NAVAL AIR TRAINING COMMAND

INSTRUMENTS

UC 09 03 01 04 ER

CNAT P-1081 (Rev. 10-77) PAT

T-28 ENGINEERING PRIMARY

1977

NAVAL AIR STATION · CORPUS CHRISTI, TEXAS

PRESSURE INSTRUMENTS

FRAME 1

All engine pressure instruments in the T-28 are direct-reading Bourdon tube instruments. The Bourdon tube is closed at the end attached to the indicator, and the other end is open to the pressure which is to be measured. The tube is curved when pressure is low, but straightens out and indicates a higher reading if pressure is increased.

All engine pressure instruments are_____pressure indicating instruments.

Bourdon tube

FRAME 2

Oil pressure originates at the rear bearing of the supercharger and leads to each cockpit. Oil pressure must register an indication of pressure within 10 seconds and 40 p.s.i. within 20 seconds. The minimum oil pressure for flight is 65 p.s.i. Normal pressure in flight is 65 to 75 p.s.i., with a maximum of 90 p.s.i. In case of a complete electrical failure in flight, this would be the only instrument available to indicate a developing engine malfunction.

State oil pressures required for operating the T-28 engine._____

_____.

Start: Indication within 10 seconds
40 p.s.i. within 20 seconds

In flight: 65 to 75 p.s.i. with a maximum of 90 p.s.i.

FRAME 3

The fuel pressure is taken at the rear chamber (D-chamber), measuring fuel pressure at the carburetor. The boost pump must be able to provide 13 p.s.i. in order to activate the primer for start. The normal range for fuel pressure in flight is 21 to 25 p.s.i. The engine-driven fuel pump will provide 21 to 25 p.s.i. and the boost pump is capable of providing 19 to 24 p.s.i.

Engine-driven fuel pump pressure is_____to_____p.s.i. and the boost pump pressure is_____to_____p.s.i. The boost pump must provide_____p.s.i. for start.

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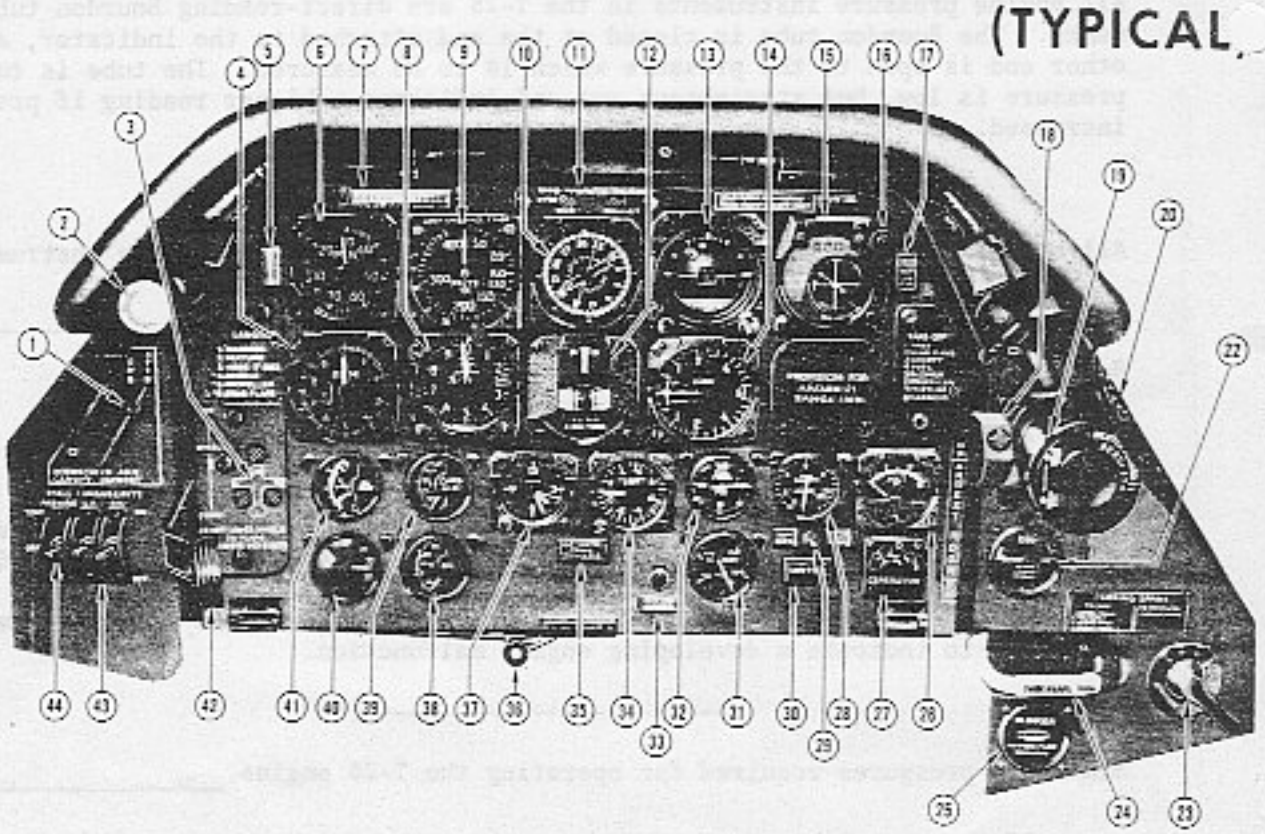
21 - 25
19 - 24
13

