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CLEAR AIR TURBULENCE RADIOMETRIC DETECTION PROGRAM

Operating Procedures-Flight Test

Supplement

G. W. Wagner
G. G. Haroules
W. E. Brown

DECEMBER 1973
FINAL REPORT
SUPPLEMENT

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16. Abstract
This final report supplement presents the procedures for ground handling of the flight test sensor system and its individual components used for the acquisition of experimental data during clear air turbulence detection flights at high altitudes.

Information on flight planning, data reduction, and data analysis is also included.

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PREFACE

The contents of this document cover the basic information and instructions usable as a guide for the interface, operation and data evaluation resulting from flight test of the clear air turbulence Radiometric sensor. The word BASIC in this case, implies that the information herein is subject to continuous revision or correction as equipment changes and new methods come to view during operational test periods.

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1. INTRODUCTION

The flight test operating procedures herein are intended to provide detailed instructions for the assembly, disassembly, installation, removal and performance checks of the Clear Air Turbulence Detection flight system and its individual components. Information is also included on flight planning, data reduction, and analysis.

The flight sensor system is an individual package consisting of all the atmospheric and dynamic sensors including their electronics. The sensor system is housed in a modified fuel tank for installation on the right wing tip of a B-57 Canberra aircraft. It is counterbalanced by a fuel tank of equal weight on the left wing of the aircraft as shown in Figure E-1.

The system operates as an independent automatic unit. Electrical power is provided from the aircraft through a single cable connector at the wing tip. Two switches are provided in the pilot's compartment for operating the complete system, one activates the power input and the other controls the data receiving function of the airborne tape recorder.

The instrumentation used for measurement of meteorological parameters associated with CAT is briefly described as follows. A CAT Sensor System Instrumentation schematic is shown in Figure G-1.

1. Dual-channel Radiometric Sensor - TSC Experiment.

The 60 GHz radiometer CAT sensor is a dual-channel sensor system for performing accurate radiometric measurements at a wavelength of 5mm. The unit is designed for aircraft installation. Its principal use is in the detection of atmospheric temperature anomalies along the horizontal forward flight path of an aircraft at flight altitudes. The radiometer is a complete sensor system consisting of two radiometric receivers packaged integrally with one common lens-corrected horn antenna. Each radiometric receiver is fed from a common orthogonal-mode transducer located at the antenna output. Atmospheric temperature signals are simultaneously processed by the two receiver channels which operate at nominal frequencies of 52 and 58 GHz. The receivers are separately tunable over ± GHz about their nominal operating frequencies.

The radiometric modes of operation are modified absolute-temperature modes. The modification introduced in the absolute modes provides for adjustment of either or both radiometer output signals to a reference level corresponding to the ambient temperature at the aircraft flight altitudes.

2. Airborne Tape Recorder (Genisco)

It consists of 15 recording channels and accepts data signals in the form of voltages which are converted back to flight parameters during the data-reduction process.

3. Time-code Generator (Datametrics)

This is recorded as real-time for ranging calculations of clear air turbulence. The actual time is set, into the TCG at pre-flight in accordance with the pilot's clock.

4. Altimeter Transducer (Edcliff)

This provides an accurate indication of flight altitude during CAT search and changes thereof during CAT encounters. This unit senses atmospheric pressures through a static port located outside the pod. These pressures are converted and recorded as voltage signals on the magnetic tape.

5. Accelerometers (Edcliff)

Three accelerometers are mounted directly on the package for g-force measurement in the vertical, lateral, and thrust direction during clear air turbulence encounters.

6. Vertical Gyro (Lear Siegler)

It provides an accurate indication of the CAT sensor attitude in "pitch" and "roll" for small degree changes.

7. Inclinometers (Edcliff)

These provide "pitch" and "roll" data for changes in attitude plus-or-minus 0 to 30 degrees.

8. Thermocouples

One internal thermocouple is used to measure temperature changes in the pod. A second external thermocouple is mounted at the top forward end of the pod to measure ambient temperatures in conjunction with clear air turbulence encounters and is used in the data analysis of the CAT sensor measurements.

9. Velocity Probe and Electronics (Datametrics)

This probe is external to the pod. It is calibrated for the operating altitude and measures wind speeds and changes thereof. These data provide a means for calculating accurate aircraft air-speed and vertical shear velocities associated with turbulence.

10. Electronic Junction Box (TSC)

This unit contains the relays, circuit breakers, and electronics. It is also the terminal point for the signals in-coming from the sensors that are distributed to the 15-channel tape transport.

Flight planning and data reduction and analysis are explained in Sections 5 and 6.

2. FLIGHT PACKAGE COMPONENTS

2.1 POD - WING TIP (B-57 AIRCRAFT)

2.1.1 Radome Assembly

a. Radome - Mounting, Hardware
b. Ring Mount- Mounting, Hardware
c. Plate-Fail Safe
d. Seal-'O' Ring

2.1.2 Front Section Assembly

a. Shell and Ring
b. Cable-Electrical Ground Checkout
c. Access Plate - Tape Recorder
d. Probe Assembly with Temp. and Velocity Probe

2.1.3 Rear Section-Shell Assembly

a. Shell-Rear Section
b. Cable-Power/Control, Electrical
c. Access Plate-Time Code
d. Cradle-Instr. Package Support w/Slide Rails
e. Tube and Fitting-Altimeter Static Port
f. Access Plate-Balance Weights Section
g. Balance Weight Assembly, Includes Base Plate, Tie Down Bolts, 18 Six Pound Weights, and Lock Down Plate.

2.1.4 Accessories

a. Lifting Fixture w/Bolts
b. Storage and Shipping Cradle

2.2 INSTRUMENTATION PACKAGE ASSEMBLY

a. Radiometer-60 GHz, Dual Channel CAT Sensor
b. Tape Transport - Airborne-Genisco Model 10-410
c. Time Code Generator (Flow Corp) 350-XR-3 code

d. Velocity Electronics (Flow Corp.)
e. Vertical Gyro (Lear Siegler)
f. Altitude Transducer (Edcliff)
g. DC-DC Power Converter (Pioneer)
h. Accelerometers (3) (Edcliff)
i. Inclinometers (2) (Edcliff)
j. Thermocouple-Internal
k. Thermocouple-External (omega)
l. Thermocouple Ohmic Devices (2) (Consol.)
m. Junction Box-Electrical Terminal
n. Servo Motor Unit-Gyro, includes Control Transformer and Demodulator (2) Kearfott
o. Cables-Electrical Interconnecting w/Connectors
p. Base Plate-Mount for Items 1 to 15.

2.3 GROUND SUPPORT EQUIPMENT

a. Tape Recorder-Playback
b. Remote Time Display (Flow.)
c. Time Code Reader (Flow)
d. DC Power Supply (Sorenson) 28 volts/DC
e. Data Readout Panel
f. Amplifier-(Bogen)
g. Electronic Counter w/Plug-ins and Case
h. Control Box for Electronics Ground Checks
i. Recorder Switch Control with Cable.
j. Velocity Probe Repair Kit
k. Tape Splicer Kit
l. Frequency Meter
m. Digital Voltmeter
n. VOM
o. Functional Generator
p. Pod Remote Control Box
q. Airborne Tape Recorder Control Box

3. FLIGHT SYSTEM INSTALLATION, REMOVAL, ASS'Y, DISASS'Y

3.1 POD INSTALLATION TO AIRCRAFT WING TIP

The instrument pod may be attached to the aircraft tip with or without the sensor equipment installed in the pod. In either case the operation must be accomplished by the aircraft maintenance personnel at NASA-FRC.

a. Connect the small connector end of the power/control cable to the pod located on top of the pod at the hang points.

b. When the pod is lifted to within 18 inches of the wing tip, connect the power/control cable (aircraft end) to the connector located in the aircraft wing tip. This is accomplished through the top access hole in the wing tip.

c. As the pod is moved into bolt on position be sure any excess cable does not interfere with the bolt on operation.

NOTE: If possible, continuity check should be made at the wing tip connector before the pod is installed.

3.2 POD DISASSEMBLY

3.2.1 Radome Assembly Removal

a. Install two lifting handles 180° apart in the four exposed holes provided (No. 1 Fig. 1).

b. Remove the 12 screws that hold the radome to the pod shell. These screws are the first row immediately aft of the radome seam. Do not remove the second row of screws. (No. 2 Fig. 1)

c. Remove the top screw last while holding pressure against the front of the radome.

d. Using lifting handles, slowly pull the radome assembly forward until disengaged from the shell ring. Take caution not to damage the "O" ring seal.

