "	- 0.010	10 "	- 0.009
5 "	- 0.008	11 "	- 0.002

Diameter at 12 o'clock = 38.732 inches

The average diameter was calculated to be 38.726 inches. The shop manual maximum serviceable limits are 38.736/38.726 inches, with a maximum allowable FIR of 0.020 inch.

In addition to the outer diameter of the frame, the inner diameter of the liner "Z" ring also controls the concentricity of the Stage 2 nozzle support. A gage was used to check the dimension UZ (see Figure 13) throughout the full 360° circumference. Except for one snug area, approximately 2 inches long at Strut Number 7, the gage passed freely throughout.

The corresponding dimension, DS, on the Stage 2 nozzle support (refer to Figure 13) was also checked with a gage and found to be acceptable.

6.3.1.3 LPT Pressure Balance Seal

An 8 diameter measurement of the stationary LPT pressure balance seal was made, with results (inches) as follows:

1.	19.053	5.	19.052
2.	19.052	6.	19.053
3.	19.053	7.	19.052
4.	19.053	8.	19.052

Average Diameter = 19.0525 inches

Shop Manual Requires = 19.050 in./19.054 in.

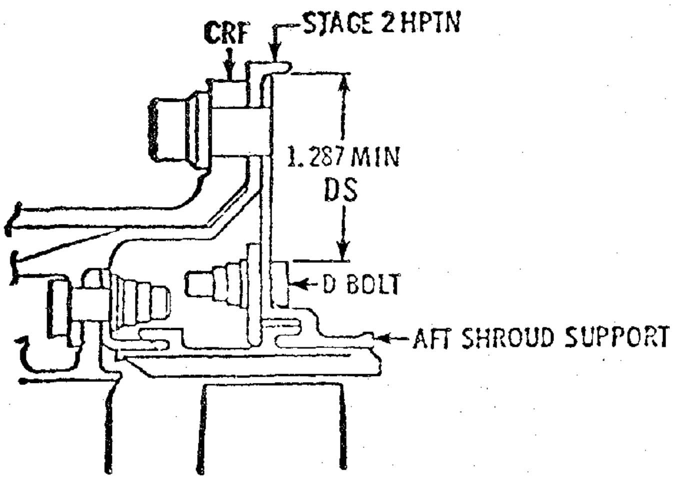
Average Clearance (C27) to the rotating seal (see Section 6.3.2.2) was calculated to be 0.028 inches. Stackup of production hardware indicates a clearance of 0.031 inches nominal.

6.3.1.4 Stage 1 LPTN Vane Airfoils

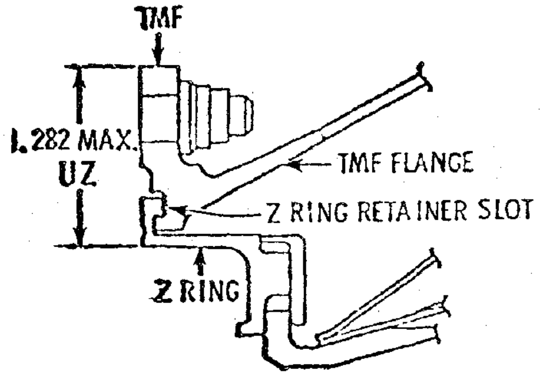
The Stage 1 low pressure turbine nozzle (LPTN) assembly was removed from the TMF and disassembled. A measurement of the surface finish of the airfoils was made on the end vanes of each of two segments. The measurements were taken 0.45/0.50 inch from the leading edge (L.E.) and from the trailing edge (T.E.) each side; tip readings were taken 0.50 inch below the outer platform.

Following the inspection checks, these vanes, together with all of the other Stage 1 vanes, were SWECO cleaned for two hours (see Figure 14 which exhibits one of the vane segments before and after cleaning). The same previously inspected airfoils were then remeasured to assess the amount of performance loss attributable to airfoil surface finish changes.

The results of the measurements of the Stage 1 airfoils are grouped with those similar measurements of vane airfoils in the other stages of the LPT system in Table XVIII. Assessment of performance loss is presented in Section 7.0.



- Stage 2 HPT Nozzle (Installed)



- Turbine Midframe

Figure 13. LPT EMU Dimensional Checks.

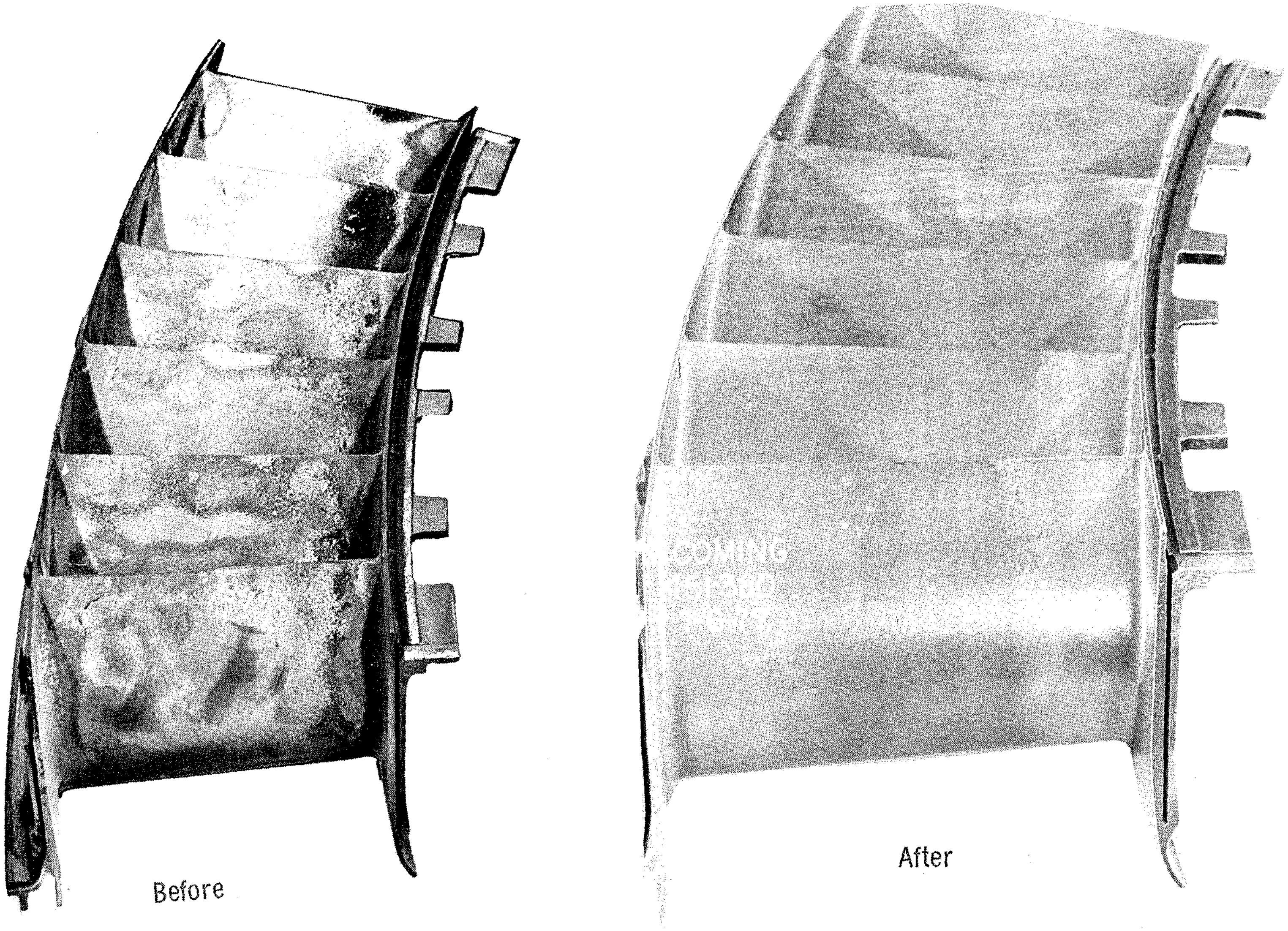


Figure 14. Stage 1 LP Turbine Nozzle Vanes Before and After SWECO Cleaning.

Table XVIII. LPTS Airfoil Surface Finish Inspection Results.

			Convex						Concave			
			Tip		Pitch				Pitch			
Stage	S/N	Condition	LE	TE	LE	TE	Avg.	Stg. Avg.	LE	TE	Avg	Stg. Avg.
1	THHA5549	D	160	195	115	180	163		95	165	130	
		C	140	120	110	115	121		70	115	92	
		Δ	20	75	5	65	42		25	50	38	
1	THHA6053	D	105	120	160	85	118	141	120	185	153	142
		C	80	80	70	60	73	97	100	150	125	109
		Δ	25	40	90	25	45	44	20	35	28	33
2	B1266	D	95	100	85	90	93		105	75	90	
		C	75	65	60	60	65		75	45	60	
		Δ	20	35	25	30	28		30	30	30	
2	B0897	D	95	85	85	75	85	89	110	80	95	93
		C	75	60	65	40	60	62	75	50	60	60
		Δ	20	25	20	35	35	27	40	30	35	33
3	T3197	D	95	65	75	60	74		65	60	63	
		C	65	48	60	40	53		60	55	58	
		Δ	30	17	15	20	21		5	5	5	
3	T2245	D	105	72	100	60	84	79	90	75	83	73
		C	85	65	85	50	71	62	85	55	70	64
		Δ	20	7	15	10	13	17	5	20	13	9
4	V3973	D	75	72	85	58	72		68	68	68	
		C	65	60	58	50	58		52	60	56	
		Δ	10	12	27	8	14		16	8	12	
4	V3739	D	73	115	77	70	84	78	75	95	85	77
		C	70	105	55	60	73	65	70	68	69	63
		Δ	3	10	22	10	11	13	5	27	16	14
5	V1425	D	75	90	70	82	79		88	50	69	
		C	55	65	40	40	50		65	40	52	
		Δ	20	25	30	42	29		23	10	17	
5	V0185	D	65	78	60	75	69	74	55	70	62	66
		C	45	55	25	47	43	46	40	35	37	45
		Δ	20	23	35	28	26	28	15	35	25	21
Avg.	Stator	D						92				90
		C						67				68
		Δ						25				22

Surface finish when new = 63 μ inches maximum.

6.3.1.5 Rebuild

After the inspection checks and cleaning were completed, the Stage 1 LPT nozzle assembly was reassembled and installed onto the TMF. All original hardware was used on the rebuild. There were six nozzle vane segments with some material missing on the aft lips, and four others were worn. All were acceptable for the rebuild.

6.3.2 Low Pressure Turbine Rotor

6.3.2.1 General

Visually, the low pressure turbine (LPT) rotor assembly was in excellent condition. The normal dirt and roughness were noted on the blade airfoils, but there was no damage to any of them. Each blade was inspected for circumferential mating face wear, with no discrepancies noted. Spool parts were also without faults.

6.3.2.2 Dimensional Inspections

The rotor was set up in a lathe bed on the Number 6 and Number 7 journals for radii measurements of the blade tip shroud seal serrations, the air seals, and the pressure balance (P/B) seal aft tooth. (Measurement of the other P/B seal teeth was not possible with the tooling on hand). The results are presented in Table XIX.

6.3.2.3 Airfoil Surface Finish Checks (RMS)

After the dimensional inspection checks were completed, two blades from each stage were removed for measurement of the airfoil surface finish. Following these checks, the remaining blades were removed and all were SWECO cleaned for two hours. The surface finish was then rechecked on the same blades previously inspected to determine the effect of the cleaning. Assessment of the performance change due to the cleaning is discussed in Section 7.0.

Table XX presents a tabulation of the surface finish inspections; dirty (D), clean (C), and the differences (Δ). All checks were taken 0.10/0.15 inch from L.E. and T.E., each side. Tip readings were taken 0.50 inch below the blade's outer platform.

6.3.2.4 Rebuild

After the cleaning and surface finish checks were completed, the blades were reinstalled in the rotor spool in their original positions.

Table XIX. LP Turbine Rotor Radii Measurements.

Blade Radii

Stage	FWD		AFT		Serviceable Limit	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	24.131	24.114	24.129	24.114	24.144	24.121
2	24.115	24.106	24.119	24.112	24.137	24.114
3	24.101	24.089	24.115	24.100	24.125	24.102
4	24.120	24.110	24.120	24.108	24.135	24.112
5	24.119	24.111	24.117	24.104	24.135	24.112

Interstage Seals Radii

Stage	FWD		AFT		Serviceable Limit	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	18.188	18.182	N/A		18.207	18.190
2	18.002	18.000	18.008	17.997	18.015	17.987
3	16.856	16.851	16.861	16.850	16.857	16.832
4	15.565	15.556	(Missed)		15.587	15.560
5	14.204	14.192	(Missed)		14.232	14.205

Pressure Balance Seal Radii

Maximum Radius = 9.501
Minimum Radius = 9.496
Average Radius = 9.498

Serviceable Limits = 9.490/9.496

Table XX. LPTR Airfoil Surface Finish Inspection Results.

			Convex						Concave			
			Tip		Pitch				Pitch			
Stage	S/N	Condition	LE	TE	LE	TE	Avg.	Stg. Avg.	LE	TE	Avg	Stg. Avg.
1	Y3984	D	100	115	125	80	105		140	140	140	
		C	65	40	80	65	63		105	90	97	
		Δ	35	75	45	15	42		35	50	43	
1	V5924	D	80	120	120	85	101	103	110	135	123	132
		C	70	60	85	80	74	68	75	95	85	91
		Δ	10	60	35	5	27	35	35	40	38	41
2	B2426	D	90	90	80	75	84		80	90	85	
		C	85	55	70	40	63		75	80	78	
		Δ	5	35	10	35	21		5	10	7	
2	B0193	D	70	90	50	65	69	77	130	70	100	93
		C	65	40	40	30	44	54	70	50	60	69
		Δ	5	50	10	35	25	23	60	20	40	24
3	Z5747	D	60	100	50	50	65		65	50	57	
		C	60	40	45	40	46		60	45	52	
		Δ	0	60	5	10	19		5	5	5	
3	Z5685	D	80	65	50	50	61	63	60	60	60	59
		C	70	40	45	40	49	48	40	50	45	49
		Δ	10	25	5	10	12	15	20	10	15	10
4	X7300	D	60	70	50	65	61		70	55	62	
		C	55	45	35	25	40		60	55	57	
		Δ	5	25	15	40	21		10	0	5	
4	X7995	D	65	80	70	70	71	66	70	70	70	66
		C	40	50	40	60	47	44	65	60	62	60
		Δ	25	30	30	10	24	22	5	10	8	6
5	V4118	D	75	80	55	90	75		70	65	67	
		C	55	60	50	45	52		55	55	55	
		Δ	20	20	5	45	23		15	10	12	
5	W9292	D	95	85	150	95	106	91	118	110	114	91
		C	65	60	95	85	76	64	90	105	97	76
		Δ	30	25	55	10	30	27	28	5	17	15
AVG	Rotor	D					80				88	
		C					55				69	
		Δ					25				19	

Surface finish when new = 45 μ inches maximum.

6.3.3 Low Pressure Turbine Stator Assembly

6.3.3.1 General

A visual inspection showed the LP turbine stator assembly to be in good condition. Vanes were dirty and rough, as expected, with the worse conditions in the forward stages. Rub patterns on the shrouds and the interstage seals were about the same as seen on the first Task IV engine, S/N 451-479. (see Figure 15). Castone impressions were made of the maximum depth rub pattern visually observed in each stage of shrouds and seals, all being in the lower case. A sketch of each of these is shown in Figure 16. The impressions are in the files of ASE Engineering and no further action is planned for them, unless some future activity in the program indicates a need for further study.

6.3.3.2 Airfoil Surface Finish Checks

Two vane segments on each stage were removed and the airfoil surface finish of each of the end vanes for each segment was inspected. The remaining vanes were then removed and all were SWECO cleaned for two hours. After cleaning, the previously inspected airfoils were rechecked to determine the effect of the cleaning. Assessment of the performance changes attributed to the cleaning are summarized in Section 7.0. Table XVIII is a tabulation of these surface measurements; dirty (D), clean (C), and the differences (Δ). (All measurements were taken 0.45/0.50 inch from the leading edge and from the trailing edge of each side. Tip readings were taken 0.50 inch below the outer platform.)

6.3.3.3 Rebuild

After completing the cleaning and inspection checks, the low pressure turbine stator was re-assembled using all the original hardware.

6.4 FAN SECTION

Another prime objective of the CF6 Engine Diagnostics Program is to evaluate fan performance restoration with regard to Stage 1 blade leading edge quality and airfoil surface cleanliness. Performance deterioration in the fan section is believed to be primarly attributed to changes in the fan blade leading edge due to F.O.D., erosion, etc., in addition to buildup of dirt on the airfoil.