COCKPIT - FORWARD VIEW (TYPICAL)



1. WINDSHIELD AND CANOPY DEFROST CONTROL HANDLE ◀
2. CANOPY EMERGENCY STOP BUTTON
3. LANDING GEAR POSITION INDICATORS
4. TACHOMETER
5. LANDING GEAR WARNING LIGHT (ASC 63)
6. MANIFOLD PRESSURE INDICATOR
7. AIRSPEED CORRECTION CARD
8. ALTIMETER
9. AIRSPEED INDICATOR
10. RADIO MAGNETIC INDICATOR
11. COMPASS ANNUNCIATOR
12. TURN-AND-BANK INDICATOR
13. GYRO HORIZON INDICATOR
14. VERTICAL SPEED INDICATOR
15. COURSE INDICATOR
16. MARKER BEACON LIGHT
17. COURSE SETTING CHANGE LIGHT
18. ARRESTING HOOK HANDLE (T-28C)
19. OXYGEN REGULATOR
20. FREE AIR TEMPERATURE INDICATOR ◀
21. (DELETED)
22. OXYGEN PRESSURE INDICATOR
23. IGNITION SWITCH
24. PARKING BRAKE HANDLE ◀
25. OXYGEN FLOW INDICATOR
26. GENERATOR VOLTMETER
27. GENERATOR LOAD INDICATOR
28. FUEL QUANTITY INDICATOR
29. FUEL QUANTITY INDICATOR TEST SWITCH
30. FUEL LOW-LEVEL WARNING LIGHT
31. OIL PRESSURE INDICATOR
32. FUEL PRESSURE INDICATOR
33. SUMP PLUG WARNING LIGHT
34. ACCELEROMETER
35. FLIGHT INSTRUMENT POWER FAILURE WARNING LIGHT
36. RUDDER PEDAL RELEASE LEVER
37. CLOCK
38. OIL TEMPERATURE INDICATOR
39. CARBURETOR AIR TEMPERATURE INDICATOR
40. WING FLAP POSITION INDICATOR
41. CYLINDER HEAD TEMPERATURE INDICATOR
42. LANDING GEAR HANDLE
43. LANDING LIGHT SWITCHES
44. STALL WARNING TEST SWITCH (T-28C)

◀ FRONT COCKPIT ONLY

NAVAIR T-28B-1-00-70F

FIGURE 1

FRAME 4

The hydraulic pressure should indicate 0 to 100 p.s.i. in flight unless one of the hydraulically operated systems is in operation, in which case the normal range is 1250 to 1650 p.s.i. Hydraulic pressure is read in the system from a point aft of the system pressure-relief valve and before the system components.