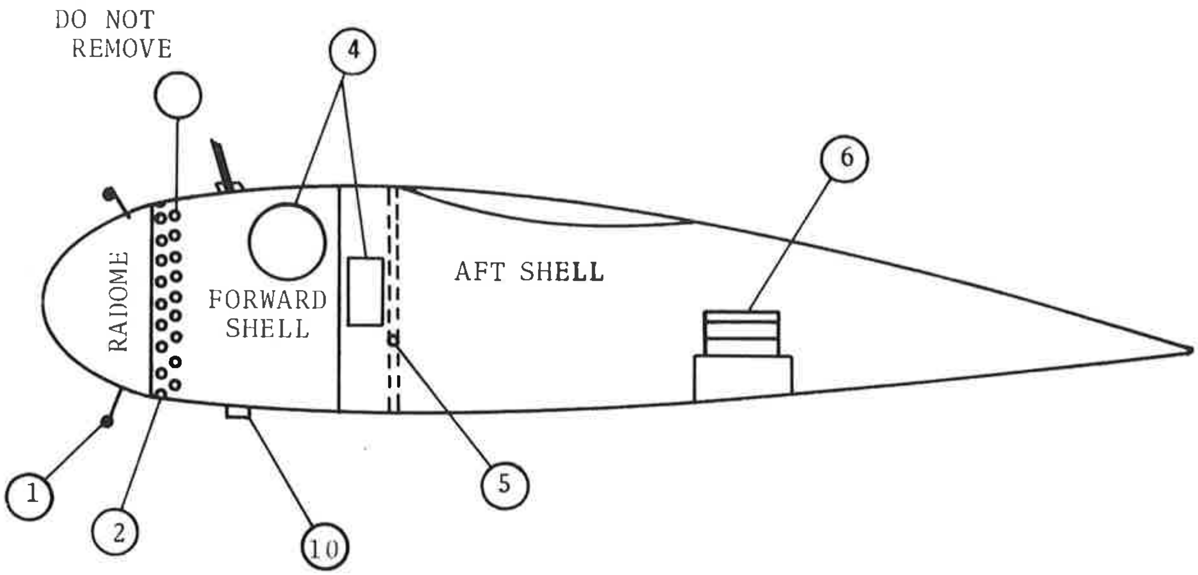


Figure 1. Pod Shell Configuration

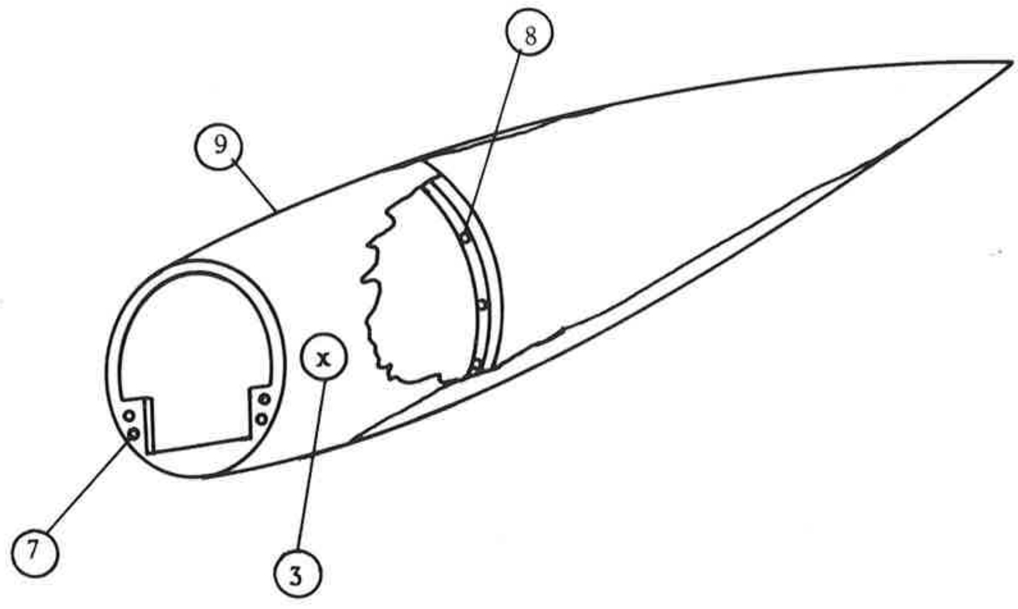


Figure 2. Pod Shell Fore and Aft Sections

e. Store radome assembly in container.

3.2.2 Instrument Package Removal

a. Remove the two inch brass disc located on the right and left side at the front of the shell. (No. 3 Fig. 2.)

b. Through the two access holes uncovered by (a), remove two 1/4-28 hex bolts on each side using a 3/8 socket wrench. These four bolts lock the instrument package to the slide rails.

c. Remove the two large access plates, one 10 inch diam. and one rectangular 5 X 9 inch. (No. 4 Fig. 1)

d. Disconnect copper static tube line on the instrument package side. Fitting is located on the first rib flange visible through the rectangular access hole. Move the disconnected tube about one inch toward the pod center to clear the bulkhead when the package is removed. (No. 5 Fig. 1)

e. Disconnect the 61 pin connector at the junction box. Access is through the 10 inch round hole.

f. Disconnect the 12 pin power/control cable at the junction box. Located next to the 61 pin connector.

g. Disconnect the external temp. and velocity probes, at the probes, from inside the pod through the 10 inch access hole. Disconnect is at the cable snap-on connector.

h. To remove the instrument package, grasp the radiometer on both sides of the front flange and pull forward 3/4 out. Lift the package out using the exposed handle slots and store on the roll-away cart.

3.2.3 Balance Weight Removal

a. Remove rectangular access plate at right rear of POD. (No. 6 Fig. 1)

b. Remove two 3/8 hex nuts at top of balance weights.

c. Remove alum holddown plate.

d. Remove lead weights as desired.

3.2.4 Forward Shell Removal

a, Remove four 1/4-28 hex bolts exposed at the front of the forward bulkhead (shell ring). (No. 7 Fig. 2)

b. Remove 10-1/4-28 hex bolts at the ring joint inside the POD. Location is 24 inches aft of front shell ring. Access to the bolts is through the front or through the side access holes. (No. 8 Fig. 2)

Caution: Remove the top bolt last and support the shell before disengaged.

c. Lift shell (No. 9 Fig. 2) away from internal structure and store. Observe internal wiring for hang-ups.

3.3 INSTRUMENT PACKAGE DISASSEMBLY

The complete system shall be placed on the roll-away cart provided before attempting disassembly.

3.3.1 Radiometer (No. 5 Fig. 3)

a. Disconnect the three power and data cables on top of the radiometer.(No. 1 Fig. 3)

b. Remove the thermocouple ohmic devices from the angle brackets on each side of radiometer. (No. 2 Fig. 3)

c. Disconnect thermocouple lead from ohmic device on the right side of the radiometer.

d. Disconnect inclinometer connector and remove clamps holding the electrical cables to same (No. 3 Fig. 3)

e. Remove six hex bolts (three each side) located on top of angle bracket and above each shock mount. (No. 4 Fig. 3) Bolt size-1/4-28.

f. Lift radiometer from base plate and store in its shipping case. (No. 5 Fig. 3)

3.3.2 Time Code Generator Removal (No. 6 Fig. 3)

a. Disconnect cable at front of Time Code. (No. 6 Fig. 3)

b. Disconnect electrical cable at top rear of time code. (No. 7 Fig. 3) Also remove cable clamp (velocity).

c. Loosen two wing nuts at front of time code and lift out of cradle.

3.3.3 Junction Box Removal (No. 9 Fig. 3)

a. Disconnect all connectors at the J-box.
b. Disconnect four dzus fasteners on J-box flange (No. 8 Fig. 3)
c. Remove four screws holding hinges and lift off J-box.
d. For access to inside of box remove six 8-32/cap screws at the flange and remove bottom plate.

3.3.4 Tape Recorder Removal (No. 10 Fig. 3)

a. Junction box must be tipped up to expose recorder.
b. Disconnect two cinch connectors (one on each side) by removing the two holding screws on each connector. Located under the base plate (No. 11 Fig. 3)
c. Remove cotter pins from each 1/2" bolt, if installed, and remove the four corner bolts and nuts holding the tape recorder to the base plate. (No. 12 Fig. 3)
d. The tape recorder can be removed by pushing upward from under the recorder and lifting topside.

3.3.5 Vertical Gyro Removal (No. 13 Fig. 3)

a. Location is under the base plate at the aft end.
b. Disconnect electrical cable.
c. Remove double lock nuts on top side of base plate which hold the cable clamps.
d. Remove four 10-32 screws holding the U shape bracket to the base plate. Located under the base plate. (No. 14 Fig. 3)

3.3.6 DC-DC Converter Removal (No. 15 Fig. 3)

a. Location is under the base plate at the aft end.
b. Remove double lock nuts holding cable clamps topside of base plate.

