CF-105

AIRCRAFT MAINTENANCE REQUIRING

ENGINE RUNNING

ANALYZED

LOG/105/30 May, 1956

1. INTRODUCTION

For the purposes of designing aircraft tie-down equipment and sound abatement facilities, the engine operating conditions must be specified. The ground running that is required for checking and adjusting the aircraft systems has been covered in report LOG/105/30, and this addendum has been prepared in order to cover the development and maintenance testing that will be required for the engine installations.

2. DEVELOPMENT TESTS

In order to comply with the aircraft design specifications, the engine installations for the CF-105 aircraft will have to be subjected to the tests laid down in USAF Memorandum Report AAF-MR-WCNEI-525-460. This document requires that, prior to the acceptance of production aircraft by the Service, engine installation tests be conducted for each installation to demonstrate the following:

(a) Control stability at military and maximum thrust on both main and emergency control systems.
(b) Adequate cooling of all components and structure.

This test includes running at maximum power for the maximum permissible time and then checking the heat dissipation after shutting down. It is assumed that both engines would have to be run simultaneously for this installation, and the test would be done on a hot day.

(c) Satisfactory fuel system functioning for all selections and all power settings.
(d) Satisfactory air pressure recovery and distribution at the compressor intakes for all power settings.
(e) Satisfactory vibration characteristics.

3. MAINTENANCE TESTS - J75

The service manual for this engine outlines three tests as below:

#1 Test - for engines requiring main and emergency control system checks and afterburner and emergency cut-off checks.

#2 Test - for engines requiring trimming and power setting adjustments in addition to #1 test.

#3 Test - for engines requiring ground check, run-up and power setting prior to time run at actual operating conditions.

3. MAINTENANCE TESTS - J75 .....cont'd

Tests #1 and 2 require use of the afterburner (up to maximum thrust) but only for function check purposes. Test #3 specifies use of maximum power for 2 minutes.

No requirement is seen for running both engines simultaneously at high power settings. Adjustments are made to the engine at idling power, and the engine is then run up to check the results.

Discussions with Pratt and Whitney have given a different impression, namely:

(1) Adjustments are being made on the engine at military power.
(2) Use of the afterburner is not required during ground runs. They indicated that checking the nozzle actuation and fuel pressure without igniting the afterburner was sufficient. Avro has written to Pratt and Whitney to clarify this matter but no answer has been received yet.

4. MAINTENANCE - PS13

On this engine, the afterburner is not strictly an on-off device, but is integrated with the power control scheduling. Engine runs therefore require covering the complete power range.

Because of the noise, considerable through is being given by the flow control manufacturers (Bendix and Lucas Rotax) to (1) feasibility of making all adjustments at idling power and (2) feasibility of making all adjustments by remote control. This will be discussed further in meetings with Orenda, Bendix, etc., at a later date.

Simultaneous running of both engines at high power settings is not likely to be required.

5. CONCLUSIONS

(a) For PS-13 engines, maintenance checks will require running each engine throughout the complete thrust range, but both engines do not need to be simultaneously.

(b) For the J-75 engines, the run-up procedure is not yet clear, but simultaneous running of both engines at high power settings will not be required.

5. CONCLUSIONS .....cont'd

(c) Simultaneous running of both engines at maximum power will be required in order to check that the engine installation is adequate with respect to cooling the equipment and structure. This test is required on a hot day.

(d) Aircraft tie-down fittings should be designed for a maximum thrust load of 50,000 lbs. This will permit running one PS-13 engine at maximum power at temperatures down to -65°F, and both engines at maximum power at temperatures above +59°F.

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AIRCRAFT MAINTENANCE REQUIRING ENGINE RUNNING

LOG/105/30

May 1956

Prepared by: D. Collingwood

Approved by: J.P. Booth

ENGINEERING DIVISION

AVRO AIRCRAFT LIMITED, MALTON, ONTARIO

1. INTRODUCTION

At the present time, an investigation is being conducted into the various problems that may result from the noise level produced by the ground running of the two J-75 or PS-13 engines installed in the CF-105.

From all available information, it would appear that the noise level will be in the order of 140 - 150 decibels. Medical research has shown that man can perform manual tasks in a noise level of 100 decibels for a period of 8 hours continuous. Unprotected personnel can withstand a noise level of 135 decibels for no longer than 10 seconds. No form of ear protector will protect a man at a noise level of 150 decibels. This report deals with the aircraft system maintenance operations that are required during engine ground running and the maximum time that ground servicing personnel would be exposed to the high noise level.

