UNCLASSIFIED

Report No. E-2

"Estimated Power Loads for CF105 Aircraft" Issue 2

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"Estimated Power Loads for CF105 Aircraft Using Sparrow Missiles"

Report # E-2

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UNCLASSIFIED

14 October 1955

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

Aircraft

CF-105

Report No. E-2

No. of Sheets 5

Issue 2

ESTIMATED POWER LOADS

FOR

CF-105 AIRCRAFT

POWER LOADS

1. Primary Electrical Service Loads - Essential for Flight

SERVICE	LOADS
Oxygen System	13.3 VA
Cockpit Lights	403.7 VA
Artificial Horizon	67.0 VA
Fuel Capacitance	13.3 VA
Air Conditioning	30.0 VA
Pressure Ratio Indicator	25.0 VA
	552.3 VA
R/H Transformer-Rectifier	2670.0 VA
L/H Transformer-Rectifier	2670.0 VA
TOTAL	5892.3 VA

1.1 D.C. loads - breakdown of transformer - rectifier loads

	CONTIN-UOUS	INTERMITT-ENT	INSTAN-TANEOUS	SHORT TIME
Engine Services	.59 amps	.50 amps	34.90 amps	
Ignition Relight (10 Secs)				14.00 amps
U/C Actuation	5.96 amps			
U/C Indication	.09 amps			
Nose Wheel Steering	1.18 amps			
Fuel System			16.00 amps	
Low Pressure Cocks			6.00 amps	
External Tank Jettison			8.35 amps	
Fire Extinguisher			19.15 amps	
Fire Detection		1.08 amps		
Canopy Actuation (8 secs)				
Refuelling	34.18 amps		34.00 amps	
Fuel Capacitance	.32 amps			
Alternator Controls	5.74 amps			
Hydraulic Press Warning	.74 amps			
Speed Brakes	.6 amps			
Turn & Bank	.2 amps			
Cockpit Lights	3.66 amps			
Exterior Lights	6.94 amps			
Ramp De-Icing (Control)	16.01 amps			
Ice Detection		32.14 amps		
Air Conditioning	2.50 amps		3.50 amps	
Landing Lights	20.00 amps			
Ice Detection (Ramps & Radome)		18.75 amps		

1.1 (Cont'd)

In terms of A.C. load an arbitrary requirement of 125 amps D.C. continuous (Based on the premise that all loads will not be on simultaneously.) is equivalent to 5340 VA which is divided between the two TRUs as shown in Para. 1.0.

1.2 On failure of one TRU part of the D.C. load (para. 2.0) is shed leaving approximately 100 amps on the remaining unit, due to the increased efficiency of the unit when loaded to its full rating this is equivalent to 4200 VA.

2.0 D.C. LOADS (SHEDDING)

This load is shed on failure of one TRU.

SERVICE	LOAD
Landing & Taxi Lights	500 Watts*

*In terms of A.C. load this equals 840 VA which is divided 420 VA on the R/H TRU and 420 VA on the L/H TRU.

3.0 PRIMARY ELECTRONIC LOADS - ESSENTIAL FOR FLIGHT

3.1 Supplied by electrics on failure of MX 1179 integrated electronics power supply unit.

SERVICE	A.C.	D.C.
AN/APX-25 Air To GND. I.F.F.	270 VA	110 Watts
AN/ARC-52 U.H.F. Communication	100 VA	220 Watts
AN/AIC-10 Interphone	-	80 Watts
Damping	100 VA	-
Misc	-	100 Watts
TOTAL	470 VA	510 Watts*

* In terms of A.C. load this equal 857 V.A. which is divided 428.5 VA each to the R/H and L/H T.R.U.'s.

3.2 Supplied by Electrics at all times

SERVICE	A.C.	D.C.
AN/ARN6 Inc. Remote Control	25 VA	140 Watts
Radar Homar	180 VA	-
Doppler	500 VA	-
Air Data Boom	300 VA	-
Damping (Emergency Channel)	100 VA	-
J-4 Compass	60 VA	-
TOTAL	1165 VA	140 Watts*

* In terms of AC load this equals 235.5 VA which is divided 118 VA each to the R/H & L/H TRU's.

4.0 WEAPONS SERVICE LOAD NOT ESSENTIAL FOR FLIGHT

SERVICE	A.C.	D.C.
Weapons System (Falcon)	400 VA	80 Watts*
Accumulator Heat	600 VA	-
TOTAL	1000 VA	80 Watts*

* In turns of A.C. load this equals 135 VA which is divided 68 VA each to the R/H & L/H TRU's.

These loads normally fed from the Electrical System are automatically shed on failure of MX 1179 power supply.

5.0 INTAKE DUCT DE-ICING LOAD

Right Hand - 8400 V.A.
Left Hand - 8400 V.A.