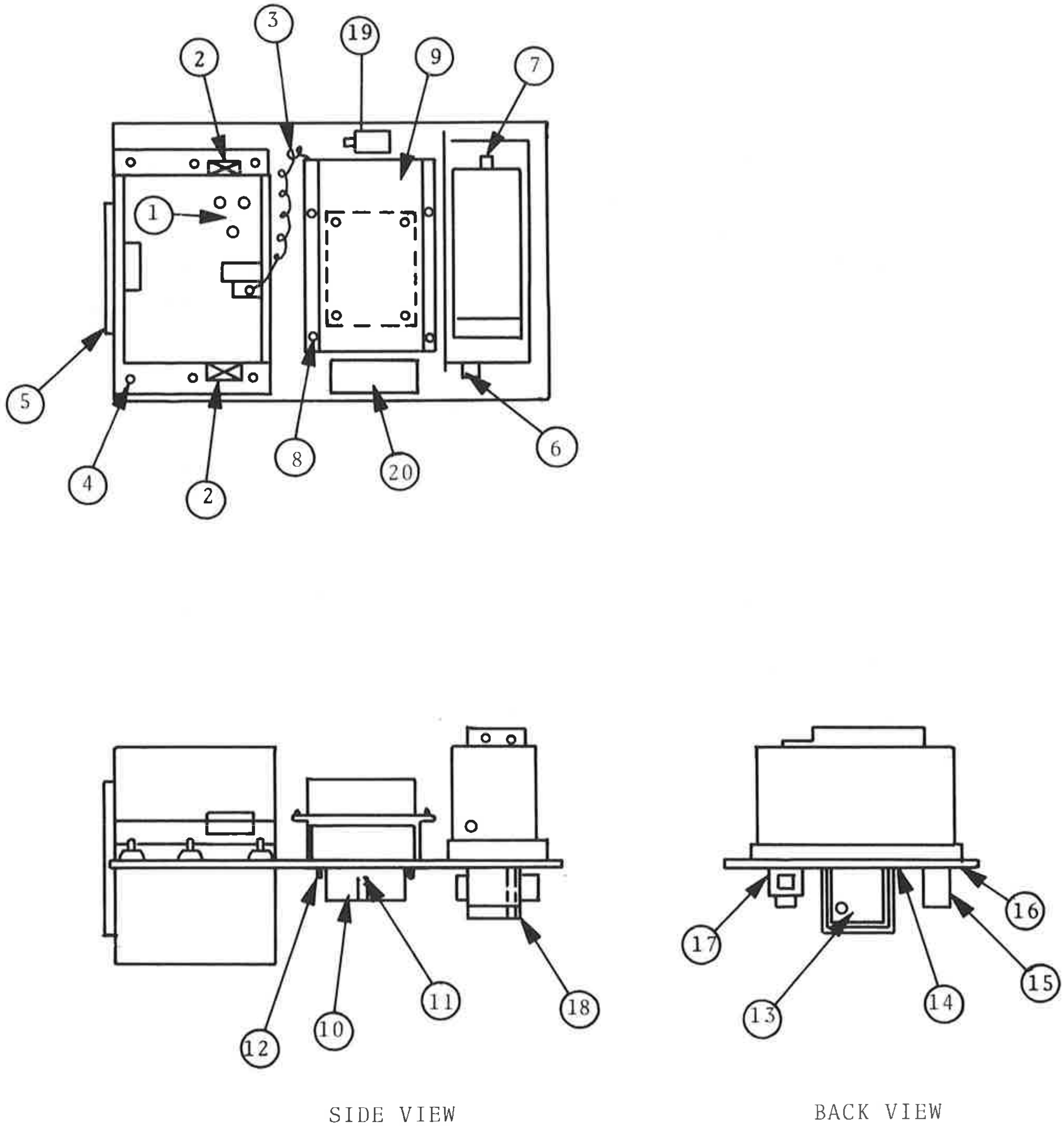


Figure 3. Flight Sensor Package

c. Disconnect electrical connector at the converter.

d. Remove four screws holding the U bracket under the base plate (No. 16 Fig. 3)

3.3.7 Accelerometer Cluster Removal (No. 17 Fig. 3)

a. Location is under the base plate at the aft end.

b. Disconnect electrical wires at the accelerometers.

c. Remove double lock nuts holding cable clamps on topside of the base plate.

d. Remove four 10-32 cap screws using an allen wrench. Screws are located in deep access holes from under the mount block. (No. 18 Fig. 3)

3.3.8 Altitude Transducer Removal (No. 19 Fig. 3)

a. Transducer is located on top of base plate behind the junction box.

b. Disconnect the copper tube fitting at the transducer.

c. Disconnect electrical connector.

d. Remove four 10-32 screws from under the base plate.

3.3.9 Velocity Servo Motor Unit (No. 20 Fig. 3)

a. Box is located on top the base plate in front of junction box.

b. Remove cover from the servo box.

c. Remove two 10-32 screws at the bottom inside the box with a crosspoint screwdriver.

d. Lift box to its limit and disconnect electrical cables at the connectors.

4. OPERATING INSTRUCTIONS AND PERFORMANCE CHECKS

This test is a complete electrical checkout of the Flight System Package and is accomplished with the system out of the Pod and set up in the laboratory.

4.1 REQUIRED BENCH TEST EQUIPMENT

a. Oscilloscope and Detector Monitor
b. Volt-Ohm meter
c. Power Supply-main-28 VDC
d. Digital Voltmeter
e. Clamp-on Ammeter
f. Crystal Current Meter
g. Ground Check-out Box.

4.2 INTERCABLE CONNECTIONS

Connect the oscilloscope to the two BNC connectors on the J-Box for the ϕ Detectors. Connect the Ground-Check-Out Box to the J-Box.

4.3 TEST PROCEDURES-EQUIPMENT PERFORMANCE

4.3.1 Radiometer

a. With power applied, connect the crystal current monitor cables to 5J3 and 5J4 or 6J3 and 6J4 on the Radiometer Preamps.
b. The output voltage should be -1.5 to -2.0 volts with oven turn on. Turning 'on' the 'Bal' switch should cause a deflection of 4 volts, then turning on the 'Cal' switch should cause a deflection of 4 volts in the opposite direction.
c. With the noise tube's off and the oven off and at room temperature the output voltage should be zero volts.

d. Detailed information, schematics and illustrations are given in:-Operating and Instruction Manual for the 60 GHz Dual Channel Radiometric Sensor.

4.3.2 Time Code Generator

The airborne TCG operates on aircraft 28 VDC power and contains a self charging battery with a 30 minute duration. The time code signal is recorded on the magnetic tape recorder as a voltage.

To set the time of day, place the Mode Control switch to STOP and press Time Reset button. Press each Time Preset button to a desired hours minute and seconds. The TCG will start counting when the Mode Control switch is switched to START.

TEST of TCG - With power applied, connect the oscilloscope to the 'DC Code' and check wave form. The code should be XR3 with 12 ms zeros and 24 ms ones.

4.3.3 Ground Checkout Box Operation

This ground control unit contains all the necessary switches and indicators for bench test or preflight test of each individual function of the flight system. See Figure 4 below.

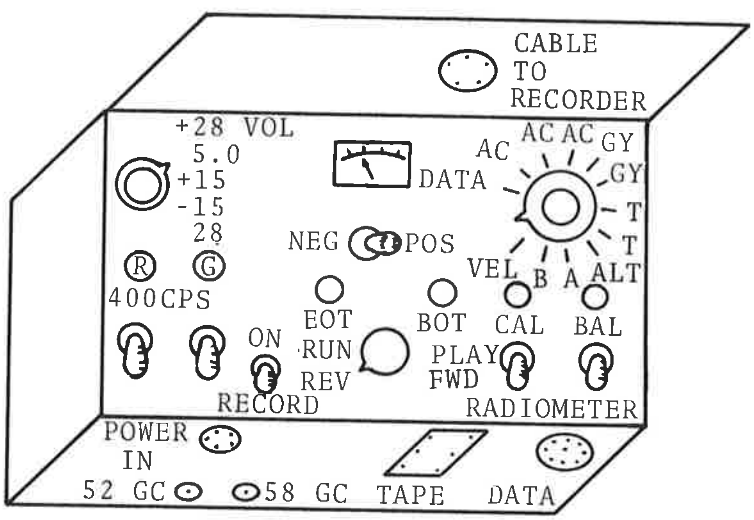


Figure 4. Sensor Functional Checkout Control Box

The switch on the left is to monitor the power supply and the other rotary switch on the right is to monitor the data. With the data (right) switch on the data position the power supply switch is connected to the meter. The meter scale reads 0-50 volts for the +28, +15, -15, +5, and -5 volts. Check using the left rotary power switch.

The POS and NEG switch below the meter is for reversing the meter scale. The meter scale has a range of 0-5 volts when the data (right) switch is in use.

The rotary switch below the meter is for operation of the tape recorder remotely. This switch provides recorder modes: stop, run, forward and reverse. The green and red lights above the switch indicates, BOT (beginning of tape) and EOT (end of tape). The remote control for the tape recorder plugs into the front of the Control Box. Only one switch should be used, that is, the sw on the control box or the sw on the remote unit. The switch not in use shall be in the stop position.

The small toggle switch to the left of the recorder mode switch turns on the recorder electronics for the collection of data on the magnetic tape in the airborne recorder.

When the record switch is ON the data is recorded on tape regardless of direction or speed of the recorder.

The two switches on the lower right marked radiometer are used to check the calibration and balancing feature of the radiometer.

The multi-cable connector on the front of the box transports the signals from the flight system to the J-Box and is so marked.

