CONFIDENTIAL

Classification cancelled / Changed to UNCLASS

Date 30 Sept 58

Signature

Unit / Rank / Appointment AVRO

May, 1958.

REQUIREMENT FOR
AIR CONDITIONER & GENERATOR AC & DC
ARROW AIRCRAFT

Report No. 72/GEQ/10.

TABLE OF CONTENTS

1. INTRODUCTION

The Avro ground power/air conditioning unit for the ARROW will embody a self-contained, automatically controlled System capable of supplying A-C electrical power and conditioned air to one aircraft for prolonged periods. It is intended that Avro will suitably package this System and mount it on a four wheeled, two wheel steerable, towable chassis with limited self-mobility.

This report states the System requirements in general terms, for the purpose of obtaining adequate preliminary engineering data on proposed sub-systems to enable Avro Aircraft Limited to order the principle "off-shelf" components and to prepare an "Avrocan" specification for subsequent detail engineering and procurement of an acceptable System and hardware. Preliminary information on enclosures and on the vehicle chassis is included, to clarify the overall concept of the unit.

The System shall supply a minimum of 130 lbs/min. of controlled temperature and pressure air. The air temperature and pressure at the aircraft shall be 55°F or 70°F (depending upon the demand of a temperature sensing device located in the cooling air duct of the aircraft) and 4.5 p.s.i.g. respectively. A maximum of 40 KVA, .75 power factor, lagging, of 400 cps 208/115 volts A-C power, plus a small amount of D-C power to energize the aircraft bus, shall be supplied simultaneously to the aircraft. D-C power will be required to operate the unit's refrigeration sub-system, control sub-system and auxiliary services. The characteristics of the A-C power supplied to the aircraft are outlined in the text of this report. The primary power source of the unit shall be two AiResearch GTCP 85 series Gas Turbines. One gas turbine shall drive the A-C generator, the other a D-C generator. The gas turbines shall supply bleed air to an air cycle cooling system of the "bootstrap" principle, which shall embody certain protective devices including anti-ice control and water separation.

An integrated control sub-system shall automatically govern the operation and output from the unit including safety shut down features in the case of any malfunction. The design aim of the control system shall be the automatic operation of the complete unit following the actuation of the engine starter switches, the load switch and the A-C power switch. An intercommunication system shall be provided. The design of the sub-systems shall provide for accessibility, ease of maintenance and noise supression. All components with the same part number shall be interchangeable.

The complete unit will be designed to be of minimum size and weight, and will, when packaged, not exceed 5'6" in height nor 7'9" in width. The system as a whole shall meet the performance requirements of this report under the environmental conditions listed on Page 2.

...../2

Altitude	Dry Bulb Temp.	Wet Bulb Temp.
Sea Level	120°F	76°F
Sea Level	100°F	80°F
Sea Level	-65°F	-
3500'	100°F	80°F
3500'	-65°F	-

The unit must operate satisfactorily when subjected to the natural environmental conditions of sand and dust, salt spray and fungus. The unit shall be designed to withstand the shock, vibration and acceleration loads associated with travel over unimproved roads and air transportation.

The components of the unit shall be subjected to Qualification Tests designed to prove its performance under all specified environmental conditions. These qualification tests need not necessarily be completed before delivery of the first unit, but should be carried out at the earliest possible date.

A schematic diagram (Drg. No. 7-4427-132) of the air cycle system and electrical circuitry is enclosed.

2. METHOD OF OPERATION

2.1 Engine Starting

The two Gas Turbine Compressors will be started in sequence as follows. Firstly, the GTC driving the D-C generator will be started by the actuation of a momentary contact switch. The starting cycle shall be automatic. Stabilization of the GTC will be indicated by the load light. Closing the load relay will energize the starting circuit of the second GTC driving the A-C Generator. The second engine can now be started by actuating the starter switch. Stabilization of the second engine will be indicated by a load light. Both engines shall be automatically protected against overspeeding and over-temperature.

2.2 Conditioned Air

With both engines running and both load lights on, it shall be possible by actuating a single switch to operate both load valves which permit bleed air to pass from each Gas Turbine Compressor through non-return valves into a common duct in the unit's refrigeration system, thence, by two 3½" flexible hoses to the aircraft. The temperature of the conditioned air supplied to the aircraft should be controlled between ± 4°, and from a range of 55° to 70°F. The required temperature will be sensed and controlled by temperature sensing devices located in the aircraft. Devices shall be incorporated downstream of the air cycle refrigeration system to sense and indicate pressure, temperature, and flow of the conditioned air. These devices shall be coupled with the A-C circuit to interrupt the A-C supply to the aircraft should the condition of the air fall outside the required limits.

...../3

2.3 Alternating Current Supply

With the air cycle system operating and the A-C supply switch selected to the "on" position, A-C power to the aircraft shall not flow under the following conditions:-

(a) If the cycles and voltage are outside the prescribed limits.
(b) If the temperature of the conditioned air is too high.
(c) If the flow of conditioned air is too low.
(d) If the pressure of the conditioned air is too low.

2.4 Electrical Sub-system

The electrical sub-system shall include sufficient protective devices to ensure that no damage occurs to the aircraft's, or the unit's, electrical equipment. The sub-system shall be self-contained and easily removable from the unit.

Protection on the D-C supply shall be confined to current and voltage. An overvoltage protective device with reset switch shall be installed. Current protection consists of reverse and overload protective devices.

The A-C supply system shall be furnished with an overvoltage protective device with reset switch, undervoltage protection, and overload relay, under/over frequency device and a reverse phase rotation protection.

3. EQUIPMENT REQUIREMENTS

3.1 Air Compressor Pack Installation

2 AiResearch GTCP 85 series Gas Turbines shall provide;

(a) A minimum of 130 lbs/min. of conditioned air under all stated environmental conditions.
(b) 40 KVA of 400 cps A-C power from an alternator driven by one GTCP unit. The requirements of the alternator are quoted in paragraph 3.3.2.
(c) Sufficient D-C electrical power obtained from a generator driven by the second GTCP unit. The requirements of the generator are quoted in paragraph 3.3.1.

3.1.1 Control Systems for GTCP Units

There shall be complete automatic control of both units following the starting sequence.

3.1.1.1 Starting: The flexible air hoses and the A-C electrical cable are coupled to the aircraft receptacles provided. When intercommunication is required the D-C cable is connected to the receptable in the nose wheel leg.

...../4

3.1.1.1 Starting: ....cont'd

The unit starting sequence is initiated by closing the start switch for the turbine driving the D-C generator. When the unit accelerates to governed speed, and stabilizes, a light on the control panel indicates that the circuit for the second turbine is energized. The second turbine is started by closing a switch and at governed speed a load light indicates that the units are ready to load. Acceleration of each unit shall be limited to ensure a long life for the unit.

3.1.1.2 Speed Control: The speed control shall hold the output drive speed of the A-C driving turbine constant at 6,000 RPM ± 1% during any steady state load condition throughout the range from no-load to full-load. Transient fluctuations in frequency owing to block loading or unloading with any load up to and including full load (pneumatic or electrical) or any combination of each shall have a maximum duration of 0.5 seconds.

3.1.1.3 Bleed Air Control: This shall limit the air flow to a minimum of 130 lbs/min. and a maximum of 180 lbs/min. The output from each engine shall pass through a non-return valve then combine to form a single flow. After passing to the air cycle system the air shall flow through a measuring device.

3.1.1.4 Emergency Controls: Provision shall be made to protect the engines against:

(i) Overspeed
(ii) Oil Pressure Failure
(iii) Over temperature
(iv) Low Fuel Pressure

3.1.2 Associated Equipment

Each engine unit shall have an air inlet screen and will be assembled on an individual frame work which can be withdrawn for ease of maintenance, but can be locked in position when the engine is in use. Necessary control wires and pipework shall be easily disconnected for servicing.

3.1.2.1 Hourmeter: An hourmeter of the odometer type, having a range of 0-9,999 hours shall be provided for each engine.

3.1.2.2 Start Counter: A start counter, having a range of 0-9,999 starts, shall be provided for each engine.

...../5

3.1.2.3 Instruments: Instruments applicable to the GTC Units, detailed in para. 4.5 shall be provided.

3.2 Air Cycle Refrigeration Unit

3.2.1 Conditioned Air

The requirement at the aircraft connections is a minimum continuous flow of 130 lbs/min. of conditioned air at a temperature of 55°F or 70°F, as demanded by the aircraft, and a pressure of 4.5 psig. The air shall be free from noxious fumes, oil and fuel vapours.

3.2.2 Refrigeration Equipment

The refrigeration unit shall be of the bootstrap type and shall consist of two air-to-air heat exchangers, a cooling turbine, an anti-ice valve, a water separator, a by-pass valve and temperature control equipment.

Electrically driven fans shall be used for cooling the heat exchangers.

3.2.2.1 Cooling Turbine Assembly: An expansion turbine of lightweight construction shall be used to provide cooling. The assembly shall require infrequent lubrication attention.