6.0 WINDSHIELD & CANOPY ANTI-ICING LOAD - Essential 2500 V.A.

7.0 LOAD DISTRIBUTION

7.1 Normal Flight

Para. Ref.			
1.0	R/H 20 KVA Alternator -	Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
4.0		Weapons	1000.0 VA
3.2		Primary Electronics	1165.0 VA
1.0		(R/H(D.C. Primary	2670.0 VA
2.0		TRU (D.C. Shedding	420.0 VA
			16707.3 VA
5.0	L/H 20 KVA Alternator	L/H Duct De-Icing	8400.0 VA
1.0		L/H (D.C. Primary	2670.0 VA
2.0		TRU (D.C. Shedding	420.0 VA
			11490.0 VA

7.2 MX1179 Failure - Both Alternators Operating

3.1	R/H 20 KVA Alternator -	Primary Electronics	470.0 VA
1.0		Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
1.0		(D.C. Primary	2670.0 VA
2.0	R/H	(D.C. Shedding	420.0 VA
3.1	TRU	(Electronic DC Primary	428.5 VA
			16605.8 VA
3.1	L/H 20 KVA Alternator		
5.0		L/H Duct De-Icing	8400.0 VA
1.0		(D.C. Primary	2670.0 VA
2.0	L/H	(D.C. Shedding	420.0 VA
3.1	TRU	(Electronic DC Primary	428.5 VA
			11918.5 VA

7.3 Right Alternator Out - MX1179 & Left Alternator Normal

1.0		Primary Electrical	552.3 VA
5.0		L/H Duct De-Icing	8400.0 VA
6.0		Wind Shield De-Icing	2500.0 VA
4.0		Weapons	1000.0 VA
3.2		Primary Electronics	1165.0 VA
1.2	L/H -	TRU - D.C. Primary	4200.0 VA
			17817.3 VA

7.4 Left Alternator Out - MX1179 & Right Alternator Normal

1.0		Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
4.0		Weapons	1000.0 VA
3.2		Primary Electronics	1165.0 VA
1.2	R/H -	TRU - D.C. Primary	4200.0 VA
			17817.3 VA

* In case of failure of 1 alternator and the loss of one TRU the remaining TRU could carry the full D.C. primary Load.

8.0 RESERVE POWER

Available power (2 alternators)	40.0 KVA
Power Load (Para 7.2)	28.5 KVA
Reserve Power	11.5 KVA
Total Electrical System Load	28.5 KVA
Less fixed anti-icing load	16.8 KVA
	11.7 KVA

Therefore reserve Electrical Power = 100%

Report # E-3

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

UNCLASSIFIED

Aircraft

CF-105

Report No. E-3

No. of Sheets 7

ESTIMATED POWER LOADS

FOR

CF-105 AIRCRAFT

USING

SPARROW MISSILES

POWER LOADS

1. Primary Electrical Service Loads - Essential for Flight

SERVICE	LOADS
Oxygen System	13.3 VA
Cockpit Lights	403.7 VA
Artificial Horizon	67.0 VA
Fuel Capacitance	13.3 VA
Air Conditioning	30.0 VA
Pressure Ratio Indicator	25.0 VA
	552.3 VA
R/H Transformer-Rectifier	2670.0 VA
L/H Transformer-Rectifier	2670.0 VA
TOTAL	5892.3 VA

1.1 D.C. loads - breakdown of transformer - rectifier loads

	CONTINUOUS	INTERMITTANT	INSTANTANEOUS	SHORT TIME
Engine Services	.59 amps	.50 amps	34.90 amps	
Ignition Relight (10 Secs)				14.00 amps
U/C Actuation	5.96 amps			
U/C Indication	.09 amps			
Nose Wheel Steering	1.18 amps			
Fuel System			16.00 amps	
Low Pressure Cocks			6.00 amps	
External Tank Jettison			8.35 amps	
Fire Extinguisher			19.15 amps	
Fire Detection		1.08 amps		
Canopy Actuation (8 secs)				17.72 amps
Refuelling	34.18 amps		34.00 amps	
Fuel Capacitance	.32 amps			
Alternator Controls	5.74 amps			
Hydraulic Press Warning	.74 amps			
Speed Brakes	.6 amps			
Turn & Bank	.2 amps			
Cockpit Lights	3.66 amps			
Exterior Lights	6.94 amps			
Ramp De-Icing (Control)	16.01 amsp			
Ice Detection		32.14 amps		
Air Conditioning	2.50 amps		3.50 amps	
Landing Lights	20.00 amps			
Ice Detection (Ramps & Radome)		18.75 amps		

1.1 (Cont'd)

In terms of A.C. load an arbitrary requirement of 125 amps D.C. continuous (Based on the premise that all loads will not be on simultaneously.) is equivalent to 5340 VA which is divided between the two TRUs as shown in Para. 1.0.