4.3.4 Tape Recorder (Airborne)

4.3.4.1 Access to Recorder (in Pod)

a. Remove the ten inch round access panel located in the pod nose section. Top side.

b. Remove the 5X9 inch access panel on the side of the pod.
c. Connect the cable with the 61 pin connector to the mate underneath the pod. (No. 10 Fig. 1)
d. Connect the tape remote control box to the master ground control checkout box. Rectangular connector.
e. Disengage the four dzus fasteners on the J-Box flange and swing the J-Box up and back on its hinges to expose the tape recorder.
f. Remove seven cap screws from the tape recorder cover plate.
g. Insert three long cap screws (just removed) in the three threaded holes of the cover plate and evenly screw down until cover plate is free.
h. Lift out cover plate to expose tape.

4.3.4.2 Tape Operation - The remote control box is used for this operation and consists of a rotary switch and two pilot lights. With 28 VDC applied the tape recorder can be operated by positioning the rotary switch for STOP, RUN, FAST FORWARD, and FAST REVERSE.

The Tape Transport can also be operated using the Genisco remote control unit during bench test operations by connecting the cinch connector to the side of the tape transport. Instructions are provided in the following section (4.3.4.2.1).

4.3.4.2.1 Tape Transport Operation - Position the switches on the remote control unit as follows:

Power: ON
Data: ON

In this mode, all of the signal electronics are operational and input data can be monitored at the test points provided on each of the record electronic modules.

Position the transport command switch to the RUN position, tape should be moving from left to right at an even rate of speed across the record heads (15/16 IPS).

If at any time the operator wishes to operate the transport in either the FAST FORWARD or the FAST REVERSE modes, he can do so by first positioning the data switch on the remote control unit to the OFF position and then positioning the command switch to either the FAST FORWARD or FAST REVERSE position.

To command the transport back to the RUN mode, (15/16 IPS) first position the transport command switch on the remote control unit to the STOP position, then position the data switch to the ON position, next position the command switch to the RUN position (15/16 IPS).

4.3.4.3 Magnetic Tape Recorder Unloading - A magnetic tape containing recorded data may only be removed with the take up spool.

a. Run the tape in the FAST-FORWARD position until the BOT light comes on and then switch off.
b. Remove the recorder cover cap screws. Using three of the cap screws in the covers threaded holes, slowly and evenly turn the screws down until the cover is free.
c. By advancing the cobelt drive, move the tape by the heads until the end of the tape is reached. Remove the masking tape holding the end of the tape and any residual gum to prevent contamination of the heads.
d. After the end of the tape passes through the recorder head section, mask the end to prevent tape unravel.
e. Remove the four hub screws.
f. Tightly grasp the tape pile and lift it out of the recorder taking care it does not slip and unravel.
g. Remove the empty supply hub and remount on the tape up spindle.
h. Install a new roll of tape on the supply end hub.

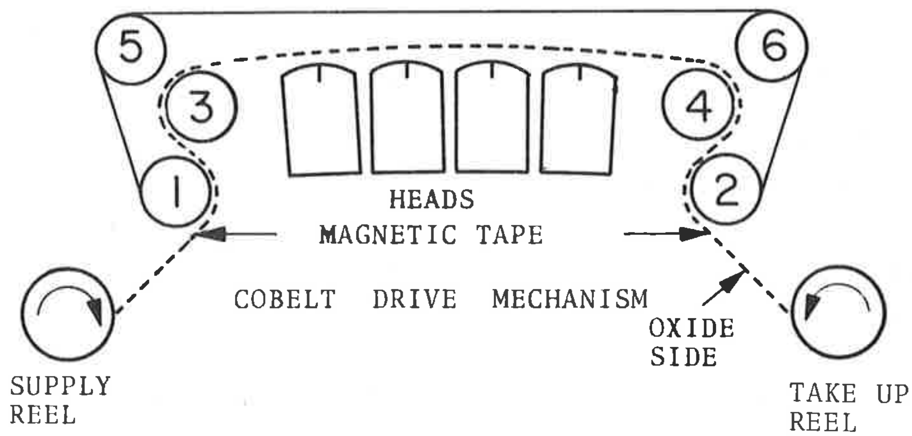


Figure 5. Magnetic Tape Threading Diagram

(Thread the tape into the Cobelt drive mechanism between the Cobelt and roller number three.)

4.3.4.4 <u>Magnetic Tape Recorder-Loading</u> -

a. Remove the cap screws holding the cover of the recorder.

b. Using three of the cap screws, reinsert these screws back in the threaded holes provided in the cover. Slowly turn down each screw evenly to raise the cover evenly until free.

c. The tape that is to be recorded is mounted on the left hand spindle (heads at the top). The dull (oxide) side of the tape should be outside on the spool. Remove the masking tape that secures the tape end and be sure that none of the tape gum remains on the magnetic tape. The end of the tape is fed onto the cobelt drive, and the belt drive is then advanced slowly so that the mag tape will pass by the heads without catching. If more than eight inches of tape is fed without appearing at the other reel end, the tape is bunched inside. In this case, back out the tape, trim off the wrinkled end, and then re-thread. The tape should be hand threaded until all the leader has passed over the heads and into the supply area.

d. Next, mount the tape end on the take-up hub using a small piece of masking tape with the dull side of the tape away from the hub. When securing the tape end, make sure it is centered exactly to the hub.

e. Advance the tape using the drive motors to be certain that it threads by the heads properly and does not creep up or down on the cobelt drive.

f. If tape is supplied on the take-up spool instead of the supply spool, then rewind using the REWIND spooling motors until the BOT light comes on stopping the tape. Leave the tape in this last position.

g. Remount the cover and secure with the cap screws.

h. Recheck the tape operation again by running the tape forward for a few feet and check for binding on the cover.

h. Rewind tape back to the BOT light. Leave tape in this position for future checks such as preflight.

4.3.4.5 Recorder Data Checks - This task must be accomplished on the lab bench with the Tape transport removed from the flight package.

Connect the Genisco control unit to the transport and apply 28 VDC power supply. Connect the necessary voltage and frequency meters.

The recorder individual electronic modules are then adjusted to the following values.

Refer to Genisco Manual.

Channel	Parameter	Voltage	
1	Accel. Th.	0-5	
2	Gyro roll	±2.5	
3	Accel. Lat	0-5	
4	Temp. out	0-5	
5	Altitude	0-5	
6	Temp. in	0-5	
7	Radiometer B	±2.5	
8	Velocity	0-5	
9	Radiometer A	±2.5	
10	Inclinometer	0-5	(pitch)
11	Accel. Vert.	0-5	
12	Time code gen	0-5	
13	Gyro pitch	±2.5	
14	Inclinometer	0-5	(roll)
15	Voice	2 Rms	

Frequency Set

0 V = 2362 cps	+2.5 V = 1012 cps
1 V = 1384 cps	0 V = 1687 cps
2 V = 1605.8 cps	-2.5 V = 2362 cps
3 V = 1229.2 cps	
4 V = 851.6 cps	
5 V = 474 cps	

4.3.5 Temperature Thermocouples

The temperature probes may be checked by setting the rotary switch on the master control box to the inside and outside temperature position and observing the meter indicator for a voltage reading. The range for the outside temperature is -80°F to +120°F for 0-5 volts. The range for the inside temperature is -30°F to +150°F for 0-5 volts. Thermocouples are checked against a known temp. values. Refer to calibration curves.

4.3.6 Power Supply

The input power is checked on the master control box meter by switching the right hand multiple switch to DATA then positioning the left rotary switch to 28 VDC, +15, -15, and +5 VDC.

4.3.7 Altimeter

Position the control box data switch to Alt. The meter should read zero volts if at sea level and the equivalent voltage for various field elevations.

4.3.8 Accelerometers

Three accelerometers are installed on the flight package and are checked on the control box meter for continuity. All three should read 2.5 volts for zero g's.

4.3.9 Vertical Gyro

The gyro requires 400 cycle power and can be checked on the aircraft or by a lab 400 cycle supply. The control box meter should read zero volts when the aircraft is in a level position. Adjustments can be made at the servo motor to correct the pitch and roll attitude readings.

4.3.10 Inclinometers

The roll inclinometer (mounted on the radiometer) should read 2.5 volts on the control box meter when the aircraft wings are in a level position. The pitch inclinometer is also mounted on the radiometer, however, since the radiometer is set pitched down 1.7° the control box meter should read 0.14 volts less at rest.

4.3.11 Velocity Probe

First check the continuity of both hot wires. After installation and with power applied to the flight system, check the velocity indication on the control box meter for zero volts with the cap on the probe. If the meter does not indicate zero, reset the fine or coarse adjustment on the velocity electronics.

Note: This zero reset must be accomplished whenever a probe change is made in the system.

Note: A quick lab electrical check is accomplished on the complete system by positioning the rotary switch on the master control panel to each individual parameter and comparing the readout meter with values on component charts.

5. SYSTEM OPERATING PROCEDURES

5.1 PREFLIGHT PROCEDURES AND CHECK LIST

This test is conducted with the equipment installed on the aircraft and just prior to the scheduled take-off of each flight.

a. Check the radome assembly for looseness.
b. Check that the balance weight access door is secured.
c. Check outside temperature probe for sensor damage.
d. Check velocity probe for removal of safety cap and after exposing the probe, check the hot wires for damage.
e. Connect the 61 pin connector to the bottom of the pod.
f. Turn on aircraft power and check all sensors for signal indication on the recording channels and record these voltages on the log sheet.
g. Check the tape recorder for loading and run ready. Beginning of tape (BOT) light should be on.
h. Have the pilot run the tape with the cockpit data switch until the light goes off.
i. Reset the time code generator with the aircraft or pilots watch.
j. Install and secure all access panels.
k. Remove the preflight cable from the bottom of the pod and cap and safety the pod connector cap.
l. Give the pilot the clearance signal for flight.