To determine the performance effects for the fan section, the same method was used as was employed on the first Task IV engine, S/N 451-479. A test cell run, after the low pressure turbine (LPT) refurbishment, served as a baseline for subsequent tests. Following this run, the Stage 1 fan blades were removed and cleaned, and the leading edges were recontoured per the Shop

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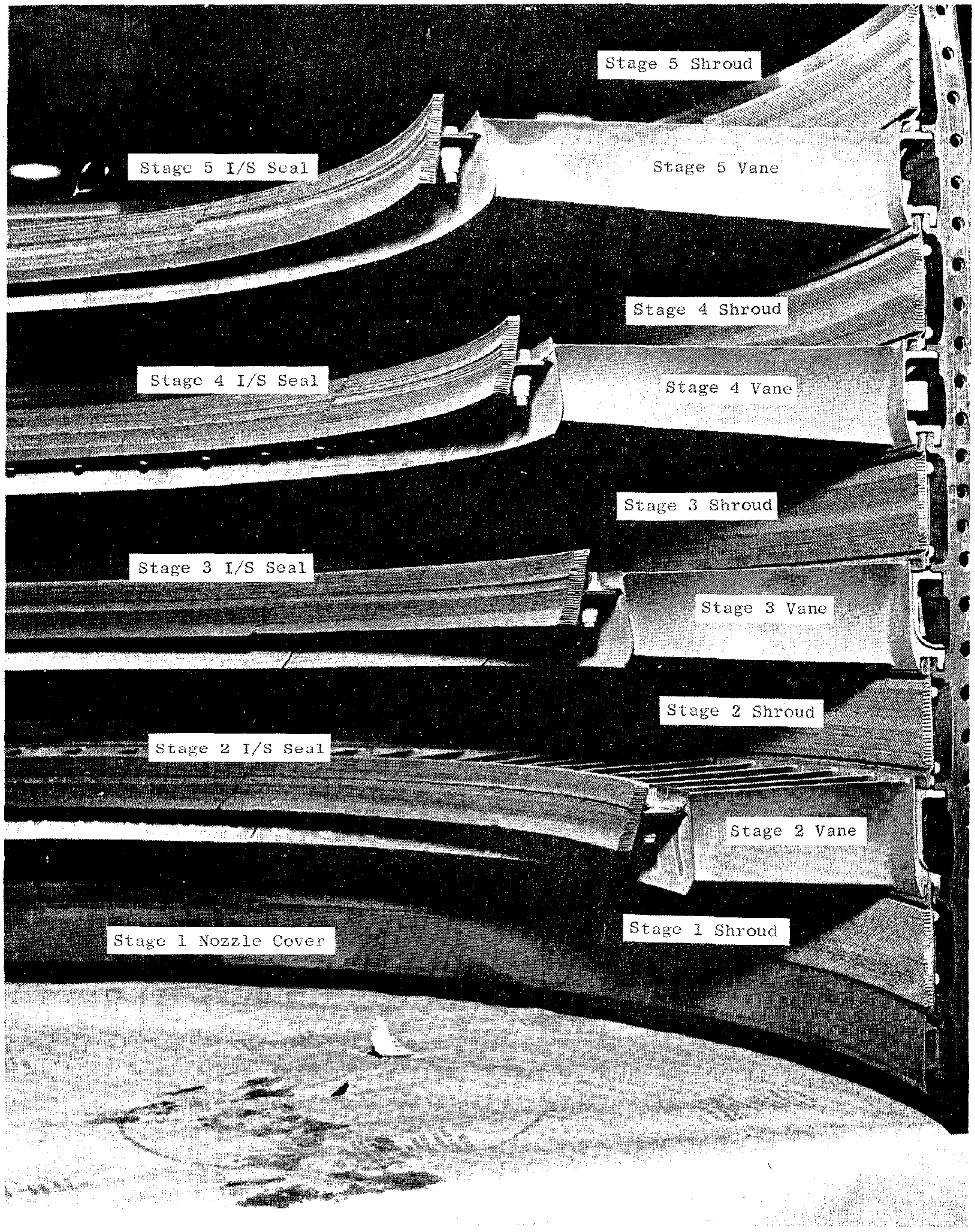

Figure 15. LP Turbine Stator Assembly, End View of Shroud and Seal Rubs.

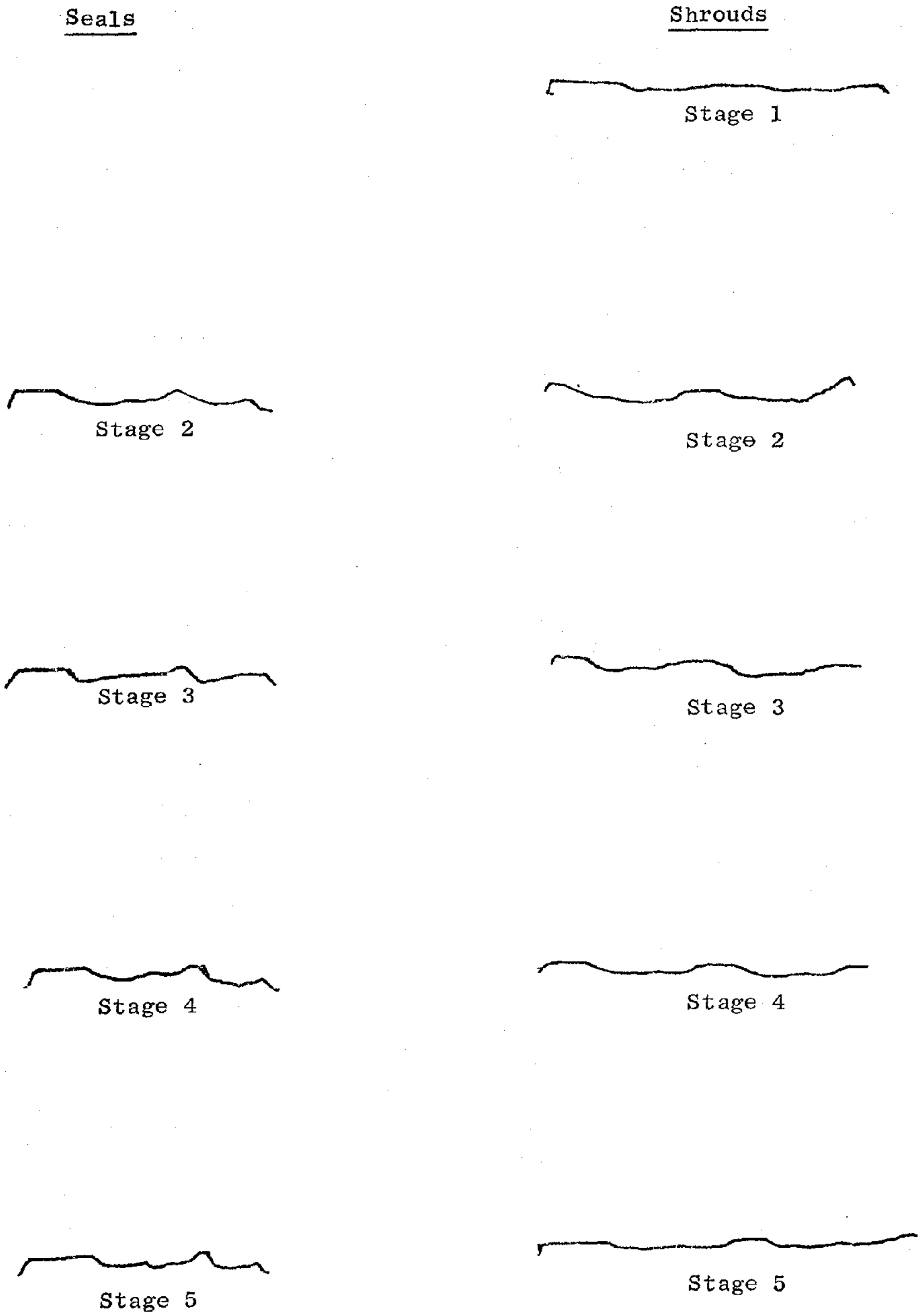

Figure 16. LPTS Shroud and Interstage Seal Rub Impressions.

Manual. Another test cell run was then conducted. No other changes were made to the engine during this time period; therefore, the performance improvements achieved could be attributed to the fan blade refurbishment. Upon completion of these tests, the core analytical teardown was begun with no further work planned in the fan section.

Figure 17 shows the fan section after the test cell runs. Note the missing coating on the outer OGV's as viewed through the blades at the top. A view of these vanes from the aft side can be seen in Figure 18.

6.4.1 Fan Rotor

Upon receipt of the engine at ASO/Ontario, a visual inspection showed that 14 Stage 1 fan blades had minor nicks on the leading edges, most of which were in the blade outer panel. Erosion had produced very sharp leading edges and the airfoils were extremely dirty. Considerable time was expended in the rework and cleaning of the blades during that portion of the test plan. The blades were steam-cleaned and then hand-cleaned using a soft cloth and solvent MEK, with little effect. Finally, Scotch Brite Pads Number 7447 were used to remove the deposits and polish the blades.

Visual inspection of the Stage 2 blades revealed no discrepancies of any kind.

6.4.2 Fan Stator

The fan stator case assembly had the microballoon grooved abradable Stage 1 fan shroud material, rather than the later improvement, open faced aluminum honeycomb. The shroud was in very good condition with only a few minor nicks in the surface.

The abradable material had been removed from the midring shroud over the Stage 2 blade tips in order to eliminate the possibility of engine overpressure in the event of high unbalance. (This modification was introduced by Service Bulletin 72-647). Without the shroud, there is some minor degree of performance loss.

Much of the urethane coating on the Stage 1 fan outer OGV's was missing on either or both sides of the vanes (see Figures 17 and 18). Visual inspection revealed no other discrepancies.

6.4.3 Stage 1 Fan Blade Tip Clearances

6.4.3.1 Rotor Runout

Rotor runout was determined by measuring the clearance between each Stage 1 fan blade and the shroud at the 6 o'clock position. Measurements

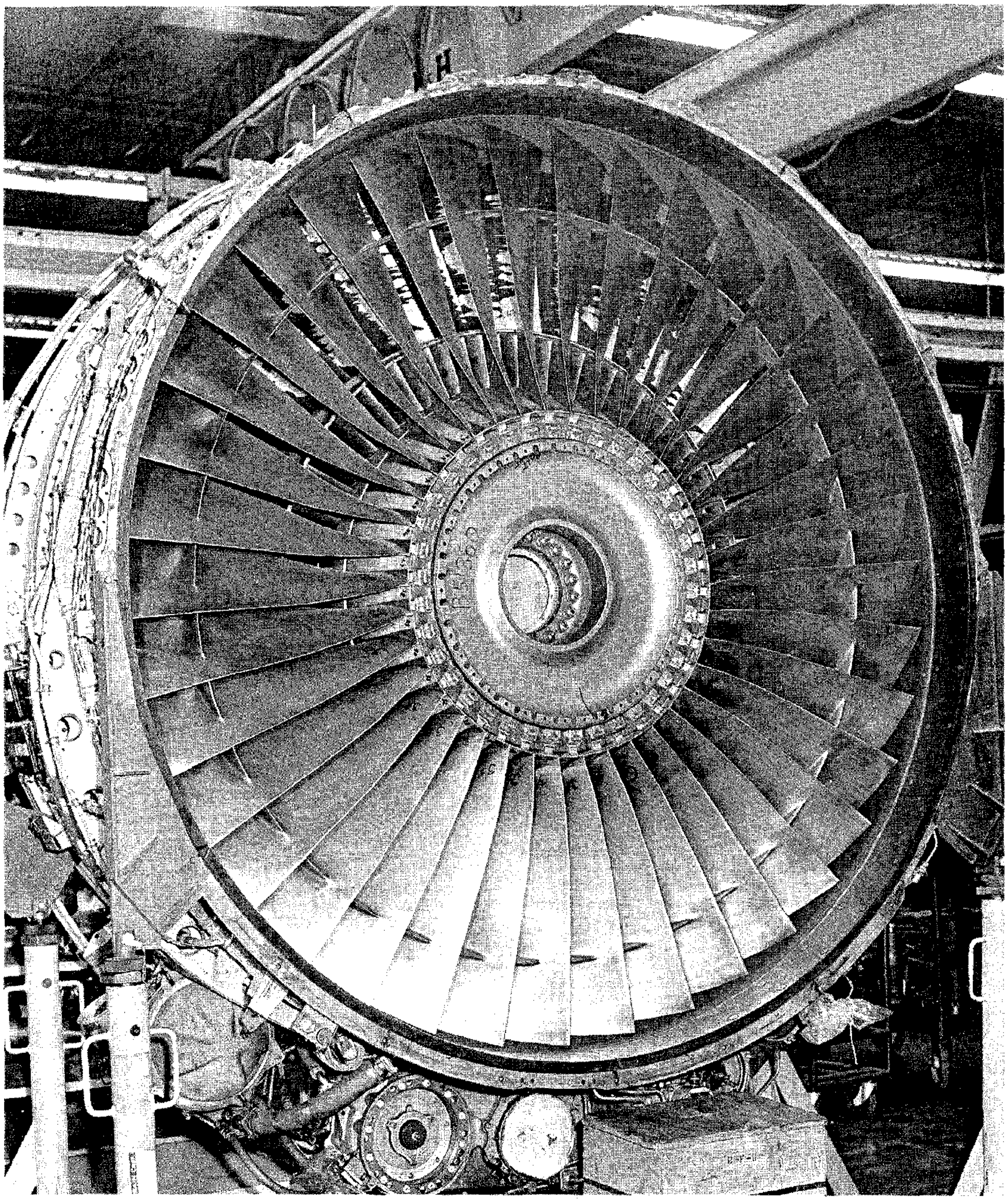

Figure 17. Fan Section, Overall View - Forward Looking Aft.

Figure 18. Stage 1 Fan Outer OGV's, Trailing Edge Coating Peeling.

were taken at both the E12 and the E13 axial locations. Tables XXI and XXII are the results of these checks:

Note: E12 location (Table XXI) is at 1.929 inches from the leading edge of the blade and E13 location (Table XXII) is at 8.099 inches, also from the leading edge of the blade.

6.4.3.2 Shroud Runout

Using the blades with the smallest clearances at locations E12 (Number 24) and E13 (Number 2), clearances between the blade tip and shroud were measured and recorded at 12 equally spaced locations, starting at 12 o'clock. The full circumference was then swept and the minimum clearance at each location was recorded. Following are the results of these measurements:

Clearances at E12 (B/P = 0.145 inch min)

Position No.	Clearance	Position No.	Clearance
12 o'clock	0.174	6 o'clock	0.171
1	0.181	7	0.167
2	0.174	8	0.159
3	0.173	9	0.147
4	0.176	10	0.145
5	0.173	11	0.150

Minimum Clearance = 0.142 in. at 9:30 o'clock
Average Clearance = 0.166 in.

Clearances at E13 (B/P = 1.45 inch min.)

Position No.	Clearance	Position No.	Clearance
12 o'clock	0.168	6 o'clock	0.180
1	0.178	7	0.176
2	0.173	8	0.168
3	0.175	9	0.150
4	0.178	10	0.148
5	0.178	11	0.158

Minimum Clearance = 0.145 in. at 9:30 o'clock
Average Clearance = 0.169 in.

Table XXI. Stage 1 Fan Blade Runout at E12.

Blade No.	Clearance	Blade No.	Clearance
1	0.206	20	0.180
2	0.196	21	0.180
3	0.196	22	0.211
4	0.180	23	0.180
5	0.195	24	0.171
6	0.182	25	0.186
7	0.196	26	0.186
8	0.198	27	0.186
9	0.205	28	0.186
10	0.191	29	0.190
11	0.180	30	0.192
12	0.185	31	0.195
13	0.180	32	0.186
14	0.190	33	0.190
15	0.192	34	0.176
16	0.196	35	0.198
17	0.180	36	0.195
18	0.182	37	0.195
19	0.180	38	0.186

Average Clearance = 0.189 in.
Smallest Clearance = 0.171 in. (Blade No. 24)

Average Rotor Runout = 0.018 in. versus 0.014 inch maximum per B/P

Table XXII. Stage 1 Fan Blade Runout at E13.

Blade No.	Clearance	Blade No.	Clearance
1	0.205	20	0.190
2	0.180	21	0.188
3	0.205	22	0.204
4	0.180	23	0.200
5	0.186	24	0.190
6	0.195	25	0.185
7	0.195	26	0.191
8	0.181	27	0.190
9	0.211	28	0.190
10	0.190	29	0.182
11	0.195	30	0.190
12	0.192	31	0.205
13	0.190	32	0.197
14	0.208	33	0.197
15	0.208	34	0.180
16	0.200	35	0.205
17	0.195	36	0.195
18	0.190	37	0.195
19	0.188	38	0.181

Average Clearance = 0.193 in.
Smallest Clearance = 0.180 in. (Blade No. 2)

Average Rotor Runout = 0.013 in. versus 0.014 inch maximum per B/P

6.4.3.3 Blade-to-Shroud Clearances

Using the prior measured data, the Stage 1 fan blade tip clearances were determined to be as follows:

	E12	E13	B/P
Minimum	0.142	0.145	0.145
Maximum	0.221	0.211	-
Average(1)	0.184	0.182	0.163

(1) Average clearances are determined by adding the average shroud clearances to the average rotor runouts.

