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**INTRODUCTION**

This chapter provides a general overview of the DC-3 Avionics Systems as well as normal operations and limitations.

**GENERAL**

**VHF COMMUNICATIONS**

The intercom control head is located within the Garmin 340 audio panel and includes independent intercom volume and squelch controls for both the Captain and the First officer. The battery bus and the radio bus must be powered in order for the intercom to function. The jump seat rider position is provided with a boom type headset. This headset permits 3 way intercom capabilities with the pilots, but does not allow access to any VHF transmitter. The microphone and headset jacks are located on top of the hydraulic control panel, to the right of the jump seat rider's seat.

The Garmin 340 Audio selector panel is located in the center avionics stack. This audio panel allows the selective monitoring of radios on the cockpit overhead speaker and/or the pilot's headsets. It also controls the microphone output. The audio control panel allows the pilots to select either transmitter number one or number two, as well as control the audio input into the intercom amplifier from any or all of the following sources: Nav 1, Nav 2, or the marker beacon receiver. The following are the primary NAV/COMM units in the DC-3:

- One Garmin GNS 430 GPS / COMM / NAV  
The transceiver is located in the center instrument panel and is made up of solid-state components and feature 20 watts of nominal output power. The VHF transceiver allows a minimal spacing of 25 KHz channel spacing and a total of 760 channels that range from 118.0 MHz to 136.975 MHz. The antenna for the transceiver is located on the bottom of the aircraft.
- One Narco Mark 12 - E COMM / NAV  
The transceiver is located in the center instrument panel and is made up of solid-state components and feature 20 watts of nominal output power. The VHF transceiver allows a minimal spacing of 25 KHz channel spacing and a total of 760 channels that range from 118.0 MHz to 135.975 MHz. The antenna for the transceiver is located on the bottom of the aircraft.

**NAVIGATION EQUIPMENT**

- One Garmin GNS 430 Navigation receiver
- One Narco Mark 12-E Navigation receiver
- Two independent Glideslope receivers
- One King KT-76-A transponder with Mode C
- One Garmin 320A transponder with mode C
- One Garmin 340 3 - light marker beacon receiver
- Three OBS indicators.

The VOR/ LOCALIZER receivers are located on the center instrument panel and allow radial indications to appear on a cross pointer instrument (deviation indicator) in conjunction with the omni-bearing selector on the instrument panels (Two on the left sub-panel and one on right sub-panel). The frequency range of these radios is 108 MHz to 118 MHz. The ILS frequencies are automatically paired only when the proper localizer frequency is selected on the Number One Nav Radio. However, the glide slope receiver indication appears on both course deviation indicators (CDIs) regardless of the frequency selected on the number 2 radio. The antenna for the VHF Nav receivers is centered on top of the aircraft.

The system has a maximum range that is dependant on the strength of the ground transmitter, the terrain in the area, and the altitude of the aircraft.

The following table lists the approximate line-of-sight range of VHF communication over level terrain between an airplane and a ground station:

*ALTITUDE (ft. AGL)	APPROX. RANGE (NM)
1,000	35
3,000	60
5,000	75
10,000	110
15,000	135

**GPS System**

The GPS (Global Positioning System) operates as follows: Numerous satellites in geosynchronous orbit above the earth continuously transmit timed electronic pulses. As many as 24 parallel receivers in the aircraft receive and measure these pulses against a known standard. The on board computer within the GPS unit uses mathematical triangulation to accurately determine its position. This information is stored within the unit until the next reading can be taken. Upon several successful cycles both a position and a speed can be determined. If enough satellite signals can be received, accurate altitude information is often available.

When a destination is selected from the GPS unit, all calculations are made based on progress towards that fix in terms of time, distance, and fuel. The Garmin GNS 430 has an internal database that is amendable. The Garmin GNS 430 navigation system in conjunction with the other aircraft systems makes the DC-3 certified for day and night flight under both IFR and VFR. The Garmin GNS 430 is certified for both enroute and terminal operations. Independent stand alone GPS approaches are routinely conducted.