It is intended to keep this report up to date by adding more information as it becomes available.

2. LEFT ENGINE RUNNING AT IDLE R.P.M.

2.1 Electrics

(a) Check A.C. voltage output from the left A.C. control unit with an A.C. Voltmeter. Adjust if necessary. The A.C. output terminals are L1, L2 and L3.

Required voltage - 120 volts - phase to ground.
208 volts - between phases.

Access - Electrical Access Door - Duration of Check - 5 minutes.

(b) Check D.C. voltage output from L.H. Rectifier unit with a sensitive D.C. Voltmeter. Adjust if necessary.

Required voltage - 27.5 $\pm$ .5 volts.

Access - Electrical Access Door - Duration of Check - 5 minutes.

2.2 Hydraulics

(a) Check hydraulic system pressure by checking the pressure reading on the Flying Control and Utility system

Accumulator air gauges.

Required pressure - 4000 p.s.i.

Access - Hydraulic Access Door and #2 Service Door

Duration of Check - 3 minutes

3. BOTH ENGINE RUNNING AT IDLE R.P.M.

3.1 Fuel System

Check the operation of both fuel booster pumps by operating the "Press-to-Test" lights installed on the E21 main Refueling Panel. If the light comes on, the pump output pressure is satisfactory.

Access - Main Refueling Panel

Duration of Check - 3 minutes

3.2 Electronics

Carry out audible noise level check on Interphone, Radio Compass and ARC 34.

Access - Rear Cockpit

Duration of Check - 15 minutes

4. BOTH ENGINES RUNNING - MAXIMUM R.P.M.

Check pressure in Air Conditioning engine bleed line at check point supplied downstream of the pressure reducing and non return valve.

Required Pressure - 85 ± 5 p.s.i.

Access - Access Panel Sta. 525, side of fuselage

Duration of Check - 5 minutes

5. L.H. ENGINE SHUT DOWN - R.H. ENGINE AT IDLE R.P.M.

5.1 Hydraulics

(a) Check Hydraulic system pressure by checking the pressure reading on the Flying Control and Utility system Accumulators air gauges.

Required Pressure - 4000 p.s.i.

Access - Hydraulic Access Door and #2 Service Door

Duration of Check - 3 minutes

5.2 Electrics

(a) Check A.C. voltage output from the R.H. A.C. control unit with an A.C. Voltmeter. Adjust if necessary. The A.C. output terminals are L1, L2 and L3.

Required voltage - 120 volts - phase to ground.
208 volts - between phases.

(b) Check D.C. voltage output from R.H. Rectifier unit with a sensitive D.C. voltmeter. Adjust if necessary.

Required voltage - 27.5 $\pm$ .5 volts

Access - Electrical Access Door

Duration of Check - 5 minutes

6. ENGINE ADJUSTMENT

With both engines at idle r.p.m. (5400) adjust maximum trimmer on fuel control unit until full throttle travel can be obtained without exceeding P_{t7} limits.

With both engines at idle r.p.m. (5400) adjust idle speed trimmer to give 55 to 65% N2 speed (High pressure compressor).

Access - Rear Engine Access Door

Duration of Check - 30 minutes

7. ELECTRONICS

The aircraft Electronics System will be powered by the aircraft alternators. For the majority of electronic system checkouts, the power could be derived from the Electrical Ground Power Rig. However, since experience with the CF100 has shown that the performance of the Electronic System is affected by the changeover from ground power to aircraft power supply, it will be necessary to check the system out using the aircraft alternators as a power source.

Due mainly to short prototype engine life and the engine noise problem, an effort is being made to power the Constant Speed Drive Units on each engine from a ground power source. This will probably consist of an hydraulic drive. Electronic System checks with engines running will probably, therefore, consist of a routine check by the navigator before takeoff.

8. CONCLUSION

At the present time it appears that 5 minutes is the maximum time that ground service personnel will be exposed to the high sound level.

During a discussion with Mr. W. Funk of Pratt and Whitney Aircraft on May 17, 1956, it was established that the engine flow control trimming adjustments at idling r.p.m. were being carried out by Pratt and Whitney service personnel wearing ear protective equipment without suffering any ill effect from engine noise. They were exposed to the noise level for approximately one minute at a time.