7.0 ANALYTICAL ASSESSMENT OF PERFORMANCE LOSSES

The 451-380 detailed analytical teardown inspections and measurements were evaluated, resulting in a performance stackup using influence coefficients listed in Tables XXIII and XXIV. The coefficients are based on current "best estimate" of hardware effects on engine performance and may be updated based on information learned during the NASA CF6 Engine Diagnostics Program. The performance stackup (Table XXV), relative to new engine performance, is based on the analytical teardown inspections summarized in Section 6.0. The first column (assessment) is based on the analytical measurements and influence coefficients, while the second column (measured) is based on the measured test cell performance differences between an average 1975 Evendale production engine and the Ontario inbound test (see Section 5.0).

Since its original production acceptance test in mid-1973, engine 451-380 had returned to the shop several times for major overhauling so that, at the time of its use as a Task IV engine, it was made up of a conglomeration of modules from several different engines (see Section 3.0). In addition, all of the performance improvement items identified for engine serial numbers 451-406 and up had been incorporated. Therefore, an average new CF6-6D production engine for the year 1976 (rather than 451-380 as shipped) was used as the baseline performance level.

The measured performance column values (EGT and sfc) are based on calculated EGT (T5X). Although the inbound calculated T5X minus indicated EGT (ΔT5X) is consistent with the April 30, 1976, outbound data (see Section 5.0), there is a significant difference when comparing the inbound ΔT5X to an average new production engine. The EGT readout can be influenced by hardware distress (i.e., TMF liner distortion). Therefore, T5X is a more consistent health parameter to use since it is independent of any EGT profile shifts and since both T5X and sfc are functions of fuel flow.

Note that the assessment differs from measured component analysis. A slight error in A4, T3, P3 or EPR can alter the component assessment significantly. A4, in conjunction with the measured HPT pressure ratio, is used to assess the performance tradeoff between parasitics and HPT efficiency. Furthermore, the condition of the TMF liner can effect the pressure (P49), as well as the temperature (EGT) measurement. Similarly, much effort has been placed in developing a simple, yet accurate, method of measuring compressor discharge temperature and pressure. A measurement error in either parameter will result in an incorrect component apportionment of compressor efficiency, turbine efficiency and parasitics.

The 5.14 percent sfc and 85° F EGT hardware assessments are acceptable when compared with the measured 7.1% sfc and 121° F EGT deltas. As stated earlier, the influence coefficients (Tables XXIII and XXIV) are "best estimates" which may be modified based on the results of the CF6 Diagnostics Program. In addition, the analysis obviously does not address all the

Table XXIII. CF6-6 Influence Coefficients.

			% sfc	
Component	Description	° F EGT	T/O	CR.
HPT				
Rotor Blades	Surface finish			
	rms μ in. for 0.1% ηt			
Stage 1	Suction 26 μ in.	2	0.08	0.06
	Pressure 330	2	0.08	0.06
Stage 2	Suction 32	2	0.08	0.06
Shrouds	Surface finish			
	Tip clearance for 1% ηt			
Stage 1	30 mils	21	0.85	0.62
Stage 2	50 mils	21	0.85	0.62
Interstage Seal	20 mils =0.15% ηt	3	0.12	0.09
Rotating				
Stationary				
Stator Vanes	Surface finish			
	rms μ in. for 0.1% ηt			
Stage 1	Suction 20	2	0.08	0.06
	Pressure 140	2	0.08	0.06
Stage 2	Suction 28	2	0.08	0.06
	Pressure 240	2	0.08	0.06
Both Nozzles	None			
Ral. Piston Seal	33 mils = 0.1% WC16 to HP	18	0.72	0.54
Rotating				
Stationary				
LPT				
Nozzles				
Stage 1				
Stage 2				
Stage 3				
Stage 4				
Stage 5				
Rotor Blades	60 μ in. surface finish			
	blades and vanes*			
Stage 1	= 0.41% η2t	3.0	0.31	0.26
Stage 2	= 0.29% η2t	2.1	0.22	0.18
Stage 3	= 0.18% η2t	1.3	0.13	0.11
Stage 4	= 0.10% η2t	0.7	0.07	0.06
Stage 5	= 0.02% η2t	0.1	0.01	0.01
	1.00% η2t	7.2	0.74	0.62
Shrouds	40 mils tip seal clear			
Stage 1	= 0.28% η2t	2.0	0.21	0.18
Stage 2	= 0.20% η2t	1.4	0.15	0.13
Stage 3	= 0.15% η2t	1.1	0.11	0.09
Stage 4	= 0.11% η2t	0.8	0.08	0.07
Stage 5	= 0.06% η2t	0.4	0.04	0.04
	0.80% η2t	5.7	0.59	0.51
Interstage Seals				
Rotating	20 mils clear			
Stage 1				
Stage 2	= 0.25% η2t	1.8	0.19	0.16
Stage 3	= 0.14% η2t	1.0	0.10	0.09
Stage 4	= 0.10% η2t	0.7	0.07	0.06
Stage 5	= 0.05% η2t	0.4	0.04	0.03
	0.54% η2t	3.9	0.40	0.34

*Pressure (concave) surface values weighted at 1/4
Suction (convex) surface values weighted at 3/4

Table XXIV. CF6-6 Influence Coefficients.

Component	Description	° F EGT	% sfc T/O	CR.
Interstage Seals Stationary Stage 1 Stage 2 Stage 3 Stage 4 Stage 5				
Bal. Piston Seal	51 mils = 0.1% WC16 to LP from HP	2	0.25	0.2
Rotating				
Stationary				
CDP Seals				
Fwd. Seal Rotating Stationary	19 mils = 1% WC16 to HP	18	0.72	0.54
Aft Seal Rotating Stationary	33 mils = 1% WC16 to HP	18	0.72	0.54
Compressor-All Parts	Dirt buildup, damage, L/E irregularity			
Rotor Blades	Tip Clear avg. 10 mils tighter throughout compressor = 1% ηc			
	Breakdown - 10 mils each stage:			
	Blade to case:			
	Stage 1-4 0.05% ηc	1	0.04	0.03
	Stage 5-16 0.49% ηc	9.3	0.37	0.25
	Vane to spool:			
	Stage 3-7 0.13% ηc	2.5	0.10	0.07
	Stage 8-15 0.33% ηc	6.3	0.25	0.18
	Total 1.00% ηc	19.0	0.75	0.54
	Surface finish: 6 rms μ in. = 0.1% ηc	2	0.08	0.03
	33% of blades eroded on each stage, stage 5 on back = 0.7% ηc 50% = 1.0% ηc			
Compressor Casings	Leaking variable stator bushings			
Stator Vanes	Surface finish: 10 rms μ in. = 0.1%	2	0.08	0.03
Fan				
Vanes	Surface finish:			
Stage 2	87 rms μ in. = 0.1% ηf	0.6	0.07	0.05
OGV - Inner	87 rms μ in. = 0.1% ηf	0.6	0.07	0.05
OGV - Outer	80 rms μ in. = 0.1% ηf	0.6	0.07	0.05
Fan Rotor Blades				
Stage 1	Tip clear 35 mils = 0.6% ηf	3.6	0.42	0.30
	Surface finish: 27 rms μ in. = 0.1% ηf	0.6	0.07	0.05
Stage 2	Tip clear 40 mils = 0.3% ηf	1.8	0.21	0.15
	22 rms μ in. 0.1% ηf	0.6	0.07	0.05

Table XXV. Analytical Assessment of 451-380 Losses.

	Assessment			(Based on T5X) Measured	
	η	EGT	sfc	T5X	sfc
HP Compressor	1.04%	20° F	0.78%	40° F	1.6%
Blade Surface Finish (30 μ in.)	0.50				
Vane Surface Finish (42 μ in.)	0.42				
Rotor Land Coating	0.12				
HP Turbine	1.39%	29° F	1.18%	110° F	4.6%
Stage 1 Nozzle Surface Finish	0.15				
Stage 1 Blade Surface Finish	0.10				
Stage 2 Blade Surface Finish					
Stage 1 Blade Tip Clearance (+25 mils)	0.83				
Stage 2 Blade Tip Clearance (+13 min)	0.26				
Stage 1 Shroud Roughness	0.05				
Parasitics	1.00%	18° F	0.72%	-38° F	-1.4%
Aft CDP Seal (+5 - Stationary)	0.15				
(+2 - Rotating)	0.06				
Balance Piston Seal					
(+17 - Stationary)	0.51				
(+4 - Rotating)	0.12				
Fwd CDP Seal (+3 mils - Rotating)	0.16				
LP Systems	3.02%	18° F	2.46%	+9° F	2.3%
LP Turbine					
Rotor Clearance	0.01%	0	0.01%		
Stage 2 (1 mil)	0.007				
Stage 3 (1 mil)	0.005				
I/S Seal Clearance	0.23%	1.7° F	0.17%		
Stage 2 (5 mil)	0.06				
Stage 4 (19 mils)	0.10				
Stage 5 (27 mils)	0.07				
Blade Airfoil Surface Finish	0.72%	5.2° F	0.53%		
Stage 1	0.45				
Stage 2	0.17				
Stage 3	0.05				
Stage 4	0.04				
Stage 5	0.01				
Vane Airfoil Surface Finish	0.74%	5.3° F	0.55%		
Stage 1	0.54				
Stage 2	0.13				
Stage 3	0.04				
Stage 4	0.03				
Stage 5	0.00				
Fan Section					
Stage 1 Blade LE/Cleanliness	0.70%	0°	0.50%		
Stage 1 Blade Tip Clearance (20 mils)	0.34%	2°	0.24%		
Stage 2 Shroud Removed	1.00 (hub)	4°	0.26%		
Outer OGV Peeled Coating	0.28	0°	0.20%		
Total		85° F	5.14%	121° F	7.1%
See Figure 19 for Engine Cross Section.					

possible loss mechanisms. For instance, no method had yet been devised to completely assess the Stage 1 HPT nozzle assembly. Losses due to vane surface finish deterioration can and are assessed, but, beyond that, no influence coefficients are available to cover other detrimental conditions. Various conditions, such as ballooning, bowing or burning of vanes, in addition to the size of the gap/interference fit between the Stage 2 HPT nozzle support forward flange and the Stage 1 vane outer flange, cannot be assessed. An excessive gap would result in cooling-air leakage between the flanges, whereas an extreme interference fit would cause the vanes to be tilted forward, resulting in uneven loading, which also would allow leakage between the flanges. During the performance restoration program for 451-337 in early 1975, back-to-back engine tests were conducted to compare the original hardware versus a new Stage 1 HPT nozzle assembly. A 1.2 percent improvement in sfc was realized; however, it should be noted that the new Stage 1 HPT nozzle assembly incorporated shims to reduce vane to Stage 2 support interference and the Stage 2 HPTN support flange was reworked to 63 rms finish. Measurements during the buildup revealed a 1 mil average interference between the nozzle vane outer flange and the Stage 2 support. Effort is planned, as part of this program at a later date, to address this condition.

The Stage 1 fan blade leading edge contour and airfoil surface cleanliness is another example of hardware condition that cannot be analytically assessed as to performance loss. For this reason, the testing sequence included back-to-back tests comparing performance levels of the blades in the "as-received" condition versus performance levels of the blades after cleaning the airfoils and reworking the leading edges. A 0.5 percent improvement in sfc was demonstrated and is included in the analytical assessment of losses (Table XXV and Figure 19).

Other potential areas that do not readily lend themselves to assessment include the dirt buildup on the HPC airfoils, partial loss of the fan OGV urethane coating, and leakage paths throughout the engine (variable stator bushings, split line flanges, and piping flanges). Following consultation with Fan Aero Design Engineering, a 0.2 percent loss in sfc was assessed for the OGV coating deterioration.

The test program also included back-to-back tests comparing low pressure turbine performance with blade and vane airfoils in the "as-received" condition versus the same blades and vanes after having been cleaned by the SWECO method (see Section 6.3). The airfoil surface finish of two blades and vanes from each stage were measured both before and after cleaning, and the measurements are reported in Sections 6.3.2.3 and 6.3.3.2.

Evaluation of the airfoil surfaces prior to cleaning indicated that a performance loss equal to about 1.08% sfc could be attributed to the existing surface condition (roughness) as compared to an airfoil surface when new. After cleaning the airfoils using the vibratory mill process (SWECO), an assessment of the surface condition indicated that only about 67% of this assumed loss had apparently been recovered; i.e., about 0.7% sfc (Table XXVI). This recovery ratio is somewhat lower than the 90% improvement assessed when LPT

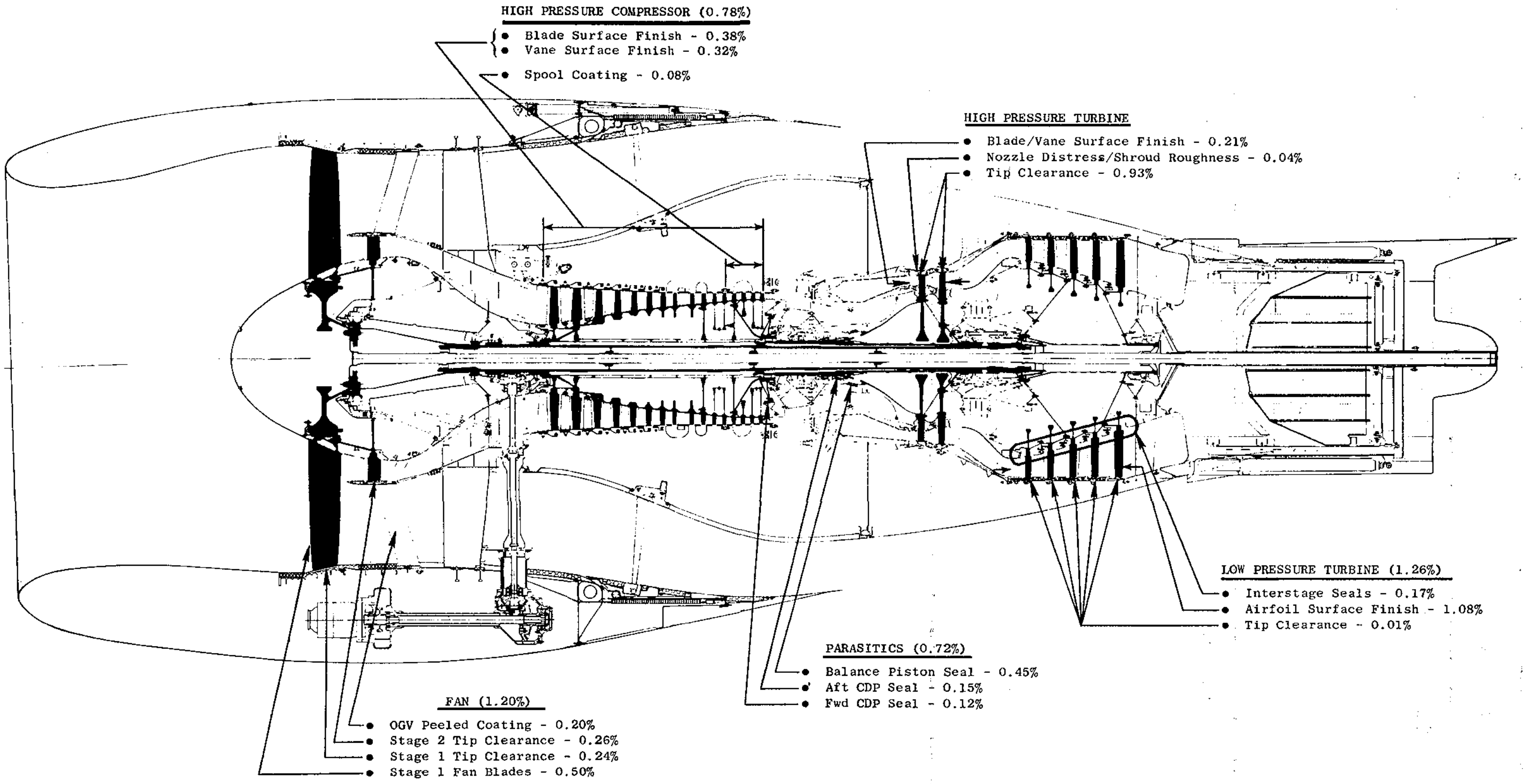

Figure 19. CF6-6 ESN 451-380 Specific Fuel Consumption Deterioration Assessment.

Table XXVI. Analytical Assessment of LPT Refurbished Airfoils.

	Assessment		
LP System Refurbishment	η	EGT	sfc
Blade Airfoil Surface Finish	0.44%	3.2° F	0.33%
Stage 1	0.25		
Stage 2	0.11		
Stage 3	0.04		
Stage 4	0.03		
Stage 5	0.01		
Vane Airfoil Surface Finish	0.50%	3.6	0.37%
Stage 1	0.28		
Stage 2	0.14		
Stage 3	0.05		
Stage 4	0.02		
Stage 5	0.01		
Total	0.94%	7° F	0.70%

airfoils of a previous service engine (S/N 451-479) were cleaned. There seems to be no apparent or obvious reason for this difference, but, it is true that the airfoils of engine 451-380 had been in service for 3249 hours longer than the 4468 hours accrued for the airfoils of engine 451-479. It is quite possible that a longer cleaning cycle may have further improved the surface quality of the airfoils for engine 451-380. It may also be that closer attention will have to be paid to the controlling variables in the cleaning process, such as the cleaning solution, so as to produce more consistent results.