### Marker Receiver

The Garmin 340 3-light marker beacon is an integral part of the audio panel. When passing over an outer marker beacon, a 400 Hz tone is produced and the blue light flashes. When passing over a middle marker, a 1300 Hz tone is produced and the amber light flashes. When passing over an inner marker, a 3000 Hz tone is produced and the white light flashes. The lights, audio switches, and accompanying hi or low sensitivity switch is located on the audio selector panel. The antenna is located on the lower forward fuselage. The audio control for the marker receiver is located on the audio control panel and may be selected by depressing the associated MKR switch.

- Sensitivity of the marker receiver is pre-set for two operating levels (HIGH or LOW). With the switch in the HIGH position the receiver is operating at its maximum and reception area will be wider than when the switch is in the LOW position.
- The marker audio volume ON/ OFF control is provided to control marker audio. The audio indication precedes the light indication when approaching the marker beacon and is heard after the light indication ceases. When the aircraft passes over a fan marker, a high pitched tone is heard. The marker light indications are not controlled by the position of the marker audio switch.

### Glide Slope Receiver

When the Captain's VOR receiver is tuned to a localizer frequency, the glide slope receiver frequency is automatically selected. The glide slope indication from this radio will be displayed on both pilots' deviation indicators.

The glide slope antenna is mounted on the nose of the aircraft

## ATC RADAR TRANSPONDERS

The DC-3 utilizes both the Garmin 320A as well as the King KT-76A ATC transponders. Each has 4096 code capabilities and a blind encoder for altitude reporting. Each unit has a monitor indicator that visually indicates proper operation during interrogation.

## POWER DISTRIBUTION

Avionics power is supplied directly from the ships batteries to the radio bus via a remote electrical relay. In the event of a dual generator failure, the avionics equipment should continue to function normally until ships power is depleted.

An avionics master switch is located on the overhead panel on the Captain's side of the aircraft. This switch energizes a relay via a five ampere circuit breaker which allows power to be supplied to the radio bus. In the event of a failure of the radio bus relay or the five-amp circuit breaker itself, the radio bus may be powered directly from the ships main DC bus by activating a switch located near the circuit breakers in the companionway.

Circuit breakers are installed for all avionics equipment. The Circuit Breakers are located in the companionway just above the main junction box.

## INSTRUMENTS

The instrument panel is comprised of 5 basic sections. There is one sub panel on each side, one flight instrument panel for each pilot and a center panel. Each instrument is provided with individual eyebrow type lights with a rheostat control.

Two basic types of instrument systems are used in the Douglas DC-3

- Direct reading
- Remote electrical

The direct reading instruments are operated mechanically by vacuum or by changes in pressure to measure system, absolute, or differential pressures.

The remote electrical instruments require 24-volt DC power, or are self-energized and operate from electrical current that they generate.

**DIRECT READING INSTRUMENTS**

- Vacuum instruments:
  - Directional gyros
  - Gyro horizons
  - Turn and bank indicators
- System pressure gauges:
  - Alcohol
  - Engine fuel
  - Heater fuel
  - Hydraulic
  - Landing gear
  - Oil
  - Oxygen
- Absolute pressure instruments:
  - Engine manifold pressure
  - Altimeters
  - Oxygen flow gauge
- Differential pressure instruments:
  - Airspeed indicators
  - Rate of climb indicators
  - Vacuum gauge

**REMOTE ELECTRICAL INSTRUMENTS**

- Self-energized electrical instruments
  - Cylinder head temperature
  - Tachometers
- 24 Volt DC electrical instruments
  - Ammeters (generator and pitot heaters)
  - Carburetor air temperature
  - Heater duct temperature
  - Fuel quantity
  - Oil temperature
  - Outside air temperature
  - Voltmeter
  - Wing flap position indicator

**PITOT STATIC SYSTEM**

**Pitot static system – pitot tubes**

Two independent pitot tubes are mounted on the lower half of the nose section. The pitot tubes are arranged in line where one pitot tube head is directly below the other. The pressure from the top pitot tube head connects to the Captain’s pitot static system and its respective airspeed indicator. The pressure from the bottom pitot head connects to the First Officer’s pitot static system and its respective airspeed indicator. The flight crew should check the altimeters periodically to assure that they are operating within limits.