1.2 On failure of one TRU part of the D.C. load (Para. 2.0) is shed leaving approximately 100 amps on the remaining unit, due to the increased efficiency of the unit when loaded to its full rating this is equivalent to 4200 VA.

2.0 D.C. LOADS (SHEDDING)

This load is shed on failure of one TRU.

SERVICE	LOAD
Landing & Taxi Lights	500 watts

In terms of A.C. load this equals 840 VA which is divided 420 VA on the R/H TRU and 420 VA on the L/H TRU.

3.0 PRIMARY ELECTRONIC LOADS - ESSENTIAL FOR FLIGHT

3.1 Supplied by electrics on failure of MX 1179 integrated electronics power supply unit.

SERVICE	A.C.	D.C.
AN/APX-25 Air To Ground I.F.F.	270 VA	110 Watts
AN/ARC-52 U.H.F. Communication	100 VA	220 Watts
AN/AIC-10 Interphone	-	80 Watts
Damping	100 VA	-
Misc	-	100 Watts
TOTAL	470 VA	510 Watts*

* In terms of A.C. load this equals 857 V.A. which is divided 428.5 V.A. each to the R/H & L/H TRU's.

3.2 Supplied By Electrics At All Times

SERVICE	A.C.	D.C.
AN/ARN6 Inc. Remote Control	25 VA	*140 Watts
Radar Homar	180 VA	-
Doppler	500 VA	-
Air Data Boom	300 VA	-
Damping (Emergency Channel)	100 VA	-
J-4 Compass	60 VA	-
TOTAL	1165 VA	140 Watts

* In terms of AC load this equals 235.5 VA which is divided 118 VA each to the R/H & L/H TRUs.

4.0 WEAPONS SERVICE LOAD NOT ESSENTIAL FOR FLIGHT

4.1 Weapons Control

SERVICE	A.C.	D.C.
Weapons control (4 Sparrow Missiles)	200 V.A.	80 Watts
Accumulator Heat	600 V.A.	
TOTAL	800 V.A.	80 Watts

4.2 Missiles

SERVICE	A.C.
Warm Up	
Filaments	3200 VA
Hydraulic Heaters	3000 VA
	6200 VA
Stand By	
Filaments, B +	5800 VA
Hydraulic Heaters	3000 VA
	8800 VA
Lock On	
All Missile Circuits (Hydraulic Heaters Off)	9400 VA

These loads normally fed from the electrical system are automatically shed on failure of the MX 1179 power supply.

5.0 INTAKE DUCT DE-ICING LOAD

Right Hand - 8400 V.A.
Left Hand - 8400 V.A.

6.0 WINDSHIELD & CANOPY ANTI-ICING LOAD - Essential 2500 V.A.

7.0 LOAD DISTRIBUTION - WEAPONS LOAD ON A.C. SHEDDING BUS

7.1 Normal Flight

This system loading provides for the firing of missiles under normal conditions, or under any failure of MX 1179 system except its power supply. No provision is made for firing missiles on failure of an aircraft alternator (see para. 8 for missile firing on alternator failure.)

PARA REF.			
1.0	R/H 20 KVA Alternator -	Primary Electrical	552.3 VA
5.0		R/H Duct De-icing	8400.0 VA
6.0		Windshield De-icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
1.0		R/H D.C. Primary	2670.0 VA
2.0		TUR D.C. Shedding	420.0 VA
			15707.3 VA
5.0	L/H 20 KVA Alternator -	L/H Duct De-icing	8400.0 VA
1.0		L/H D.C. Primary	2670.0 VA
2.0		TRU D.C. Shedding	420.0 VA
4.1		Weapons Control	800.0 VA
4.2		* Missiles (Lock On)	9400.0 VA
			** 21690.0 VA

** The existing power system will be adequate for this load for the ten minute max. time interval possible.

7.2 MX 1179 Power Supply Failure - Both Alternators Operating

1.0	R/H 20 KVA Alternator -	Primary Electrical	552.3 VA
5.0		R/H Duct De-icing	8400.0 VA
6.0		Windshield De-icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
1.0	R/H	D.C. Primary	2670.0 VA
2.0		D.C. Shedding	420.0 VA
3.1	TRU	Electronic DC Primary	428.5 VA
3.1		Primary Electronics	470.0 VA
			16605.8 VA
5.0		L/H Duct De-icing	8400.0 VA
1.0	L/H	D.C. Primary	2670.0 VA
2.0		D.C. Shedding	420.0 VA
3.1	TRU	Electronic DC Primary	428.5 VA
			11918.5 VA

* Lock on can last up to 10 minutes and two lock on periods may be required during a flight cycle.