5.2 POST-FLIGHT PROCEDURES

This procedure is accomplished just after landing and parking of the aircraft and consists of a System operational electrical check.

a. Install the 61 pin connector in the bottom of the pod for the remote control operation.
b. Turn on ground power (28 VDC and 400 cycle AC)

c. Check for proper operation of each parameter in the system and enter values on the log sheet used during preflight checks for comparison. The rotary switch on the ground control box is used and the voltage values observed on the meter.
d. Remove the two access panels on the side of the pod.
e. Turn off time code switch.
f. Connect the tape recorder remote control unit to the remote master control box.
g. Unlock the J-box and lift it away from the tape recorder.
h. Check the tape recorder for after flight operation.
i. Run the recorder forward to the end of the tape and remove used tape. See section for unloading tape.
j. Install a new tape in accordance with loading instructions and check functioning.
k. Button up tape recorder and leave system as is for the next pre-flight check.

5.3 PILOT OPERATING PROCEDURE

5.3.1 Preflight Flight Plan Briefing

a. Pilot reviews flight plan.
b. Pilot is briefed and reviews meteorological data.
c. Pilot is briefed on the equipment operation.

5.3.2 In-Flight Operation

The cockpit power switch to the CAT system will remain on throughout the flight.

At start of taxi or as instructed, the pilot will turn on the tape record switch and state the clock time on radio intercom.

During flight, the pilot shall voice the following information on tape at suggested intervals.

a. Time and identification of all check points.

b. Course heading, course changes time and location.

c. Start time of a run on a clear air turbulence, and heading of each penetration.

d. Estimated severity of turbulence encounter and location, altitude, etc.

e. Time of completion of turbulence pattern.

If another experiment is on board and not operating at a desirable altitude, the pilot will proceed at his discretion to the flight plan altitude and location for high altitude detection runs on CAT.

Upon completion of the flight plan, the pilot will leave the equipment and tape recorder in the operating mode during the return flight to base. All encounters should be voice recorded. Equipment should remain functional until the completion of post-flight CAT equipment checks on the parking ramp before engine shut down.

5.3.3 Post-Flight Procedures

A briefing with the pilot will be conducted to review and notate all aspects of the flight including the number and type of CAT encounters.

6. FLIGHT PLANNING PROCEDURES

6.1 METEOROLOGICAL FORECAST DATA

Obtain turbulence forecast for an area within the operating range of the aircraft from the local weather station.

Obtain reports of turbulence from Airways control centers and any other available weather stations.

Obtain upper winds charts and temperature charts for altitudes up to 50,000 feet.

The above procedures should be started 24 hours prior to a planned flight and a final weather check made within 2 hours of take-off.

6.2 FLIGHT SCHEDULING

Test flights are normally scheduled according to periods of availability of the aircraft and pilots. These periods are usually two to four weeks unless aircraft maintenance problems occur. Operational periods are also dependent upon prevailing seasonal locations of CAT.

6.3 FLIGHT PLANNING

When availability of the aircraft indicates, the equipment and personnel are put on a stand by.

As soon as meterological conditions look favorable for CAT a take-off flight time is scheduled. A flight plan should be compiled to include: take-off time, duration of flight, location of intended CAT search, type of pattern desired at the turbulent area and desired altitude of operation. Alternate flight procedures are also included in the event no CAT activity exists at the planned locale.

7. DATA REDUCTION AND ANALYSIS

This procedure is accomplished at the home base laboratory where data reduction equipment is available.

In the field, a quick review of the data is made to observe discrepancies or failures and as a guide for improvement or changes for future flights.

7.1 TEST SITE DATA REVIEW

Processing of the magnetic tape to retrieve flight data from the airborne recorder is accomplished through a playback recorder with the same electronic characteristics as the airborne recorder. Taped data is first converted back to voltage signals, displayed on the voltmeters or oscillograms at the test site and used for a post flight cursory review of the results. The data obtained immediately after flight is also used for future flight planning and repair or calibration of the sensors when the data indicates the need exists. At the same time, the temperature, acceleration, and CAT sensor parameters (including the pilot's taped reports) are reviewed to verify atmospheric conditions which are forecasted prior to flights. Otherwise, all the test data in the form of magnetic tape, meteorological charts, flight plans, flight course maps, pilot's debriefing reports and any oscillograms are returned to DOT/TSC for thorough analysis.

7.2 DATA REDUCTION AND ANALYSIS AT HOME BASE

A special switch control unit is used for distribution of data signals. A multi-cable is first connected from the data playback recorder to the switching box for each data channel. Coax-cables are then connected from the box to either a chart recorder or the meter display panel or both. The voice channel connects from the switch box to a Bogen amplifier and speaker. Data channels can also be tapped off to digital voltmeters for accurate voltage readings.

For the final data analysis, the flight test magnetic tape is reprocessed on oscillograms to include real time and notations of comments by the test pilot on turbulence encounters. Events of turbulence are then selected based on vertical acceleration response and unusual sudden temperature changes in the oscillograph trace. These parameters are compared with the aircraft attitude roll and pitch traces (gyro response) as well as pressure transducer traces for constant altitude during a turbulence penetration. Whenever the attitude data indicates excessive aircraft motion in a particular sample, the sample is normally eliminated as unusable data. After a sample event is selected, beginning and end times are established. The data conversion back to actual flight parameter values are then completed. With the data conversion back to real values, such as, temperature, etc., it is possible to evaluate the response of the radiometer CAT sensor to a turbulence event before and during penetration. The intensity of a turbulence encounter is an important consideration for both selecting a data sample and evaluating the CAT sensor. Turbulence of low intensity produces little or no temperature differences. Consequently, the radiometer records signals too low for an accurate data analysis. Conversions to real values are plotted in the form of curves as final results.

APPENDIX A

TIME CODE GENERATOR OPERATION AND RESET

TIME CODE GENERATOR OPERATION AND RESET

1. Remove the pod access cover (rectangular) to allow access to the TCG controls.
2. Without the 28 VDC connected, turning the power switch ON will energize the internal electronics only. In order to SET time on the TCG an external 28 VDC power source must be connected since the power required for the readout lights needs an external source.
3. When the TCG is turned ON six random numbers will appear on the display. Switch the TGC rotary control to STOP. Press the reset button (left button under number display) to set the six indicated numbers to zero.
4. Setting the correct time is accomplished as follows:

   Press the button under the hour indicator to advance the hour display.

   Press the two buttons under MINUTES to advance the minutes display.

   Press the two buttons under SECONDS to advance the seconds display.
5. When the actual hack time on a watch or cockpit clock coincides with the numbers displayed, switch the rotary control switch to START position for the TCG to count on the display. Recheck TCG time with hack watch.
6. Replace the pod access cover after completing all instrumentation adjustments within the pod.

Shut-Down After Flight

After flight is completed and the aircraft engines are stopped, the TCG power switch must be turned OFF to conserve TCG internal battery supply.

APPENDIX B

DATA FORMS

TABLE B-1. TEST DATA RECORDING FORM

CHANNEL NO.		WING	1	3	11	13	2	6	4	10	14	5	9	7	8	PAGE____
TAPE FOOTAGE	TIME CODE 12	MASTER PANEL	ACCEL THRUST	ACCEL LAT	ACCEL VERT	GYRO #1 PITCH	GYRO #2 ROLL	TEMP #1 IN	TEMP #2 OUT	INCLIN #1 PITCH	INCLIN #2 ROLL	ALT	RAD CH"A" 52 GHz	RAD CH"B" 58 GHz	VEL	REMARKS
	H:M:S	VOLTS	g,s	g,s	g's	DEG	DEG	°F	°F	DEG	DEG	FEET			MPH	

DOT-FAA/TSC CAT FLIGHT TEST DATA

Flt. Plan:
DOT/TSC-Flt.# FRC-Flt.#

Flight Date:
Table # Page #

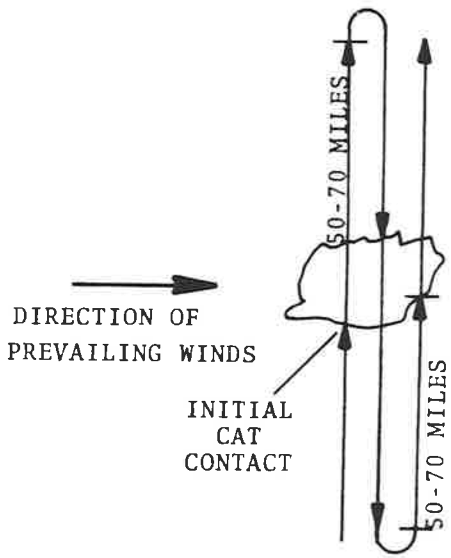
TABLE B-2. PREFLIGHT/POST-FLIGHT DATA FORM