**Pitot static system - static ports**

The Captain’s and First Officer’s pitot static systems each utilize small holes located on the base of the respective pitot static heads to sense ambient atmospheric pressure. This ambient atmospheric pressure is used to provide information for the altimeters and vertical speed indicators.

**Pitot heat**

By selecting the Pitot Heat switches to the ON position, electrical power from the DC bus may be utilized to provide continuous heat to either the Captain’s or the First Officer’s pitot head masts. Both the pitot head and the static port will be heated whenever the respective pitot heat selector switch is in the ON position. The Pitot heat system is an anti-ice system and should be selected to ON while in flight and prior to entering visible moisture regardless of the outside air temperature.

**Static selector valves**

An alternate static source is available for both the Captain’s and the First Officer’s pitot static systems. The static selector valves are two identical 2 position selectors that are mounted on each instrument sub panel. In the NORMAL position, each system utilizes a static port associated with its respective pitot head. In the alternate position (ALT), the Captain’s pitot system utilizes the First Officer’s static port at the base of the lower pitot head. In the alternate position (ALT), the First Officer’s pitot system utilizes the static port located in the right auxiliary fuel tank bay area.

The following airspeed and altimeter corrections should be used when ALT static air is selected. These corrections are approximations only and are contingent on the cockpit windows being closed.

<u>Speed (KIAS)</u>	<u>A/S Corr.</u>	<u>Altim. Corr. (ft.)</u>
69	+7	45
78	-2	-30
87	-2	-10
96	-3	-60
104	-3	-60
113	-4	-50
122	-4	-40
130	-7	-50
139	-8	-50
148	-9	-120
156	-5	-140
165	-11	-130
174	-12	-194
182	-13	-208

**VACUUM SYSTEM**

**Engine driven pumps**

One vacuum pump on each engine is provided to supply vacuum for operation of the gyroscopic instruments. The gyroscopic instruments are the artificial horizons, the turn and bank indicators, and the directional gyros. Each vacuum pump supplies suction through a check valve to the main vacuum manifold. Both the Captain's and the First Officer's flight instruments utilize this main vacuum manifold as their source of vacuum for their respective flight instruments. This arrangement allows for the continuous and uninterrupted operation of both the Captain's and the First Officer's flight instruments in the event of an engine failure or vacuum pump failure. A check valve is installed on each side to isolate a pump from the manifold if it becomes inoperative.

**Relief valves**

A relief valve for both the left and right engine vacuum pumps regulates the vacuum at 5.0 ± 1/2 inches (Hg.) each.

**Suction Gauges**

Each engine vacuum pump has a suction gauge on its respective instrument panel to indicate the vacuum pressure produced by the pump. The normal operating vacuum is 5.0 ± 1/2 inches (Hg).

**Alternate vacuum**

The alternate vacuum selector valves are two identical 2 - position selectors that are mounted on each instrument sub panel. By activating either of these switches out of NORM, the respective system vacuum pressure is reduced to approximately 2.5 in. Hg. These switches are normally used for aircraft maintenance functions only.

**OPERATION**

To accomplish the altimeter ground checks:

- Set both altimeters to current local altimeter setting.
- Lightly tap face of each instrument to assure a settled reading.
- Both altimeters should indicate published elevation plus or minus 50 feet.
- The maximum differential between the two altimeters is 100 feet.