7.3 Right Alternator Out - MX 1179 & Left Alternator Normal

1.0		Primary Electrical	552.3 VA
5.0		L/H Duct De-Icing	8400.0 VA
6.0		Wind Shield De-Icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
1.2	L/H -	TRU - D.C. Primary	4200.0 VA
			16817.3 VA

7.4 Left Alternator Out - MX 1179 & Right Alternator Normal

1.0		Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
1.2	R/H -	TRU - D.C. Primary	4200.0 VA
			16817.3 VA

In case of failure of 1 alternator and the loss of one TRU the remaining TRU could carry the full D.C. primary Load.

Available Power (2 Alternators)	40.0 KVA
Power Load (7.1)	37.0 KVA
Reserve	3.0 KVA

Total Electrical System Load	37.0 KVA
Fixed Anti-Icing Load	16.8 KVA
Electrical Load Less Anti-Icing	20.2 KVA

$\therefore$ Reserve Electrical Power = $\frac{.3}{202} \times 100 = 14.8\%$

8.0 LOAD DISTRIBUTION - Weapons Load On A.C. Priority Bus

This system loading is based on missile firing under normal conditions, under any failure of MX 1179 except its power supply, or under any single aircraft alternator failure.

8.1 Normal Flight

PARA REF.			
1.0	R/H 20 KVA Alternator -	Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
4.1		Weapons Control	800.0 VA
4.2		* Missiles (Lock On)	9400.0 VA
3.2		Primary Electronics	1165.0 VA
1.0		R/H (D.C. Primary	2670.0 VA
2.0		TRU (D.C. Shedding	420.0 VA
			25907.3 VA
5.0	L/H 20 KVA Alternator -	L/H Duct De-Icing	8400.0 VA
1.0		L/H (D.C. Primary	2670.0 VA
2.0		TRU (D.C. Shedding	420.0 VA
			11490.0 VA

8.2 MX 1179 Power Supply Failure - Both Alternators Operating

1.0	R/H 20 KVA Alternator -	Primary Electrical	552.3 VA
5.0		R/H Duct De-Icing	8400.0 VA
6.0		Windshield De-Icing	2500.0 VA
3.2		Primary Electronics	1165.0 VA
3.1		Primary Electronics	470.0 VA
1.0		D.C. Primary	2670.0 VA
2.0		D.C. Shedding	420.0 VA
3.1		Electronic D.C. Primary	428.5 VA
			16605.8 VA
5.0	L/H 20 KVA Alternator -	L/H Duct De-Icing	8400.0 VA
1.0		(D.C. Primary	2670.0 VA
2.0	L/H	(D.C. Shedding	420.0 VA
3.1	TRU	(Electronic DC Primary	428.5 VA
			11918.5 VA

8.3 Right Alternator Out - MX 1179 & L/H Alternator Normal

1.0	Primary Electrical	552.3 VA
5.0	L/H Duct De-Icing	8400.0 VA
6.0	Windshield De-Icing	2500.0 VA
4.1	Weapons Control	800.0 VA
4.2	*Missiles (Lock On)	9400.0 VA
3.2	Primary Electronics	1165.0 VA
1.2	TRU - D.C. Primary	4200.0 VA
		27017.3 VA

8.4 Left Alternator Out - MX 1179 & R/H Alternator Normal

1.0	Primary Electrical	552.3 VA
5.0	R/H Duct De-Icing	8400.0 VA
6.0	Windshield De-Icing	2500.0 VA
4.1	Weapons Control	800.0 VA
4.2	*Missiles (Lock On)	9400.0 VA
3.2	Primary Electronics	1165.0 VA
1.2	TRU - D.C. Primary	4200.0 VA
		27017.3 VA

Para 7.2 and 8.2

In order to fire missiles optically if MX 1179 power supply fails it would be necessary to provide an auxilary power supply which would provide D.C. plate voltage supply for the two sparrow missile auxiliaries, and high frequency A.C. (3 to 4 K.C.) for sparrow antenna slaving. This would mean a weight penalty of approx. 33 lbs. The penalty to the electrical system is not known.

NOTE: If missiles are fired after the radar or computer (or both) have failed but the MX 1179 power supply & missile auxiliaries are servicable. The load on the electrical system will be the same as para. 7.1 & 8.1.

Probable Changes Involved In Fitting a New Power System To The CF105 If The Conditions Of Para. 8 Are To Be Met.

1. Changes in size of nose bullet & struts.
2. New Alternators
3. New Constant Speed Drive Units
4. Larger Bulkhead Connectors for Engine and firewall quick disconnects.
5. Increased size of wire on Power Leads.
6. Internal changes to Alternator Control/T.R.U. boxes.
7. Internal changes to Power Panel
   - Larger wire sizes on Power Leads
   - Larger Limiters
   - Probable revision to connectors.