The results of back-to-back tests (before and after cleaning LPT airfoils) are reported in Section 5.0 and show that there was a measured performance improvement in the low pressure system of about 0.5% sfc. This compares favorably with the assessed value of 0.7% sfc improvement as determined from surface roughness measurements obtained before and after cleaning. The results of similar back-to-back tests with engine 451-479 had indicated no measurable performance improvement. Although not conclusive, the data obtained to date indicates that some reevaluation of surface finish influence coefficients may be required.

8.0 APPENDICES

APPENDIX A - FUEL ANALYSIS

APPENDIX B - LOG SHEETS - INBOUND RUN

APPENDIX C - LOG SHEETS - REFURBISHED LOW PRESSURE SYSTEM

APPENDIX A - FUEL ANALYSIS

Following are the results of fuel analysis by the Bearings/Gears and Fuels/Lubes Lab:

Sample Identification:	1.	"Eng. No. 451-380 Inbound 6-23-77 Ontario"
	2.	"Eng. No. 451-380 after-LPT Sample No. 1, 8-2-77"
	3.	"Eng. No. 451-380 after Fan Rework Sample No. 3, 8-7-77"
Hydrogen:	1.	14.00%
	2.	13.92%
	3.	13.90%
Sulfur:	1.	0.085%
	2.	0.0115%
	3.	0.074%
Net Heat by Precision Bomb:	1.	18574 Btu/No.
	2.	18582 Btu/No.
	3.	18605 Btu/No.
Comments:	1.	Specific Gravity 0.7851 at 60° F
	2.	Specific Gravity 0.7922 at 60° F
	3.	Specific Gravity 0.7892 at 60° F

APPENDIX B - LOG SHEETS, INBOUND RUN

ORIGINAL PAGE IS
OF POOR QUALITY

Date 6-23-77
Operator Hernandez
Inspector Jones

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Gas Turbine Serial No. 451-380
Nature of Test Per Sales Reg.
Sheet 1 of 6 Sheets

RUN NO. Incoming

ATMOSPHERIC CONDITIONS				
TIME	PRESS.	TEMP.	W	D
09:22	~~[illegible]~~ 29.085	ABS.	62	66
		Grains =	76	
10:57	29.02	ABS.	67	76
ALT. IN FT:	1000	Grains =	82	

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP4
LHV: (.7842 @ 60°F)
CONSUM.: 7119
SP. GR.: .7778 (.7786
TEMP.: @ 74°F @ 74°F)

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER: NASA/WAL

NO. OF STARTS 7
LAST READING NO. 40
TOTAL RUNNING TIME 5 Hrs. 12 min.
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VRV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} B M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		0832				Pre. Test motoring Check N_2 2632 RPM, N_1 - OK. RPM, SAP = 38 PSIG, Wf = 600 PPH, Lod = 13.5 PSIG, T_2 62 °F																															
						stop cock. OK. Coast down. N_2 2-55 Sec. N_1 3-50 Sec.																															
						Closed Fan Cowl doors oil Level = - 6 Qts.																															
	zero	0834	0	0	-	65	64	.7	-.2	64	69	0	0	66	75	74	460	-	4.66	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0
1		0853				max. start T_5 = 987 °F, Time To idle 37 Sec, Fired At N_2 2448 RPM, Wf = 520 PPH, SAP = 38 PSIG																															
						Lod = 33 PSIG, T_2 = 66 °F, No. 1 Ign., N_1 = 689 RPM.																															
	1	0857	5565	691	-	104	102	26.9	4.8	35.5	74	1010	1010	63	284	807	1470	-	4.51	1.5	-	.05	20	1.6	.05	.06	.06	.35	.35	.05	.15	.4	.1				
						Leak Check - OK- oil Press = 57.9 PSID																															
		0858				Shut down - Coast down - N_2 3-05 Sec N_1 4-25 Sec.																															
						Closed Core Cowl doors - oil Level - 4.1 Qts. Low At 120 °F																															
	zero	0914	0	0	-	106	88	.6	-.3	52	73	0	0	66	157	268	430	-	4.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0			33	/05
2.		0917				max. start T_5 = 1013 °F, Time To idle 31 Sec, Fired At N_2 2560 RPM, Wf = 560 PPH, SAP = 38 PSIG																															
						Lod = 24.3 PSIG, T_2 = 66 °F, N_1 691 RPM, No. 2 Ign-																															
	2.	0921	5556	689	-	126	128	23.1	4.8	34.7	74	990	1000	65	284	801	1500	-	4.49	1.5	-	.05	21	1.75	.07	.08	.09	.35	.4	.05	.1	.7	.05				
						Slow Accel To 50 %.																															
50%	3	0926	8712	2655	-	139	172	~~27.9~~ 45.4	5.6	27.9	79	6760	6740	65	756	1173	18300	-	1.39	29	-	1.8	185	24.5	1.14	1.52	1.54	1.2	.8	.65	.45	.7	1.3				
		0932				Slow Accel To 75 %																															
75%	4	0936	9173	3120	-	151	202	48.8	5.7	25	78	10440	10440	64	870	1388	27380	-	.29	43.8	-	2.9	258	38	1.70	2.1	2.15	1.4	1.45	1.75	.4	.5	1.1				
		0938				Slow Decel To Ground Idle-																															
		0945				Shut down - Coast down - N_2 3-35 Sec. N_1 4-38 Sec. oil Level - 4.0 Qts At 170 °F																															
	zero	1055	0	0	-	99	84	-.1	.4	0	75	0	0	70	209	215	400	-	4.58	0	-	0	0	0	0	0	0	0	0	0	0	0	0			39.5	/39
3	[illegible]	1059				max. start T_5 = 1039 °F, Time To idle 35 Sec, Fired At N_2 2637 RPM, SAP = 38 PSIG, Wf = 560 PPH																															
						Lod = 21 PSIG, T_2 = 71 °F, N_1 687 RPM, No. 1 Ign-																															

REMARKS: oil Press Corr. To 51.95 PSID. At Rd NO. 8 speed = 9599 RPM, Temp = 155 °F, Lod = 52.5 PSIG, Sump = + 3.65 PSIG, Tank = -.1 PSIG

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

Date 6-23-77
Operator Hernandez
Inspector Jones

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 2 of 6 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP4
LHV:
CONSUM. :
SP. GR. :
TEMP. :

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 FGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S2} R.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
	5	1103	5552	687	-	155	165	19.6	5.0	34.9	76	980	980	70	290	815	1440	-	4.51	1.2	-	.05	20	1.6	.85	.06	.06	.15	.3	.05	.15	.45	.05				
		1107				Slow Accel TO M.C.									for Soak Period.																						
M.C.	6	1109	9520	3419	-	143	198	53.0	6.0	22.2	78	13800	13800	72	962	1570	34620	-	.46	54.8	-	3.5	311	48.8	2.15	2.80	2.70	2.35	1.5	1.85	.5	.9	1.0				
		1114				Accel TO T.O.																															
T.O.	7	1118	9601	3487	-	154	223	52.4	6.1	20.4	78	14630	14630	71	980	1597	36370	-	.38	57.2	-	3.65	330	51.9	2.35	2.80	2.80	2.15	1.9	1.55	.45	.85	.8				
T.O.	8	1121	9599	3491	-	155	224	52.5	6.1	20.1	78	14490	14490	72	980	1596	36210	-	.39	57.2	-	3.65	328	51.3	2.2	2.80	2.80	2.15	1.75	1.50	.45	.85	.7				
		1122				Decel TO M.C.									oil Press Corr. PSID = 51.95 @ RD No. 8														Alternate N_1 Tach ok.								
M.C.	9	1126	9544	3449	-	156	225	51.8	6.1	22.4	76	13970	13970	72	968	1575	34880	-	.43	55.1	-	3.55	318	49.5	2.15	2.70	2.70	2.0	1.6	1.5	.45	.8	.65				
M.C.	10	1129	9544	3445	-	156	225	51.8	6.1	22.4	77	13960	13960	72	968	1576	34770	-	.44	55.1	-	3.55	317	49.4	2.2	2.65	2.60	1.95	1.55	1.5	.45	.85	.65				
		1131				Decel TO M.C.R.																															
M.C.R.	11	1135	9424	3342	-	157	224	50.4	6.2	24.0	77	12720	12680	72	940	1521	32260	-	.59	51.3	-	3.30	297	45.4	2.05	2.45	2.40	1.75	1.4	1.45	.45	.8	.7				
M.C.R	12	1137	9419	3339	-	157	222	50.3	6.1	23.7	77	12540	12550	74	940	1518	31720	-	.59	51.1	-	3.30	296	45.0	2.0	2.50	2.40	1.75	1.35	1.35	.45	.85	.7				
		1139				Decel TO 75%																															
75%	13	1143	9194	3142	-	160	221	47.8	6.1	27.0	77	10430	10430	74	888	1411	27870	-	.87	43.6	-	2.90	258	38.2	1.75	2.15	2.20	1.65	1.4	1.6	.35	.75	1.05				
75%	14	1146	9192	3136	-	160	120	47.8	6.1	27.0	77	10390	10380	73	888	1411	27210	-	.88	43.6	-	2.90	256	37.60	1.70	2.20	2.10	1.65	1.45	1.4	.35	.65	.95				
		1148				Decel TO Flight Idle.																															
		1153				Switch TO G.I.																															
		1155				Shut down -							Coast down -						N_2			3-43 Sec					N_1		4-25 Sec								
								oil Level = -4.0 @ 179 °F																													
	zero	1200	0	0	-	179	16[illegible]	.2	.2	0	78	0	0	76	204	384	390	-	4.59	0	-	0	0	0	0	0	0	0	0	0	0	0	0			1875	1/29
	zero	1251	0	0	-	114	90	-.6	.5	0	91	0	0	80	221	229	400	-	4.59	0	-	0	0	0	0	0	0	0	0	0	0	0	0			1875	1/29

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

ORIGINAL PAGE IS
OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 6-23-77
Operator Hernandez
Inspector Jones
RUN NO.
Gas Turbine Serial No. 451-380
Nature of Test
Sheet 3 of 6 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
1302	29.00	ABS	68	79
		Grain =	82	
13 23	28.99	ABS		
13:59 T:	28.972	ABS		

OIL TYPE: mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4.
LHV:
CONSUM.:
SP. GR.: .7775 (.7783
TEMP.: 76 °F @ 74 °F)

MODEL NO: CF6-6D
WORK ORDER: 191650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS INLET PSIG	LUBE OIL PRESS FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T2 FAN IN °F	T3 CDT °F	T5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	PS2 P M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
4		1305				Max. start T5 = 1052 °F, Time To idle 34 Sec, Fired At N2 2550 RPM, SAP = 38 PSIG, Wf = 620 PPH																															
						Lod = 20.8 PSIG, T2 = 79 °F N1 650 RPM, No. 2 Ign.																															
	15	1309	5613	694	–	160	170	19.9	4.9	35	80	990	970	81	305	842	1460	–	4.50	1.2	–	.05	20	1.7	.06	.08	.08	.2	.3	.05	.25	.75	.05				
		1328				Slow Accel To M.C. For Soak Period.																															
		1333				Accel To T.O.																															
T.O.	16	1337	9679	3524	–	158	229	52.4	6.6	20.1	79	14760	14790	80	1002	1628	36190	–	.37	56.5	–	3.7	328	514	2.25	2.8	2.65	2.4	2.0	1.5	.5	1.0	.75				
T.O.	17	1340	9675	3516	–	159	231	52.2	6.7	20.1	79	14610	14610	82	1005	1628	35870	–	.38	57.0	–	3.7	327	51.3	2.26	2.76	2.90	2.4	1.75	1.4	.5	1.1	.8				
		1342				Decel To M.C.																															
M.C.	18	1347	9585	3448	–	161	231	51.1	6.7	22.4	79	13770	13760	81	984	1596	34190	–	.44	54.0	–	3.5	310	48.2	2.1	2.60	2.55	2.2	1.8	1.45	.45	1.0	.7				
M.C.	19	1351	9583	3442	–	161	230	50.8	6.5	22.8	79	13670	13690	82	986	1596	34170	–	.46	53.5	–	3.5	312	48.3	2.2	2.65	2.60	2.35	1.6	1.4	.5	1.0	.7				
		1352				Decel To M.C.R.																															
M.C.R.	20	1356	9487	3360	–	162	231	49.7	6.5	23.4	79	12640	12640	83	962	1551	31780	–	.55	50.8	–	325	293	45	2.05	2.50	2.45	2.05	1.4	1.35	.45	.95	.7				
M.C.R.	21	1359	9482	3364	–	162	230	49.6	6.6	23.8	79	12750	12740	82	960	1551	31860	–	.54	51	–	3.25	295	45.2	2.1	2.55	2.50	2.05	1.4	1.35	.45	1.0	.7				
		1400				Decel To 75%																															
75%	22	1404	9257	3162	–	164	228	47.3	6.6	27.0	79	10590	10550	82	909	1441	27390	–	.82	43.5	–	2.90	260	38.40	1.8	2.25	2.15	1.55	1.6	1.6	.4	.9	1.15				
75%	23	1408	9255	3169	–	163	225	47.3	6.6	26.4	78	10620	10690	82	908	1443	27180	–	.84	43.5	–	2.90	259	38.40	1.85	2.20	2.15	1.55	1.55	1.4	.45	.8	.9				
		1409				Decel To Flight Idle																															
		1414				Switch To Ground Idle - Leak Check																															
		1416				Shut down - Coast down - N2 3-48 Sec - N1 4-24 Sec.																															
	zero	1424	0	0	–	185	176	-.2	.3	0	88	0	0	84	205	381	400	–	4.62	0	–	0	0	0	0	0	0	0	0	0	0	0	0			3424	2/40
						Filters Finger Screens And Mag Plugs Checked All - ok.																															
5.		1530				Max start T5 = 1057 °F, Time To idle 36 Sec, Fired At N2 — RPM, SAP = 38 PSIG, Wf = 570 PPH																															
						Lod = 20.7 PSIG, T2 = 85 °F, N1 695 RPM, No. 2 Ign.																															

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

Date 6-23-77
Operator Hernandez
Inspector Jones

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

RUN NO. ______

Gas Turbine Serial No. 451-380
Nature of Test ______
Sheet 4 of 6 Sheets

ATMOSPHERIC CONDITIONS TIME	PRESS	TEMP.	W	D
1918	28.965	Abs	67	77
			81 grains	

ALT. IN FT: 1000

OIL TYPE:	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE:
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 FGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S2} RM WALL "H_2O	FRONT CELL TOTAL "H_2O	FRONT CELL STATIC H_2O	REAR CELL STATIC H_2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
	24	1534	9232	686	—	120	179	19.2	5.0	34.5	89	1000	980	85	311	853	1470	—	4.52	1.5	—	.05	20	—	—	—	—	.15	.1	.1	.35	.75	.25				
		1536				Slow Accel To 75% for Trouble shooting Fuel Flow Count. ON Scope																															
		1558				DECEL To Flt. idle																															
		1602				DECEL To grd idle																															
						Leak check-																															
		1606				Shut down, dump OK, coast down, Core = 3 min 45 sec Fan = 4 min 25 sec																														4049	3/16
	ZERO	1919	C	0	/	51	174	0.5	0	0	82	0	0	76	175	143	450	/	4.62	0	0	0	0	0	0	0	0	0	C	0	0	0	0				
6		1921				Max start T5 = 1032° F fired @ 2527 RPM SHP = 37 PSIG T2 = 76°F																															
						Wf = 540 PPH Lod = 26 PSIG Time To idle = 32 SEC # 2 Ign																															
	25	1924	5577	658	/	156	161	19.7	7	37	83	990	1000	74	296	833	1500	/	4.51	1.3	/	.05	20	1.6				.05	.1	.05	.1	.3	.05				
						Leak check-																															
		1927				slow accel To MC for soak period-																															
		1935				accel To T.O. for power cal																															
T.O	26	1939	9606	3498	/	155	225	52.4	9	21	76	14610	14610	72	982	1611	36420	/	.38	57.0	/	3.65	326	51.6	2.3	2.85	2.8	2.6	1.9	1.5	.5	.9	.8				
													T3=	977	972	971	993	998			~~36420~~																
T.O.	27	1942	9607	3500	/	155	225	52.4	9	22	76	14620	14620	71	980	1610	36460	/	.37	57.0	/	3.6	326	51.7	2.3	2.8	2.8	2.6	2.0	1.3	.5	1.0	.9				
													T3=	977	970	970	992	997																			
		1944				Decel To MC																															
MC	28	1948	9529	3433	/	156	224	51.6	9	24	76	13810	13810	71	964	1574	34660	/	.44	54.8	/	3.5	315	49.1	2.15	2.75	2.6	2.5	1.6	1.5	.5	1.0	.9				
													T3=	959	954	953	974	979																			
MC	29	1951	9529	3440	/	155	224	51.8	9	23	76	13910	13910	70	963	1575	34740	/	.44	55.0	/	3.55	316	49.4	2.2	2.7	2.65	2.4	1.8	1.6	.5	1.1	.9				

REMARKS: T3 = 958 — 952 — 953 — 972 — 979

QC - 189 - 1 FORM CF6 TEST 1
REV 5/75

ORIGINAL PAGE IS
OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF · 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 6-23-77
Operator Moreno
Inspector Cimorelli

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 5 of 6 Sheets
RUN NO.