3.2.2.2 Heat Exchangers: The heat exchangers shall be of the extended surface type and lightweight in construction. If possible the same model shall be used for both applications.

3.2.2.3 Cooling Air Fans: Electrically driven fans, of lightweight construction, shall be used to draw air through the air-to-air heat exchangers.

3.2.2.4 Water Separator: The water separator shall be of lightweight construction and shall incorporate a pressure relief valve. The dew point of the air delivered at the aircraft connection shall not exceed 65°F under the stated ambient conditions.

3.2.2.5 Anti-Ice Valve: An anti-ice valve shall be installed upstream of the water separator to prevent the latter from "icing-up" at high humidity conditions.

3.2.2.6 By-Pass Valve: A by-pass valve shall be installed in the warm air by-pass line.

...../6

3.2.2.7 Temperature Control Equipment: Necessary temperature control equipment shall regulate the temperature of the air from the refrigeration package. Under the entire operating range the aircraft will demand a delivered air temperature of 55°F or 70°F. The temperature will be selected by a thermistor in the aircraft ducting and the requirement will be signalled to a temperature controller in the ground unit. The temperature controller shall automatically regulate the settings of the by-pass valve para. 3.2.2.6 to meet the requirement.

The signal for this control shall be carried from the aircraft to the unit by a cable, terminating at the aircraft end in a quick disconnect coupling. Protection will be given to the cable by a strain relief cable. It may be necessary to install a temperature anticipator downstream of the mixing chamber, which will signal the temperature controller, in order to prevent cycling.

3.2.2.7.1 Overtemperature: A thermal switch, set to operate at 85°F ± 2°F shall be provided to automatically cease the A-C power supply. This ensures that the electrical power supply to the aircraft is cut off should overheating of the air conditioning system occur. This temperature shall be sensed downstream of the mixing chamber prior to the discharge hoses. A warning light shall be incorporated in the control panel to give indication of this over-temperature condition.

3.2.2.8 Pressure Control: The maximum back pressure at the refrigeration unit outlet shall be the sum total of the delivery pressure to the aircraft of 4.5 psig minimum and a pressure drop resulting from the use of 45 feet of 3½" i/d flexible hose complete with couplings.

The outlet to the flexible hose shall incorporate a relief valve to limit the discharge pressure to not more than 10 ± 0.5 psig.

A pressure controller, situated downstream of the mixing chamber shall automatically cease the A-C power supply, should the discharge pressure fall below 4 psig.

3.2.2.9 Flow Control: Mass flow shall be measured by means of a flow meter, e.g. venturi or nozzle. Should the air flow fall below 130 lbs/min. a switch shall be actuated to cut off the A-C power supply. The value of the air flow shall be given by an indicator on the control panel.

...../7

3.2.2.10 Ducts

3.2.2.10.1 Internal Ducts: Suitable ducting shall be used, where necessary, for guiding air through various assemblies. The ducts shall be constructed of lightweight sheet metal, all bends being internally smooth. All duct intersections shall ensure uniform mixing of the various airstreams. Where applicable, expansion joints shall be used.

3.2.2.10.2 Mixing Chamber: A mixing chamber shall be installed at the outlet of the refrigeration unit. This shall afford uniform mixing of cold air from the unit and warm air from the by-pass line.

The outlet from the mixing chamber shall terminate in a Y-branch to supply two discharge hoses.

3.2.2.10.3 Flexible Hoses: Two flexible hoses each $3\frac{1}{2}$" i/d x 45 ft. long will be provided, permanently attached to the ducting from the refrigeration package. Quick disconnect lanyard-release couplings will be fitted to the discharge end of the hoses. Scuffing strips or a scuff preventive covering will be provided along the length of each hose to obviate undue wear from contact with rough and abrasive surfaces. The hoses will be made of material impervious to fuel and oil which is flexible at all operating conditions. The couplings will be provided by Avro Aircraft Limited. The hoses will be so located that they may easily be stowed without disconnection from the unit.

3.3 Electrical System

The unit shall provide both A-C and D-C electrical power. The A-C power shall be generated by a 3 phase, 400 cps, wye wound generator which shall be driven by one of the gas turbine engines. D-C power shall be obtained from a D-C generator driven by the second gas turbine engine. Both generators shall be air cooled by air supplied from the gas turbine.

The D-C generator turbine shall be started first to assist in recharging the batteries, provide D-C for control purposes and to energize the starting circuit for the A-C generator turbine. When the D-C generator turbine reaches normal running speed a green light shall be lighted to indicate that the A-C generator turbine may be started.

...../8

3.3.1 D-C System

The D-C generator shall be rated at not less than - amps at 27.5 volts continuous or as required to supply the following services plus 50 amperes.

(a) Supply power for the cooling fans.
(b) Energize the aircraft/ground power changeover relays.
(c) Energize the thermistor in the aircraft.
(d) Charge the units' engine starting batteries.
(e) Charge the units' traction batteries.
(f) Operate the control system and lighting.
(g) Supply 30 amps to one convenience outlet.

3.3.1.1 Performance: The electrical characteristics and test requirements of the generator shall be as defined in MIL-P-6905A. Requirements not defined in MIL-P-6905A shall be as defined in MIL-E-7894.

For any steady load from no load to full load, the voltage shall remain within plus or minus 1 volt of any setting within the range of adjustment. The adjustment range shall be from 27.0 to 29.0 volts with at least 8 equal steps.

3.3.1.1.1 Recovery Time: When the full-rated D-C load is applied and removed, the output voltage shall recover and remain within plus or minus 10% of the D-C output voltage setting within 0.1 seconds of load switching and shall further recover within plus or minus 1 volt of the setting within 0.5 seconds of load switching.

3.3.1.2 Overloads: The D-C system shall be capable of meeting the following overload conditions without damage during any period of continuous operation at full rated load.

(a) 200% of rated load current for 5 seconds.
(b) 300% of rated load current for 2 seconds.

Under conditions of 200% overload, the output voltage shall not fall below 20 volts for any voltage setting within the range of adjustments.

3.3.1.3 Batteries: A 24 v battery shall be provided whose sole purpose shall be engine starting. It shall be mounted in an insulated carrier which shall accept either,

(a) 2 - AN 3150-2 Batteries, or,
(b) A commercial automotive type 24V battery set of equivalent capacity.

...../9

3.3.1.3 Batteries: .....cont'd

A second and independent 24 v battery shall be provided to propell the entire unit through an electric motor drive. This traction battery shall be capable of moving the unit at walking pace on level ground over a distance of 200 feet. A combustion heater will be provided for battery heating in cold weather operation.

The batteries will be located so that they may be easily removed or serviced and will be vented to permit excess acid to drain directly to ground. Such drains will not discharge in the vicinity of the unit's tires.

3.3.1.3.1 Battery Charging: All batteries will be charged from the D-C Generator and the necessary voltage and current regulators shall be part of the control system. An external power receptacle AN 2552-3A shall be provided for external battery charging and assisting in starting the engine.

3.3.1.4 System Components: The following components shall be included.

(a) An output voltage regulator with adjusting control.
(b) A voltage and current regulator for battery charging.
(c) An ammeter to indicate output current.
(d) A voltmeter to indicate output voltage.
(e) An ammeter to indicate battery charging current.
(f) A generator overload protection system consisting of an overload relay to open the master output circuit breaker.
(g) An overvoltage protective device, with reset switch marked "D-C over voltage reset".
(h) A master output switch marked "D-C Power".
(i) A reverse current cut out.
(j) A Green light on the control panel to indicate "D-C ON".
(k) A Power Failure Red light on the control panel to indicate when the over voltage relay is opening the circuit.

3.3.2 A-C System

The A-C Generator shall be required to supply the following:

(a) 40 KVA, 3 phase, 400 cps (at 0.75 Power Factor, lagging) to the aircraft.

...../10

3.3.2 A-C System .....cont'd

(b) 5 KW, 3 phase 400 cps to a convenience outlet.
(c) 3 KW single phase 400 cps to each of two convenience outlets.

(a) (b) and (c) will not be required simultaneously. The three phase power output shall meet the same requirements as laid down in Avrocan Spec. E-500 for the aircraft electrical supply system. The single phase A-C power shall have the characteristics required of one of the phases in the three phase system.

3.3.2.1 Performance: Voltage transients shall be within the limits specified in Spec. MIL-E-7894 para. 3.2.1.2.3.

3.3.2.1.1 Frequency: The frequency shall be maintained at 400 plus or minus 4 cycles. Transient fluctuations in frequency due to A-C generator loading shall have a maximum duration of .5 seconds.