DOT-CAT-GROUND CHECK DATA FLT# DATE:

CHANNEL NO.	PARAMETER	PRE-FLIGHT ENGINES "OFF" GRD POWER	PRE-FLIGHT ENGINES "ON" A/C POWER	POST FLIGHT ENGINE "ON" A/C POWER	POST FLIGHT ENGINE "OFF" GRD POWER	OTHER CHECKS	REMARKS
	Master Panel Meter Voltage(28 VDC)						
	Triplet Meter (28 VDC)						
	GND Pow						
1	Accel. Thrust						
3	Accel - Lateral						
11	Accel. - Vertical						
13	Gyro #1 "PITCH"						
2	Gyro #2 "ROLL"						
6	Temp. #1 "INSIDE"						
4	Temp. #2 "OUTSIDE"						
10	Inclin #1 "PITCH"						
14	Inclin #2 "ROLL"						
5	Altimeter TransD.						
9	Radiom "A" CH (52 GHz)						
7	Radiom "B" CH (58 GHz)						
8	Velocity						
12	Time code Gen.						
	Clock Time						

APPENDIX C

CAT ENCOUNTER FLIGHT PATTERN



SEQUENCE

	CAT ENCOUNTER
	OUTBOUND, 50-70 MILES
	180° TURN
	INBOUND, 50-70 MILES
	OUTBOUND, 50-70 MILES
	180° TURN
	INBOUND, 50-70 MILES
	OUTBOUND, 10 MILES
	END OF PATTERN

NOTE:

1. CAT MISSED-RELOCATE & REPEAT PATTERN
2. REPORT PASSING THROUGH CAT-INTENSITY & G-FORCE

Figure C-1. Flight Pattern After CAT Encounter (Revised)

