

# DIRECTED STUDY PROGRAM

USFAA EXAMINATION GUIDE

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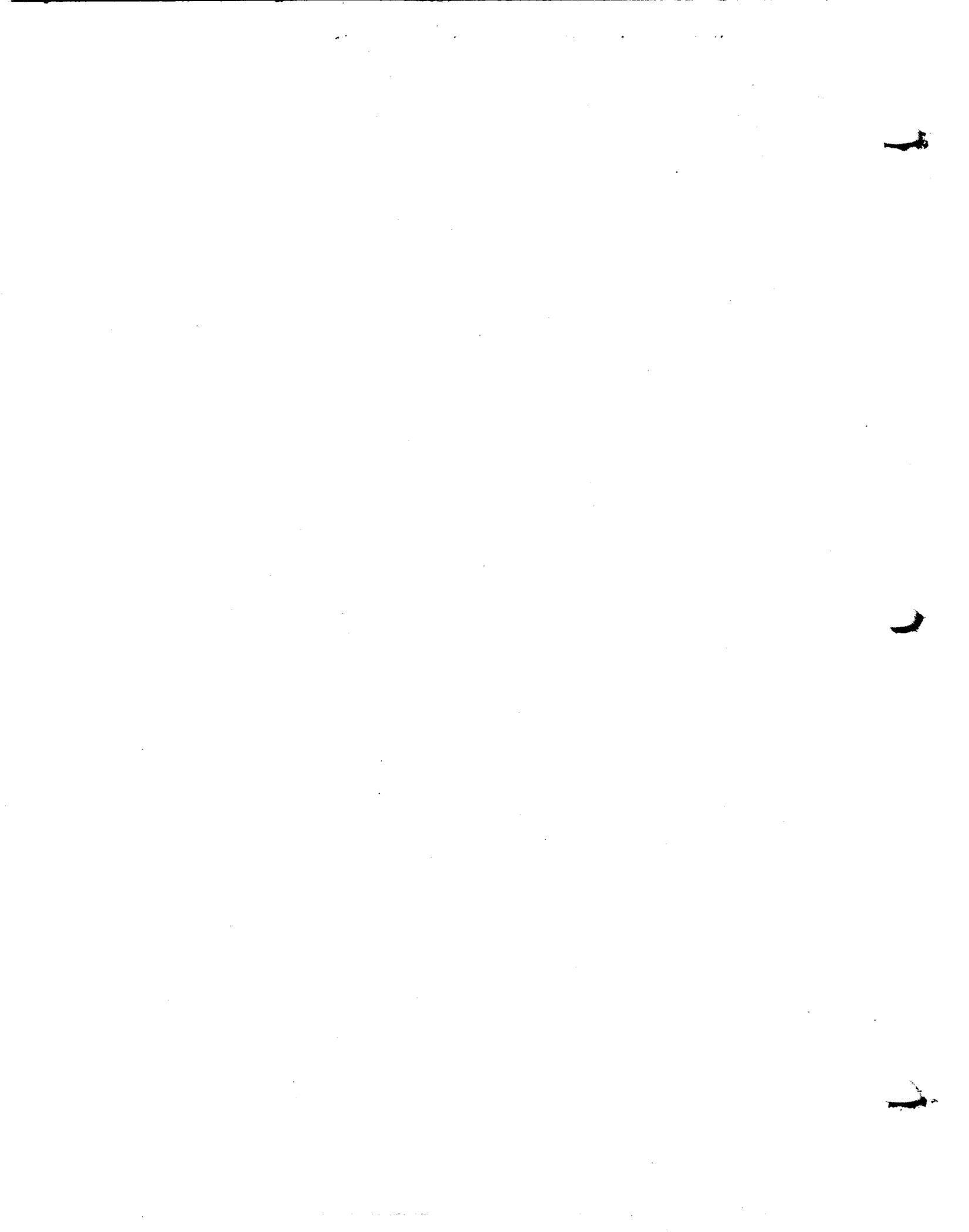
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## C O N T E N T S

### AIRLINE TRANSPORT PILOT

(ATR)

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### AIRLINE TRANSPORT PILOT (AIRPLANE) WRITTEN EXAMINATION GUIDE

#### Introduction

The written examination for the Airline Transport Pilot (Airplane) Certificate places major emphasis on the specific requirements and duties of an airline transport pilot, in accordance with the requirements stipulated in Federal Aviation Regulations Part 61. This examination guide outlines the aeronautical knowledge needed to obtain an Airline Transport Pilot Certificate and stresses requirements relating specifically to airline operations. Pilots wishing to acquire this certificate only for its advantage to them in their line of aviation activity must expect to be examined on the same basis as an applicant seeking the certificate for use in an airline pilot's job.

The following excerpts from the Federal Aviation Regulations Part 61, pertaining to eligibility, are given for the convenience of the applicant.

#### § 61.41 Eligibility requirements: general.

To be eligible for an airline transport pilot certificate, a person must-

- (a) Be at least 23 years of age;
- (b) Be of good moral character;
- (c) Be able to read, write, and understand the English language and speak it without accent or impediment of speech that would interfere with two-way radio conversation;
- (d) Be a high school graduate, or its equivalent in the Administrator's opinion, based on the applicant's general experience and aeronautical experience, knowledge, and skill.
- (e) Have a first-class medical certificate issued under Part 67 of this

chapter within the 6 months before the date he applies; and

- (f) Comply with the sections of this Part that apply to the rating he seeks.

#### § 61.145 Airplane rating: aeronautical experience.

- (a) An applicant for an airline transport pilot certificate with an airplane rating must hold a commercial pilot certificate or a foreign airline transport pilot or commercial pilot license without limitations, issued by a member state of ICAO, or he must be a pilot in an Armed Force of the United States whose military experience qualifies him for a commercial pilot certificate under 61.31 of this Part.
- (b) An applicant must have had -
  - (1) At least 250 hours of flight time as pilot in command, or as copilot performing the duties and functions of a pilot in command under the supervision of a pilot in command, or any combination thereof, at least 100 hours of which were cross-country time and 25 hours of which were night flight time; and
  - (2) At least 1,200 hours of flight time as a pilot within the 8 years before the date he applies, including at least -
    - (i) 5 hours within the 60 days before the date he applies;
    - (ii) 500 hours of cross-country flight time;
    - (iii) 100 hours of night flight time; and
    - (iv) 75 hours of actual or simulated instrument time,

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at least 50 hours of  
which were in actual flight.

Flight time used to meet the requirements of subparagraph (1) of this paragraph may also be used to meet the requirements of subparagraph (2) of this paragraph.

- (c) If an applicant with less than 250 hours of pilot-in-command time otherwise meets the requirements of paragraph (b)(1) of this section, his certificate will be endorsed "Holder does not meet the pilot-in-command flight experience requirements of ICAO," as prescribed by article 39 of the "Convention on International Civil Aviation." Whenever he presents satisfactory written evidence that he has accumulated the 250 hours of pilot-in-command time, he is entitled to a new certificate without the endorsement.

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## Recommended Study Areas

FAR PART 1  
FAR PART 25  
FAR PART 61  
FAR PART 65  
FAR PART 91  
FAR PART 121  
FAR PART 320  
ICAO

- ATC Procedures, ATP 7110.1A or USFAA ATR/AC Dispatcher Study Guide
- Know all of FAR Part 1.

Scheduled Air Carrier Certification and Operation Rules FAR Part 121. The following Sections are of particular interest to the Aircraft Dispatcher and ATR Student.

### 1. Certification rules & operations specifications

- a. Issuance of certificate. (FAR 121.1 thru 121.45)
- b. Rules covering all certificate holders  
FAR Part 121 Subpart D (121.73, 121.81)
- c. Approval of routes: Domestic & Flag.  
FAR Part 121 Subpart E (121.97, 121.99, 121.101, 121.103, 121.105, 121.107)
- d. Requirement for aircraft FAR Part 121 (121.153) (121.161)
- e. Airplane Performance Operating Limitations.  
Subpart I FAR Part 121.171, 121.175, 121.177, 121.181, 121.183, 121.185, 121.187, 121.189, 121.191, 121.193, 121.195, 121.197.
- f. Special Airworthiness requirements  
Subpart J 121.221, 121.265, 121.285, 121.287.
- g. FAR Part 121 Subpart K Instrument & Equipment Requirements.  
FAR Part 121.305, 121.309, 121.319, 121.323, 121.327, 121.329, 121.331, 121.337, 121.339, 121.341, 121.343, 121.345, 121.349, 121.359.
- h. Maintenance, Preventive Maintenance  
FAR Part 121 Subpart L 121.378.
- i. Airman & Crewmember Requirements FAR 121 Subpart M  
121.383, 121.385, 121.391, 121.397.