3.3.2.2 System Components:

(a) A voltage regulator of the magnetic amplifier type as described in Avrocan Spec. E-500. In addition the regulator shall exercise frequency control to keep the frequency within the limits specified above.
(b) An ammeter with current transformers and selector switch for indicating line currents.
(c) A voltmeter with selector switch for indicating each phase to neutral output voltages.
(d) An overvoltage protective device with reset switch marked "A-C overvoltage reset" as specified in Avrocan Spec. E-500 para. 5.8.9.2.
(e) A generator overcurrent protection system consisting of an overload relay to open the master output circuit breaker and as specified in Avrocan Spec. E-500 para. 5.8.9.4.
(f) A master output switch marked "A-C Power".
(g) A reverse phase rotation protection relay or device to prevent the wrong phases being supplied to the output cable in the event of internal equipment disconnections.
(h) A frequency meter (not of the vibrating reed type).
(i) A Green light on the control panel to indicate "A-C ON" and mounted above the A-C Master output switch.
(j) A Red light on the control panel to indicate when the overvoltage relay opens the circuit.
(k) An underfrequency device to prevent the master output switch being closed until the frequency is within the required range (380-420 cps).

...../11

3.3.2.2 System Components: .....cont'd

(1) An undervoltage protective device as specified in Avrocan Spec. E-500 para. 5.8.9.3.

The A-C generator may be brushless but in the event of a brush type being used the brushes shall be easily accessible for examination or removal.

3.3.3 Intercommunication

An intercom amplifier control unit and headset shall be provided. Under-cover stowage shall be made for the amplifier. An intercom "ON-OFF" switch with small amber light shall be adjacent to the amplifier, deriving power from the 24 V battery system. D-C power will be obtained from the aircraft to operate the intercommunication system. This power will be carried by a cable, 50 ft. long, terminating at the aircraft end in a lanyard release plug connector 2GS-C-142. The following are the items concerned:

Control, Intercom Set
Mounting
Headset - Microphone.

The intercom set shall be capable of operating from the battery without the necessity of the D-C generator running.

3.3.4 Power Cable

A power delivery cable 45 feet long shall be provided similar to AN 3430. It shall contain the 3 phase wires and neutral and the D-C relay control wire.

The connector at the aircraft end shall conform to Specification.

3.3.5 Packaging

The electrical equipment with the exception of generators, batteries and power cables shall be, where possible, packaged as a sub-system so that it may easily be removed "in toto" for servicing. To aid removal, wires and cables shall terminate, at the package, in plug-in type connectors.

3.4 Enclosure

The enclosure will be of a suitable lightweight structure. The structure will be panelled with light gauge sheet aluminum. Access doors will be provided for operation and servicing. The Gas Turbine's frames and the Refrigeration equipment will be rigidly attached to the structure. Suitable framework will be provided to support a fuel tank.

...../12

3.4 Enclosure .....cont'd

The whole enclosure will be (i) either rigidly attached to the vehicle bed or (ii) the wheel axles will be suitably assembled on a sub-frame forming part of the main structure.

3.4.1 Envelope

With the towbar in the stowed position and the unit closed down, the vehicle will conform to the following overall dimensions. Maximum height 5'6", and maximum width 7'9". Design objective for length 9'6". As a design objective the gross weight will not exceed 5,000 lbs.

3.4.2 Doors

All doors will have handles easily operated by personnel wearing arctic gloves.

Doors fitted to the top of the enclosure, when open, must conform to the height envelope. Intake and exhaust doors for the GTCP units will preferably open upwards and will actuate a microswitch to prevent equipment operating with doors closed.

3.4.3 Air Intakes

Air intakes and exhausts will be suitably positioned to prevent clogging with snow and re-cycling of exhaust gasses. Each engine unit intake will be protected by means of a suitable screen of $\frac{1}{2}$ to 3/4 inch mesh to prevent the entrance of foreign objects. As a further protection a suitable filter will be provided to screen dust particles.

3.4.4 Noise Suppression

The enclosure will be suitably lagged with sound absorbent material to reduce the noise level to a minimum. Particular attention will be given to the design of the turbine exhaust stack.

3.4.5 Fuel System

The fuel system will comprise the following equipment. A fuel tank with usable capacity of 120 Imperial gallons having a vent (with flametrap) and a filler cap. The tank will have a drain located at the lowest position. Fuel boost pump(s) and a filter will be provided. A fuel gauge will be installed on the control panel.

...../13

3.4.6 Lubrication System

The lubrication system shall consist of:
An oil tank with filler cap and dipstick, an oil filter with replaceable element, an oil cooler and drain plug. A pressure indicator for each engine shall be installed on the control panel.

3.4.7 Instrument and Control Panel

The panel will contain the necessary instruments and controls for full operation of the unit. The panel will be suitably illuminated by white lights together with dimming rheostats.

At least the following instruments shall be provided.

(a) Starting switch and green load light for the D-C generator driving GTCP.
(b) Starting switch and green load light for the A-C generator driving GTCP.
(c) Outlet Air Temperature (°F) indicator.
(d) 850 ± 2°F warning light (red).
(e) Discharge pressure (psig) gauge.
(f) Approx. air flow lbs/min. indicator.
*(g) Engine speed indicator.
*(h) Engine jet pipe temp (°F) indicator.
*(i) Engine oil pressure indicator.
**(j) Hourmeter.
**(k) Startmeter.

Items marked * shall be duplicated.
Items marked ** may accompany the engine unit.

(l) A switch (with red light) for selecting self-mobility.

The following electrical apparatus:

(i) A-C power output switch.
(ii) A-C ammeter.
(iii) A-C Voltmeter with a selector switch for indicating all line to neutral output voltages.
(iv) Frequency meter A-C.
(v) Control switch for A-C convenience outlets.
(vi) A-C voltage reset switch.
(vii) D-C power output switch.
(viii) D-C Ammeter.
(ix) D-C Voltmeter.
(x) D-C voltage reset switch.
(xi) Intercom switch and amber pilot light.
(xii) D-C 30 amp. outlet switch.
(xiii) Flood lights switch.
(xiv) Obstruction lights switch.
(xv) Cockpit valve switch.

...../14

3.4.8 Exterior Fittings

Provision will be made for the following:-

(a) A floodlight at each end of the unit.
(b) Two red obstruction lights shall be on top of the unit, one at each end.
(c) Stowage space for the A-C and D-C power cables.
(d) A fire extinguisher.

3.4.9 Chassis

The chassis will be of the 4 wheel towable, 2 wheel steerable design. The wheels will be inside the width envelope.

3.4.9.1 Steering: The unit will be equipped with knuckle type steering incorporating tie rods and king pins. It will be controlled by a tow bar to provide a high degree of manoeuvreability. A compensated angle type of steering linkage will be adopted.

The cramping angle will be, as a design objective, not less than 40°.

3.4.9.2 Tow Bar: The unit will be furnished with a hinged tow bar. The tow bar will have a lunette eye and be retained in a vertical position during stowage.

3.4.9.3 Wheels, Hubs, Tires: The vehicle will be equipped with wheels, hubs and tires in accordance with Spec. MIL-W-8005B.

3.4.9.4 Parking Brakes: The vehicle will be equipped with drum-type brakes. The brakes will have sufficient braking action to hold the vehicle on a slope of 35 per cent. If a brake handle is used for the actuation of the brakes, it will be located adjacent to or near the hinged tow bar.

3.4.9.5 Springs: Suitable springs will be furnished to provide good riding qualities in order to protect the mounted equipment. No more than 2 inches will be added to the frame height for spring deflection when the unit is fully equipped.

3.4.9.6 Clearance: The fully loaded trailer will have a road clearance of at least 8".

3.4.9.7 Pintle: The rear end will be equipped with a pintle.

3.4.9.8 Loadings: The entire vehicle will be designed to conform with Spec. MIL-A-8421.

...../15

3.4.9.9 Tie-Down Fittings: Eight (8) tie-down points are required, any (4) of which will be capable of being used for hoisting. The fittings must conform with Spec. MIL-A-8421.

3.4.10 Self Mobility

Limited self mobility is required. The vehicle will be required to travel a distance of 200 feet at 2 m.p.h. on one charging of the storage battery. A suitable electric motor will provide, through speed reduction, power to the two non-steerable wheels. A clutch is required, fitted between the drive motor assembly and the rear end so that the mobility drive will be engaged only whilst in operation. This leaves the vehicle free to be towed at any other time. The drive requires a forward and reverse switch located conveniently on the drawbar to automatically engage the clutch.

Self mobility will be selected, on the control panel, by the operation of a switch. This switch will be accompanied by a red light indicating that self mobility is available. Suitable protection will be provided in the traction motor circuit, to prevent overload should ground conditions cause too heavy a load on the motor.

4. DIVISION OF ENGINEERING WORK

Avro Aircraft Limited will design, manufacture and test the Air Conditioning and Generator A-C and D-C Unit as defined in this report.

The Garrett Corporation of Canada, by sub-contract, shall provide technical assistance to Avro Aircraft Limited as defined below.

1. The Garrett Corporation of Canada shall prepare and submit to Avro Aircraft Limited a complete system proposal for the System described hereafter. The System is defined as all components, contained within the enclosure(s) and does NOT include the enclosure(s), running gear, batteries, fuel tank, external hoses and cables, control panel and inter-communication sub-system. The complete System shall comprise of the following sub-systems:

   (a) Gas Turbine Compressors Sub-system.
   (b) Air Cycle Refrigeration Sub-system complete with intercoolers and water separator.
   (c) Generator A-C/D-C Sub-system.
   (d) Integrated Control Sub-system including instruments.