**VHF Navigation Receiver Check**

The following checks test the accuracy of VOR functions only. If an ILS runway is crossed during taxiing, note that the indicator needle centers as a check of localizer operation.

At airports having an approved VOR test facility:

- Turn VHF navigation receiver switch on.
- Select frequency of test facility and identify.
- Set OBS to 180°.
- OBS TO-FROM needle should indicate TO.
- Vertical needle of indicator should center. If not centered, adjust OBS until needle is centered. Required OBS adjustment should not exceed ± 4°.
- Set OBS 10° (in each direction) from the established bearing, noting indicator: needle should deflect 2 dots, or more.

At airports having an FAA certified check point:

- With airplane parked at airport certified check point and VOR tuned to designated facility, adjust OBS until indicator is centered. OBS should indicate certified bearing ± 4°.
- Set OBS 10° (in each direction) from the established bearing, noting indicator; NEEDLE should deflect 2 dots, or more.

**NOTE:** *The Captain's and First Officer's VOR indications should agree within ± 4°.*

**LIMITATIONS**

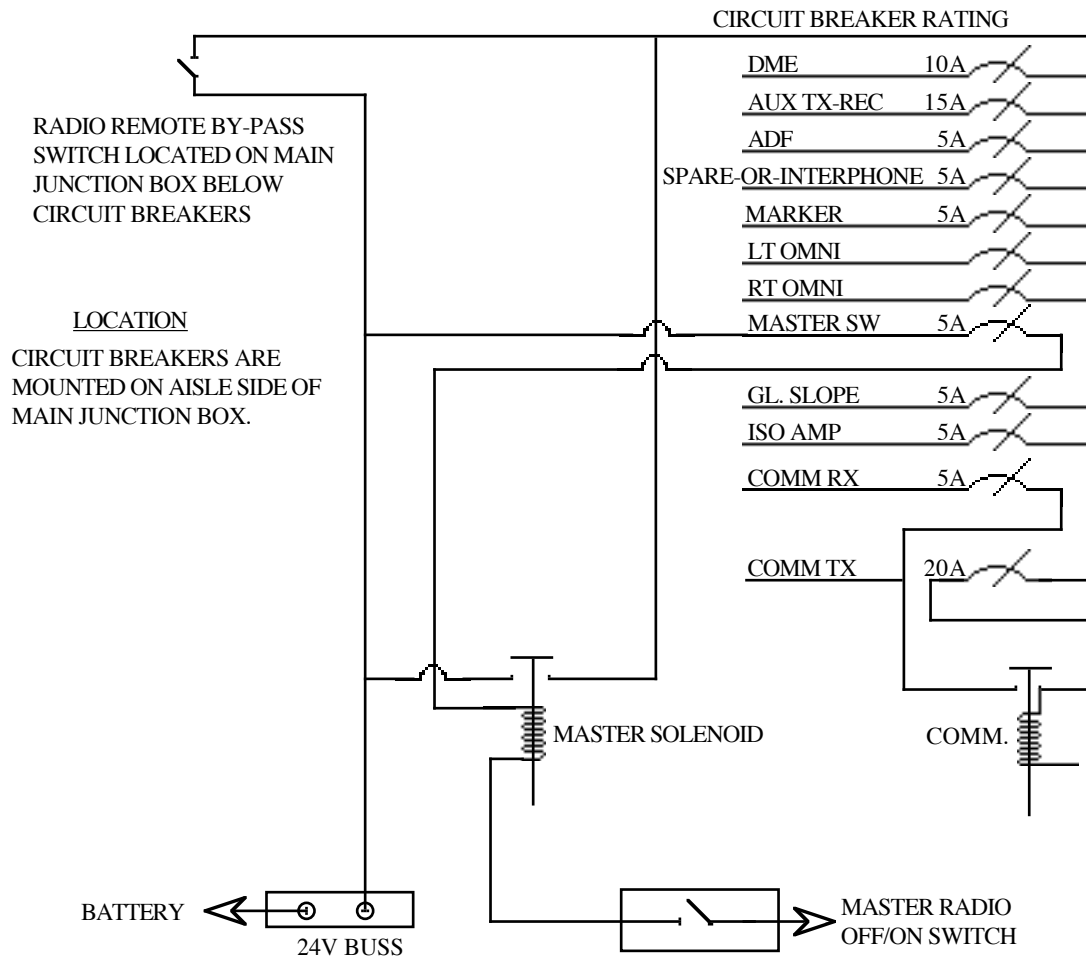
Allowable diff. (altimeter-to-field elev.) ..... 50 ft.  
 Allowable diff. (between altimeters) ..... 100 ft.