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- j. Training Program FAR Part 121 Subpart N  
121.411, 121.415, 121.423.
- k. Flight Crewmember Qualifications FAR Part 121 Subpart O  
121.432, 121.437, 121.439, 121.441, 121.443, 121.447, 121.449.
- l. Flight Time Limitations Domestic Air Carriers  
FAR Subpart Q - 121.471
- m. Flight Operations FAR Part 121 Subpart T  
121.533, 121.543, 121.547, 121.549, 121.557, 121.565, 121.575, 121.579,  
121.587.
- n. Dispatching & Flight Release FAR 121 Subpart U  
121.593, 121.601, 121.611, 121.617, 121.619, 121.625, 121.627,  
121.629, 121.631, 121.637, 121.639, 121.647, 121.649, 121.651, 121.655,  
121.657, 121.659, 121.663, 121.665.
- o. Records & Reports Part 121 Subpart V  
121.683, 121.687, 121.691, 121.695, 121.709, 121.711.

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## INSTRUMENTS AND INSTRUMENT PRINCIPLES

This section explains the operational aspects of several instruments used directly as references for instrument flight.

### HOW THE COMPASS INDICATES DIRECTION

#### Basic Magnetism

The magnetic compass works according to principles of magnetism; therefore, it is necessary to understand basic magnetism to understand the compass' operation. A simple bar magnet has two points, called the poles, at which magnetic lines of force are concentrated. The poles are located at either end of the bar. Magnetic lines of force fan out from each pole in all directions, eventually bending around and returning to the other pole, Figure 1-1. The area in which the lines of force are arranged is called the field of the magnet. The poles are usually designated "North" and "South". Opposite magnetic poles *attract* each other, and like poles *repel* each other.

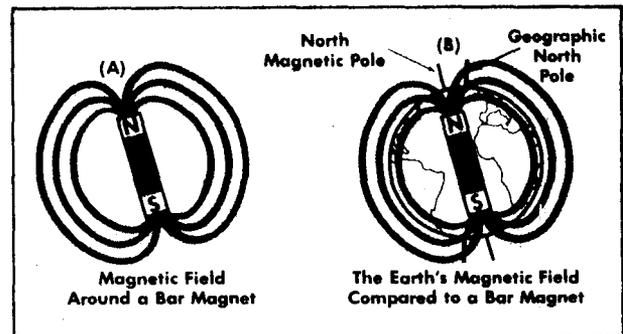


Fig. 1-1 - Magnetism

#### Earth A Magnet

There is a magnetic field around the earth. This field acts very much as if there was a huge bar magnet running along the axis of the earth with its ends several hundred miles below the surface. Unfortunately for the pilot, the earth's geographic poles and magnetic poles do not coincide. The magnetic poles are located a distance of approximately 1,000 miles from the geographic poles. The displacement of the magnetic and geographic poles accounts for variation. Variation is the amount, measured in degrees, that a bearing to the geographic pole varies from a bearing to the magnetic pole. Variation is designated as east or west of a line of zero variation, called the agonic line. Along the agonic line, there is 0° variation and a compass with no deviation will point to the North Geographic Pole, Figure 1-2.

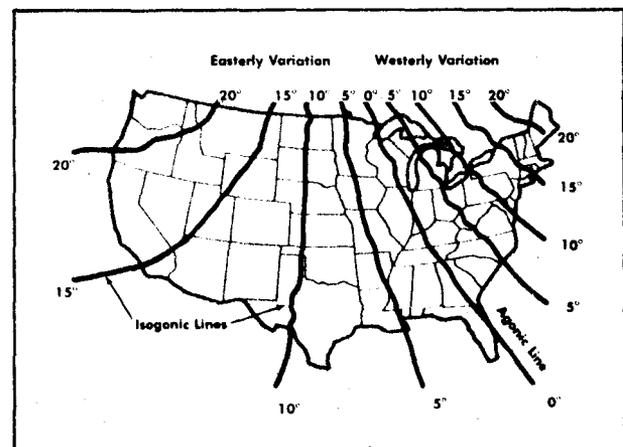


Fig. 1-2 - Magnetic Agonic & Isogonic Lines

The magnetic compass works according to the principles of \_\_\_\_\_

A simple bar magnet has two points at which magnetic lines of force are concentrated. These points are called \_\_\_\_\_

*magnetism*

These poles are usually designated as north and \_\_\_\_\_

*poles*

The earth's magnetic field is the same as though there was a huge bar magnet running through its \_\_\_\_\_

*south*

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There is a difference in the location of the earth's geographic and \_\_\_\_\_ poles.

*axis*

The Magnetic Pole is located approximately 1,000 miles from the \_\_\_\_\_ Pole.

*magnetic*

The displacement of the two poles is called \_\_\_\_\_.

*Geographic*

Variation is designated as being east or \_\_\_\_\_.

*variation*

The east or west designation is measured from a line of zero variation called the \_\_\_\_\_ line.

*west*

Along the agonic line, a compass (with no deviation) points to the North \_\_\_\_\_ Pole because there is no \_\_\_\_\_.

*agonic*

*Geographic  
variation*

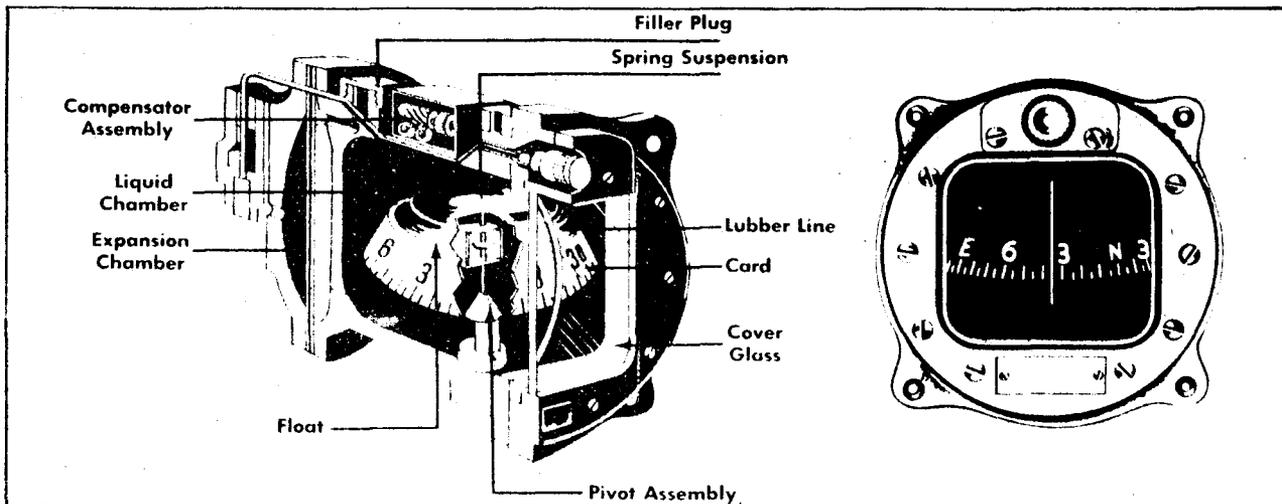


Fig. 1-3 - Magnetic Compass

### Magnetic Compass

The panel type magnetic compass is simple in construction. It contains two magnetized steel needles mounted on a float around which is mounted the compass card, Figure 1-3. The needles are parallel, with their north seeking ends pointed in the same direction. The compass card has letters for cardinal headings, and every 30° is represented by a number, the last zero of which is omitted. Between these numbers, the card is graduated for each 5°. The float assembly which consists of the magnetized needles, compass card, and float is housed in a bowl filled with acid free white kerosene. The purposes of this liquid are to dampen out excessive oscillations of the compass card and relieve, by buoyancy, part of the weight of the float from the bearings. The liquid also provides lubrication and prevents rust within the case of the instrument. The float rests on a pedestal protruding up from the bottom of the case. Jewel bearings are used to mount the float on top of the pedestal. At the rear of the compass bowl, a diaphragm is installed to allow for any expansion or contraction of the liquid, thus preventing the formation of bubbles or possible bursting of the case. The glass face of the compass is an integral part

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of the bowl and has mounted behind it a lubber line, or reference line, by which compass indications are read. If the face is broken, the fluid is lost and the compass becomes inoperative. A compensating device is mounted on top of the compass. This device consists of several small bar magnets which are adjusted by two set screws labeled "N-S" for north-south and "E-W" for east-west.

## Deviation

The airplane's electrical equipment and items made of iron or steel, may affect the reading of the magnetic compass. The amount these factors cause the compass to vary, in degrees, from its normal reading is called "deviation".

FOR	0	30	60	90	120	150	180	210	240	270	300	330
STEER	359	30	60	88	120	152	183	212	240	268	300	329

Fig. 1-4 - Compass Correction Card

This error can be partially corrected by adjustment of the compensating bar magnets built into the instrument. The remainder of the error, that cannot be removed through compensation, is indicated on a compass deviation card usually located near the magnetic compass (Figure 1-4).

Deviation may change with each unit of electrical equipment turned on, and the magnetism of the airplane itself may change as a result of severe jolts. Therefore, it is necessary to swing the compass periodically to determine its deviation. If there is a change, a new compass deviation card should be made.

The magnetic compass mounted in airplanes, is contained in a bowl filled with acid free

The kerosene serves to dampen out excessive oscillations of the card.