Normal system hydraulic pressure with no systems in operation is _____ to _____ p.s.i., and with the landing gear extended will be _____ to _____ p.s.i.

---

0 to 100
1250 to 1650

FRAME 5

An oxygen pressure gauge is located on the right forward instrument panel above the ignition switch in each cockpit. Oxygen pressure should be 1000 p.s.i. to 1800 p.s.i.

Normal oxygen pressure is _____ to _____ p.s.i.

1000 to 1800

FRAME 6

The canopy air pressure gauge is located adjacent to the emergency air bottle in the baggage compartment. Normal pressure is 1600 to 1800 p.s.i. Minimum pressure is 1300 p.s.i., and maximum is 1980 p.s.i. Emergency operation of the canopy requires about 300 p.s.i.

The canopy air pressure gauge is located in the _____ and must read between _____ (minimum) and _____ (maximum) p.s.i.

---

baggage compartment
1300
1980

ENGINE TEMPERATURE INDICATORS

FRAME 7

The temperature instruments on the engine use bulb resistance units powered from the primary bus. A bulb resistance unit encloses a resistor which is more sensitive to changes in temperature than a thermocouple, especially at extremes of temperature. As the temperature changes, so does the resistance, thus varying the amperage, or current flow, through the bulb. The temperature gauge is calibrated to convert amperage to temperature display.

The engine temperature gauges are_____units powered from the_____.

---

bulb resistance
primary bus

FRAME 8

The cylinder head temperature (CHT) is taken at the two lower cylinders of the engine. The location of the front sump tank between these two cylinders reduces the effectiveness of their cooling fins and causes them to run hotter than the other seven cylinders. The front cockpit CHT gauge shows the temperature of the No. 6 cylinder, which is usually the hottest. The temperature of the No. 5 cylinder is presented in the aft cockpit.

The front cockpit CHT is taken from the_____cylinder. The aft cockpit CHT is taken from the_____cylinder, which is usually_____. (hotter/cooler)

No. 6
No. 5
cooler

FRAME 9

Normal range of CHT according to the NATOPS is 150° to 230° C. The training squadrons require 180° to 200° C in order to increase engine life. Maximum continuous is 245°; maximum military for a short period in flight and takeoff is 260° C.

The CHT requirements for operating the T-28 engine are: NATOPS_____to_____C ; maximum continuous_____; maximum inflight_____; takeoff_____.

150° to 230° C
245° C
260° C

FRAME 10

Oil temperature is taken between the oil cooler and the oil tank. At least 40° C must be indicated prior to engine runup and flight. The normal range in flight is 75° - 90° C, and the maximum is 95° C. If oil temperature exceeds 95° C and cannot be reduced with the use of the cowl oil cooler flaps, the aircraft must be landed as soon as practicable because the oil breaks down.

The oil temperatures for operating the T-28 engine are: minimum for runup and flight_____; normal_____to_____; maximum_____.

40° C
75° to 90° C
95° C

FRAME 11

Carburetor air temperature (CAT) is taken prior to the carburetor, before the air has been mixed with fuel. CAT is regulated by proper use of the alternate air handle. For continuous operation it is maintained between plus 15° and plus 38° C in low blower, and below plus 15° C in high blower. A backfire usually produces a rise in carburetor air temperature.

The CAT is taken prior to the_____and the low blower operating range is between_____°C and_____°C.

---

carburetor
15
38

FRAME 12

A prime concern is to avoid the carburetor icing range which is between minus 10° and plus 5° C. Carburetor icing must be prevented in the T-28, since it cannot be melted once it has formed.

The CAT is controlled by the_____, and the icing range is_____°C to_____°C.

---

alternate air handle
minus 10
plus 5

ENGINE POWER INSTRUMENTS

FRAME 13

Manifold air pressure (MAP) is measured at the diffuser collector ring of the supercharger and indicates absolute rather than gauge pressure in inches of Hg. The indicator functions as an aneroid barometer and is calibrated from 10 to 75 inches.