More definite information is required on sound levels produced by the engine through the complete range of engine r.p.m. before it will be possible to ascertain the seriousness of the problem. The possibility of reducing the sound level by silencers on the engine must be investigated. It is recommended that the practicability of a ground test unit be investigated which could enable the maintenance operations to be carried out from a remote point where the noise level would permit satisfactory working conditions.

MAINTENANCE OPERATIONS REQUIRIN

SYSTEM	BETWEEN FLIGHT			PRIMAR
	Operation	Engine R.P.M.	Period	Operation
1. Engines.				With engines at id check for fuel and Check for security equipment.
2. Hydraulics	At the termination of a flight shut down R.H. engine first. Check operation of L.H. Hydraulic pumps by observing cockpit warning lights.	5400 r.p.m.	1 Min.	With L.H. engine r check Hydraulic sy ure by checking pr reading on the fly accumulators and u accumulator. With
	On engine start, light R.H. engine first to check operation of R.H. pumps.	5400 r.p.m.	1 Min.	running check press ing on the accumul Check pumps for le
3. Electrical				With L.H. engine r check AC voltage o left AC control uni DC voltage output rectifier unit. engine running che age and DC voltage
4. Fuel System				With both engines check operation of booster pumps by o press to test ligh refueling panel.
5. Electronics				With both engines check audible nois inter phone, Radio and ARC.34 Check on integrate ic system pending.

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OPERATIONS REQUIRING ENGINE RUN - UP

PRIMARY MAINTENANCE			SECOND LINE MAINTENANCE		
Operation	Engine R.P.M.	Period	Operation	Engine R.P.M.	Period
With engines at idle r.p.m. check for fuel and oil leaks. Check for security of engine equipment.	5400 r.p.m. idle	5 min.	With both engines at idle r.p.m. adjust max. trimmer on fuel control unit until full throttle travel can be obtained without exceeding P_{t7} limits. With both engines at idle adjust idle speed trimmer to give 55 to 55% max. N_2 speed (high pressure compressor).	5400 r.p.m. max. 5400 r.p.m. idle	5 min. 1 min intervals 5 min. 1 min intervals
With L.H. engine running check Hydraulic system pressure by checking pressure reading on the flying control accumulators and utility accumulator. With R.H. engine running check pressure reading on the accumulators. Check pumps for leaks.	5400 r.p.m idle 5400 r.p.m. idle	3 Min. 3 Min	Similar operation as that on primary maint. may be carried out if system has been broken down to replace unserviceable Hydraulic equipment.	5400 r.p.m. idle	3 Min.
With L.H. engine running check AC voltage output from left AC control unit. Check DC voltage output from L.H. rectifier unit. With R.H. engine running check AC voltage and DC voltage output.	5400 r.p.m. idle 5400 r.p.m. idle	5 Min 5 Min	Similar operation as that on primary maint. may be carried out if system has been broken down to replace unserviceable electrical equipment.	5400 r.p.m. idle	5 Min
With both engines running check operation of both booster pumps by operating press to test lights on main refueling panel.	5400 r.p.m. idle	3 Min	Similar operation as that on primary maint. may be carried out if system has been broken down to replace unserviceable electrical equipment.	5400 r.p.m. idle	3 Min
With both engines running check audible noise level on inter phone, Radio compass and ARC.34 Check on integrated electronic system pending.	5400 r.p.m. idle	15 Min.			

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MAINTENANCE OPERATIONS REQUIRIN

SYSTEM	BETWEEN FLIGHT			PRIMARY
	Operation	Engine r.p.m.	Period	Operation
6. Air Conditioning				With both engines r max. r.p.m. check in engine bleed lin stream of press. re non return line.

CE OPERATIONS REQUIRING ENGINE RUN - UP

d	PRIMARY MAINTENANCE			SECOND LINE MAINTENANCE		
	Operation	Engine r.p.m.	Period	Operation	Engine r.p.m.	Period
	With both engines running at max. r.p.m. check pressures in engine bleed line down-stream of press. reducing and non return line.	7800 r.p.m. max.	5 Min.	Similar operation as that on primary may be carried out if system has been broken down to replace unserviceable equip-ment.	7800 r.p.m. max.	5 Min.

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ENGINE RUNNING ON THE GROUND

Addendum 1 - LOG/105/30

September 1956

Prepared by: D.A. Ridler
Approved by: J.P. Booth

ENGINEERING DIVISION

AVRO AIRCRAFT LIMITED, MALTON, ONTARIO

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