2. The Garrett Corporation of Canada shall at the earliest possible time submit to Avro Aircraft Limited a system proposal comprising of:

   (a) System schematic drawings.
   (b) Wiring diagrams.

...../16

4. DIVISION OF ENGINEERING WORK .....cont'd

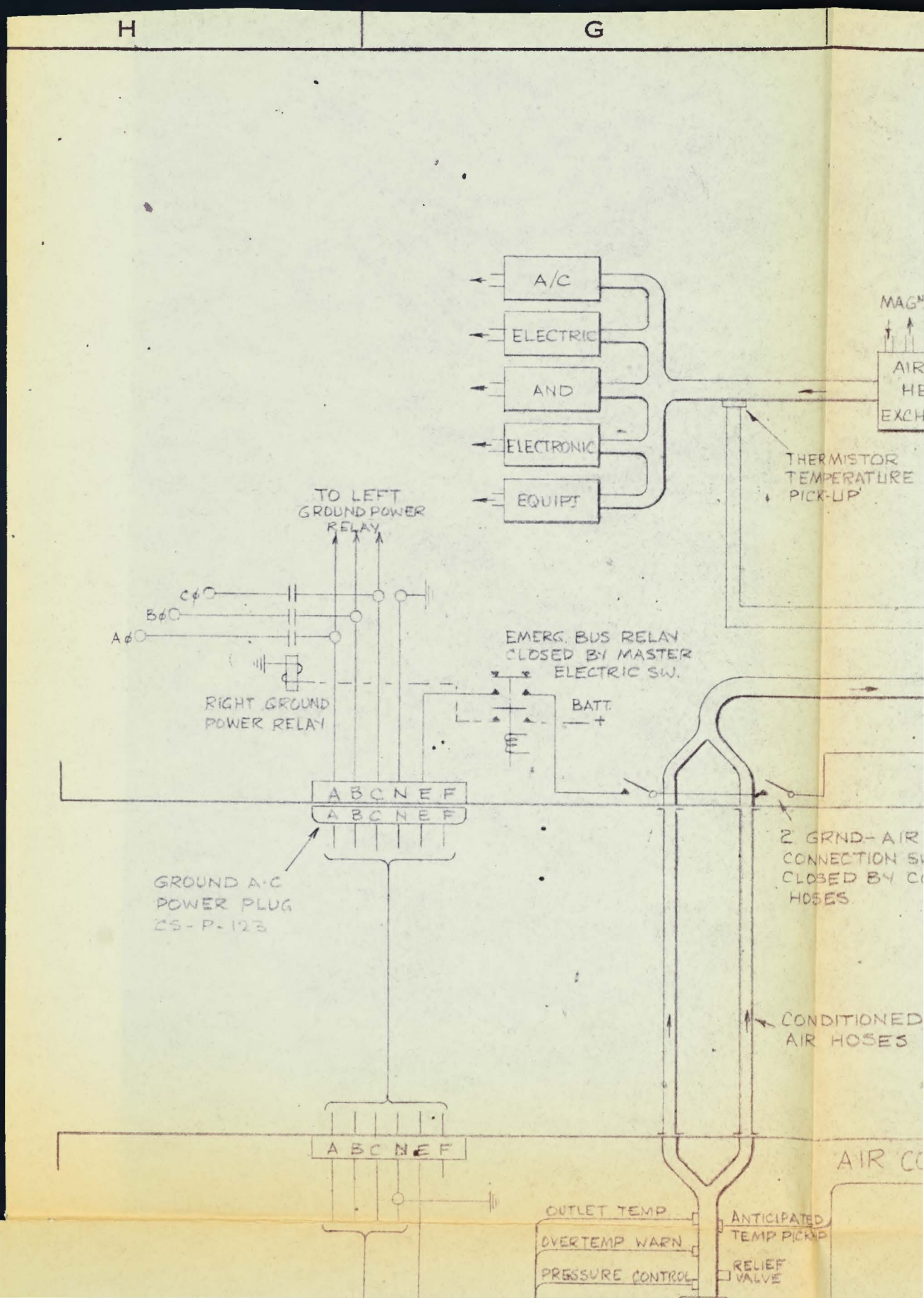
(c) Installation drawings of off-shelf components made by the Garrett Corporation.
(d) Parts list including manufacturer's name and part number.
(e) A technical report describing the system and its components.

3. The Garrett Corporation shall assist Avro Aircraft Limited on the following points:-

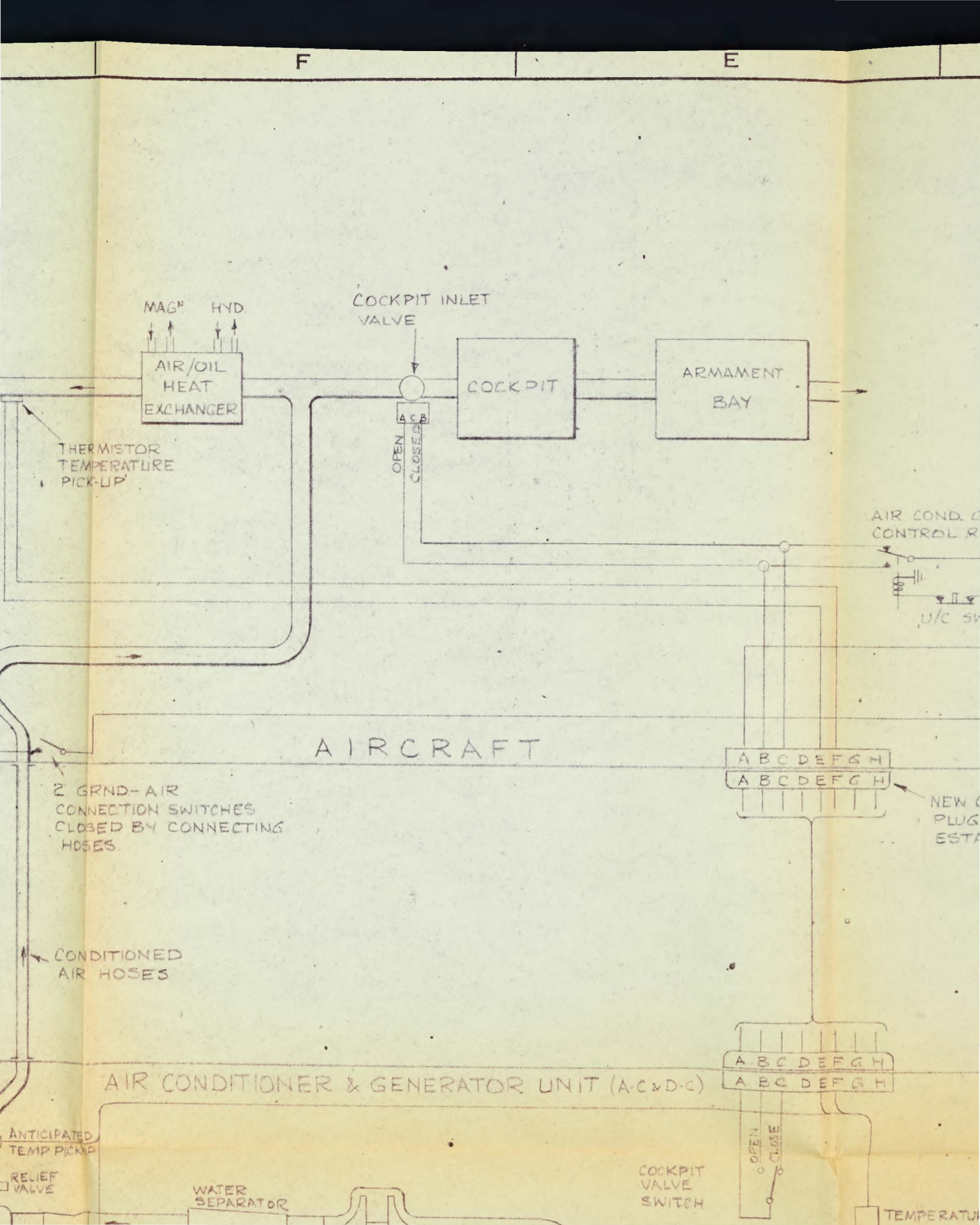
(a) Recommendations and advice on the arrangement of components within the enclosure(s).
(b) Recommendations and advice on ventilation and required air circulation within the enclosure(s).
(c) Recommendations and advice on the design of ducts between principal components.
(d) Recommendations and advice on the installation of controls.
(e) Recommendations and advice concerning anti-vibration mounts.
(f) Recommendations and advice concerning the location of the temperature sensing devices.
(g) Recommendations and advice on the design of the air mixing chamber.
(h) Recommendations and advice on sound attenuation.

The Garrett Corporation will provide technical assistance and advice, as required, throughout the basic development program. The basic development program will be considered completed with the delivery of the first complete unit to the Avro flight test organization.