Along with acting as a dampener, the kerosene relieves weight on the bearing and prevents in the case:

If the kerosene is lost from the bowl, the instrument will become

The reading of the magnetic compass may be affected by items made of iron or steel, or the airplane's equipment.

The effect these factors have on the compass reading is called

The deviation errors that cannot be compensated for by adjustment within the compass are listed on the compass deviation

By swinging the compass periodically, the compass card can be kept current for correction.

*kerosene*

*compass*

*rust*

*inoperative*

*electrical*

*deviation*

*card*

*deviation*

## Magnetic Dip

The tendency of the magnetic compass to point downward, as well as north in certain latitudes, is known as "magnetic dip" and is responsible for northerly and southerly turning errors, as well as the acceleration and deceleration errors on headings of east and west. At the magnetic equator, the

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"vertical component" of the earth's magnetic field is zero and the magnetic compass is not disturbed by this factor. Vertical component causes the compass needle to point down. Flying from the magnetic equator toward the higher latitudes, the effect of the vertical component of the earth's magnetic field becomes increasingly pronounced. Only the northern latitudes will be considered here. The errors are reversed in the Southern Hemisphere.

## Northerly Turning Error

In addition to aligning itself with the Magnetic Poles, the magnetic compass has a tendency to "dip" downward because of the downward pull of the earth's magnetic field. This tendency is not noticed in straight and level, unaccelerated, flight because the compass card is mounted in such a way that its center of gravity is below the pivot point and the card is well balanced in the fluid. When the airplane is banked, the compass card also banks because of the centrifugal force acting upon it. While the compass card is in this banked attitude, the vertical component of the earth's magnetic field causes the north seeking end of the compass to dip to the low side of the turn, giving the pilot an erroneous turn indication. This error is most apparent on headings of north and south. When making a turn from a heading of north, the compass briefly gives an indication of a turn in the opposite direction and when making a turn from a heading of south, it gives an indication of a turn in the proper direction, but at a more rapid rate than is actually being made.

## Turns Using Magnetic Compass

When making turns to headings with the magnetic compass, a maximum of 18° of bank should be used. When using 18° of bank in turning to north or south, the amount of roll-out is proportional to the latitude. For example, in turning to north from east in the 30° north latitude area, a pilot would start a roll-out 30° before reaching north, plus ½ the degree of bank to allow for roll-out, in this case 39°. To roll-out on a heading of south, fly past south the number of degrees of latitude minus ½ the degree of bank. For example, turning from the east to south, 30° north latitude, 18° bank, start a roll-out on 201° (180° + 30° N latitude = 210° - ½ of the 18° bank = 201°). Because of the turning error from north and south, roll-outs on east or west headings are lead 10° when turning from north and 5° when turning from south.

## Acceleration Error

Acceleration error is another effect caused by a combination of inertia and the vertical component of the earth's magnetic field. Because of its pendulous type mounting and the causes mentioned, the compass card is tilted during changes of speed. The momentary tilting of the card from the horizontal results in an error which is most apparent on headings of east and west. When accelerating on either of these headings, the error is in the form of an indication of a turn to the north, and when decelerating, the error is in the form of an indication of a turn to the south.

## Oscillation Error

Erratic swinging of the compass card, which may be the result of rough air or certain maneuvers, is called "oscillation error".

## Hints on Flying by Compass

The magnetic compass, if its errors and characteristics are thoroughly understood, offers the pilot a most reliable means of determining the direction in which his airplane is headed. While reading the compass to determine direction, the pilot should be certain the airplane is held as steady as possible, is not in a turn and is at constant airspeed.

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The magnetic compass is subject to operational errors. Turning error is present when turning *from* north and \_\_\_\_\_ headings.

A momentary turn in the opposite direction will be indicated on the magnetic compass when turning \_\_\_\_\_ a north heading.

*south*

When turning from south, a turn will be indicated in the proper direction but at a rate that is \_\_\_\_\_ than the actual turn.

*from*

The north turning error causes an indication of a turn in the \_\_\_\_\_ direction.

*greater*

The south turning error causes an indication of a turn at a \_\_\_\_\_ rate.

*opposite*

There is no turning error on east and \_\_\_\_\_ headings.

*faster*

On east and west headings, there is "dip" error caused by an increase or \_\_\_\_\_ in airspeed.

*west*

An increase of airspeed while on east or west headings will cause an indication of a turn to the north. A decrease in airspeed will cause an indication of a turn to the \_\_\_\_\_

*decrease*

"Dip" error is caused by \_\_\_\_\_ or \_\_\_\_\_ airspeed.

*south*

When flying on east or west headings, an increase in airspeed will cause an indication of a turn to the \_\_\_\_\_

*increasing  
decreasing*

When flying on an east or west heading, a decrease in airspeed will cause an indication of a turn to the \_\_\_\_\_

*north*

When using only the magnetic compass as a reference, a maximum of 18° bank should be used for making \_\_\_\_\_

*south*

Roll-out lead from a turn to north is based upon the degree of latitude plus ½ degree of bank. Turning left to north (360°) at 30° N latitude, 18° of bank, the roll-out would start at 30° plus ½ of \_\_\_\_\_ degrees.

*turns*

Turning right to 360° at 40° N latitude, using 10° of bank, the roll-out would be started when the magnetic compass reads \_\_\_\_\_ degrees.

*18*

Turning left to 360° at 40° N latitude, using 18° of bank, the roll-out would be started when the magnetic compass reads \_\_\_\_\_ degrees.

*315*

Turning to north, the roll-out is started prior to reaching the heading. Turning to south, the reverse is used, fly past the heading the degree of latitude minus half the degree of \_\_\_\_\_

*49*

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Turning right to 180°, 30° N latitude, 18° bank, the roll-out would be started when the compass reads _____ degrees.	<i>bank</i>
Turning left to 180°, 40° N latitude, 10° bank, roll-out would be started when the compass reads _____ degrees.	201 (180 + 30 - 9)
Turning to north headings, the roll-out is started _____ reaching the headings; turning to south headings, the roll-out is started _____ reaching the headings.	145
Because of turning errors from north and south, roll-outs on east and west headings are lead 10° when turning from north, and 5° when turning from _____.	<i>before</i> <i>after</i>
Turning from north to roll-out on 270°, the roll-out would be started when the compass reads _____ degrees.	<i>south</i>
Turning from south to roll-out on 270°, the roll-out would be started when the compass reads _____ degrees.	280
East or west heading roll-outs, when turning from north, are led _____ degrees; when turning from south, the lead is _____ degrees.	265
	10 5

### Radio Magnetic Indicator (RMI)

Most transport category airplanes are equipped with a radio magnetic indicator (Figure 1-5). The RMI consists of a rotating compass card and two bearing indicators. The bearing indicators are associated with the navigation system in the airplane and will be discussed later.

The rotating compass card is actuated by a remote compass transmitter located away from the cockpit to avoid deviation errors. The compass card rotates as the airplane turns so that the magnetic heading of the airplane is always under the index at the top of the instrument.

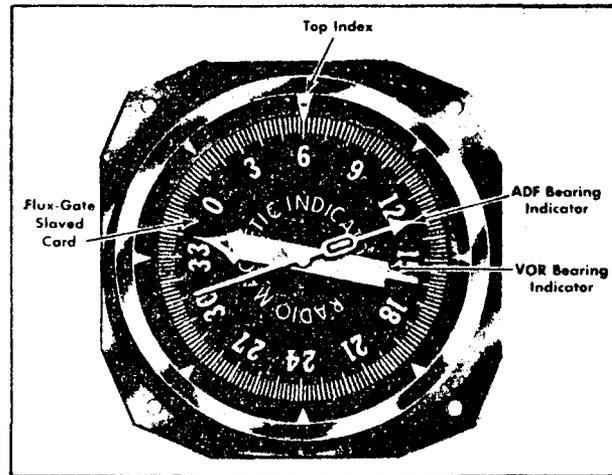


Fig. 1-5 - Radio Magnetic Indicator

The RMI consists of two bearing indicators and a rotating compass \_\_\_\_\_

The compass card receives directional information from the remote compass \_\_\_\_\_ *card*

As the airplane turns, the compass card \_\_\_\_\_ *transmitter*

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The magnetic heading of the airplane is always under the  
\_\_\_\_\_ at the top of the instrument.

*rotates*

*index*

## Gyroscopic Principles

The basis for the use of the gyroscopic principles in flight instruments is rigidity in space. Newton's First Law states "A body at rest will remain at rest; or if in motion in a straight line, it will continue in motion in a straight line unless acted upon by an outside force".

A universally mounted gyro, Figure 1-6, is used in many flight instruments and operates according to Newton's Law. When the rotor of the gyro is spinning, it has the ability to remain in its original plane of rotation during movement of the base. The degree of rigidity depends upon the weight and the speed of rotation of the rotor, because the force required to deflect a moving body is proportional to the weight and speed of the body. For this reason, the rotors are as heavy as possible for their size and are given a high speed of rotation.