ATMOSPHERIC CONDITIONS TIME	PRESS	TEMP.	W	D
6-24-77 0811	29.02	A.B.S.	61	65
		Grain =	72	

ALT. IN FT: 1600

OIL TYPE: Mobil Jet II	TIME	OIL WT.	TIME	OIL WT
START				
END				
CONSUM.				

FUEL TYPE: JP-4-
LHV:
CONSUM.:
SP. GR.: .778 (.7836)
TEMP.: @74 (@60)

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T2 FAN IN °F	T3 CDT °F	T5 FGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	PS2 O.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG	VIBRATION CORE TMF	VIBRATION CORE TRH				FUEL USED	TOTAL RUN TIME
		1954				DECEL To MCR																																
MCR	30	1959	9402	3331	/	156	221	50.4	8	26	76	12640	12640	69	934	1516	32340	/	.59	51.2	—	3.25	297	45.8	2.0	2.6	2.55	2.0	1.4	1.4	.5	1.1	.85					
												T3=	929	923	923	943	949																					
MCR		2002	9402	3334	/	155	220	50.5	8	26	76	12640	12620	69	934	1516	32340	/	.59	51.1	/	3.25	296	45.5	2.05	2.55	2.5	2.0	1.4	1.35	.5	1.1	.9					
		2004				DECEL To 75%																																
75%	31	2008	9171	3140	/	157	217	48.1	8	29	76	10460	10460	69	879	1408	27450	/	.87	43.5	—	2.85	254	38.3	1.7	2.2	2.15	1.55	1.5	1.55	.4	1.0	1.2					
												T3=	876	869	868	886	894																					
		2011				DECEL To flt. idle																																
		2015				DECEL To grd. idle																																
G1	32	2017	5514	687	/	196	207	17.9	6	38	76	430	430	69	293	798	1480	/	4.46	1.5	—	.05	20	1.9	.07	.08	.09	.1	.1	.05	.35	.35	.05					
										leak check-																												
		2021				Shutdown, damp OK, coast down, Core = 3 min 40 sec Fan = 4 min 25 sec																															559	4/16
	ZERO		0	0	—	172	161	6.4	6	0	72	0	0	69	179	347	+420	—	4.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
									Oil Level @ -6 qts @ 169°																													
								All filters, finger screens & mag plug checked - OK -																														
	6-24-77																																					
	zero	0811	0	0	-	64	64	.6	-.9	0	66	0	0	64	92	76	430	-	4.63	0	-	0	0	0	0	0	0	0	0	0	0	0	0				559,	4/16
7.		0821				max start T5 = 993 °F, Time To Idle 35 Sec, fired At N2 2679 RPM, SAP = 58 PSIG, Wf = 550 PPH.																																
						Lod = 35 PSIG, T2 = 65 °F, N1 684 RPM, No. 1 Ign.																																
	33	0825	5519	682	-	105	105	25	4.4	34.6	63	940	940	62	280	811	1510	-	4.52	1.5	-	.05	21	1.7	.06	.07	.07	.15	.1	.05	.1	.35	.05					
		0832				Slow Accel To M.C. for Soak Period.																																
		0838				Accel To T.O.																																

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 6-24-77
Operator Hernandez
Inspector Jones

RUN NO.

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 6 of 6 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
ALT. IN FT: 1000				

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4.
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} R M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
T.O.	34	0843	9507	3457	–	149	214	52.9	5.0	20.4	76	14260	14250	62	954	1572	35860	–	.41	56.8	–	3.70	324	51.1	2.3	2.8	2.75	2.3	1.8	1.5	.45	1.1	1.1				
T.O	35	0846	9505	3452	–	151	218	52.6	5.0	20.3	76	14230	14230	62	953	1569	35810	–	.41	56.8	–	3.70	324	50.6	2.25	2.85	2.75	2.3	1.7	1.6	.45	1.25	1.1				
		0847			Decel TO M.C.																																
M.C.	36	0852	9461	3413	–	152	219	52	5.0	22.6	75	13710	13710	63	942	1547	34660	–	.46	55	–	3.60	315	49	2.2	2.75	2.65	2.2	1.6	1.65	.45	1.2	1.15				
M.C.	37	0855	9461	3412	–	152	219	52	5.0	22.3	76	13710	13730	63	943	1548	34640	–	.46	55	–	3.55	316	49	2.25	2.75	2.66	2.15	1.65	1.65	.45	1.3	1.15				
		0856			Accel TO T.O.																																
T.O.	38	0900	9530	3471	–	151	219	52.7	5.2	20.7	76	14420	14420	63	958	1578	36130	–	.39	57	–	3.70	324 324	51	2.35	2.8	2.8	2.45	1.85	1.55	.45	1.3	1.15				
T.O.	39	0904	9529	3469	–	152	220	52.6	5.1	20.6	76	14360	14360	63	958	1577	35280	–	.39	57	–	3.70	324	51	2.3	2.8	2.75	2.35	1.95	1.55	.45	1.3	1.1				
		0907			Decel TO M.C.																																
M.C.	40				–	152	220	51.9	5.1	22.9	75				942			–	.46	54.8	–	3.50	314	48.7	2.25	2.75	2.7	2.25	1.65 1.65	1.6	.45	1.3	1.15				
		0911			Decel TO Idle. Flight Idle												Problem with T_2 Indication into Vidar																				
		0916			Switch To Ground Idle																																
		0918			Shut down Coast down- N_2 3-39 Sec.																					N_1		4 - 20 Sec.								7/19	5/13
					Filters And Finger screens- & Mag. Plugs. Checked -OK-																																

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

APPENDIX C - LOG SHEETS, REFURBISHED LOW PRESSURE SYSTEM

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-2-77
Operator Lockie
Inspector Jones

RUN NO.
Gas Turbine Serial No. 451-380
Nature of Test
Sheet 1 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
21.44	29.00	ABS	68	78
		Grains = 84		
ALT. IN FT:				

OIL TYPE: Mobil Jet II	TIME	OIL WT.	TIME	OIL WT.
START	21:51	-3.0 @	135	- 3.8
END	23.46	-2.5 @	180	- 3.8
CONSUM.		NONE		

FUEL TYPE: JP-4 -
LHV:
CONSUM.: 17350
SP. GR.: .779 (.7842)
TEMP.: 87 °F (74 °F)

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER: NASA,

NO. OF STARTS 14
LAST READING NO. 94
TOTAL RUNNING TIME 12 HRS 39 MIN.
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} R M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		21:13			Pre-Test motoring check N_2 2622 RPM, N_1 - ok - RPM, SAP = 40 PSIG, Wf = 520 PPH.																																
					Lod = 10 PSIG, T_2 = 82 °F																																
					Stop cock -OK- Coast down - N_2 2-50 sec- N_1 3-52 sec.																																
					Closed fan cowl doors - oil level = 4 Qts.																																
	zero	2123	0	0	-	84	84	.6	.5	61	83	0	0	84	87	91	480	-	4.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1		2128			max start T_5 = 1023 °F, Time to idle 35 sec, fired at N_2 2702 RPM, SAP = 40 PSIG, Wf = 580 PPH.																																
					Lod = 27 PSIG, T_2 = 84 °F, N_1 714 RPM, No. 1 Ign																																
	1	2131	5643	724	-	107	107	26	6.4	31.5	85	1040	1060	78	112	837	1500	-	4.48	1.4	-	.05	20	1.8	.06	.07	.08	.15	.3	.05	.05	.55	.05				
					Leak check OK																																
		2136			Shut down Drain Coast down N_2 3-29 sec- N_1 4-15 sec																																
					Closed core cowl doors - oil level -3 Qts. At 135 °F																																
*	zero	2148	0	0	~~123~~	123 ~~104~~	107	.6	.5	51	81	0	0	80	138	298	440	-	4.64	0	-	0	0	0	0	0	0	0	0	0	0	0	0			36	/8
									T3: 132	137	138	139	138																								
2		2151			max-start T_5 = 1056 °F, Time to idle 32 sec, fired at N_2 2293 RPM, SAP = 40 PSIG, Wf = 500 PPH																																
					Lod = 22 PSIG, T_2 = 80 °F, N_1 712 RPM No. 2 Ign -																																
	2	2156	5598	708	-	143	148	21.7	5.17	31.0	80	1000	1010	~~80~~	132	832	1510	-	4.49	1.4	-	.05	20	1.8	.1	.1	.1	.2	.2	.1	.55	1.4	.2				
					Ground Idle speeds - ok - oil press = 55.65 PSID																																
		22:00			Switch to flight idle																																
	3	2201	7247	1174										77		831			3.66	4.5	-	.15	50					.45	.45	.1	.3	1.2	.05				
					Flight idle speeds - ok -																																
		2203			Switch to G. I.																																
		2205			Accel to 25% N_1																																
25%.	4	2207	8100	1930		169		36.8				3520		76		954			2.41	14.5	-	.75	109					.65	.7	.2	.15	.95	.2				

REMARKS: ROC #8, L.OD: 52.4 PSI @ 9597 RPM, 162°, sump. 3.65, TARE: .6 = 51.65 PSID

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

ORIGINAL PAGE IS
OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-2-77
Operator Lockle
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 2 of 16 Sheets

ATMOSPHERIC CONDITIONS

TIME	PRESS	TEMP.	W	D

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER: NASA

NO. OF STARTS
LAST READING NO
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED		THROTTLE ANGLE	LUBE OIL				FUEL				T_2	T_3	T_5	THRUST LBS.	VBV	STATOR BETA	PT_5	RECOUP CAV.	SUMP VENT		P_{S_2}	FRONT	FRONT	REAR	VIBRATION								FUEL USED	TOTAL RUN TIME
			CORE	FAN		TEMP.		PRESS.		INLET PRESS	INLET TEMP.	FLOW		FAN IN	CDT	EGT		VOLTS		LPT INLET		PRESS	CDP	R-M WALL	CELL TOTAL	CELL STATIC	CELL STATIC	FAN			CORE						
			N_2	N_1		INLET	SCAV.	INLET	FILTER ΔP			MAIN	VAR															NO. 1 BRG.	TMF	TRH	NO. 1 BRG.	TMF	TRH				
			RPM	RPM		°F	°F	PSIG	PSID	PSIG	°F	PPH	PPH	°F	°F	°F			VOLTS	PSIG	"HG	PSIG	PSIG	"H2O	"H2O	H2O	H2O										
		2009				Accel		TO 50%																													
50%	5	2211	8771	2672		163		43.5				6850		76		1215			1.37	28.5	-	1.8	184					1.05	.95	.6	.4	.65	.6				
		2213				Accel		TO 75%																													
75%	6	2215	9230	3147		162		48.2				10710		75		1435			.76	43		2.85	255					.8	1.25	1.05	.35	.6	.75				
		2218				Accel		TO	M.C.			Soak		Period -																							
M.C.	7	2220	9538	3449		161		51.6				14080		74		1589			.41	54.5		3.5	312					1.25	1.5	1.2	.4	1.05	.8				
		2224				Accel		TO		T.O.	87																										
T.O.	8	2229	9597	3504	-	162	229	52.4	6.0	18.3	87	14680	14700	74	365	1613	36090	-	.37	57	-	3.65	325	51.2	2.3	2.9	2.8	1.15	1.95	1.35	.4	1.25	1.1				
											87	T3=	366	342	354	366	371																				
T.O.	9	2233	9597	3507	-	163	231	52.4	6.1	18.3	87	14650	14670	74	364	1613	36020	—	.37	57	—	3.70	326	51.2	2.25	2.9	2.85	1.2	2.0	1.25	.4	1.35	1.1				
												T3 =	367	343	353	371	375																				
		2233				Decel		TO	M.C.																												
M.C.	10	2238	9535	3455	-	163	231	51.6	6.1	19.7	89	14040	14040	74	353	1584	34720	-	.43	55	-	3.60	316	47.2	2.25	2.85	2.8	1.15	1.6	1.2	.4	1.45	1.05				
												T3 =	362	335	352	354	371																				
M.C.	11	2242	9537	3450	-	163	230	51.7	6.0	19.5	87	14020	14060	74	360	1590	34820	—	.42	55.2	-	3.60	316	47.3	2.2	2.8	2.75	1.1	1.8	1.2	.4	1.4	1.1				
												T3 =	360	335	348	358	370																				
		2243				Decel		TO	M.CR.																												
M.CR.	12	2247	9414	3347	-	164	229	50.5	5.7	22.0	87	12720	12740	74	344	1527	31920	-	.57	51	-	3.30	295	45	2.15	2.6	2.55	1.15	1.5	1.1	.4	1.45	1.1				
												T3 =	347	327	341	347	355																				
M.CR.	13	2250	9414	3349	-	164	228	50.6	5.8	21.5	87	12740	12740	73	345	1527	31900	-	.58	51	-	3.30	294	45	2.1	2.6	2.5	1.2	1.4	1.05	.4	1.45	1.1				
												T3 =	348	331	342	346	358																				
		2251				Decel		TO	75%																												
75%	14	2256	9188	3146	-	167	226	48	5.5	24.1	87	10550	10550	73	320	1419	27060	-	.84	43.4	-	2.90	258	38	1.85	2.3	2.3	.85	1.05	.9	.35	1.25	1.1				

REMARKS: T3 = 380 305 313 318 381

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-2-77
Operator Lockie
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 3 of 16 Sheets
RUN NO.

ATMOSPHERIC CONDITIONS: TIME, PRESS, TEMP., W, D
ALT. IN FT: 1000

OIL TYPE: Mobil Jet II
START, END, CONSUM. — TIME, OIL WT., TIME, OIL WT.

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER: NASA

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED		THROTTLE ANGLE	LUBE OIL				FUEL				T2	T3	T5	THRUST LBS.	VBV	STATOR BETA	PT5	RECOUP CAV.	SUMP VENT		Ps2	FRONT	FRONT	REAR	VIBRATION								FUEL USED	TOTAL RUN TIME
			CORE	FAN		TEMP.		PRESS.		INLET PRESS	INLET TEMP.	FLOW		FAN IN	CDT	EGT		VOLTS		LPT INLET		PRESS	CDP	B.M WALL	CELL TOTAL	CELL STATIC	CELL STATIC	FAN			CORE						
			N2	N1		INLET	SCAV.	INLET	FILTER ΔP			MAIN	VAR															NO. 1 BRG.	TMF	TRH	NO. 1 BRG.	TMF	TRH				
			RPM	RPM		°F	°F	PSIG	PSID	PSIG	°F	PPH	PPH	°F	°F	°F			VOLTS	PSIG	"HG	PSIG	PSIG	"H2O	"H2O	H20	H20										
75%	15	2259	9187	3150	-	165	223	481	5.5	23.9	87	10540	10530	73	315	1421	27160	—	.86	43.2	-	2.90	257	38	1.82	2.25	2.25	.85	1.1	1.05	.35	1.25	1.15				
												T3=		322	300	309	316	326																			
		2300				Accel To M.C.						Soak - Period -																									
		2306				Accl To T.O.																															
T.O.	16	2311	9590	3499	-	162	229	52.6	6.1	18.1	87	14620	14640	73	362	1609	36410	-	.37	57	-	3.65	326	51.4	2.25	2.8	2.75	1.1	1.8	1.3	.4	1.15	1.25				
												T3=		360	343	352	370	376																			
T.O	17	2314	9589	3502	-	162	230	52.7	6.2	18.2	87	14630	14680	73	362	1608	35950	—	.37	57	-	3.65	326	51.3	2.4	2.85	2.80	1.15	1.25	1.3	.4	1.15	1.2				
												T3 =		362	340	355	366	374																			
		2315				Decl To M.C.																															
M.C.	18	2319	9516	3430	-	163	230	51.9	5.9	15.8	87	13890	13900	72	354	1580	34380	-	.42	55	-	3.60	316	49	2.2	2.85	2.75	1.3	1.2	1.15	.4	1.2	1.1				
												T3 =		359	340	346	358	369																			
M.C.	19	2322	9516	3442	-	163	229	51.7	5.7	20.0	87	13890	13920	72	352	1581	34630	-	.43	54.7	-	3.60	314	48.9	2.22	2.85	2.75	1.3	1.65	1.3	.4	1.2	1.1				
												T3=		356	336	349	354	367																			
		2324				Decl To M.C.R.																															
M.C.R.	20	2328	9403	3340	-	164	229	50.5	5.8	21.5	87	12690	12690	72	343	1523	31980	-	.58	51	-	3.30	295	45.2	2.1	2.65	2.5	1.1	1.2	.9	.4	1.35	1.2				
												T3=		350	333	337	344	353																			
M.C.R.	21	2331	9404	3344	-	163	226	50.7	5.5	21.7	87	12720	12730	72	342	1523	32080	-	.58	51.2	-	3.30	296	45.2	215	2.65	2.60	1.1	1.2	1.05	.4	1.3	1.2				
												T3=		346	324	336	344	353																			
		2332				Decl To 75%																															
75%	22	2336	9174	3144	-	166	226	48.2	5.3	24	87	10530	10550	71	318	1417	27290	-	.86	43.5	-	2.90	259	38.2	1.85	2.3	2.2	.8	1.2	.85	.35	1.25	1.1				
												T3=		331	306	311	320	327																			
75%	23	2340	9174	3146	-	165	221	48.2	5.3	24	87	10570	10540	71	314	1416	27220	-	.87	43.5	-	2.90	259	38.2	1.82	2.25	2.2	.8	1.1	.9	.35	1.3	1.15				
												T3 =		322	297	309	314	324																			

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

ORIGINAL PAGE IS OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-2-77
Operator Lockie
Inspector Jones
RUN NO.
Gas Turbine Serial No. 451-380
Nature of Test
Sheet 4 of 16 Sheets

ATMOSPHERIC CONDITIONS

TIME	PRESS	TEMP.	W	D
23.42	29.00	A.B.S		
08:15	29.00		67	77
		80GRS.		