APPENDIX D

DATA CONVERSION CURVES

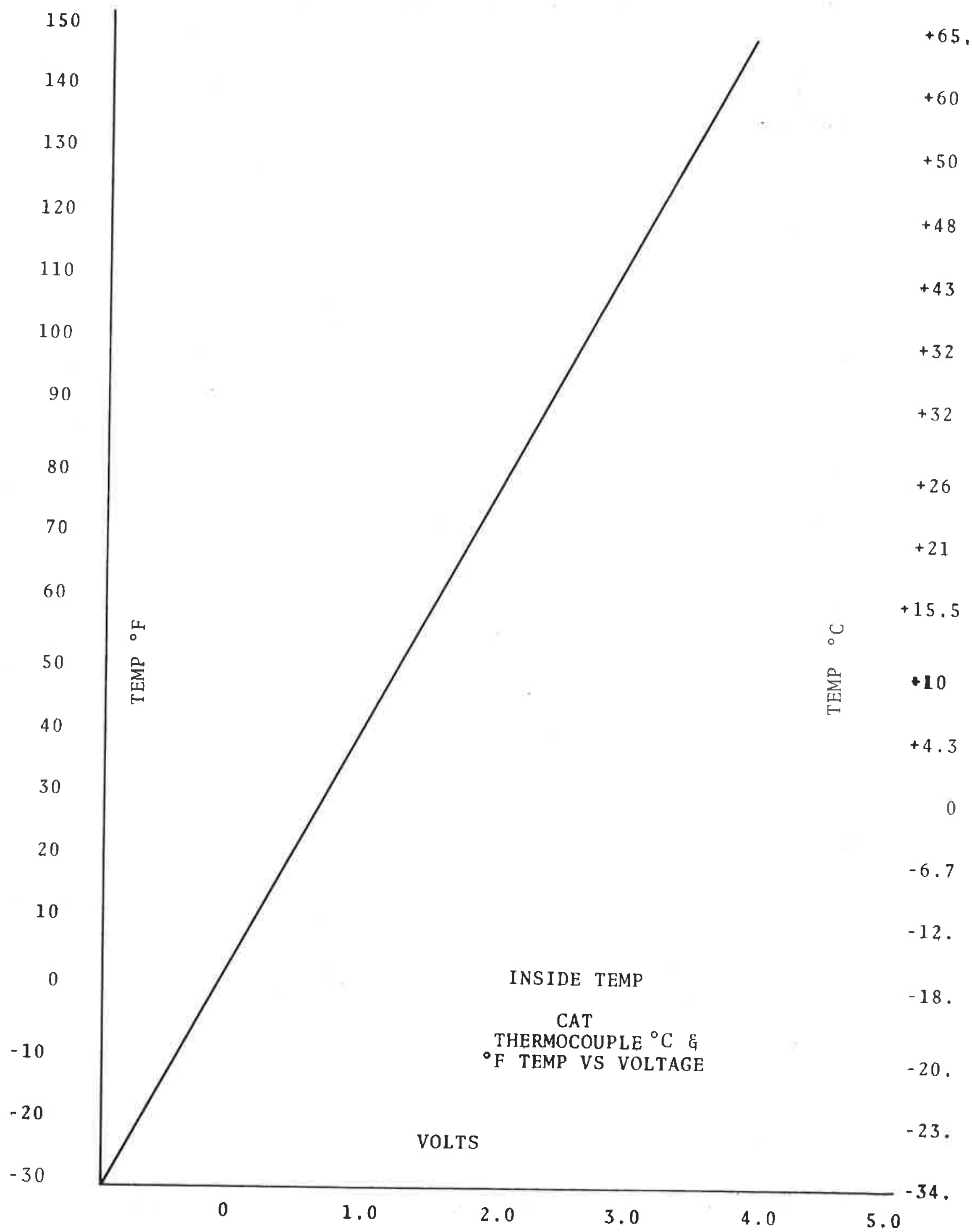


Figure D-1. Internal Temperature Conversion Curve

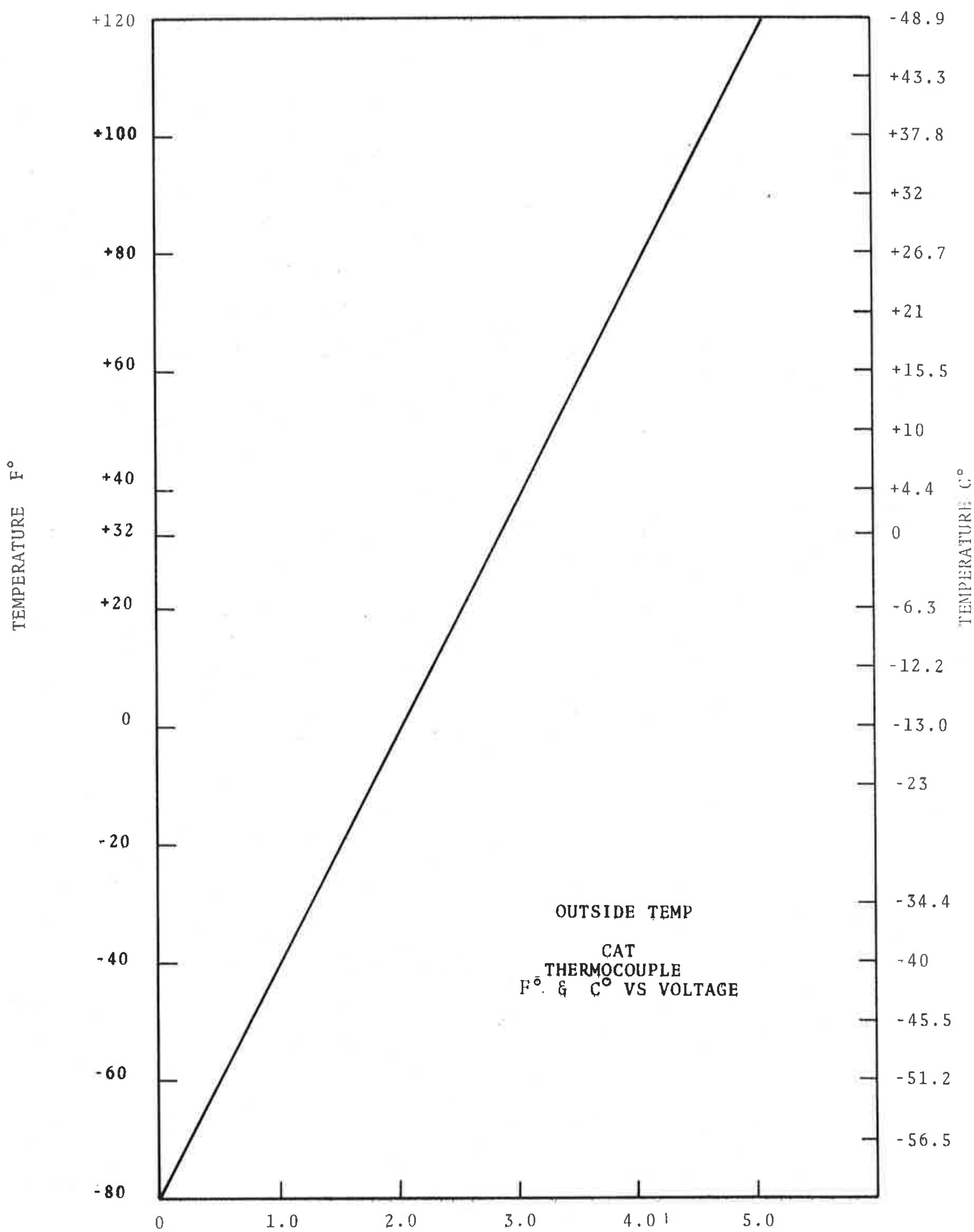


Figure D-2. Ambient Air Temperature Conversion Curve

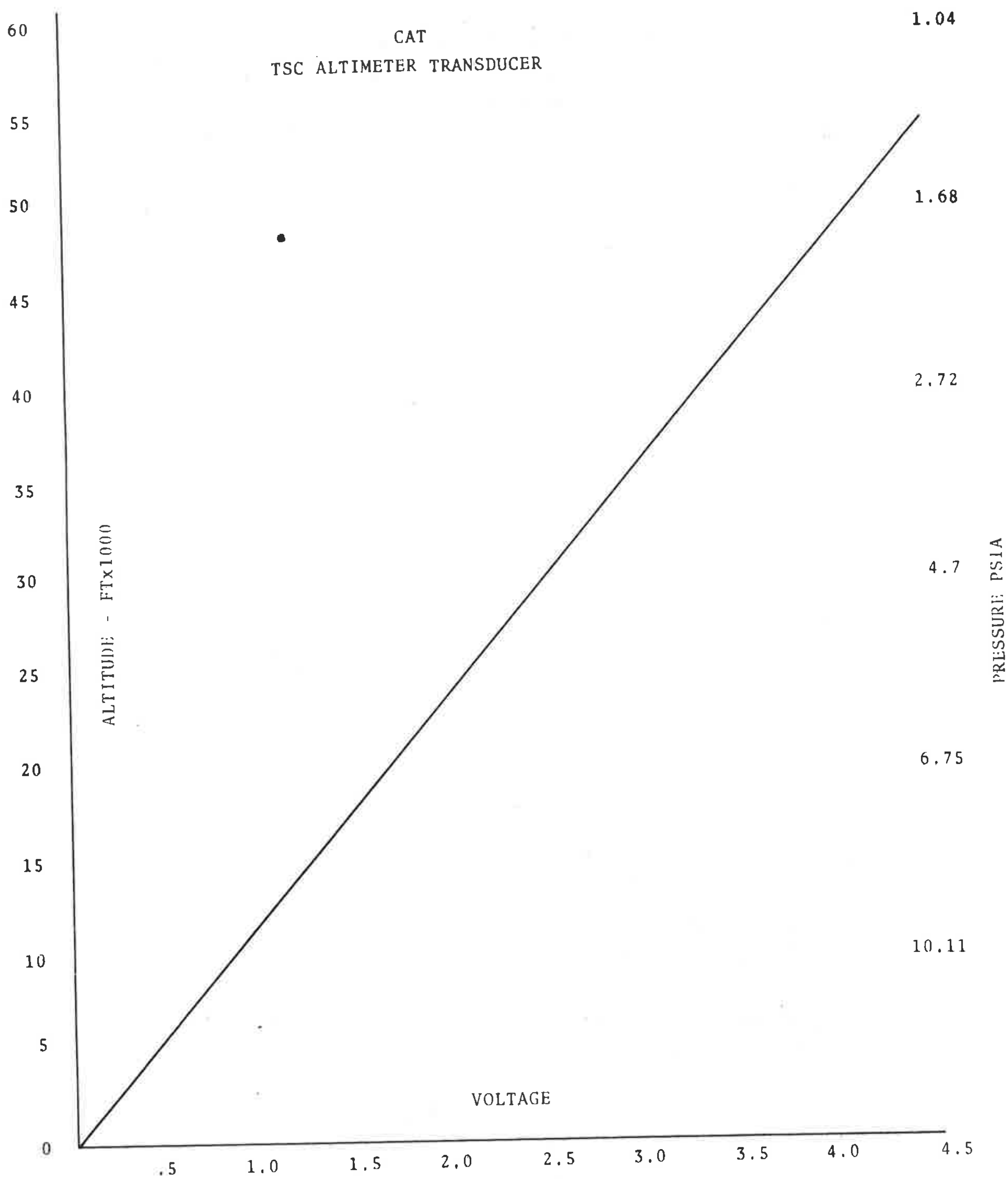


Figure D-3. Altitude Sensor Conversion Chart

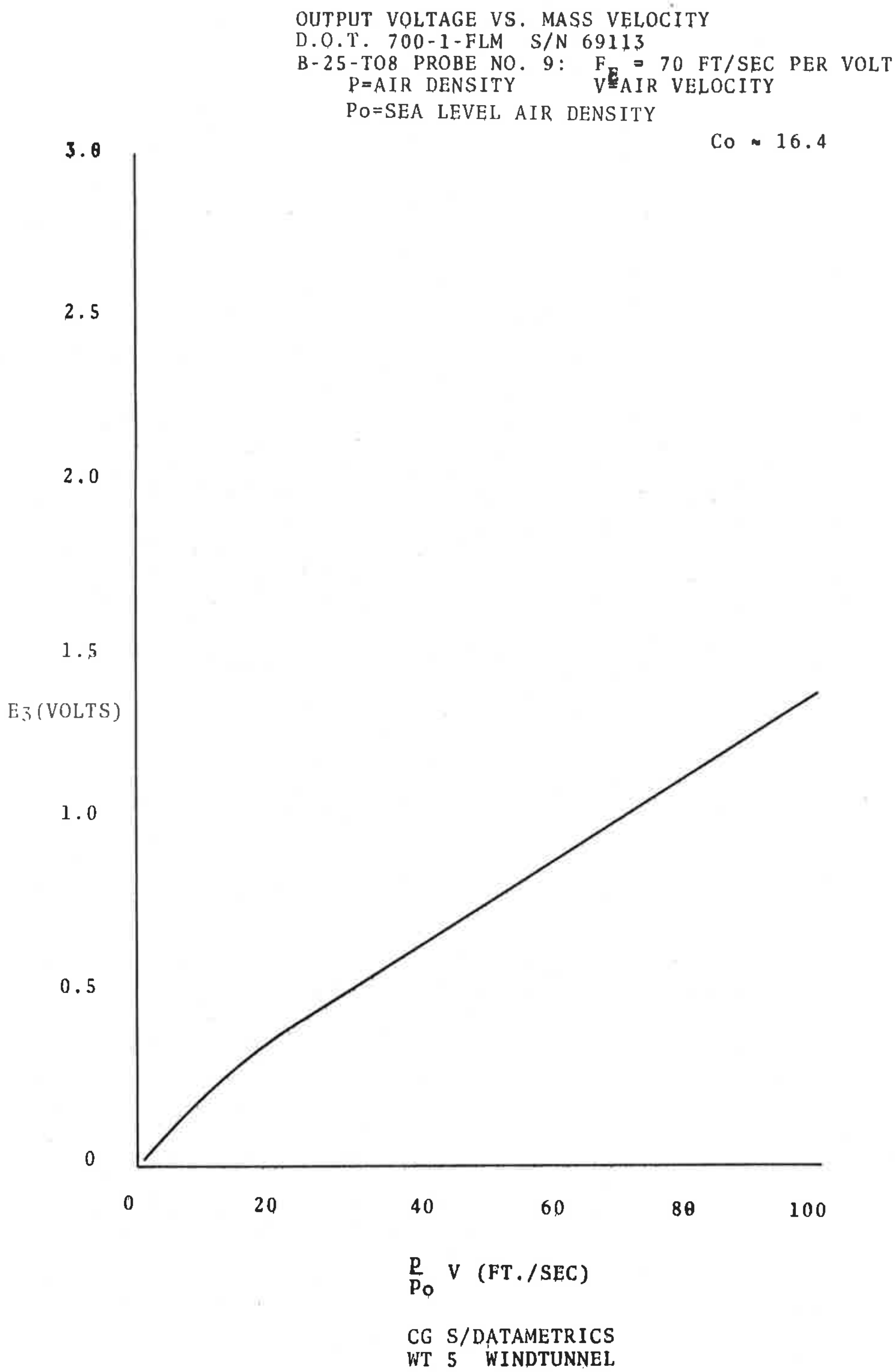


Figure D-4. Air Velocity Calibration Curve

APPENDIX E

AIRCRAFT CONFIGURATION PHOTOS

Figure E-1. Angle View of TSC Pod on Wing Tip

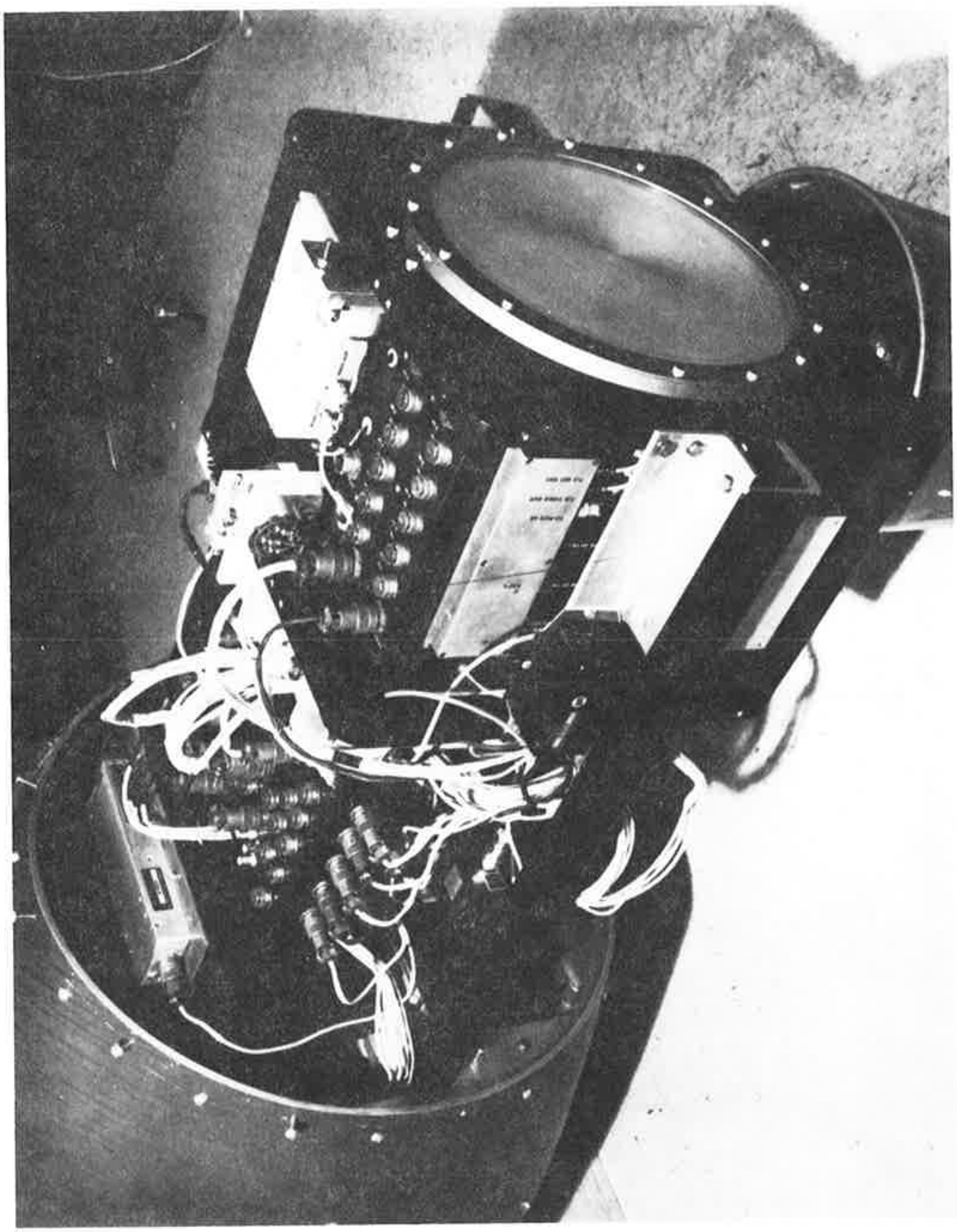


Figure E-2. Radiometric Sensor System Package

APPENDIX F

WEIGHT AND BALANCE