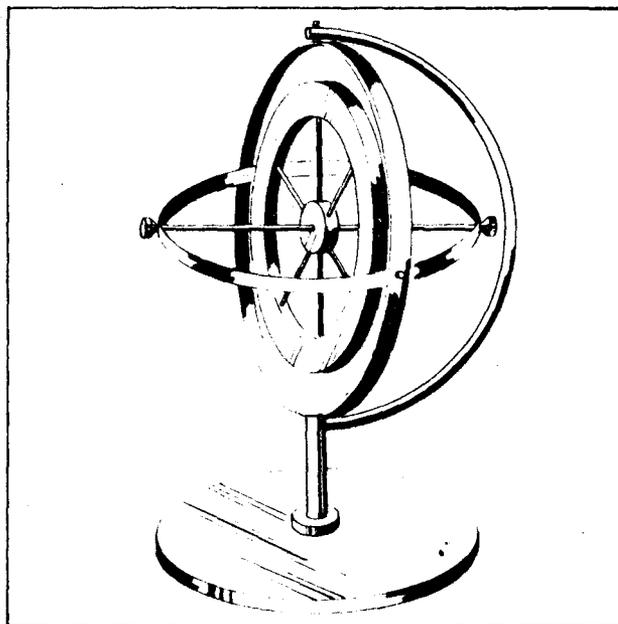


Fig. 1-6 - Universally Mounted Gyro  
(Demonstration Unit)

When a deflection force is applied to the rim of the spinning rotor, the result is called precession. If the deflection becomes too great, the gyro falls over, "spills"; when this happens, the gyro must be righted by "caging" the instrument to return the gyro to its original position.

Precession is caused by the friction of bearings, rings, and pivots, and also by centrifugal force in banks, acceleration and deceleration, and gravity force when not in coordinated flight.

The three basic types of gyro instruments are the turn and bank indicator, directional gyro (heading indicator) and attitude indicator (artificial horizon). The gyros of the instruments are either electrically or suction driven.

The basis for the use of gyroscopic principles in flight instruments is rigidity in \_\_\_\_\_

Newton's First Law states "A body at rest will remain at \_\_\_\_\_; or if in motion in a straight line, it will continue in motion in a straight line unless acted upon by an outside \_\_\_\_\_"

*space*

A universally mounted gyro used in flight instruments operates in accordance with \_\_\_\_\_ First Law

*rest  
force*

When a universally mounted gyro is spinning, it has the ability to remain in its original plane of rotation in spite of movement of its \_\_\_\_\_

*Newton's*

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The degree of a gyro's rigidity depends upon the weight and the _____ of the rotation of the rotor.	<i>base</i>
The force required to deflect a moving body is proportional to the speed of rotation and _____ of the body.	<i>speed</i>
The rotors of a gyro are as heavy as possible for their size and are given a high speed of _____.	<i>weight</i>
When a deflection force is applied to the rim of a spinning _____, the result is called precession.	<i>rotation</i>
If the deflection becomes too great, the gyro "_____".	<i>rotor</i>
When the gyro has "spilled", it is returned to its original position by _____ the instrument.	<i>"spills"</i>
Precession is caused by the effect of _____ on bearings, rings, and pivots, among other causes.	<i>caging</i>
Precession is also caused by centrifugal force in banks, and by acceleration, _____, and gravity when the airplane is not in coordinated _____.	<i>friction</i>
The three basic types of gyro instruments are (1) directional gyro, (2) attitude (horizon) indicator, and (3) turn and _____ indicator.	<i>deceleration flight</i>
The gyros of the turn and bank indicator, directional gyro and the _____ (horizon) indicator are either suction (vacuum) or _____ driven.	<i>bank</i>
	<i>attitude electrically</i>

## THE GYRO INSTRUMENTS

### Directional Gyro (Heading Indicator)

The directional gyro, Figure 1-7, has been developed to assist the pilot in holding a steady heading. Since it operates on the principles of gyroscopic rigidity in space, it is not affected by the errors that affect the magnetic compass. The directional gyro has no direction seeking qualities and is either suction or electrically operated. The gyro compass must be set on the desired heading with reference to the magnetic compass. This must be done while the airplane is flying in straight and level, unaccelerated flight or while the airplane is stationary on the ground. The gyro

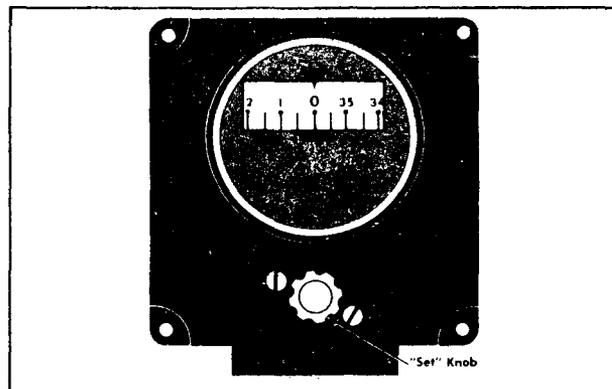


Fig. 1-7 - Directional Gyro

is affected by precession which is seen as a tendency for the instrument to drift off heading and, therefore, it must be reset by reference to the magnetic compass approximately every 15 minutes.

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The directional gyro is electrically or driven.

The directional gyro has no seeking qualities.

*suction*

The directional gyro has no direction seeking qualities and is subject to precession.

*direction*

The directional gyro must be checked frequently and reset with the magnetic compass because of error.

*error*

The operational limitations are 55° of pitch or

*precession*

If the airplane exceeds 55° of pitch or bank, the instrument must be reset with the compass.

*bank*

The directional gyro should be reset only when in unaccelerated, straight and flight.

*magnetic*

The directional gyro should be set any time there is a noticeable error and it should be checked with the magnetic compass at least every 15

*level*

The reading of the directional gyro can be kept fairly accurate, if it is checked with the magnetic compass at least every minutes.

*minutes*

15

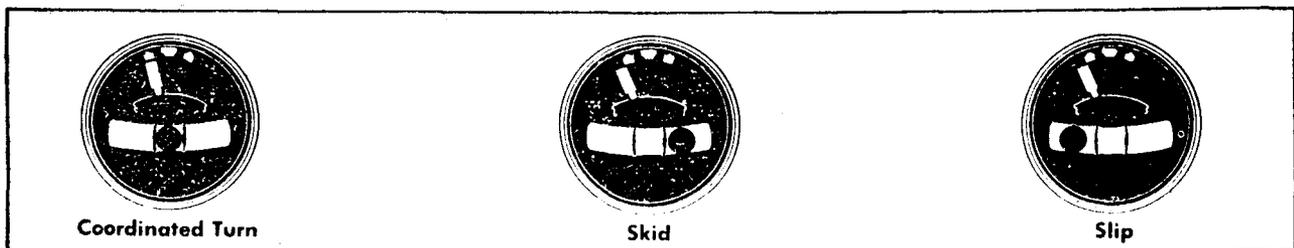


Fig. 1-8 - Turn and Bank Indicator

## Turn and Bank Indicator

The turn and bank indicator has two functions - the ball indicates the quality of a turn; the needle indicates the rate and direction of the turn.

When the ball is centered, flight is coordinated. In a left turn, if the ball is also displaced to the left or inside of the turn, (Figure 1-8), the rate of turn is slower than it should be for the angle of bank and the airplane is slipping. To center the ball, or to return to coordinated flight, a pilot must decrease the angle of bank or increase the rate of turn by the use of rudder to center the ball. If the ball is displaced to the outside of a turn, the angle of bank is too shallow for the rate of turn and the airplane is skidding (Figure 1-8). To return to coordinated flight, the angle of bank must be increased or the rate of turn decreased.

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The turn needle deflects in the direction of turn and indicates the rate, in degrees-per-second (or minute) that the airplane is turning. In turbulent air, the needle will oscillate and a pilot must interpolate the movement to detect turning. If the needle is oscillating equally to each side of center, the airplane is in straight flight. If the oscillation is greater on one side, the pilot can interpret a turn in the direction of the greater oscillation.

The ball of the turn and bank indicator indicates the \_\_\_\_\_ of a turn.

The needle indicates the rate and \_\_\_\_\_ of a turn.

*quality*

When the ball is centered, flight is \_\_\_\_\_.

*direction*

In a left turn, if the ball is also displaced to the left or to the inside of the turn, the airplane is \_\_\_\_\_.

*coordinated*

In a slip, the rate of turn is too slow for the angle of \_\_\_\_\_.

*slipping*

To return the airplane from a slip to coordinated flight the angle of bank must be \_\_\_\_\_ or the rate of turn \_\_\_\_\_.

*bank*

The rate of turn in a slip can be increased by the use of \_\_\_\_\_.

*decreased  
increased*

If the ball is displaced to the outside of a turn, the angle of bank is too shallow for the \_\_\_\_\_ of turn.

*rudder*

If the angle of bank is too shallow for the rate of turn, the airplane is \_\_\_\_\_.

*rate*

To return the airplane from a skid to coordinated flight, the angle of bank must be \_\_\_\_\_ or the rate of turn \_\_\_\_\_.