MAP is measured at the_____of the supercharger and indicates_____ pressure.

---

diffuser collector ring
absolute

FRAME 14

MAP is the pilot's index as to the pressure being generated in the cylinders. Overboost is avoided by keeping MAP below the limit for the RPM, altitude, and the blower setting. Underboost is avoided by maintaining at least 1 inch of MAP for each 100 RPM.

Underboost is best avoided by maintaining at least_____inch of MAP for each _____.

1
100 RPM

FRAME 15

The tachometer indicates engine crankshaft RPM by means of a generator which is completely independent of the aircraft's electrical system. Propeller RPM is two-thirds that of the engine crankshaft RPM. Although the instrument is calibrated to indicate 500 to 4000 RPM, the propeller governing range is 1200 to 2700 RPM.

With a complete d.c. power failure, what is the prop RPM if the engine RPM is 2100?_____ What effect does the electrical failure have on this problem?

1400
None

FLIGHT INSTRUMENTS

FRAME 16

The altimeter indications show the altitude of the airplane based on the existing static pressure of the atmosphere surrounding the aircraft. Static pressure is taken from two static ports located below and aft of the canopy on the sides of the fuselage. These ports should always be checked free of obstructions during pre-flight.

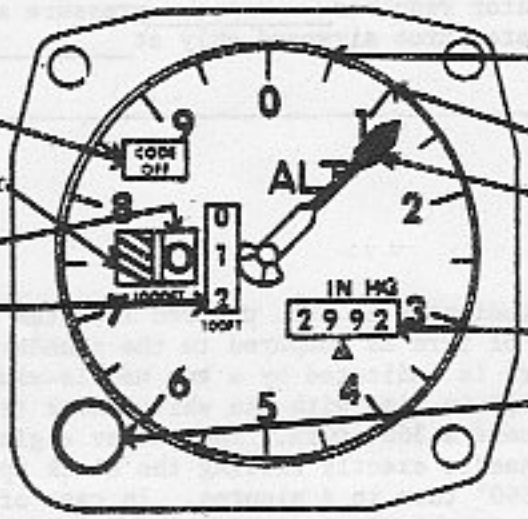
The altimeters take static pressure from two_____located on the sides of the aft fuselage section.

---

static ports

FRAME 17

The altimeters used in the T-28 are an AAU-21 encoder altimeter in the front cockpit and an AAU-24 pressure altimeter in the rear cockpit. The AAU-21 encoder altimeter is a pressure altimeter with an a.c. powered digital encoder that encodes altitude information for transmission on Mode C of the APX-72 (transponder). If a.c. power to the AAU-21 is lost, the AAU-21 will operate normally as a pressure altimeter, but a CODE OFF flag will appear on the altimeter indicating no altitude signal is being provided to the transponder. The AAU-24 is a pressure altimeter with an altitude display like the AAU-21. The AAU-21 and AAU-24 display altitude information in the same way.



1. CODE OFF flag (only on AAU-21)
2. 10,000 ft counter
3. 1000 ft counter
4. 100 ft counter
5. 50 ft center graduation
6. 100 ft increment
7. Single pointer indicating 100 ft increments
8. Barometric setting
9. Barometric pressure set knob

ENCODING ALTIMETER

FIGURE 2

No response required.

FRAME 18

The vertical speed indicator (VSI) is calibrated to show from 0 to 6,000 feet per minute rate of climb or descent. The VSI is essentially an aneroid barometer with a restrictor. It compares present static pressure with the pressure recorded an instant ago. It is more responsive than the altimeter with smooth attitude changes, but with rapid attitude changes the momemtum of the needle may cause the indicator to read opposite to the actual performance of the aircraft. The VSI requires only static air pressure to function.

The VSI is _____ responsive to smooth attitude changes than the _____ and requires only _____ pressure to function.