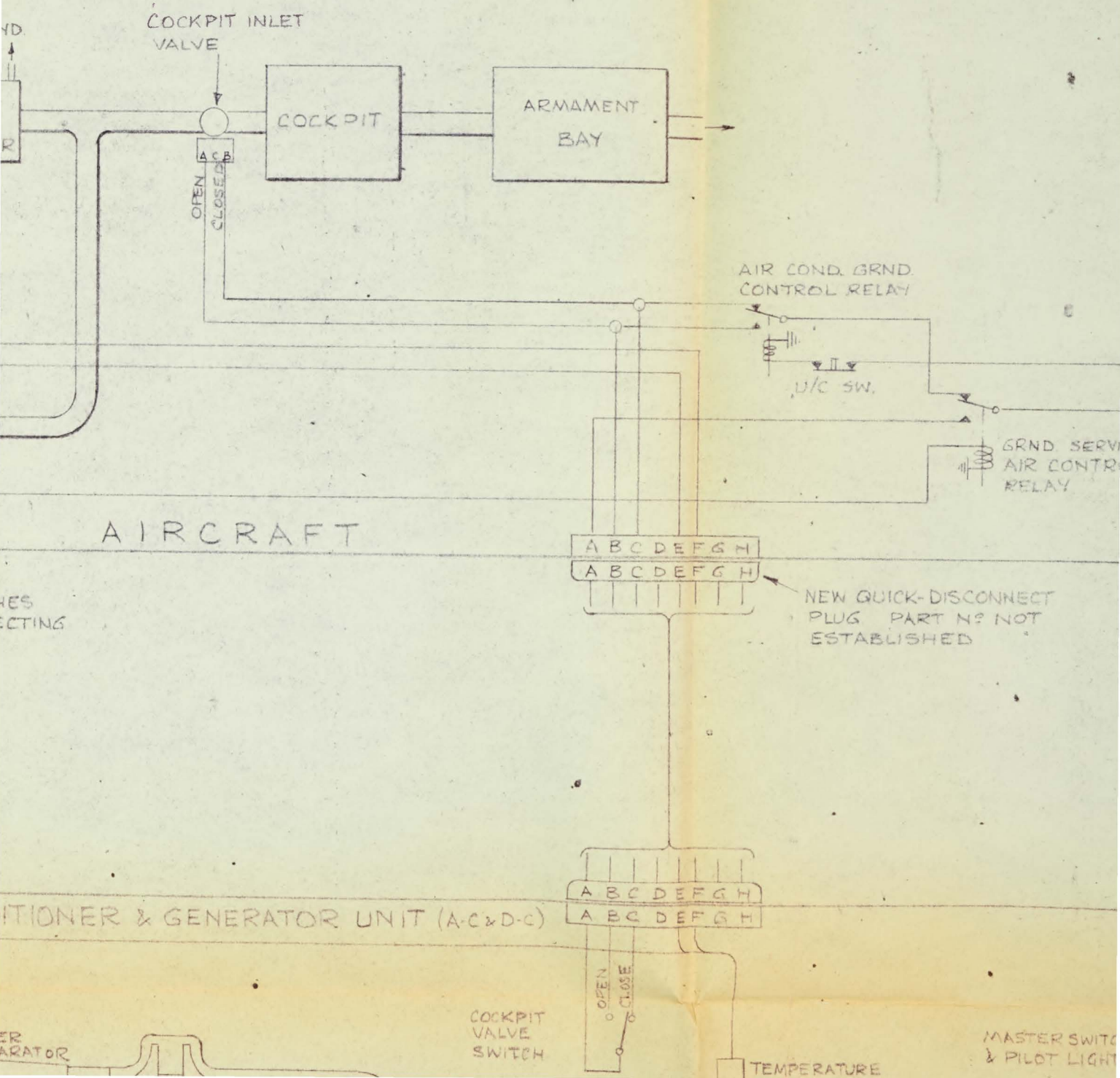
4. The Garrett Corporation of Canada Limited shall prepare and submit to Avro Aircraft Limited maintenance and overhaul instructions for the System and its components.

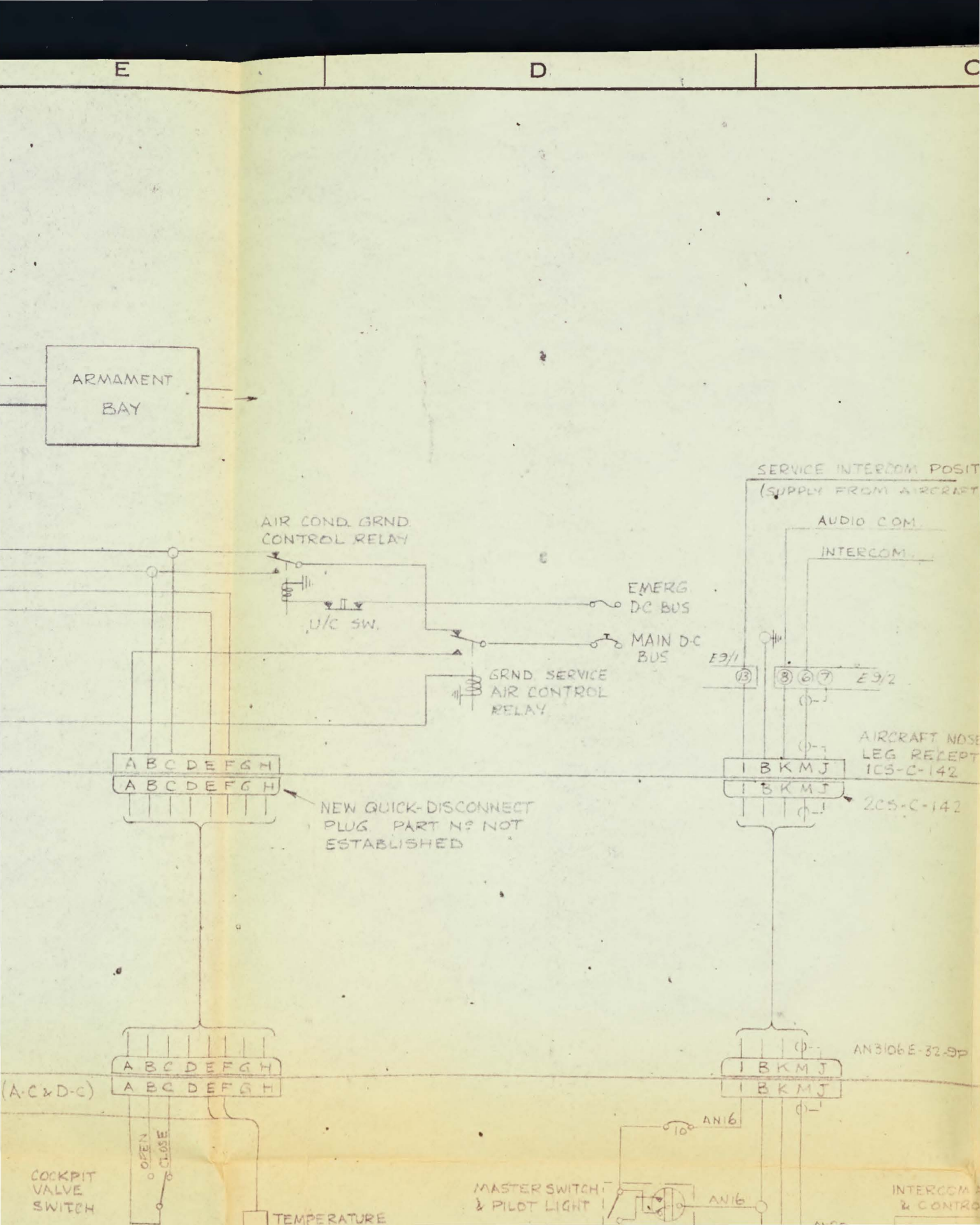

H
G
A/C
ELECTRIC
AND
ELECTRONIC
EQUIPT
MAGN
AIR
HE
EXCH
THERMISTOR
TEMPERATURE
PICK-UP
TO LEFT
GROUND POWER
RELAY
Cϕ
Bϕ
Aϕ
RIGHT GROUND
POWER RELAY
EMERG. BUS RELAY
CLOSED BY MASTER
ELECTRIC SW.
BATT.
+
A B C N E F
A B C N E F
GROUND A-C
POWER PLUG
CS-P-123
2 GRND-AIR
CONNECTION SW
CLOSED BY C
HOSES
CONDITIONED
AIR HOSES
A B C N E F
AIR C
OUTLET TEMP
OVERTEMP WARN
PRESSURE CONTROL
ANTICIPATED
TEMP PICKUP
RELIEF
VALVE