*skidding*

The turn needle deflects in the direction of turn and indicates the rate at which the airplane is turning in degrees per \_\_\_\_\_.

*increased  
decreased*

In turbulent air, the needle will oscillate and to detect a turn, the movement of the needle must be \_\_\_\_\_.

*second*

If the needle is oscillating equally to each side of center, the airplane is in \_\_\_\_\_ flight.

*interpolated*

If the oscillation is greater to one side, the pilot can interpret a turn in the direction of the \_\_\_\_\_ oscillation.

*straight*

*greater*

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## Attitude Indicator (Horizon)

In instrument flying, the attitude indicator or artificial horizon is substituted for the real horizon (Figure 1-9). The artificial horizon is used in the same way as the real horizon. The miniature airplane mounted on the instrument is kept on the horizon by raising or lowering the horizon bar through application of control pressure. The miniature airplane should be aligned with the horizon bar while on the ground. If the miniature airplane is not level with the horizon bar when in level flight at normal cruising speed, it should be adjusted. However, once the artificial horizon is set for level flight, it should not be changed for varying airspeeds or the true attitude of the airplane will not be indicated. In conventional gear airplanes the bar is above the horizon bar when sitting on the ground.

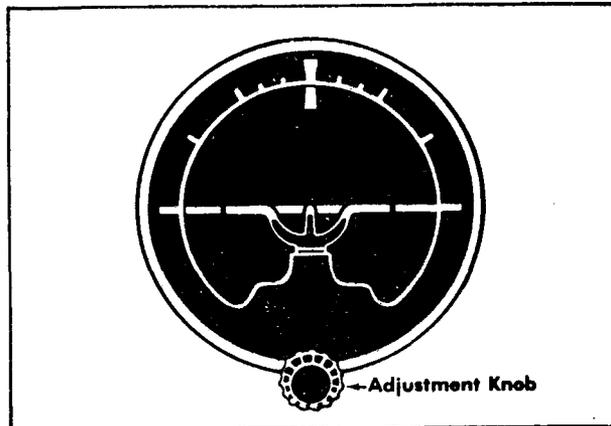


Fig. 1-9 - Attitude Indicator

Degree of bank is indicated by the pointer at the top of the case. The scale is graduated in 10° increments from 0° to 30°, then 30° increments up to 90°. Electrically operated attitude indicators have no spilling limits but vacuum operated instruments will normally spill after exceeding 70° of pitch or 90° of bank. After an instrument has spilled, it should be caged or reset only when in straight and level flight.

Degree of bank is indicated by the pointer at the top of the case. The scale is graduated in 10° increments from 0° to 30°, then 30° increments up to 90°. Electrically operated attitude indicators have no spilling limits but vacuum operated instruments will normally spill after exceeding 70° of pitch or 90° of bank. After an instrument has spilled, it should be caged or reset only when in straight and level flight.

In instrument flying, the attitude indicator (artificial horizon) is substituted for the real \_\_\_\_\_.

The artificial horizon is used to control airplane attitude in the same manner as the real horizon is utilized. The attitude is actually controlled by correctly positioning the horizon bar of the instrument by the use of \_\_\_\_\_ pressure.

*horizon*

The miniature airplane is adjustable and should be aligned with the horizon \_\_\_\_\_ while on the ground.

*control*

If the miniature airplane is not superimposed on the horizon bar when in level flight at normal cruising speed, it should be \_\_\_\_\_.

*bar*

When the artificial horizon is set for level flight, it should not be changed for varying airspeed. In this way, the true attitude of the \_\_\_\_\_ is always presented.

*aligned*

A pointer that operates with the miniature airplane indicates, on the scale at the top of the instrument, the airplane's degree of \_\_\_\_\_.

*airplane*

Electrical attitude instruments have no spilling limits, but vacuum operated instruments, after exceeding 70° of pitch or 90° of bank, will \_\_\_\_\_.

*bank*

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When the instrument has spilled after exceeding 70° of pitch or 90° of bank, the instrument is caged or reset only when in straight \_\_\_\_\_ flights.

*spill*

*level*

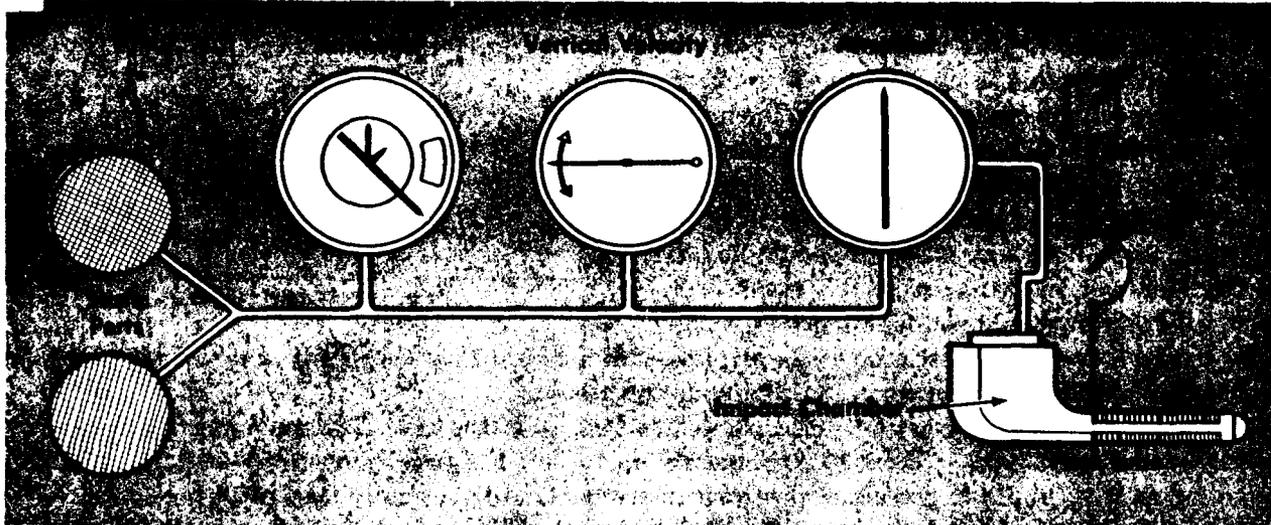


Fig. 1-10 - Pitot Static System

### The Pitot Static System

There are three major components (Figure 1-10) of the pitot static system: (1) the static pressure chamber, (static ports), (2) the impact pressure chamber, and (3) the heating unit, which prevents icing on the exposed pitot tube.

The *impact chamber* receives ram air pressure supplied by the pitot tube which is mounted parallel to the longitudinal axis of the airplane. The *static chamber* contains atmospheric pressure (air pressure at flight altitude) which is supplied by the static intake ports usually located on both sides of the airplane.

The pressure differential between ram and static air is required to operate the airspeed indicator. Static pressure alone is required for the operation of the altimeter and the vertical velocity indicator.

The three major components of the pitot static system are the static pressure chamber, the heating unit, and the \_\_\_\_\_ pressure chamber.

The impact chamber receives \_\_\_\_\_ air pressure.

*impact*

The static chamber is the source for \_\_\_\_\_ pressure.

*ram*

The sources for the static chamber are the static intake ports usually located on the \_\_\_\_\_ of the airplane.

*atmospheric  
(static)*

Ram air pressure is required for the operation of the \_\_\_\_\_ indicator.

*sides*

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The pitot static system serves as the air pressure source for the  
airspeed indicator, the vertical velocity indicator and the

*airspeed*

*altimeter*

### The Vertical Velocity Indicator

The vertical velocity indicator (Figure 1-11) measures the rate of change in atmospheric pressure. When there is no change in atmospheric pressure, i.e. no change in altitude, the needle will indicate "0". However, when the airplane is climbing or descending, a change in pressure will be indicated by an upward or downward movement of the needle. The instrument is calibrated to indicate the rate of change of altitude in terms of feet per minute.

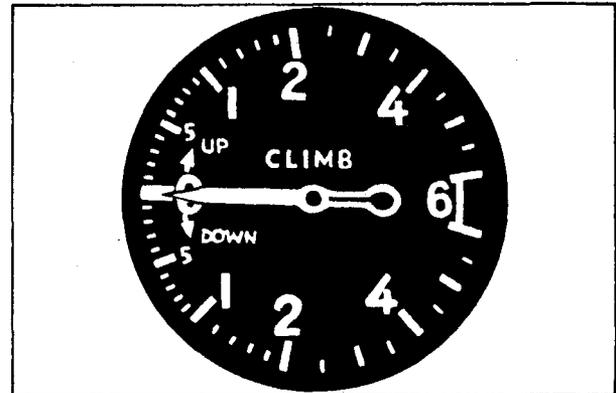


Fig. 1-11 - Vertical Velocity Indicator

The vertical velocity indicator measures the changes in atmospheric

If an airplane is in level flight, the needle of the vertical velocity indicator will indicate

*pressure*

A change in altitude causes an increase or decrease in atmospheric pressure. As atmospheric pressure changes, the vertical velocity indicator will register the rate of altitude

*"0"*

The vertical velocity indicator is calibrated in terms of feet per

*change*

*minute*

### The Airspeed Indicator

The airspeed indicator (Figure 1-12) actually measures the difference between impact and static air pressure, and converts this measurement into a speed indication. When the airplane is motionless, there is no pressure differential and consequently no speed indication (assuming no wind). However, as the airplane gains speed, a pressure differential develops which is registered on the airspeed indicator as either knots or miles per hour.