The allowable differences between the Captain's and First Officer's VOR bearing indications when tuned to same facility are:

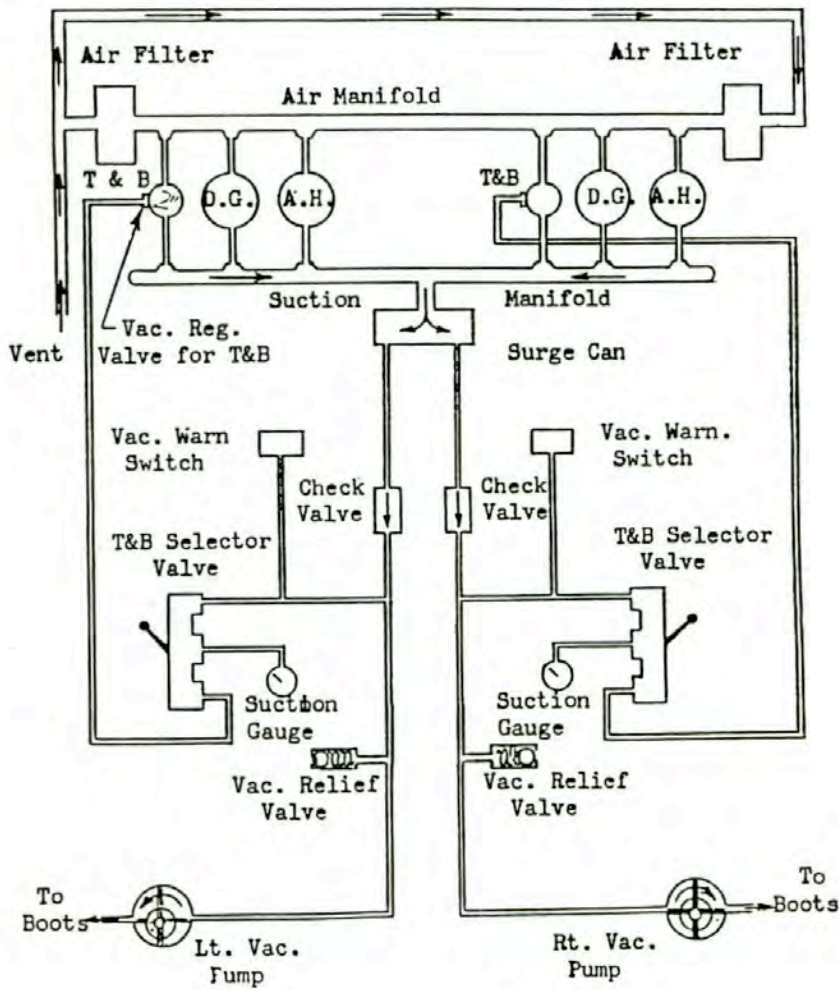
Ground Test Check ..... ± 4°  
 Air Test Check ..... ± 6°

The allowable difference between the Captain's and First Officer's indications when tuned to same ILS facility is 2 needle widths.

RADIO POWER DISTRIBUTION - SCHEMATIC



Radio Power Distribution



Vacuum System

———— End of Chapter ————