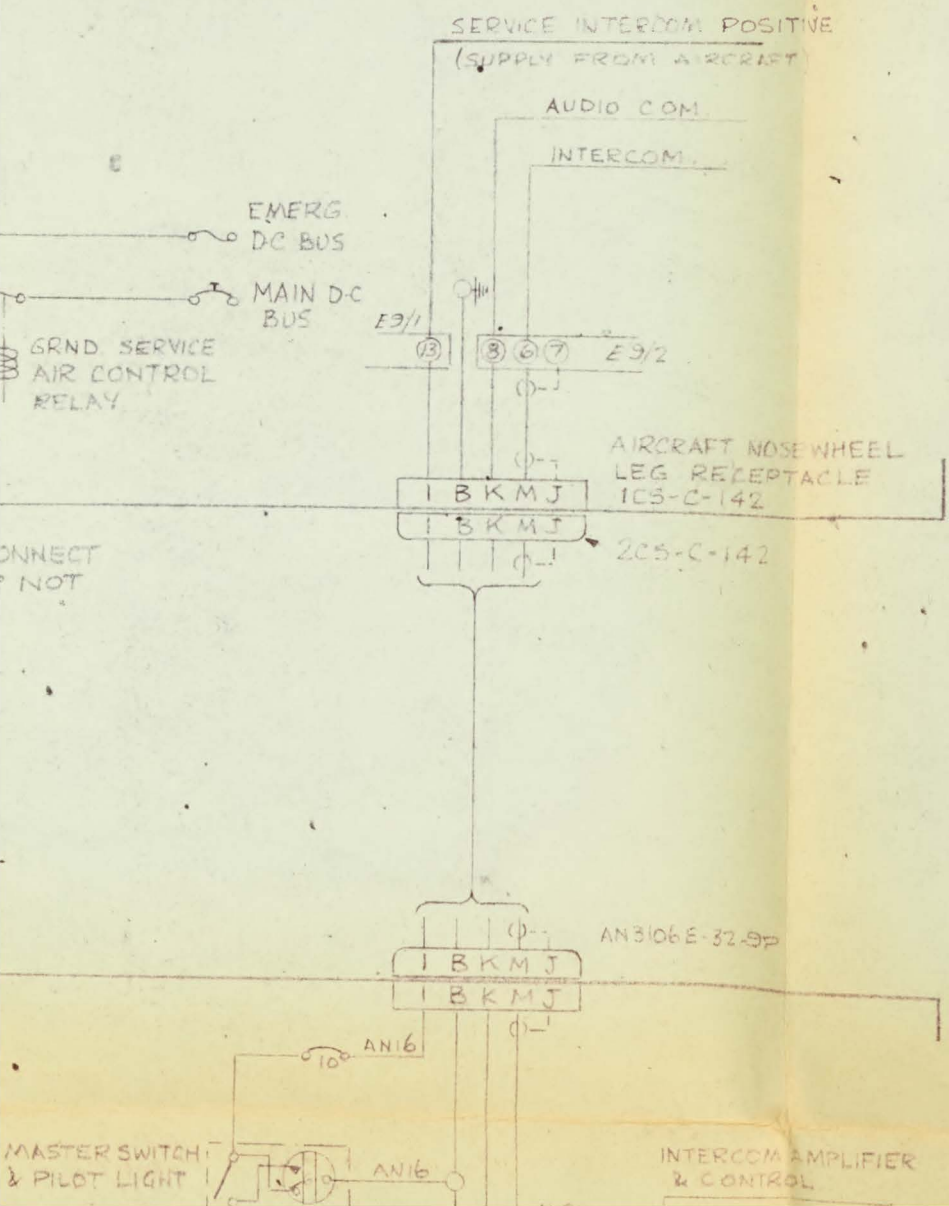
F E

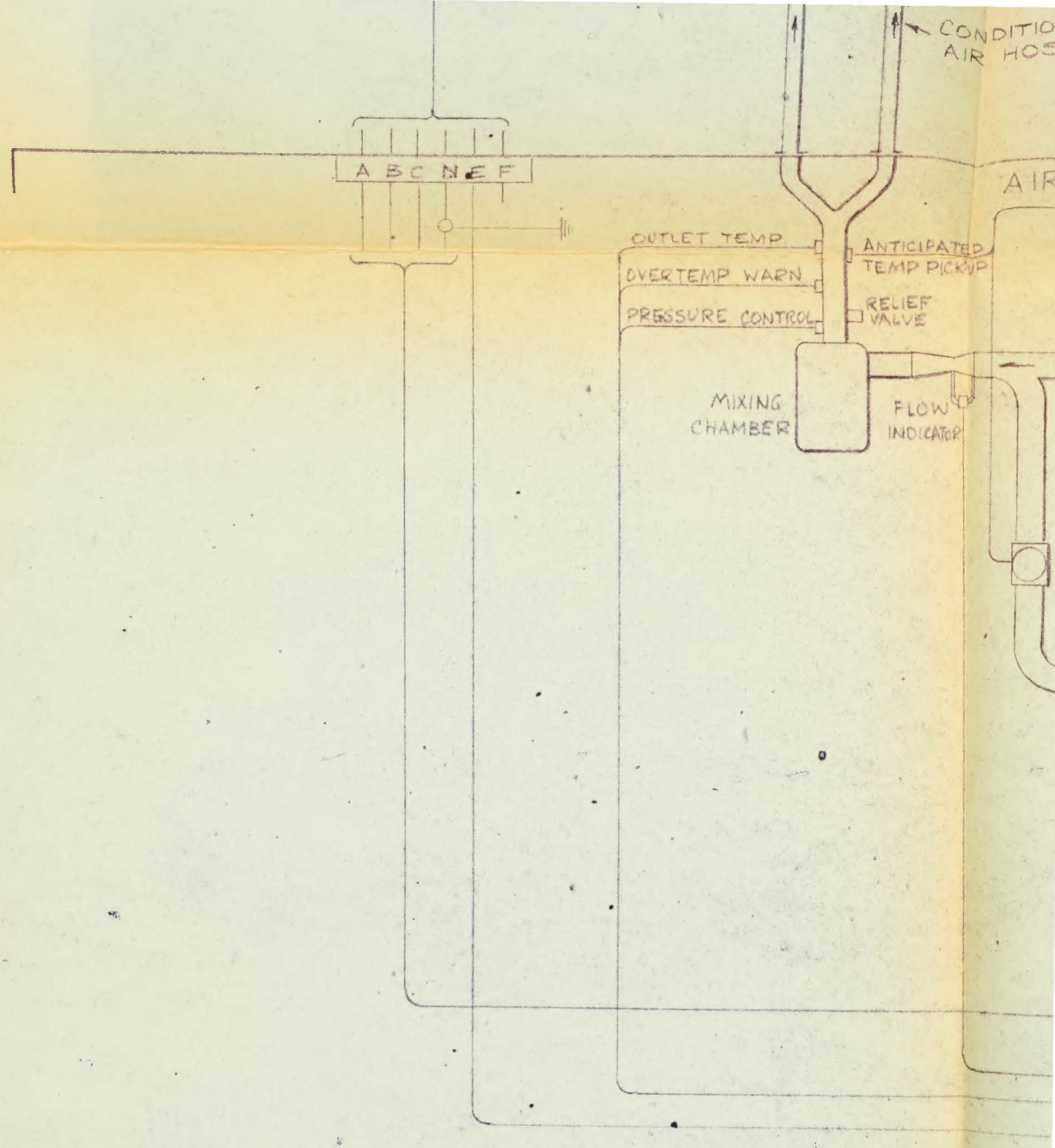

MAG"
HYD.
AIR/OIL HEAT EXCHANGER
THERMISTOR TEMPERATURE PICK-UP
COCKPIT INLET VALVE
A C B
OPEN
CLOSED
COCKPIT
ARMAMENT BAY
AIR COND. C
CONTROL R
U/C SW
AIRCRAFT
A B C D E F G H
A B C D E F G H
NEW
PLUG
ESTA
2 GRND-AIR CONNECTION SWITCHES CLOSED BY CONNECTING HOSES
CONDITIONED AIR HOSES
A B C D E F G H
A B C D E F G H
AIR CONDITIONER & GENERATOR UNIT (A-C & D-C)
OPEN
CLOSE
ANTICIPATED TEMP PICKUP
RELIEF VALVE
WATER SEPARATOR
COCKPIT VALVE SWITCH
TEMPERATU