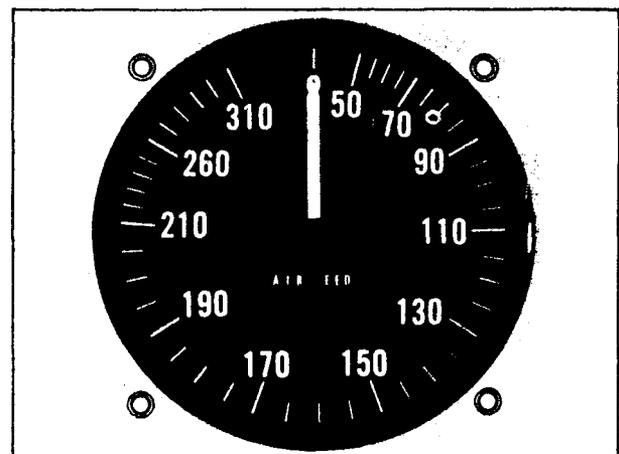


Fig. 1-12 - Airspeed Indicator

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The operation of the airspeed indicator is dependent upon the pressure differential between static and \_\_\_\_\_ air pressure.

No pressure differential is present when the airplane is \_\_\_\_\_ (assume no wind).

*impact  
(ram)*

Motion of the airplane generates a pressure difference between static and impact air which is registered on the airspeed indicator in either miles per hour or \_\_\_\_\_.

*motionless*

*knots*

## The Altimeter

The altimeter (Figure 1-13) is simply an aneroid barometer which measures the weight of the air above the airplane and displays the information in terms of feet of altitude.

Air is more dense at the surface of the earth than it is aloft. This *decrease in atmospheric pressure as altitude increases* is the natural phenomenon on which the operation of the altimeter is based. As an airplane ascends, less air pressure is exerted on the barometric apparatus inside the altimeter and an increase in altitude is indicated. Conversely, the increasing atmospheric pressure encountered in a descent produces a lower altitude indication.

The pressure over any given portion of the surface of the earth is constantly changing. This presents a requirement for a method of adjusting the altimeter to compensate for atmospheric pressure variations. This need is met by providing an adjustment dial located inside the small cutout window at the right of the altimeter face (Figure 1-13). Pressure variations are compensated for by adjusting this dial to reflect the prevailing atmospheric pressure (corrected to sea level).

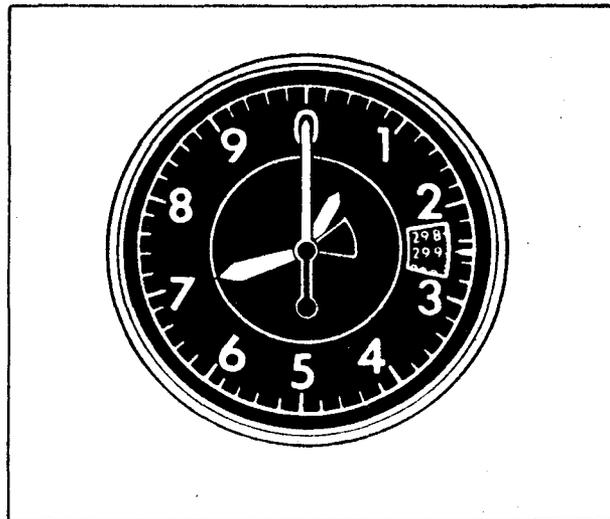


Fig. 1-13 - Altimeter

The altimeter can be referred to as an aneroid \_\_\_\_\_.

The altimeter measures the weight of the air above the \_\_\_\_\_.

*barometer*

The altimeter is calibrated in terms of \_\_\_\_\_ of altitude.

*airplane*

A descent or ascent is accompanied by a change in altimeter indication because the atmospheric pressure has increased or \_\_\_\_\_.

*feet*

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The altimeter may be corrected for variations in atmospheric pressure by setting the dial in the cutout window to reflect the current \_\_\_\_\_

*decreased*

*pressure*

## INSTRUMENT SYSTEMS

The instruments which have been considered thus far in this section have been long tried and proven. However, each is susceptible to certain weaknesses and inherent errors. These errors may not assume critical proportions at low speeds and altitudes, but with the advent of the jet airplane and its performance capabilities, an entirely new standard of accuracy is required. This need has been met in part by a system of integrated flight instruments, which is vastly superior in point of accuracy, safety, and in pilot time saved.

The system considered, in this text, is the Kollsman Integrated Flight Instrument System (KIFIS). The instruments associated with this system which will be briefly explained are the *Machmeter*, *altimeter*, *airspeed angle-of-attack indicator*, *true airspeed indicator* and the *static air temperature indicator*.

The advent of the jet airplane and its performance capabilities has necessitated a new accuracy standard for airplane \_\_\_\_\_

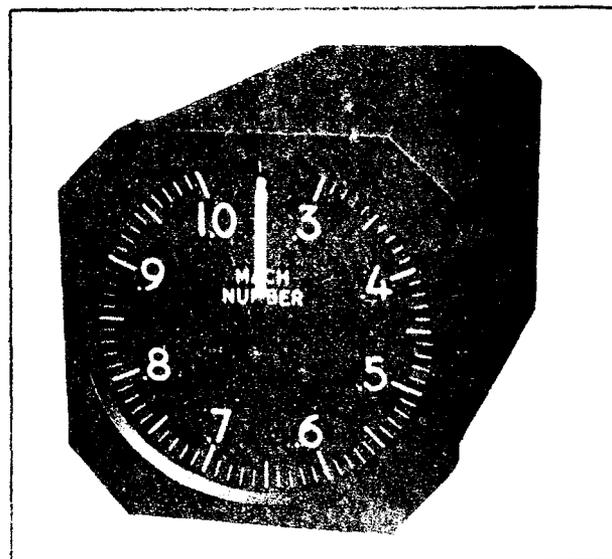
The instruments included in the KIFIS are the Machmeter, altimeter, airspeed angle-of-attack indicator, true airspeed indicator and the \_\_\_\_\_ temperature indicator.

*instruments*

*static air*

### The Machmeter

First to be discussed is the Machmeter (Figure 1-14) which indicates the speed of the airplane in terms of a percentage of the speed of sound. Basically, the Machmeter functions in the same manner as an airspeed indicator (compares static and ram air pressure) except that a mechanical computer is installed to convert the data received into a Mach number indication.



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Fig. 1-14 - The Machmeter

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The Machmeter indicates the speed of the airplane in terms of a percentage of the speed of \_\_\_\_\_.

The Machmeter receives data from the same source as the air-speed \_\_\_\_\_.

*sound*

This data is converted to a Mach number indication by a mechanical \_\_\_\_\_.

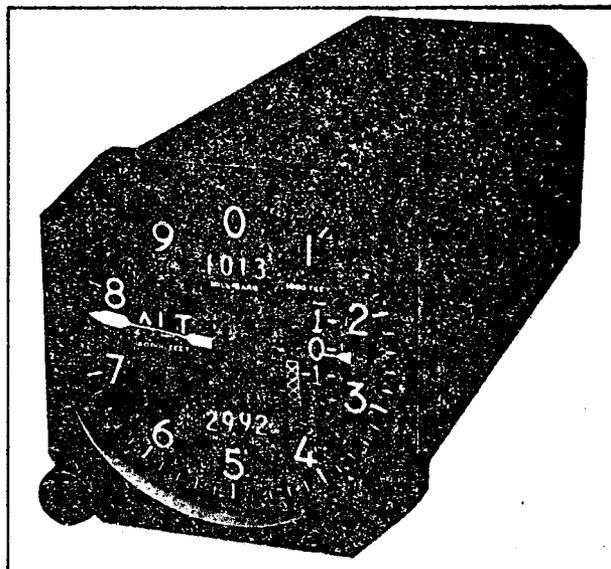
*indicator*

*computer*

### The Altimeter

Standard barometric altimeters have two inherent errors known as a scale error and static source error. Scale error is completely mechanical in nature and is caused by the non-uniform expansion and contraction of the aneroid bellows as the airplane ascends or descends. This error is corrected in the Kollsman system by means of a small cam which is adjusted to operate with one specific altimeter. The cam is calibrated to correct the altimeter a predetermined amount for the level at which the airplane is flying.

Static source error is the result of the speed of the aircraft which causes varying static air pressures at the static ports. The amount of error is in direct proportion to the speed of the airplane and thus can be corrected by an impulse from the Machmeter. The altimeter illustrated in Figure 1-15, is an example of the needle-and-drum type altimeter utilized in most jet transports. The drum at the right of the instrument face rotates to indicate the nearest 1,000 foot level and the pointer moves around a dial which is calibrated in 20 foot increments.