---

more
altimeter
static air

FRAME 19

The airspeed indicator is the only instrument in the aircraft which requires dynamic pressure as measured by the pitot tube in order to function. It compares ram air pressure with static air pressure, giving a reading which is equal to th true airspeed of the aircraft only at sea level on a standard day. The instrument is calibrated to show between 40 and 400 knots, and the ring attached to the outside shows the aricraft's maximum permissible indicated airspeed at various altitudes.

The airspeed indicator requires _____ pressure as well as static pressure to function and indicates true airspeed only at _____.

---

dynamic
sea level

FRAME 20

The turn and bank indicator is d.c. powered from the primary bus.and indicates the rate and direction of turn as compared to the standard rate, which is 3° per second. A standard-rate turn is indicated by a two needle-width deflection of the turn needle, which puts it in line with the white index line. At this rate, it would take 2 minutes to make a 360° turn. The proper angle of bank to give a one needle-width deflection (needle exactly filling the black space adjacent to the zero turn index) would give 360° turn in 4 minutes. In case of loss of a.c. power under instrument conditions, this instrument must be used to judge and maintain desired wing attitude.

The standard rate turn as indicated on the turn needle would be _____.

---

two needle-widths

FRAME 21

The balance ball assembly is mounted in the same case as the turn and bank indicator but is unrelated. A heavy ball is immersed in a low density fluid inside a curved tube. Gravitational force or centrifugal force will displace the ball, indicating a need for the addition of rudder in that direction in order to restore the aircraft to balanced flight.

If the ball is out to the left, you must apply _____ to return to balanced flight.

---

left rudder

FRAME 22

The attitude indicator shows the attitude of the aircraft, in both pitch and roll, using a stabilized gyro to maintain artificial horizon. A miniture airplane is attached to the frame and is compared to the horizon bar to indicate the angular displacement of the aircraft in both pitch and bank. Review units 2 and 3 for power supply for each cockpit.

The attitude indicator shows _____ and _____ relationships.

---

pitch
roll

FRAME 23

The bank index and fixed dial at the top of the instrument also indicate angle of bank up to 90°. On some versions, there is also a pitch scale window indexed up to 80° nose high or nose low attitude. The adjustment knob in the lower left corner of the frame may be used to adjust the miniature aircraft up or down so that it appears to be on the horizon when the aircraft is in a normal cruise attitude. An OFF flag will appear in the upper right corner of the instrument if power is lost.

The miniture aircraft should be adjusted so that it is _____ when the aircraft is straight and level in normal cruise.

---

on the horizon

NAVIGATIONAL INSTRUMENTS

FRAME 24

The radio magnetic indicator (RMI), or ID-250, is a gyro-stabilized magnetic compass powered from the appropriate a.c. bus. The pointer at the top of the instrument (called the "lubber line") shows the magnetic heading of the aircraft, and the No. 1 and No. 2 needles facilitate taking magnetic bearings on two navigation aids simultaneously.

The _____-powered RMI shows the _____ of the aircraft, while the needles show _____ to navigation aids.

---

a.c.
magnetic heading
magnetic bearing

FRAME 25

Occasionally, the RMI will not be properly aligned with either the wet compass or the duty runway when in position for takeoff. It may be realigned by placing the free-slaved switch to the FREE GYRO position and rotating the compass card by us of the increase-decrease switch on the compass control panel. The aligning of t compass may be accomplished by the pilot having control of the VHF NAV/compass control system. This procedure must be done prior to every flight. The position of the free-slaved switch will be indicated by the annunciator windows. The RMI should be cross-checked with the wet compass in flight, especially after turns, for proper alignment or precession.

To align the RMI, the free-slaved switch must be in the_____position, and then placed to the_____position for flight.