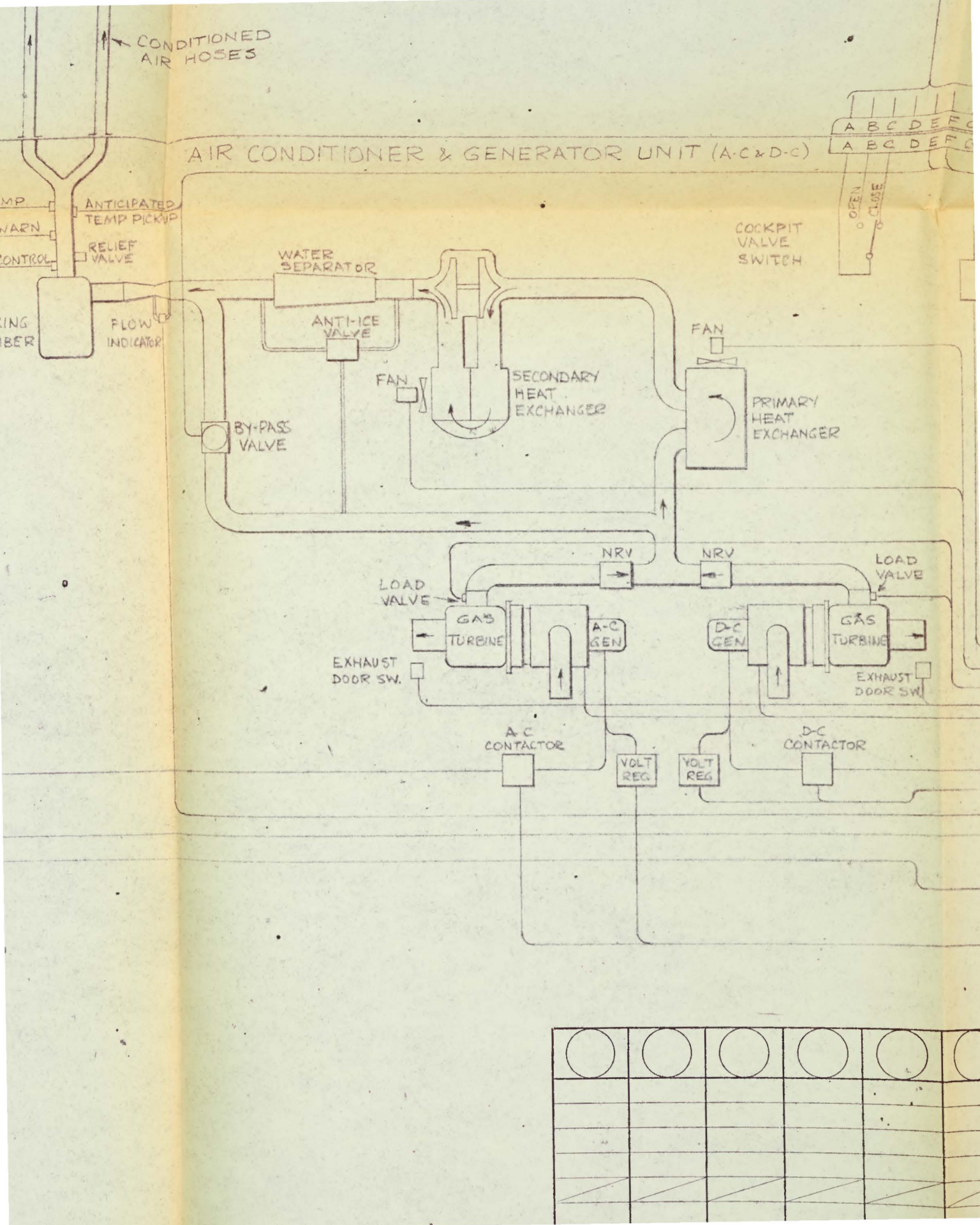
F E D

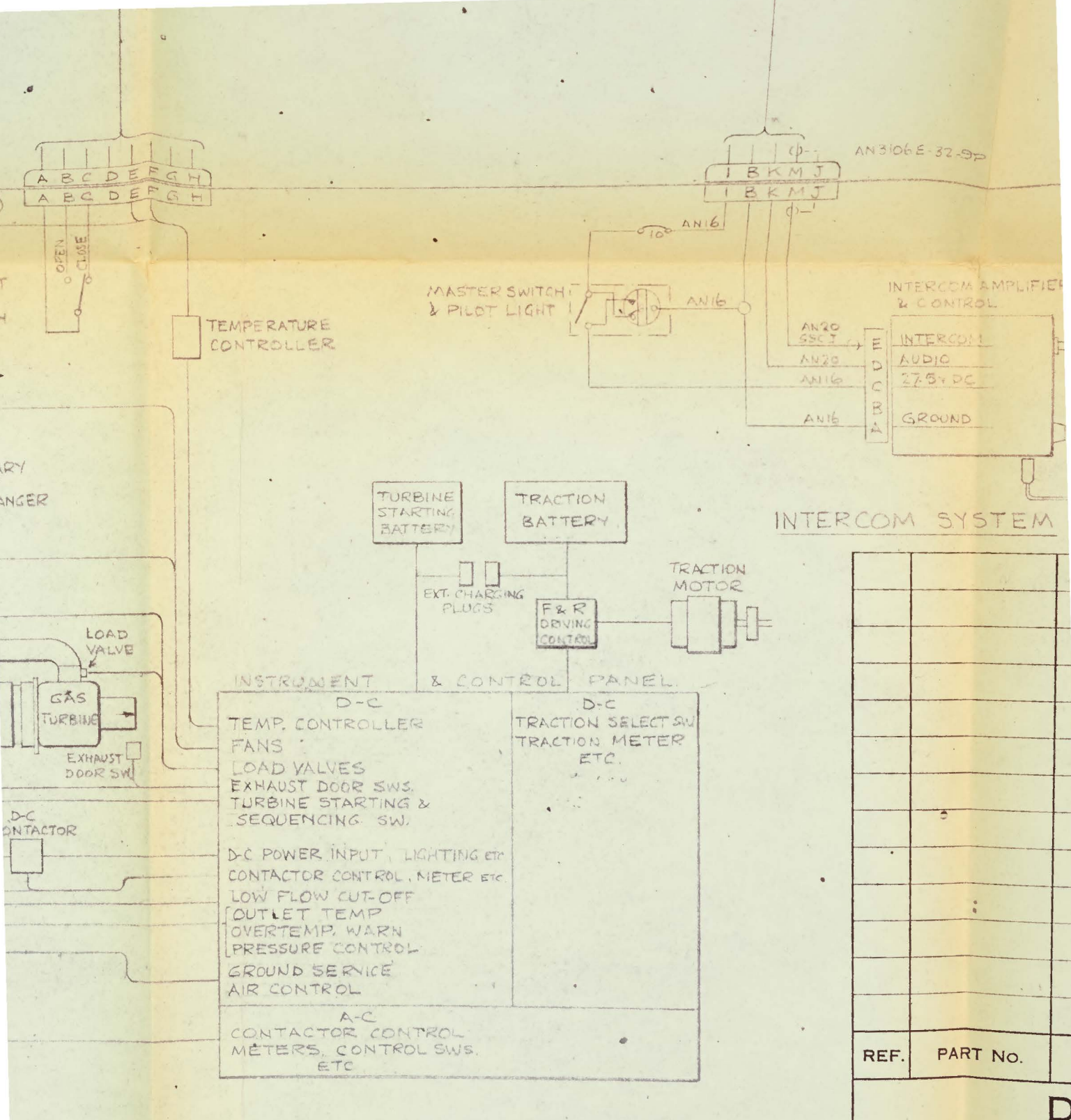

COCKPIT INLET VALVE
COCKPIT
ARMAMENT BAY
A C B
OPEN
CLOSED
AIR COND. GRND. CONTROL RELAY
U/C SW.
GRND SERV
AIR CONTR
RELAY
AIRCRAFT
A B C D E F G H
A B C D E F G H
NEW QUICK-DISCONNECT PLUG PART Nº NOT ESTABLISHED
A B C D E F G H
A B C D E F G H
ITIONER & GENERATOR UNIT (A-C & D-C)
OPEN
CLOSE
COCKPIT VALVE SWITCH
TEMPERATURE
MASTER SWITC
& PILOT LIGHT


ARMAMENT BAY
AIR COND. GRND. CONTROL RELAY
U/C SW.
EMERG. D.C BUS
MAIN D.C BUS
GRND. SERVICE AIR CONTROL RELAY
SERVICE INTERCOM POSIT
(SUPPLY FROM AIRCRAFT
AUDIO COM.
INTERCOM.
E9/1
E9/2
AIRCRAFT NOSE LEG RECEPT 1C5-C-142
2C5-C-142
A B C D E F G H
I B K M J
NEW QUICK-DISCONNECT PLUG PART Nº NOT ESTABLISHED
AN3106E-32-9P
(A-C & D-C)
AN16
COCKPIT VALVE SWITCH
OPEN
CLOSE
MASTER SWITCH & PILOT LIGHT
TEMPERATURE
INTERCOM & CONTRO


SERVICE INTERCOM POSITIVE
(SUPPLY FROM AIRCRAFT)
AUDIO COM.
INTERCOM.
EMERG. D-C BUS
MAIN D-C BUS
E3/1
13
8 6 7 E3/2
GRND SERVICE AIR CONTROL RELAY
AIRCRAFT NOSEWHEEL LEG RECEPTACLE
1CS-C-142
I B K M J
2CS-C-142
ONNECT
NOT
AN3106E-32-9P
AN16
10
MASTER SWITCH & PILOT LIGHT
INTERCOM AMPLIFIER & CONTROL


CONDITIO
AIR HOS
A B C N E F
AIR
OUTLET TEMP
OVERTEMP WARN
PRESSURE CONTROL
ANTICIPATED
TEMP PICKUP
RELIEF
VALVE
MIXING
CHAMBER
FLOW
INDICATOR