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Fig. 1-15 - The Altimeter

Standard altimeters are subject to two inherent errors known as scale error and \_\_\_\_\_ source error.

The non-uniform expansion and contraction of the aneroid bellows is the cause of \_\_\_\_\_ error.

*static*

Scale error is corrected in the KIFIS altimeter by means of a cam which is calibrated to one specific \_\_\_\_\_.

*scale*

Varying static air pressures at the static ports caused by the speed of the airplane produces static \_\_\_\_\_ error.

*altimeter*

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The KIFIS corrects static source error by means of an impulse from the \_\_\_\_\_

source

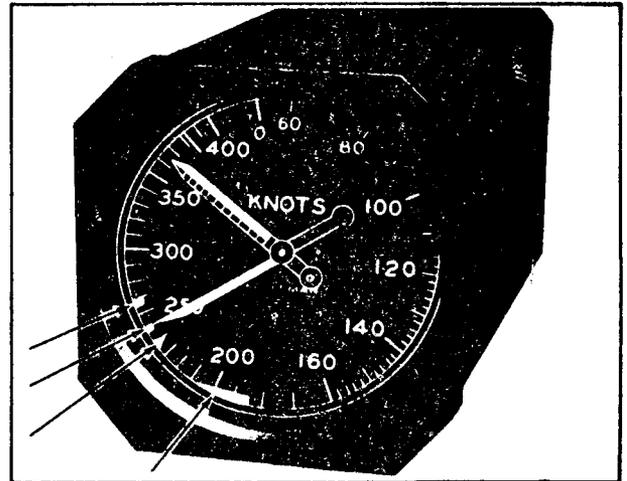
Machmeter

### The Airspeed Angle of Attack Indicator

The airspeed indicator operates by comparing static and ram pressure as do conventional airspeed indicators. There is no correction input into this instrument, however, additional built-in features make it more valuable to the pilot.

As seen in Figure 1-16, the airspeed indicator incorporates a banded maximum allowable airspeed needle. This needle automatically indicates the maximum operating speed at the altitude at which the airplane is flying.

Angle of attack information is also provided with the airspeed indicator. Small "bugs" (see arrows) located on the periphery of the instrument face automatically move to indicate the optimum angles of attack for stall, cruise, approach, climbout and rotation.



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Fig. 1-16 - Airspeed Angle of Attack Indicator

The KIFIS airspeed angle of attack indicator operates by comparing static and \_\_\_\_\_ air pressure.

The banded maximum allowable airspeed needle automatically indicates the maximum \_\_\_\_\_ at the flight altitude.

ram

Angle of attack information is provided by "bugs" located at the periphery of the instrument face. Optimum angles of attack are given for stall, cruise, approach, climbout and \_\_\_\_\_

speed

rotation

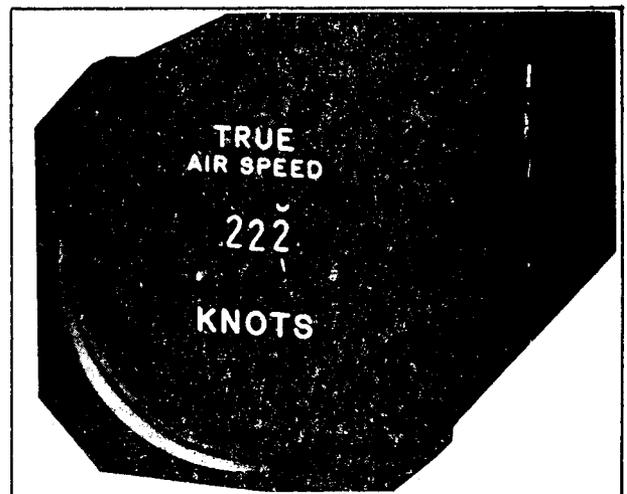
### The True Airspeed Indicator

The true airspeed indicator displays the true airspeed of the airplane in digital form as seen in Figure 1-17. The information fed to the indicator is derived from the Machmeter and is corrected for true air temperature. The TAS indication is purely a computed value which is calibrated to read in knots.

### Static Air Temperature Indicator

(not illustrated)

This instrument indicates the true temperature of the outside air. The KIFIS automatically corrects the errors resulting from air friction and compressibility thus avoiding the distorted indications by most outside air temperature gauges.



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Fig. 1-17 - True Airspeed Indicator

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The KIFIS true airspeed indicator displays information in \_\_\_\_\_ form.

True airspeed data is provided by the Machmeter and is corrected for true air \_\_\_\_\_

*digital*

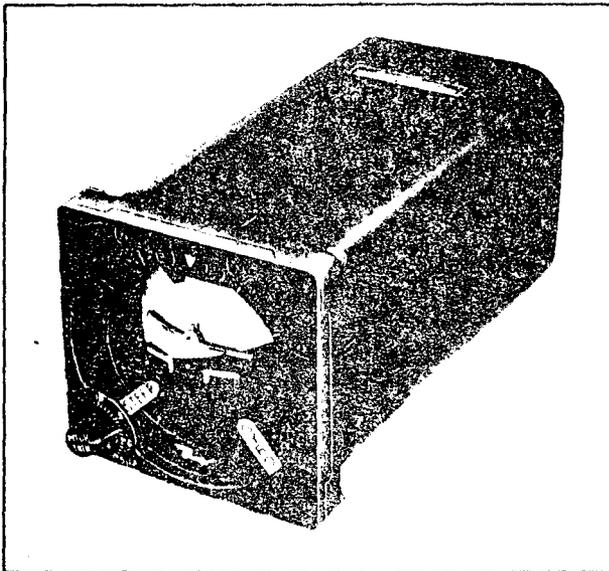
The true airspeed is purely a \_\_\_\_\_ value.

*temperature*

The KIFIS static air temperature indicator automatically corrects the errors resulting from air friction and \_\_\_\_\_

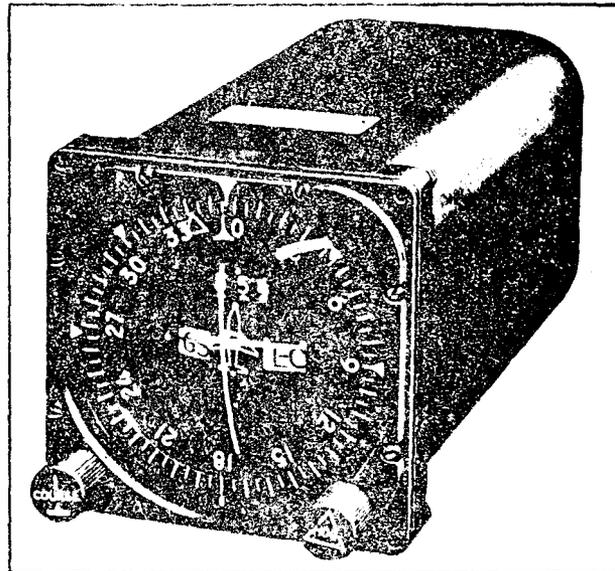
*computed*

*compressibility*



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Fig. 1-18 - Horizon Director Indicator



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Fig. 1-19 - Course Deviation Indicator

### The Flight Director

Modern jet transports incorporate into their instrument panel a combination of navigational electronic components generally called the *flight director*. This system provides a constant instrument picture of the position of the airplane in relation to a desired pre-selected course. The system also indicates the direction the airplane should be turned in order to acquire and hold a selected course or heading.

Flight directors vary widely, however, the system which will be briefly described here is the Bendix 300 Series Flight Director. This system is composed of two instruments, the Horizon Director Indicator (HDI) and the Course Deviation Indicator (CDI).

The *HORIZON DIRECTOR INDICATOR*, illustrated in Figure 1-18, is similar to the conventional gyro horizon except that a *command bar* has been added. The command bar indicates to the pilot the direction of roll and pitch required to control the airplane along a given flight path.

The *COURSE DEVIATION INDICATOR*, illustrated in Figure 1-19, is used for VOR and ILS navigation. This instrument presents a plan view picture of the displacement of the airplane from the selected course or radial. A correct angular relationship between the airplane and the selected course is always shown.

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The flight director automatically provides an instrument picture of the position of the airplane in relation to a pre-selected \_\_\_\_\_

The system also registers the direction in which the pilot must turn the airplane to acquire or hold a course or \_\_\_\_\_

*course*

The Bendix Flight Director is composed of two instruments known as the Horizon Director Indicator and the \_\_\_\_\_

*heading*

The HDI incorporates a command bar which provides the pilot with \_\_\_\_\_ and \_\_\_\_\_ information necessary to control an airplane along a given flight path.

*Course Deviation Indicator*

The CDI is utilized for both VOR and \_\_\_\_\_ navigation.

*roll  
pitch*

The CDI presents a plan view of the displacement of the airplane from the selected course or \_\_\_\_\_

*ILS*

A correct angular relationship between the airplane and the selected course is shown by the \_\_\_\_\_

*radial*

*CDI*

### Sensations of Instrument Flight

When flying in VFR conditions, orientation is maintained by visual reference to the natural horizon of the earth. When flying in actual IFR conditions, the pilot must depend upon flight instruments to give him a visual orientation relative to the natural horizon of the earth.