FREE GYRO
SLAVED GYRO

FRAME 26

The annunciator windows above the compass show whether the gyros are free or slaved and whether the No. 1 needle is receiving signals from the AN/ARA-25 or AN/ARN-6. The No. 2 needle receives signals from either the AN/ARN-14 VHF NAV receiver or the AN/ARN-21 TACAN receiver, whichever is installed in the particular aircraft. The No. 2 needle will be slaved to the No. 1 when the ARN-14 or ARN-21 is not operating. Control of the RMI is on the same circuit as control of the ARN-14 or ARN-21. The annunciators will show barber pole when power is not applied to the respective systems. The left annunciator applies to RMI (free-slaved) control, and the right indicates which receiver is utilizing the No. 1 needle.

No response required.

FRAME 27

The standby compass is installed on the top left side of the windshield of the front cockpit only. The standby compass should be used as a backup for the RMI, and and read while in unaccelerated, straight and level flight.

The standby compass is a backup for the_____and is to be read while_____.

RMI
straight and level

FRAME 28

The ID-249 course indicator gives navigational information to the pilots in conjunction with either the AN/ARN-14 or the AN/ARN-21 TACAN. A Course Deviation Indicator (CDI) is d.c. powered from the secondary bus. It moves laterally across the instrument and shows the position of the selected course relative to the aircraft postion. An OFF flag on the vertical crossbar of the ID-249, means the CDI information is unreliable.

An OFF flag on the vertical line of the ID-249 means that the CDI is_____.

---

unreliable

FRAME 29

An OFF flag is always visible on the left side of the ID-249, on the horizontal crossbar, indicating that glide slope readings are unreliable. Since a glide slope receiver is not installed in the T-28, this OFF flag will always be visible. The TO-FROM window on the left side of the ID-249 indicates whether the course selected by the pilot will take the aircraft to or from the navigation aid.

If a course of 270 is selected and the TO-FROM window reads FROM, the aircraft's position is_____of the navigational aid.

West

FRAME 30

The a.c. power magnetic heading indicator shows the magnetic heading of the aircraft relative to the course selected. All the information on the ID-249 is relative to the course selected in the cockpit which has control of the ARN-14 or ARN-21. The yellow warning light adjacent to the ID-249 on the right side of the cockpit reads "OBTAIN COURSE SETTING FROM OTHER COCKPIT" and will illuminate in the cockpit that does not have control of the navigation radio (VOR/TACAN).

If the controlling pilot has selected a course of 180°, the TO-FROM window reads TO, and the magnetic heading indicator is 0° relative, the aircraft heading is_____.

180

FRAME 31

The ID-310 range indicator (DME--Distance Measuring Equipment) is installed and operated by the AN/ARN-21 TACAN navigation system. It is a.c. powered from the large (750 VA) inverter and can be read only in the cockpit which has control of the ARN-21. When the control (ON-OFF) switch is placed in the T/R postion on the

TACAN control panel, the ID-310 indicates slant range (mileage) between the TACAN station and the aircraft. With the control switch in the REC position, only bearing and course information is received from the TACAN.

The TACAN is _____ powered from the _____ and the ID-310 indicates _____ range (mileage) between the TACAN station and the aircraft.

---

a.c.
large inverter
slant

FRAME 32

All warning lights and the landing gear warning horn are powered from the primary bus. These include the sump plug (chip detector) warning light, low-level fuel warning light (less than 200 pounds), a.c. instrument power failure light (selected inverter), generator off light, landing gear handle light, (gear not locked up or down), and landing gear warning horn (MAP less than 18 inches, gear not down and locked).

All warning lights and the landing gear warning horn are powered from the _____ bus, and _____ be functional with a generator failure.

---

primary
will

FRAME 33

Miscellaneous instruments include the fuel quantity indicator powered from the primary bus, gear and flap position indicators powered from the secondary bus, an 8-day clock, a voltmeter powered from the primary bus, a generator load meter which measures the percent of the rated output of the generator being used, and a free air temperature gauge in the front cockpit only.

No response required.

FRAME 34

The navigation and radio instruments will be covered in more detail in the instrument navigation phase of training, both flight and academic. Other miscellaneous instruments mentioned will be covered in detail in other units within the engineering phase.

No response required.