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4-
LHV:
CONSUM.:
SP. GR.: .779 .7822
TEMP.: 82° 74

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS. PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	N/θ VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} R M WALL "H_2O	FRONT CELL TOTAL "H_2O	FRONT CELL STATIC H_2O	REAR CELL STATIC H_2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		2341				Decl TO Flight Idle																															
		2344				Decl TO Ground Idle																															
		2346				Shut down-						Coast down-								N_2		3-40				N_1		4-35									
	~~zero~~											oil Level = -2.5							@	180°F																	
*	zero	2354	0	0	–	178	158	1.1	.1	0	85	0	0	72	186	376	390	–	4.60	0	–	0	0	0	0	0	0	0	0	0	0	0	0			3155	2/03
1ST SHIFT		″			* T^3	READINGS NOT VALID, NOT CONNECTED TO -6 LEAD.																															
		8-3-77				CORRECTED T^3 INDICATION PROBLEM:																		oil Tank level = -4 qts @ 74°													
	zero	0810	0	0	0	74	75	0	0	0	76	0	0	74	116	94	1/50	[redacted]	4.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0			3155	3/03
3		08:15				MAX START T_5 = 1018°F Time To IDLE: 34 sec. - T_2 = 74 FIRED AT CORE - 2430 RPM, wf = 510 pph.																															
GRD -						S.O.P. = 40 psig. # 1 IGN. L.O.P: 33 PSIG.																															
IDLE	24	08:18	5609	718		138	142	23	5	31	78	1020	1020	74	398	838	1530	[redacted]	4.49	1.1	0	.1	20	1.6	.1	.1	.1	.1	.1	.1	.5	1.1	.1				
						T_3 =		297	297	297	299	300																									
		08:22			ACCEL TO M.C. SOAK PERIOD-																																
	pp	08:30			ACCEL TO TAKE OFF.											NOTE:- PERMISSION GRANTED TO LIMIT T^5 = TO 1670°F FOR THIS TEST OVER 5 min PERIOD.																					
T.O.	25	08:34	9593	3495	0	161	228	53.5	6	18	85.8	14/570	14/580	74.6	987	1624	35/980	[redacted]	.37	56.5	0	3.7	324	60.7	2.25	2.8	2.8	2.2	1.8	1.5	.5	1.1	1.0				
	pp				T^3 =		982	975	976	998	1004													50.7													
T.O.	26	0837	9590	3495	0	162	230	52.0	6	18	85.5	14/560	14/590	74.7	987	16/22	35/750	[redacted]	.37	56.5	0	3.7	325	60.7	2.25	2.8	2.8	2.0	2.0	1.3	.5	1.2	1.0				
					T^3 =		982	974	976	996	1003																										
	pp	08:40			DECEL TO M.C.																																
MC	27	08:45	9550	3460	0	162	230	51.5	6	20	85.3	11/060	11/070	75.3	978	1600	31/900	[redacted]	.41	55.	0	3.6	317	49.5	2.20	2.7	2.7	2.0	1.8	1.5	.5	1.2	1.0				
					T^3 =	972	965	967	988	993																											
MC.	28	0847	9517	3456	0	162	230	51.5	6	20	85.3	11/050	11/070	75.2	977	1601	31/950	[redacted]	.40	55	0	3.6	317	49.5	2.2	2.7	2.7	2.0	2.0	1.5	.5	1.2	1.0				
					T^3 =	972	965	967	987	994																											

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-3-77
Operator LOWTHER
Inspector NEUBAUER

RUN NO. ____

Gas Turbine Serial No. 451-380
Nature of Test ____
Sheet 5 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS.	TEMP.	W	D
0902	29.00			
09:40	29.00		69	80
			86 GRS.	

ALT. IN FT: 1000

OIL TYPE: MOBIL JET II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP4
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED		THROTTLE ANGLE	LUBE OIL				FUEL				T_2	T_3	T_5	THRUST LBS.	N/A VOLTS	STATOR BETA	PT_5	RECOUP CAV.	SUMP VENT		P_{S_2}	FRONT	FRONT	REAR	VIBRATION								FUEL USED	TOTAL RUN TIME
			CORE	FAN		TEMP.		PRESS.		INLET PRESS	INLET TEMP.	FLOW		FAN IN	CDT	EGT				LPT INLET		PRESS	CDP	B M WALL	CELL TOTAL	CELL STATIC	CELL STATIC	FAN			CORE						
			N_2	N_1		INLET	SCAV	INLET	FILTER ΔP			MAIN	VAR															NO. 1 BRG.	TMF	TRH	NO. 1 BRG.	TMF	TRH				
			RPM	RPM		°F	°F	PSIG	PSID	PSIG	°F	PPH	PPH	°F	°F	°F			VOLTS	PSIG	"HG	PSIG	PSIG	"H_2O	"H_2O	H_2O	H_2O										
		08:50		DECEL TO M.C.R.																																	
MCR	P.P. 29	08:54	94/45	3353	0	164	229	50.1	6	21	85.1	12810	12810	74.5	948	1541	32300	[redacted]	.56	51.	0	2.35	296	45.4	2.1	2.6	2.55	1.8	1.5	1.1	.5	1.1	1.2				
				T3	=	942	935	937	956	963					947																						
MCR	PP 30	0856	94/34	3352	0	164	[illegible]	50.2	6	21	85.2	12790	12800	74.8	947	1540	32100	[redacted]	.56	51	0	2.35	296	45.4	2.1	2.6	2.55	1.8	1.5	1.1	.5	1.2	1.2				
				T3	=	944	936	938	957	965																											
	PP	0859			DECEL TO 75% -																																
75%	31	0903	92/13	3161	0	166	226	479	6	24	85.1	10670	10700	75.3	896	1433	27240	[redacted]	.84	43.5	0	3.0	258	38.4	1.8	2.2	2.2	1.2	1.3	1.0	.4	1.0	1.1				
				T3	=	891	885	883	901	910																											
75%	32	0906	92/13	3162	0	166	226	47.9	6	24	85.3	10660	10670	75.0	895	1435	27500	[redacted]	.84	43.6	0	3.0	259	38.4	1.8	2.2	2.2	1.2	1.3	1.0	.4	1.0	1.2				
				T3	=	891	884	884	901	91.0																											
		0909			DECEL TO FLT. IDLE																																
		09:12			SWITCH TO GRD. IDLE																																
		09:15			SHUT DOWN - COAST DOWN:										CORE: 3-43					FAN = 4-09																	
	Zero	09:20	0	0	0	180	172	0	0	70	84	0	0	77.4	197	328	+400	0	4.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0			4775	3/03
					OIL TANK LEVEL = -2.4 @ 138°																																
	Zero	09:43	0	0	0	138	104	+3	0	0	82	0	0	79	215	332	+400	0	4.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4		09:44	MAX START T5 = 1058° TIME TO IDLE = 33 SEC. T2 = 79 FIRED AT CORE 2475 RPM, FAN 219 RPM,																																		
				WF = 570 PPH, S.A.P. = 40 PSIG. # 2 IGN-																																	
	33	09:47	56/46	725	0	175	187	19.5	5	31	84	1020	1010	796	308	829	1490	0	4.47	1.4	0	.1	20	1.7	.1	.1	.1	.2	.1	.1	.4	1.0	.1				
					T3 =	305	305	314	307	309																											
		09:50			ACCEL TO M.C. - SOAK PERIOD; STABILIZED AT 1600 °F																																
		0958			ACCEL TO TAKE OFF POWER																																

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

Date 8.3.77

Operator LOWTHER

Inspector NEUBAUER

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

RUN NO.

Gas Turbine Serial No. 451-380

Nature of Test

Sheet 6 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
09:40	29.00		69	80
		-	86GRS	
ALT. IN FT: 1000				

OIL TYPE: MOBIL JET II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLES	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	N/A VRV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} O.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
T.O.	pp 34	10:04	9652	3528	0	163	332	53.2	7	19	86	17/870	17/860	79.4	1001	1642	36/150	0	.36	57.3	0	3.75	326	51.5	2.35	2.75	2.75	2.5	2.0	1.5	.5	1.5	1.2				
			T3 =		998	990	992	1012	1018																												
T.O.	pp 35	10:06	9657	3516	0	163	332	52.1	7	19	85.7	14/680	14/720	80.1	1002	1643	36/100	0	.36	57.3	0	3.75	326	51.5	2.25	2.75	2.75	2.5	2.0	1.4	.5	1.4	1.25				
			T3	=	996	990	992	1011	1018																												
	pp	10:07			DECEL TO M.C.																																
M.C.	36	10:11	9589	3466	0	165	234	51.2	7	21	85.7	14/050	14/040	80.9	990	1612	34/500	0	.45	54.2	0	3.7	313	48.9	2.2	2.7	2.7	2.4	2.0	1.4	.4	1.5	1.2				
			T3 =		982	974	977	998	1004																												
MC	pp 37	10:13	9591	3471	0	165	234	51.3	7	21	85.7	13/950	13/920	81.5	989	1612	34/600	0	.43	54.5	0	3.7	313	48.9	2.2	2.7	2.7	2.5	2.0	1.2	.4	1.4	1.2				
			T3	=	~~0~~	~~165~~	~~234~~	~~51.3~~	~~7~~	~~21~~	~~85.7~~	983	977	978	999	1005																					
	pp	10:15			DECEL TO MCR-																																
MCR	38	10:19	9476	3370	0	166	234	50.1	6.5	21	85.5	12/860	12/880	81.5	963	1562	31/90	0	.56	50.6	0	3.3	293	44.8	2.1	2.45	2.45	2.1	1.5	1.0	.4	1.5	1.3				
			T3	=		958	951	952	971	979																											
MCR	39	10:22	9476	3371	0	166	234	50.1	6.5	21	85.7	12/850	12/840	81.2	962	1562	32/00	0	.56	50.6	0	3.3	293	45	2.1	2.45	2.45	2.1	1.5	1.1	.4	1.5	1.2				
			T3	=		958	950	951	972	978																											
		10:25			DECEL TO 75%-																																
75%	40	10:29.5	9163	3177	0	169	230	47.5	6.0	24	85.7	10/810	10/810	81.8	909	1456	27/560	0	.84	43.5	0	3.0	258	38.5	1.85	2.25	2.25	1.0	1.3	1.2	.4	1.2	1.4				
			T3 =			906	899	898	916	927																											
75%	41	10:34	9162	3174	0	169	230	47.5	6.0	24	85.7	10/730	10/730	81.9	909	1455	27/380	0	.84	43.5	0	3.0	257	38.4	1.85	2.25	2.25	1.0	1.2	1.2	.4	1.3	1.5				
			T3	=		907	900	899	916	927																											
		10:36			DECEL TO FLT. IDLE																																
		10:40			SWITCH TO GRD IDLE																																
		10:44			SHUT DOWN-				COAST DOWN-				CORE = 3.17				FAN = 4-10																				
	Zero	10:49	0	0	0	190	185	.4	0	65	86	0	0	84.1	208	373	+390	0	4.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0			64.12	4/03

REMARKS: OIL TANK LEVEL = -2.4 @ 94

Replaced Verification wf meter. Installed Cox. 16* S/N 26406 Removed S/N 15047

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-3-77
Operator Lackie
Inspector Jones

RUN NO.

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 7 of 16 Sheets

ATMOSPHERIC CONDITIONS TIME	PRESS	TEMP.	W	D
16:53	28.92	A.B.S.	71	96
17:54	28.91	A.B.S.	70	94
		Grains		70

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4.
LHV:
CONSUM.:
SP. GR.: .776 (.7812
TEMP.: 87°F @ 74°F)

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS INLET PSIG	LUBE OIL PRESS FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{s_2} R.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
	Zero	1634	0	0	-	93	94	-.5	1.7	5.0	107	0	0	94	151	126	460	—	462	0	0	0	0	0	0	0	0	0	0	0	0	0	0			6412	4/03
5		1637	Max. start T5 = 1064 °F, Time to idle 34 Sec, Fired At N2 2340 RPM, SAP = 40 PSIG, Wf = 504 P.P.H																																		
			Lod = 26.5 PSIG, T2 = 94 °F, N1 726 RPM, No. 1 Ign.																																		
	42	1641	5704	731	-	151	156	20.5	6.2	31.9	94	920	910	93	325	883	1540	-	4.49	1.4	-	.05	20.2	1.8	.09	.09	.09	.3	.45	.05	.05	.5	.05				
		1756	Accel for Soak Period. T5 = 1585 °F																																		
		1759	Accel to M.C.R. T5 = 1582																																		
M.C.R.	43	1805	9543	3370	-	169	233	49.8	7.3	20.1	89	12720	12760	89	983	1587	31750	-	.51	50.5	-	3.3	290	44.6	2.15	2.65	2.60	2.0	1.5	1.2	.45	1.1	1.0				
									T3=	977	969	972	980	998																							
M.C.R.	44	1808	9543	3371	-	170	237	49.8	7.1	20.5	88	12740	12770	89	984	1586	31780	-	.51	50.4	-	3.35	291	44.6	2.15	2.60	2.55	1.9	1.45	1.2	.45	1.25	.55				
									T3=	975	969	971	990	986																							
		1811	Decel to Flight Idle-																																		
		1816	Switch to G.I.																																		
		1818	Shut down- Drain ok- Coast down- N2 3-50 sec- N1 4-16 sec-																																		
			Removed main Wf meter- S/N 13140 Installed original Verification meter S/N 15047																																	7687	5/44
6.		1852	Max. start T5 = 1076 °F, Time to idle 35 Sec, Fired At N2 2326 RPM, SAP = 40 PSIG, Wf = 700 P.P.H.																																		
			Lod = 18.3 PSIG, T2 = 88 °F, N1 726 RPM, No. 2 Ign-																																		
	45	1856	5657	725	-	189	201	18.1	5.9	31.1	92	1020	940	87	317	853	1500	-	4.48	1.4	-	.05	20	1.8	.09	.10	.11	.2	.2	.05	.35	1.35	.05				
		1858	Accel to M.C.R.																																		
M.C.R.	46	1902	9527	3372	-	162	216	49.8	7.3	20.3	91	12880	12850	85	975	1580	31890	-	.51	50.5	-	3.35	293	45	2.15	2.70	2.65	2.4	1.15	1.3	.5	1.25	1.25				
									T3=	968	963	965	978	990																							
M.C.R.	47	1906	9524	3369	-	168	232	49.7	6.5	20.4	89	12820	12790	85	977	1577	31720	-	.49	50.5	-	3.35	293	44.8	2.15	2.65	2.50	2.25	1.45	1.0	.45	1.3	1.3				
									T3=	969	962	964	983	990																							

REMARKS:

QC - 189 - 1 FORM CF6 TEST 1
REV 5/75

C-2

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-3-77
Operator Lockie
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 8 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
1930	28.92	A.B.S.	69	85
		Grains = 78		

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4-
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO: CF6-6D
WORK ORDER: 18/650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VPV VOLTS	STATOR BETA VOLTS	P_{T5} LPT INLET PSIG	RECOUP CAV "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S2} R.M. WALL "H_2O	FRONT CELL TOTAL "H_2O	FRONT CELL STATIC H_2O	REAR CELL STATIC H_2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		1910				Slow Decel To flight idle-																															
		1915				Switch To Ground idle																															
		1914				Shut down- Drain Coast down- N2 3-50 Sec- N1 4-12 Sec-																															
						moved fuel flow meter ~~[illegible]~~ S/N ~~[illegible]~~ 15097 TO main Position-																															6/08
						Installed S/N 13140 TO Verification Position																															
7.		1933				max. start T5= 1076 °F, Time To idle 33 Sec, Fired At N2 2645 RPM, SAP= 40 PSIG, Wf= 640 PPH																															
						Lod= 18.6 PSIG, T2= 54 °F, N1 730 RPM, No 1 Ign-																															
	48	1936	5623	724	—	198	209	17.9	5.2	31.1	88	960	950	83	310	840	1320	—	4.48	1.4	—	.05	20	1.8	.09	.09	.11	.05	.2	.05	.35	1.2	.05				
		1938				Accel TO M.C.R.																															
M.CR.	49	1942	9502	3365	—	161	216	50.1	7.1	19.7	90	12910	12900	82	969	1573	32050	—	.49	50.5	—	3.35	293	45	2.15	2.60	2.55	2.7	1.2	1.2	.45	1.3	1.15				
											T3=	962	958	960	973	982																					
M.C.R	50	1946	9499	3364	—	166	230	50.2	6.5	20.2	89	12830	12810	82	969	1572	32070	—	.49	50.7	—	3.35	294	45.2	2.15	2.60	2.60	2.4	1.45	1.2	.45	1.45	1.2				
											T3	961	957	958	975	983																					
		1951				Slow Decel To flight idle.																															
		1955				Switch To Ground idle.																															
		1958				Shut down- Drain OK Coast down- N2 3-45 Sec. N1 4-12																														2637	6/33
						Flow ~~[illegible]~~																															

