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Avro
CF105
E-2 &
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UNCLASSIFIED
Report No. E-2
"Estimated Power Loads for CF105
Aircraft" *Issue 2*

UNCLASSIFIED
Report No. E-2
"Estimated Power Loads for CF105
Aircraft Using Sparrow Missiles"

FILE IN VAULT
NRC - CISTI
J. H. PARKIN
BRANCH
MAY 29 1995
ANNEXE
J. H. PARKIN
CNRC - ICIST

Report # E-2

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by authority of _____ (date) _____
Signature *[Handwritten Signature]* Rank _____

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14 October 1955

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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

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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 | 14.00 amps |
| Ignition Relight (10 Secs) | | | | |
| 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 | | |

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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.

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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.

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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 |
| | | | <hr/> |
| | | | 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 |
| | | | <hr/> |
| | | | 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 | | (D.C. Shedding | 420.0 VA |
| 3.1 | R/H | (Electronic DC Primary | 428.5 VA |
| | | | <hr/> |
| | | | 16605.8 VA |
| | | | |
| 3.1 | L/H 20 KVA Alternator | L/H Duct De-Icing | 8400.0 VA |
| 5.0 | | (D.C. Primary | 2670.0 VA |
| 1.0 | | (D.C. Shedding | 420.0 VA |
| 2.0 | L/H | (Electronic DC Primary | 428.5 VA |
| 3.1 | TRU | | |
| | | | <hr/> |
| | | | 11918.5 VA |

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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 |
| | | <hr/> |
| | | 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 |
| | | <hr/> |
| | | 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 |
| | <hr/> |
| Reserve Power | 11.5 KVA |
| Total Electrical System Load | 28.5 KVA |
| Less fixed anti-icing load | 16.8 KVA |
| | <hr/> |
| | 11.7 KVA |

Therefore reserve Electrical Power = 100%

Report # E-3

AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

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Aircraft

CF-105

Report No. E-3

No. of Sheets 7

ESTIMATED POWER LOADS

FOR

CF-105 AIRCRAFT

USING

SPARROW MISSILES

POWER LOADS

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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 |
| | <u>552.3 VA</u> |
| R/H Transformer-Rectifier | 2670.0 VA |
| L/H Transformer-Rectifier | 2670.0 VA |
| | <u>5892.3 VA</u> |
| TOTAL | <u>5892.3 VA</u> |

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 | | |

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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 electricians 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.

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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. |
|--|---------|
| <u>Warm Up</u> | |
| Filaments | 3200 VA |
| Hydraulic Heaters | 3000 VA |
| | 6200 VA |
| <u>Stand By</u> | |
| Filaments, B + | 5800 VA |
| Hydraulic Heaters | 3000 VA |
| | 8800 VA |
| <u>Lock On</u> | |
| 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.

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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 |
| | | <hr/> |
| | | 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 |
| | | <hr/> |
| | | 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 | (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 |
| 3.1 | Primary Electronics | 470.0 VA |
| | | <hr/> |
| | | 16605.8 VA |

| | | |
|-----|----------------------------|------------|
| 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 |
| | | <hr/> |
| | | 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 |
| | | <u>16817.3 VA</u> |

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 |
| | | <u>16817.3 VA</u> |

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 | <u>3.0 KVA</u> |
| Total Electrical System Load | 37.0 KVA |
| Fixed Anti-Icing Load | 16.8 KVA |
| Electrical Load Less Anti-Icing | <u>20.2 KVA</u> |

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

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 |
| | | <u>25907.3 VA</u> |
| 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 |
| | | <u>11490.0 VA</u> |

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 |
| | | <u>16605.8 VA</u> |
| 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 |
| | | <u>11918.5 VA</u> |

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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 |
| | | <hr/> |
| | | 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 |
| | | <hr/> |
| | | 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 auxiliary 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.