WEIGHT AND BALANCE

<u>Flight package weight and balance are as follows:</u>

Right wing pod empty		174.0 lbs.
Instrumentation package	156.0	
Radome assembly	18.0	
Internal support structure	25.5	
Pod pitch (c.g.) balance weight	125.0	
Right pod unbalance----	324.5 lbs.	
Total right wing weight		498.5 lbs.
Left wing-tip tank empty		- 174.0 lbs.
Left wing water-glycol ballast		324.5 lbs.

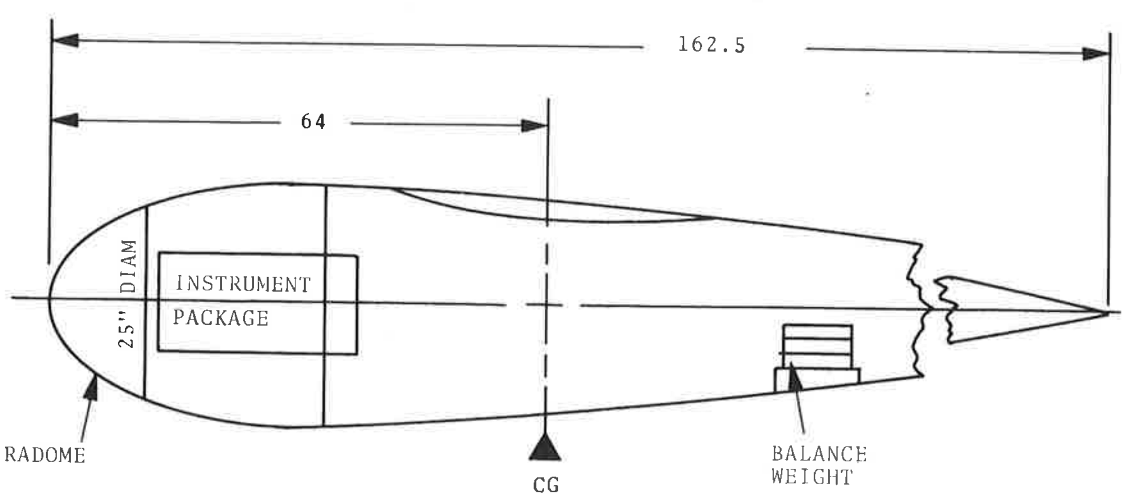


Figure F-1. Flight Package Center of Gravity Diagram

APPENDIX G

INSTRUMENTATION SCHEMATIC

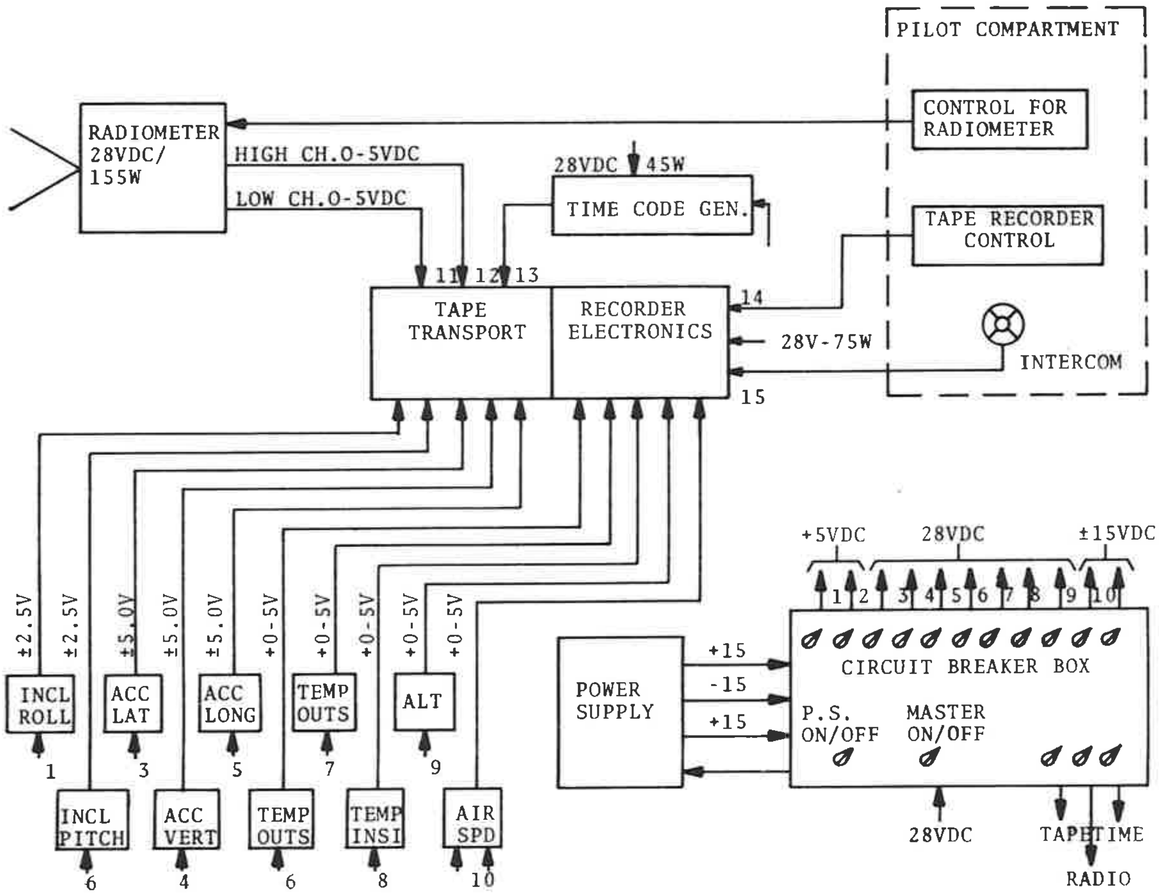


Figure G-1. CAT Sensor System Instrumentation Schematic