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

Date 8-4-77
Operator LOWTHER
Inspector NEUBAUER-

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 9 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
10:00	28.98		68	80
		80GRS.		
ALT. IN FT: 1000				

OIL TYPE: MOBIL JET II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.: .778 .7824
TEMP.: 850 74

MODEL NO: CF6-6 II
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS INLET PSIG	LUBE OIL PRESS FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T2 FAN IN °F	T3 CDT °F	T5 EGT °F	THRUST LBS.	N/A VBV VOLTS	STATOR BETA VOLTS	PT5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	PS2 H M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
			Fuel Flow meters Back To orginal Positions: But Leads Reversed To Counters -																																		
	ZERO	09:55	0	0	0	78	75	0	0	70	79	0	0	80	100	96	+/30	0	4.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0			8639	6/33
8		09:57	MAX START T5 = 1023° Time To IDLE = 34 sec. FIRED AT CORE 2379 RPM, FAN — RPM, T2: 80°																																		
			S.A.P: 40 PSIG. wf= 490 PPH, # 1 IGN. L.O.P: 34 PSIG.																																		
	51	10:00	5657	725	0	122	123	24.9	6	31	82.7	1040	1040	80	307	856	1520	0	4.50	1.1	0	.1	20	1.6	.1	.1	.1	.2	.2	.1	.1	.5	.1				
					T3=	306	307	306	307	309																											
		10:07			ACCEL To M.CR. SOAK																																
MCR	52	10:12	9488	3375	0	163	226	50.5	6	21	875	13000	13000	80	962	1573	32300	0	.49	51.1	0	3.4	296	45.4	2.1	2.5	2.5	2.2	1.5	1.2	.5	1.0	1.0				
MCR	53	10:16	9486	3369	0	164	229	50.4	6	21	87	12940	12930	80	960	1570	32200	0	.49	51	0	3.4	294	45	2.1	2.55	2.55	2.0	1.6	1.3	.5	1.1	1.0				
					T3 =	957	949	950	970	979	-																										
		10:24			ACCEL To M.C.-																																
M.C.	54	10:28	9605	3473	0	164	232	51.7	6.1	19	87	14130	14120	80.9	991	1630	34470	0	.40	54.5	0	3.6	313	49	2.3	2.75	2.7	2.4	1.8	1.2	.5	1.2	.7				
					T3=	985	9.76	980	1000	1007																											
MC	55	10:32	9607	3471	0	164	232	51.7	6.1	19	87	14100	14090	81.8	990	1630	34480	0	.40	54.5	0	3.6	314	49	2.3	2.1	2.7	2.4	2.0	1.2	.5	1.2	.8				
		10:34			DECEL TO MCR-																																
MCR.	56	10:38	9479	3364	0	166	233	50.0	6	22	869	12830	12840	81.6	963	1567	31950	0	.52	51	0	3.4	294	45	2.1	2.5	2.5	2.1	1.5	1.1	.5	1.3	.8				
					T3=	957	952	952	974	979																											
MCR	57	10:41	9480	3367	0	166	233	50.	6	22	87.0	12830	12830	81.9	963	1571	32000	0	.53	50.9	0	3.4	293	45	2.1	2.5	2.5	2.1	1.5	1.1	.5	1.4	.8				
		1044			DECEL		T3=	960	953	954	975	982				TO FLT. IDLE																					
		1048			SWITCH TO GRD IDLE																																
		10:53			SHUT DOWN - COAST DOWN - CORE: 3-50 FANS 5-12																																
	ZERO	10:58	0	0	0	189	186	.8	0	64	86.7	0	0	83.6	205	361	+/00	0	4.64	0	0	0	0	0	0	0	0	0	0	0	0	0	0			10004	7/29
					MADE BORESCOPE INSPECTION Leads from Flow meters To Counters back To Original																																

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

Date 8-4-77
Operator LOWTHER LOCKIE
Inspector NEUBAUER JONES

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 10 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
2114	28.94	A.B.S.	66	79
		Grains = 73		
ALT. IN FT: 1000				

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.: .777 (.7824
TEMP.: @ 87.5 74°F)

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED		THROTTLE ANGLE	LUBE OIL				FUEL				T2	T3	T5	THRUST LBS.	VBV	STATOR BETA	PT5	RECOUP CAV	SUMP VENT		PS2	FRONT	FRONT	REAR	VIBRATION								FUEL USED	TOTAL RUN TIME
			CORE	FAN		TEMP.		PRESS.		INLET PRESS.	INLET TEMP.	FLOW		FAN IN	CDT	EGT				LPT INLET		PRESS.	CDP	R.M. WALL	CELL TOTAL	CELL STATIC	CELL STATIC	FAN			CORE						
			N2	N1		INLET	SCAV.	INLET	FILTER ΔP			MAIN	VAR					VOLTS										NO. 1 BRG.	TMF	TRH	NO. 1 BRG.	IMF	TRH				
			RPM	RPM		°F	°F	PSIG	PSID	PSIG	°F	PPH	PPH	°F	°F	°F			VOLTS	PSIG	"HG	PSIG	PSIG	"H2O	"H2O	H2O	H2O										
	2800	2057	0	0	–	84	84	1.3	.3	14	88	0	0	82	120	105	450	–	4.62	0	–	0	0	0	0	0	0	0	0	0	0	0	0			10004	7/29
9		2105	MAX START T5's = 1025 TIME TO IDLE = 35 T2 = 79 FIREOUT CORE 2510 RPM; Wf = -- PPH, SAP = 40 PSIG-																																		
			# 1 IGN L.O.P. = 30.9 PSIG-																																		
	58	2108	5659	728	–	119	122	24.7	5.3	32.4	85	1070	1080	78	306	845	1580	–	4.48	1.2	–	.05	21	1.8	.08	.09	.1	.2	.15	.05	.05	.25	.05				
					Leak Check																																
		2118			Accel TO M.C. Soak. T5 = 1595°F Approx 55 RPM Below M.C.																																
		2124			Accel to T.O.																																
T.O.	59	2128	9610	3506	–	162	228	52.0	6.2	16.3	88	14750	14770	76	993	1647	36130	–	.34	57	–	3.70	322	51	2.3	2.95	2.95	2.3	1.7	1.45	.45	1.35	1.05				
										T3	=	986	980	982	1003	1011																					
T.O.	60	2131	9612	3511	–	163	231	52.1	6.2	18.5	88	14720	14720	76	995	1640	36020	–	.36	57	–	3.20	324	51.2	2.3	2.90	2.90	2.1	1.7	1.1	.45	1.4	1.1				
										T3	=	988	980	982	1003	996																					
		2132			Decel TO M.C.																																
M.C.	61	2134	9551	3458	–	164	231	51.5	6.2	19.6	87	14060	14070	76	978	1610	34670	–	.41	55	–	3.65	314	49	2.15	2.75	2.7	2.0	1.6	1.1	.45	1.6	1.6				
										T3	=	974	947	968	990	995																					
M.C.	62	2141	9548	3455	–	163	231	51.4	6.1	19.7	87	14050	14050	75	979	1608	34640	–	.41	55	–	3.65	314	49.2	2.3	2.85	2.75	2.0	1.75	1.2	.45	1.5	1.0				
										T3	=	972	945	962	987	995																					
		2142			Decel TO M.C.R.																																
MCR	63	2146	9423	3351	–	165	230	50.0	5.9	21.8	87	12750	12760	75	953	1547	31900	–	.54	51.0	–	3.35	293	45	2.05	2.65	2.55	1.75	1.4	1.1	.45	1.5	.8				
										T3	=	944	937	940	959	967																					
	64	2148			Decel TO 75%																																
75%	↓	2152	9197	3154	–	167	228	42.6	5.4	24.3	87	10570	10560	75	892	1433	27290	–	.86	43.4	–	2.90	258	38	1.75	2.2	2.15	.95	1.1	1.1	.35	1.2	1.1				
										T3	=	888	881	880	899	908																					

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-4-77
Operator Lockie
Inspector Jones

Run No.
Gas Turbine Serial No. 451-380
Nature of Test
Sheet 11 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
2218	28.95	A.B.S.	66	77
		Grains = 76		
ALT. IN FT: 1000				

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4-
LHV:
CONSUM.:
SP. GR.:
TEMP.:

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} R M WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		2155				Decel To Flight Idle																															
		2159				Switch To ~~Flight~~ ~~Idle~~. Ground Idle -																															
		2201				Shut down - Drain OK. Coast Down N_2 3-47 Sec. N_1 4-9 Sec.																															
	zero	2220	0	0	-	155	114	.9	.4	23.8	84	0	0	77	233	363	410	-	4.61	0	-	0	0	0	0	0	0	0	0	0	0	0	0			11395	8/25
10		2222				Max start T5 = 1064 °F, Time to idle 33 Sec, Lit At N_2 2360 RPM, SAP = 40 PSIG, Wf = 570 PPH.																															
						Lod = 18.8 PSIG, T_2 = 77 °F, N_1 = 746 RPM No. 2 Ign																															
	65	2225	5570	716	-	186	196	18.9	4.9	31.1	84	990	990	75	298	817	1500	-	4.47	1.5	-	.05	21	1.8	.09	.09	.1	.15	.2	.05	.3	1.1	.05				
		2227				Slow Accel To M.C. for Soak																															
		2233				Accel To T.O.																															
T.O.	66	2237	9600	3500	-	162	229	52.3	6.0	18.3	88	14660	14610	74	990	1638	36070	-	.36	57	-	3.70	325	51.3	2.25	2.90	2.85	2.5	2.0	1.5	.5	1.35	1.25				
											T3 =	982	977	980	1000	1004																					
T.O.	67	2241	9597	3502	-	163	231	52.1	6.0	18.0	88	14670	14680	73	990	1634	36150	-	.35	57	-	3.75	325	51.4	2.3	2.90	2.80	2.45	1.8	1.5	.5	1.3	1.26				
											T3 =	981	976	978	998	1004																					
		2242				Decel To M.C.																															
M.C.	68	2246	9523	3442	-	164	231	51.4	5.7	19.4	87	13930	13990	73	972	1577	34510	-	.41	55	-	3.65	315	49	2.2	2.8	2.70	2.4	1.6	1.5	.5	1.5	1.3				
											T3 =	965	959	959	981	987																					
M.C.	69	2250	9525	3445	-	163	220	51.3	5.7	19.7	87	13940	13950	72	972	1594	34630	-	.41	55	-	3.65	315	49.2	2.25	2.8	2.80	2.3	1.6	1.4	.5	1.35	1.3				
											T3 =	965	957	959	979	986																					
		2251				Decel To M.C.R.																															
M.C.R	70	2255	9404	3344	-	164	231	50.2	5.6	21.4	87	12700	12700	72	946	1538	31970	-	.57	51	-	3.35	295	45.2	2.1	2.65	2.6	2.1	1.3	1.3	.45	1.6	1.4				
											T3 =	939	932	933	953	959																					
		2256				Decel To 75%																															

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

ORIGINAL PAGE IS
OF POOR QUALITY

Date 8-4-77

Operator Lockie

Inspector Jones

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

RUN NO.

Gas Turbine Serial No. 451-380

Nature of Test

Sheet 12 of 16 Sheets

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
13:00	28.97		69	90
			70	68.5

ALT. IN FT: 1000

OIL TYPE: Mobil Jet II

	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4-

LHV:

CONSUM.:

SP. GR.: .778 .7824

TEMP.: 85° 74

MODEL NO: CF6-6D

WORK ORDER: 181650

CUSTOMER:

NO. OF STARTS

LAST READING NO.

TOTAL RUNNING TIME

OVER CRUISE

AUGMENTED

GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED		THROTTLE ANGLE	LUBE OIL				FUEL				T_2	T_3	T_5	THRUST LBS.	VRV	STATOR BETA	PT_5	RECOUP CAV.	SUMP VENT		P_{S_2}	FRONT	FRONT	REAR	VIBRATION								FUEL USED	TOTAL RUN TIME
			CORE	FAN		TEMP.		PRESS		INLET PRESS	INLET TEMP.	FLOW		FAN IN	CDT	FGT				LPT INLET		PRESS	CDP	R M WALL	CELL TOTAL	CELL STATIC	CELL STATIC	FAN			CORE						
			N_2	N_1		INLET	SCAV.	INLET	FILTER ΔP			MAIN	VAR															NO. 1 BRG.	TMF	TRH	NO. 1 BRG.	TMF	TRH				
			RPM	RPM		°F	°F	PSIG	PSID	PSIG	°F	PPH	PPH	°F	°F	°F		VOLTS	VOLTS	PSIG	"HG	PSIG	PSIG	"H_2O	"H_2O	H_2O	H_2O										
75%	71	2301	9173	3144	—	167	227	47.7	5.5	23.7	87	10520	10510	72	888	1424	27240	—	.84	43.5	—	2.9	256	38	1.8	2.25	2.2	1.1	1.15	1.1	.4	1.3	1.5				
											T3=	883	877	875	892	901																					
		2303				Decel To Flight Idle -																															
		2308				Switch TO Ground Idle -																															
		2309				Shut down - Drain OK. Coast down - N2 3-46 sec N1 4-40 sec -																															
	Zero	2316	0	0	-	179	165	1.4	0	55	84	0	0	73	209	387	400	—	4.60	0	—	0	0	0	0	0	0	0	0	0	0	0	0			12699	9/12
											T3=	202	203	206	209	215																					
				Removed all fan blades for rework;																																	
"1st shift"				Replaced air starter & C.S.D pad seals: (Fwd only)																																	
8-6-77				Repaired Gen. pad seal; Reinstalled, reworked fan blades; oil tank level - 4.5 qts @ 79°																																	
	Zero	1248	0	0	0	85	83	0	0	0	98	0	0	87	79	78	440	0	4.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0			12699	9/12
11		12:53		Max start T5: 1066°F Time to idle: 35 sec T2: 87 Fired at core 2417 rpm, Fan 152 rpm, WF = 480 PPH,																																	
				S.A.P. = 40 psig. No 2 IGN. L.O.P. = 38 psig -																																	
	72	12:57	5901	767	0	145	149	22.7	6	32	88	1040	1040	87	325	868	1570	0	4.46	1.5	0	.1	20	1.9	.1	.1	.1	.4	.3	.1	.1	.2	.1				
						T3=	318	318	317	320	321																										
	pp	13:05			Slow accel to max cruise Vibration - OK -																																
	73	13:11	9537	3376	0	163	224	50.4	6	21	87.7	13111	13130	85.5	979	1594	32760	0	.48	51	0	3.25	294	45.5	2.15	2.6	2.6	.8	1.5	.4	1.3	1.3	1.2				
						T3=	974	968	970	989	998																										
		1313 -			Decel to flt. idle																																
					Switch to grd idle; Leak check - Indication of oil leak at C.S.D. pad seal -																																
		13:24		Accel to MCR. Vibration - OK - Cleaned off area																																	
		13:29		Decel to flt. idle																																	
		13:34		Switch to grd idle Indication of oil leak at C.S.D. pad.																																	

REMARKS:

QC-169-1 FORM CF6 TEST 1

REV 5/75

ORIGINAL PAGE IS
OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-6-77
Operator Lockie
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 13 of 16 Sheets
RUN NO.