CONDITIONED AIR HOSES
AIR CONDITIONER & GENERATOR UNIT (A-C & D-C)
A B C D E F
A B C D E F
OPEN
CLOSE
COCKPIT VALVE SWITCH
MP
NARN
CONTROL
ANTICIPATED TEMP PICKUP
RELIEF VALVE
RING
BER
FLOW INDICATOR
WATER SEPARATOR
ANTI-ICE VALVE
FAN
SECONDARY HEAT EXCHANGER
FAN
PRIMARY HEAT EXCHANGER
BY-PASS VALVE
NRV
NRV
LOAD VALVE
LOAD VALVE
GAS TURBINE
A-C GEN
D-C GEN
GAS TURBINE
EXHAUST DOOR SW.
EXHAUST DOOR SW.
A-C CONTACTOR
D-C CONTACTOR
VOLT REG
VOLT REG



INTERCOM SYSTEM

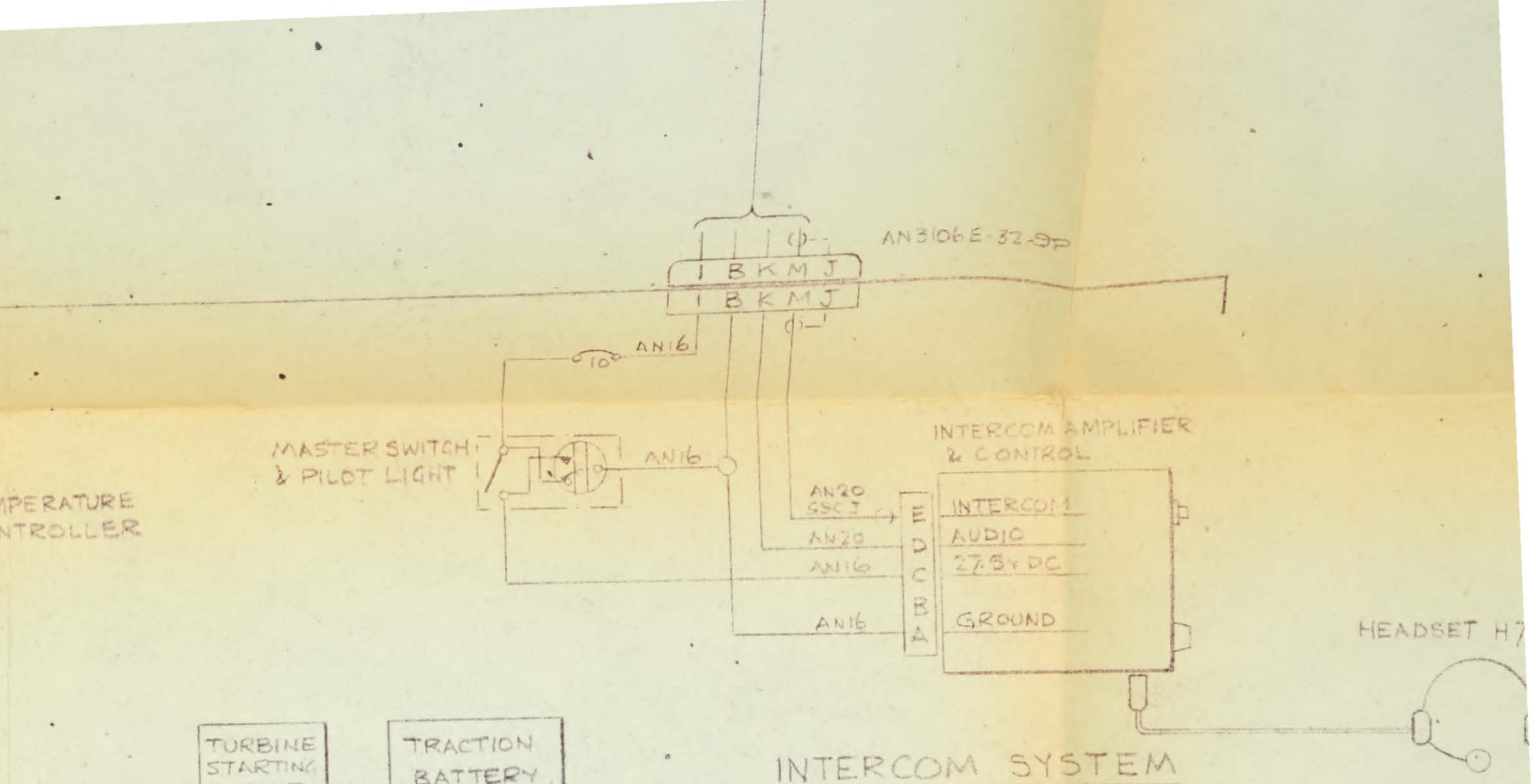
REF.	PART No.

D

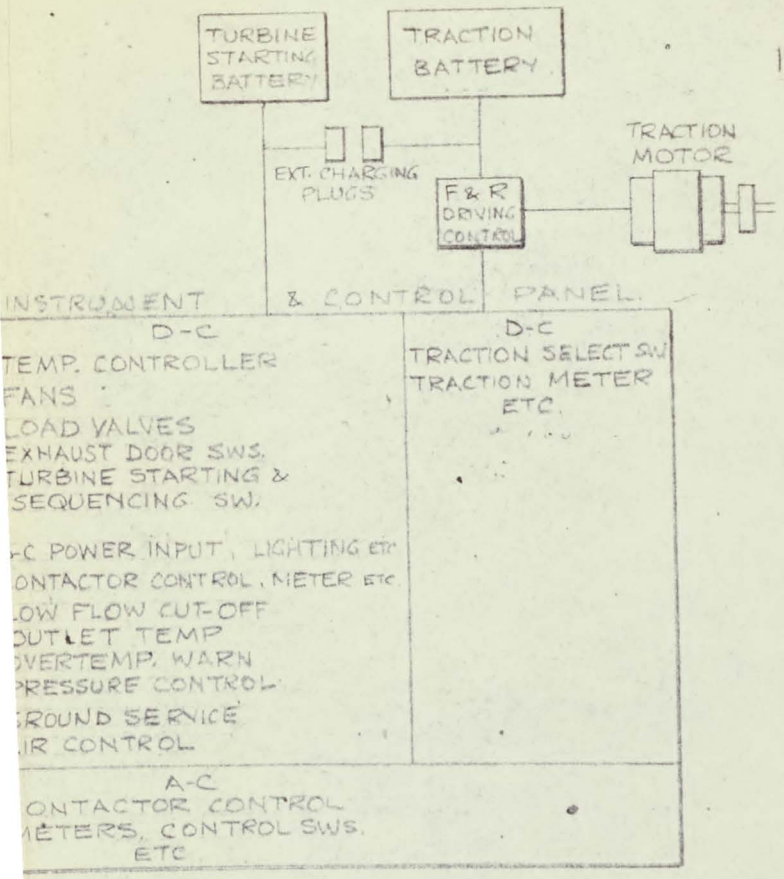
ISSUE No.	1
MOD. No.	
E.R.N. No.	
DRAWN BY	F.K. BRADLEY
DATE	APRIL 23/58
CHECKED	
STRENGTH APP	

REFERENCE DRAWINGS

DWG. No.	DESCRIPTION



INTERCOM SYSTEM



REF.	PART No.	DESCRIPTION

DRAWING

				ISSUE No.
				MOD. No.
				E.R.N. No.
			E.K. BRADLEY	DRAWN BY
			APRIL 23/58	DATE
				CHECKED

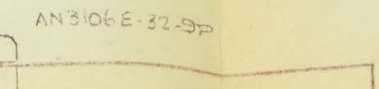
REFERENCE DRAWINGS	
DWG. No.	DESCRIPTION

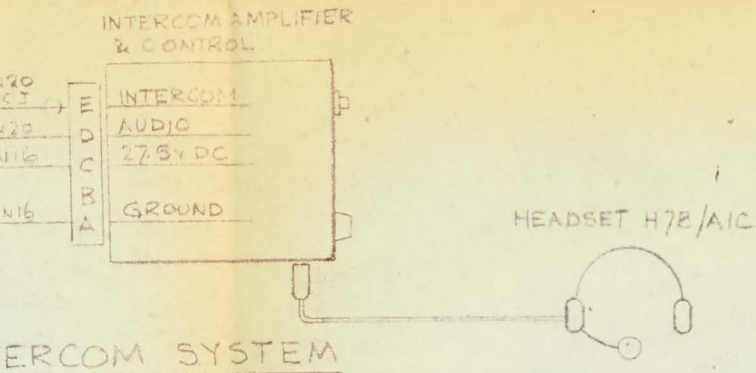
DESCRIPTION

SCHEMA

AIR CONDITIONER

GROUND





THIS DRAWING SHALL BE USED
CONJUNCTION WITH AVRO REPORT

ERCOM SYSTEM

REF.	PART No.	DESCRIPTION	L.H. UNIT No.	R.H. OFF	DESCRIPTION FINISHED PART SPECIFICATION	SPECN—CONDN	LOF

DRAWING PARTS LIST

ERENCE DRAWINGS	
O.	DESCRIPTION

DESCRIPTION

SCHEMATIC DIAGRAM

AIR CONDITIONER & GENERATOR, A-C & D-C.

GROUND EQUIPMENT