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
2100	28.96	A.B.S.	65	75
		Grains =	75	
ALT. IN FT: 1000				

OIL TYPE: MOBIL JET II	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP4
LHV:
CONSUM.:
SP. GR.: .777 (.7818)
TEMP.: 86°F (94°F)

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	P_{T5} LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S2} R.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H20	REAR CELL STATIC H20	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		13:40	SHUT DOWN COAST DOWN- CORE: 3:48 FAN= 4-30																																		
			REMOVED CSD PAD SEAL, - REMOVED & REPLACED "O" RING, - SECURED-																																	1334	9/59
	ZERO	2100	0	0	—	80	82	.4	.9	4.7	83	0	0	77	134	109	460	—	4.63	0	—	0	0	0	0	0	0	0	0	0	0	0	0				
12		2103	MAX START T5= 1020°F TIME TO IDLE= 34 T2= 77 FIRED AT CORE 2549 RPM, WF= 520 PPH,																																		
			S.A.P.= 40 PSIG. #1 IGN. L.O.P.= 30 PSIG.																																		
	74	2107	5586	714	—	126	129	23.1	5.9	31.3	81	1060	1010	72	297	830	1550	—	4.49	14	—	.05	20	1.7	.08	.08	.09	.2	.35	.05	.15	.25	.05				
			Leak Check.																																		
		2112	Slow Accel To M.C. For Soak.																																		
		2119	Accel To T.O.																																		
T.O.	75	2123	9567	3487	—	159	223	52.3	5.9	18.5	87	14760	14770	69	981	1623	36540	—	.35	57.4	—	3.70	327	52	2.34	3.0	2.9	.4	1.6	1.3	.4	1.15	.95				
											T3=	973	967	968	987	995																					
T.O	76	2127	9566	3488	—	160	227	52.1	5.9	18.5	87	14730	14730	69	979	1623	36550	—	.35	57.5	—	3.75	327	52	2.4	3.0	2.95	.45	1.7	1.25	.4	1.3	1.15				
											T3=	972	965	965	987	995																					
		2128	Decel To M.C.																																		
M.C.	77	2132	9502	3431	—	161	227	51.5	5.7	19.7	86	14010	14020	68	962	1585	35010	—	.43	55	—	3.55	316	49.5	2.3	2.88	2.80	.35	1.6	1.35	.4	1.4	1.15				
											T3=	957	950	950	970	977																					
M.C.	78	2136	9501	3431	—	161	227	51.4	5.7	19.7	86	14020	14020	66	963	1585	35010	—	.42	55.2	—	3.56	316	49.6	2.30	2.80	2.75	.35	1.5	1.35	.4	1.35	1.15				
											T3=	957	950	950	970	978																					
		2134	Decel To M.C.R.																																		
M.C.R.	79	2140	9384	3327	—	162	226	50.2	5.5	22.1	86	12780	12780	68	936	1530	32490	—	.56	51.5	—	3.35	297	45.6	2.14	2.65	2.60	.3	1.2	1.05	.4	1.45	1.05				
											T3=	930	922	923	942	952																					
		2142	Decel To 75%																																		
75%	80	2146	9150	3135	—	164	223	47.8	5.3	24.0	86	10680	10630	68	880	1420	27660	—	.83	44.2	—	2.95	260	38.6	1.86	2.20	2.25	.2	1.15	1.2	.35	1.2	1.35				

REMARKS: T3= 876 869 867 884 893

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-6-77
Operator Lockie
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
RUN NO.
Sheet 14 of 16 Sheets

ATMOSPHERIC CONDITIONS					OIL TYPE: Mobil Jet II				
TIME	PRESS	TEMP.	W	D		TIME	OIL WT.	TIME	OIL WT.
2212	28.98	A.B.S.	64	72	START				
		Grains =	74		END				
					CONSUM.				
ALT. IN FT: 1000									

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.: .777 (.7818
TEMP.: 86°F (74°F

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N_2 RPM	SPEED FAN N_1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_2} R.M. WALL "H_2O	FRONT CELL TOTAL "H_2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
		2149			Decel To flight Idle-																																
		2153			Switch To Ground Idle-																																
		2156			Shut down- Drain OK- Coast down- N_2 3-40 N_1 4-18																																
	Zero	2200	0	0	–	180	170	1.5	-.1	65.7	81	0	0	70	193	372	410	–	4.63	0	~~0~~	0	0	0	0	0	0	0	0	0	0	0	0				10/52
	Zero	2215	0	0	–	154	114	1.0	.3	41.2	79	0	0	71	206	358	410	–	4.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
13		2217			Max start T5 = 1039 °F, Time to Idle 33 Sec, Lited At N_2 2420 RPM, SAP = 40.5 PSIG, Wf = 540 PPH.																																
					Lod = 20 PSIG, T2 = 71 °F, N_1 714 RPM, No. 2 Ign-																																
	81	2221	5527	707	–	179	189	18.9	4.1	31	83	990	980	69	289	810	1480	–	4.48	1.4	–	.05	20	1.8	.06	.07	.07	.1	.5	.05	.15	.9	.05				
		2223			Slow Accel To M.C. for Leak																																
		2229			Accel to T.O.																																
T.O.	82	2233	9564	3484	–	160	225	52.3	5.7	18.0	87	14750	14780	68	978 988	1620	36530	–	.35	57.5	–	3.75	327	52	2.4	2.9	2.85	.45	1.5	1.3	.45	1.2	1.05				
											T3 =	972	965	965	986	994																					
T.O.	83	2237	9563	3484	–	161	227	52.2	5.7	18.2	87	14720	14720	68	978	1620	36530	–	.35	57.5	–	3.75	327	52	2.32	2.95	2.85	.5	1.6	1.2	.45	1.15	1.15				
											T3 =	970	965	962	984	992																					
		2238			Decel to M.C.																																
M.C.	84	2242	9500	3430	–	161	228	51.5	5.5	19.3	87	14000	14000	68	963	1583	35080	–	.42	55.4	–	3.60	317	49.8	2.2	2.9	2.80	.35	1.45	1.4	.45	1.2	1.1				
											T3 =	957	949	949	970	977																					
M.C.	85	2245	9499	3428	–	161	227	51.5	5.5	19.7	87	14100	14100	68	962	1582	35090	–	.42	55.4	–	3.60	317	49.8	2.3	2.85	2.75	.35	1.45	1.25	.45	1.15	1.1				
											T3 =	953	947	949	969	975																					
		2246			Decel to M.C.R.																																
M.CR.	86	2250	9379	3327	–	162	226	50.3	5.3	21.4	87	12800	12790	68	935	1524	32440	–	.56	58.4	–	3.35	297	45.8	2.15	3.65 2.65	2.6	.35	1.25	1.25	.4	1.15	1.15				
											T3 =	928	921	921	940	949																					

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/76

ORIGINAL PAGE IS
OF POOR QUALITY

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-6-77
Operator Lockie
Inspector Jones

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 15 of 16 Sheets
RUN NO.

ATMOSPHERIC CONDITIONS TIME	PRESS.	TEMP.	W	D
07:50	29.02		59	62
			68GRS	
08:07	29.015		61	64
ALT. IN FT: 1000			74GRS	

OIL TYPE: Mobil Jet II	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.: .780 .782
TEMP.: 79 74

MODEL NO: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	N/A VRV VOLTS	STATOR BETA VOLTS	PT_5 LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S_3} R.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H20	REAR CELL STATIC H20	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN IMF	VIBRATION FAN TRF	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE IMF	VIBRATION CORE TRF			FUEL USED	TOTAL RUN TIME
		2252				Decel TO 75%																															
75%	87	2256	9144	3128	—	164	223	47.7	5.4	23.7	87	10600	10550	67	880	1417	37650	—	.84	44.2	—	2.90	260	38.7	1.85	2.25	2.20	.25	1.0	1.0	.35	1.05	1.2				
											T3 =	874	866	865	884	893																					
		2259				Decel TO Flight																															
		2303				Switch TO Ground Idle -																															
		2305				Shut down - Drain OK Coast down - N_2 3-40 sec. N_1 4-22 sec																															
	Zero	2311	0	0	—	177	164	1.5	-.1	39.2	82	0	0	68	197	377	390	—	4.61	0	—	0	0	0	0	0	0	0	0	0	0	0	0			15994	11/40
						Removed Top Right Thermocouple Harness P/N 9055M89 P01 S/N GDB06828																															
"						Installed " " " " P/N 9055M89 P01 S/N GDB07880																															
1ST SHIFT "			8-7-77																																		
	ZERO	0800	0	0	0	64	65	0	0	0	64	0	0	62	110	85	+430	0	4.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0			15994	11/40
14		08:07	MAX START T_5 = 996°F TIME TO IDLE: 33 SEC. T_2: 62 FIRED AT CORE 2543 RPM, wf: 500 pph,																																		
GRD.			S.A.P: 41 PSIG. # 1 IGN. L.O.P: 35.2 PSIG.																																		
IDLE	88	08:11	5533	708	0	130	132	23.0	5	31	64.5	1070	1040	61.7	279	806	1510	0	4.49	1.4	0	.1	30	1.6	.1	.1	.1	.2	.2	.1	.1	.2	.1				
				LEAK CHECK: -																																	
	FP.	08:20	ACCEL TO MAX CONT. SOAK PERIOD.																																		
MC	89	08:27	944½	3404	0	155	218	52.1	5	20	84	13980	13980	59.6	941	1558	35100	0	.43	55.2	0	3.6	316	49.5	1.95	2.45	2.45	.4	1.4	1.2	.4	1.0	1.1				
MC	P.P. 90	0830	9441	3404	0	156	219	52.0	5	20	84	13960	13980	59.6	940	1557	35180	0	.43	55.2	0	3.6	316	49.5	1.95	2.43	2.45	.4	1.4	1.1	.4	1.1	1.1				
					T3 =	935	928	929	947	957																											
		0932				ACCEL TO TAKE OFF																															
T.O.	P.P. 91	08:37	9496	3458	0	155	220	52.5	5	19	84.1	14570	14590	60.1	954	1587	36600	0	.39	57	0	3.75	326	51.4	2.05	2.55	2.5	.5	1.5	1.1	.4	1.1	1.1				
				T^3 =	950	942	944	963	972																												
T.O.	P.P. 92	08:39	9495	3456	0	155	220	52.5	5	19	84.1	14540	14550	60.2	955	1586	36590	0	.39	57	0	3.75	326	51.5	2.05	2.5	2.5	.5	1.5	1.1	.4	1.2	1.2				

REMARKS: T3: 948, 942, 943, 962, 970

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

AIRCRAFT TURBINE TEST LOG SHEET

CF - 6 / TF-39
GENERAL ELECTRIC COMPANY
ONTARIO, CALIFORNIA

Date 8-7-77
Operator LOWTHER
Inspector NEUBAUER

Gas Turbine Serial No. 451-380
Nature of Test
Sheet 16 of 16 Sheets
RUN NO.

ATMOSPHERIC CONDITIONS				
TIME	PRESS	TEMP.	W	D
08:07	29015		61 74GRS	64

ALT. IN FT: 1000

OIL TYPE: MOBIL JET II	TIME	OIL WT.	TIME	OIL WT.
START				
END				
CONSUM.				

FUEL TYPE: JP-4
LHV:
CONSUM.:
SP. GR.: .780 .782
TEMP.: 79 74

MODEL NO.: CF6-6D
WORK ORDER: 181650
CUSTOMER:

NO. OF STARTS
LAST READING NO.
TOTAL RUNNING TIME
OVER CRUISE
AUGMENTED
GENERAL ELECTRIC ACCEPTANCE DATE

START NO.	READING NO.	TIME HRS.	SPEED CORE N2 RPM	SPEED FAN N1 RPM	THROTTLE ANGLE	LUBE OIL TEMP. INLET °F	LUBE OIL TEMP. SCAV. °F	LUBE OIL PRESS. INLET PSIG	LUBE OIL PRESS. FILTER ΔP PSID	FUEL INLET PRESS PSIG	FUEL INLET TEMP. °F	FUEL FLOW MAIN PPH	FUEL FLOW VAR PPH	T_2 FAN IN °F	T_3 CDT °F	T_5 EGT °F	THRUST LBS.	VBV VOLTS	STATOR BETA VOLTS	P_{T5} LPT INLET PSIG	RECOUP CAV. "HG	SUMP VENT PRESS PSIG	CDP PSIG	P_{S2} H.M. WALL "H2O	FRONT CELL TOTAL "H2O	FRONT CELL STATIC H2O	REAR CELL STATIC H2O	VIBRATION FAN NO. 1 BRG.	VIBRATION FAN TMF	VIBRATION FAN TRH	VIBRATION CORE NO. 1 BRG.	VIBRATION CORE TMF	VIBRATION CORE TRH			FUEL USED	TOTAL RUN TIME
	P.P.	08:42	DECAL TO MAX CONT.																															UNDER COWL			
mc.	93	08:46	94 4/3	3408	ø	157	221	51.9	5	20	84.1	13960	13960	61.1	944	1559	35080	ø	.44	55	ø	3.5	316	49.5	2.0	2.55	2.5	.3	1.5	1.1	.4	1.2	1.2	318	302 222		
				T3=		938	931	931	952	960																											
mc.	P.P. 94	08:49	94 4/3	3409	ø	157	221	51.9	5	20	84.1	13930	13930	61.1	944	1559	35090	ø	.44	55	ø	3.5	316	49.5	2.0	2.55	2.5	.3	1.5	1.1	.4	1.2	1.2				
				T3=		938	932	932	952	962																											
		0851	DISCONNECTED COOLING AIR FROM V.S.V. POTENTIOMETER																																		
		08:55	DECEL TO FLT IDLE NO CHANGE ON V.S.V. INDICATOR IN 4 MIN. TIME																																		
		09:00	SWITCH TO GRD. IDLE																																		
			LEAK CHECK'S -																																		
		0906	SHUT DOWN - CORE= 3-43 FAN= 4 20																																	17350	4/39
	ZERO	0911	0	0	ø	177	171	0	0	70	81.8	0	0	64.3	178	330	+360	ø	464	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
			FILTERS & MAG PLUG CHECKED - OK																																		
			UNDER COWL CHECK - OK																																		
			~~FILTER & f~~																																		
			SPECIAL TEST COMPLETED.																																		

REMARKS:

QC - 169 - 1 FORM CF6 TEST 1
REV 5/75

SYMBOLS AND ACRONYMS

A_4	Stage One High Pressure Turbine Nozzle Area
A/C	Aircraft
ALF	Aft Looking Forward
ASE	Airline Support Engineering
ASO	Aviation Service Operation
ASO/O	Aviation Service Operation/Ontario
AVG	Average
B30	Forward Compressor Discharge Pressure Seal Clearance - Reference Shop Manual, 72-00-00
B70	Aft Compressor Discharge Pressure Seal Clearance - Reference Shop Manual, 72-00-00
B71	High Pressure Compressor Balance Piston Seal Clearance - Reference Shop Manual, 72-00-00
B/P	Blueprint
BW	Blade Width
C27	Low Pressure Turbine Pressure Balance Seal Clearance - Reference Shop Manual, 72-00-00
CDP	Compressor Discharge Pressure
CR	Cruise
CRF	Compressor Rear Frame
CSI	Cycles Since Installed
CSN	Cycles Since New
CSO	Cycles Since Overhaul
CW	Clockwise
DACO	Douglas Aircraft Company
DELT	Delta
DETAC	Delta High Pressure Compressor Efficiency

DETALP	Delta Low Pressure System Efficiency
DETALPS	Delta Low Pressure System Efficiency
DFN1	Delta Net Thrust at Constant Fan Speed
DIA.	Diameter
DPARA	Delta Parasitics
DPARAS	Delta Parasitics
E12, E13	Fan Blade Tip Clearances - Reference Shop Manual, 72-20-01
EGT	Exhaust Gas Temperature
EGT Margin	Exhaust Gas Temperature Margin
EMU	Engine Maintenance Unit
EPR	Engine Pressure Ratio
ESN	Engine Serial Number
ETAC	High Pressure Compressor Efficiency
ETALPS	Low Pressure System Efficiency
ETAT	High Pressure Turbine Efficiency
FBW	Full Blade Width
FIR	Full Indicated Runout
FLA	Forward Looking Aft
F_N	Net Thrust
F_N @ N1	Net Thrust at Constant Fan Speed
FOD	Foreign Object Damage
FPI	Fluorescent Penetrant Inspection
FWD	Forward

G1,G2,G3, G4,G5,G6	High Pressure Turbine Rotor Forward Shaft, Forward Seal Teeth
H1,H2,H3 H4,H5,H6	High Pressure Turbine Rotor Forward Shaft - Aft Seal Teeth
HP	High Pressure
HPC	High Pressure Compressor
HPS	High Pressure System
HPT	High Pressure Turbine
HPTN	High Pressure Turbine Nozzle
HPTR	High Pressure Turbine Rotor
HRS	Hours
ID	Inside Diameter
IGB	Inlet Gearbox
IGV	Inlet Guide Vane
IN	Inch
I/S	Interstage
Dim "K"	Dimension "K", High Pressure Turbine Nozzle Support - Reference Shop Manual, 72-52-00
LE, L/E	Leading Edge
LP	Low Pressure
LPS	Low Pressure System
LPT	Low Pressure Turbine
LPTN	Low Pressure Turbine Nozzle
LPTR	Low Pressure Turbine Rotor
MAX	Maximum
M/C	Maximum Continuous

SYMBOLS AND ACRONYMS (Continued)

MIN	Minimum
MM	Maintenance Manual
MRL	Maximum Repairable Limit
N1, N_1	Fan Speed
N/A	Not Applicable
NASA-Lewis	National Aeronautics and Space Administration - Lewis Research Center
NO.	Number
No. 4B	Number Four Ball Bearing
Noz.	Nozzle
OGV	Outlet Guide Vane
P_3, P3	Compressor Discharge Pressure
P_{49}, P49	Low Pressure Turbine Inlet Pressure
QEC	Quick Engine Connect
RAD	Radius
RMS	Root Mean Square
SB	Service Bulletin
Serve Limit	Servicable Limit
sfc	Specific Fuel Consumption
sfc MARGIN	Specific Fuel Consumption Margin
SL	Sea Level
S/M	Shop Manual
S/N	Serial Number
STG	Stage

SYMBOLS AND ACRONYMS (Concluded)

SWECO	Vibratory Mill Cleaning Process
T_3	Compressor Discharge Total Temperature
T_5X	Calculated Exhaust Gas Temperature
T/C	Thermocouple
TE	Trailing Edge
TMF	Turbine Mid Frame
T/O	Takeoff
TSI	Time Since Installed
TSN	Time Since New
TSO	Time Since Overhaul
V1,V2, V3,V4	High Pressure Turbine Rotor Thermal Shield Seal Teeth
WAL	Western Airlines
WC16	Sixteenth Stage Cooling Flow
WF	Fuel Flow
Δ	Delta
η	Efficiency (Eta)
ηc	High Pressure Compressor Efficiency
ηf	Fan Efficiency
ηt	High Pressure Turbine Efficiency
η 2t	Low Pressure Turbine Efficiency