The individual's ability to maintain equilibrium, which is extremely important at all times, especially in instrument flying, depends primarily on three sensing sources: The motion sensing organs of the inner ear; the postural senses which derive their sensations from touch, pressure and tension; and sight.

The inner ears have semicircular canals which are filled with fluid. Each canal has small sensory hairs and when the fluid moves, it deflects the hairs and the sensation of the movement is transmitted to the brain. When the head is rotated, the fluid in the canal of that plane will move, deflect the hairs, and cause a sensation of turning. The inner ear registers both linear and rotational acceleration and deceleration but it cannot, by itself, distinguish between centrifugal force and gravity, nor can it detect small changes in velocity. The result of centrifugal force combined with gravity cannot be interpreted by the inner ear without visual reference. For example, without visual reference, deceleration while turning can cause the sensation of a reverse turn. For this reason, the sensations from the inner ear *must be disregarded in instrument flying.*

The postural sense depends upon the expansion and contraction of muscles and tendons, touch and pressure, and the shifting of abdominal muscles for its sensations. Without visual reference, the postural sense may falsely interpret centrifugal force as a climb or descent. For example, without looking at the flight instruments, a steep bank may be interpreted as a steep climb.

It is important to realize that these false sensations can occur while flying when the pilot's attention is directed away from the flight instruments. A pilot must learn to continually depend upon the flight instruments. *Suppress the sensations and fly the instruments.*

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When flying in VFR conditions, orientation is maintained by visual reference to the natural

When flying in actual IFR conditions, the pilot must maintain his orientation relative to the earth's horizon by reference to

*horizon*

The ability of the individual to maintain equilibrium depends primarily on three sources. One source is the motion sensing organ of the inner

*flight instruments*

The second source is the postural senses which derive sensations from touch, pressure and

*ear*

Equilibrium is maintained from three sources, motion sensing from the inner ear, postural sense, and

*tension*

The inner ear has semicircular canals which are filled with

*sight*

Each canal contains small sensory

*fluid*

When the fluid in the canals moves, it deflects the hairs, and the sensation of the movement is transmitted to the

*hairs*

When the head is rotated, the fluid in the canal of that plane will move, deflect the and cause a sensation of

*brain*

The inner ear registers both linear and rotational acceleration and

*hairs turning*

The inner ear cannot detect small changes in gravity nor can it, by itself, distinguish between centrifugal force and

*deceleration*

The result of centrifugal force combined with gravity cannot be interpreted by the inner ear without reference.

*gravity*

Without visual reference, deceleration while turning can cause a sensation of a turn in the direction.

*visual*

The sensations of the inner ear must be disregarded in flying.

*opposite*

Contraction of muscles and tendons, touch, pressure, and the shifting of abdominal muscles are sensations that make up postural

*instrument*

Without visual reference, the postural sense may interpret centrifugal force as a climb or

*sense*

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A false postural sense may be the interpretation of a steep bank as a steep

*descent*

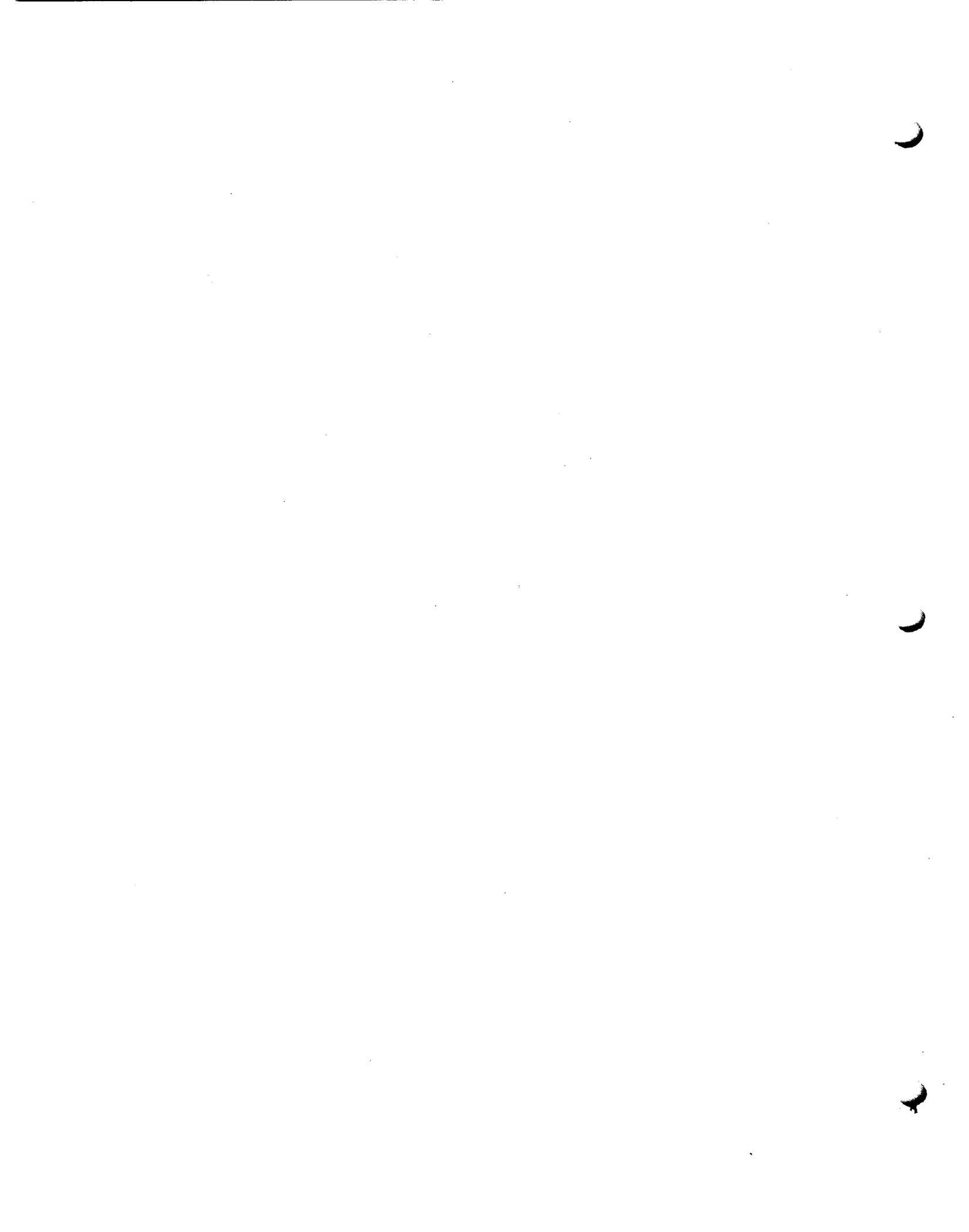
False sensations can occur when the pilot's attention is directed away from the flight

*climb*

A pilot must learn to depend upon the flight instruments and suppress the desire to react to false

*instruments*

*sensations*



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## The Atmosphere of the Earth

The common approach to a discussion of the atmosphere concerns itself with a two-layer system consisting of the troposphere and stratosphere separated by the tropopause. However, little mention is made of the factors that are of concern to the pilot other than weather. The system selected for discussion here is based primarily on temperature (Figure 2-1), because temperature has a great effect on atmospheric pressure, wind speed and moisture content. Also, temperature variation may produce conditions that cause bad flying weather.

When referring to the layers of the atmosphere, usually the \_\_\_\_\_-layer system is referenced.

The two-layer system consists of the troposphere and the stratosphere, separated by the \_\_\_\_\_.

*two*

The system used here to describe the atmosphere, is based primarily on \_\_\_\_\_ variation.

*tropopause*

*temperature*

## Troposphere

In the temperature layer system, the first layer is termed the troposphere and is nearest the earth. This layer contains most of the weather and varies in depth from approximately 25,000 feet over the poles, to 60,000 feet or more over the equator. The average depth at mid-latitude is around 35,000 feet. In the troposphere, the average temperature variation is a drop of approximately 2°C. (3.5°F.) for each 1,000 foot rise above the surface. This is known as the average lapse rate.

In the layer system based on temperature, the layer nearest the earth is called the (stratosphere) (troposphere) \_\_\_\_\_.

The troposphere contains most of the \_\_\_\_\_ encountered in flying.

*troposphere*

The depth of the troposphere varies from approximately 25,000 feet at the poles to about \_\_\_\_\_ feet at the equator.

*weather*

The average depth of the troposphere at mid-latitude, is about \_\_\_\_\_ feet.

*60,000*

When leaving the surface of the earth, the temperature decreases approximately 2°C. for each \_\_\_\_\_ foot increase in altitude.

*35,000*

By knowing the average temperature decrease with altitude, and the surface temperature, the approximate temperature at any altitude can be \_\_\_\_\_.

*1,000*

$\frac{3.5^\circ\text{F}}{2^\circ\text{C}} / 1000'$

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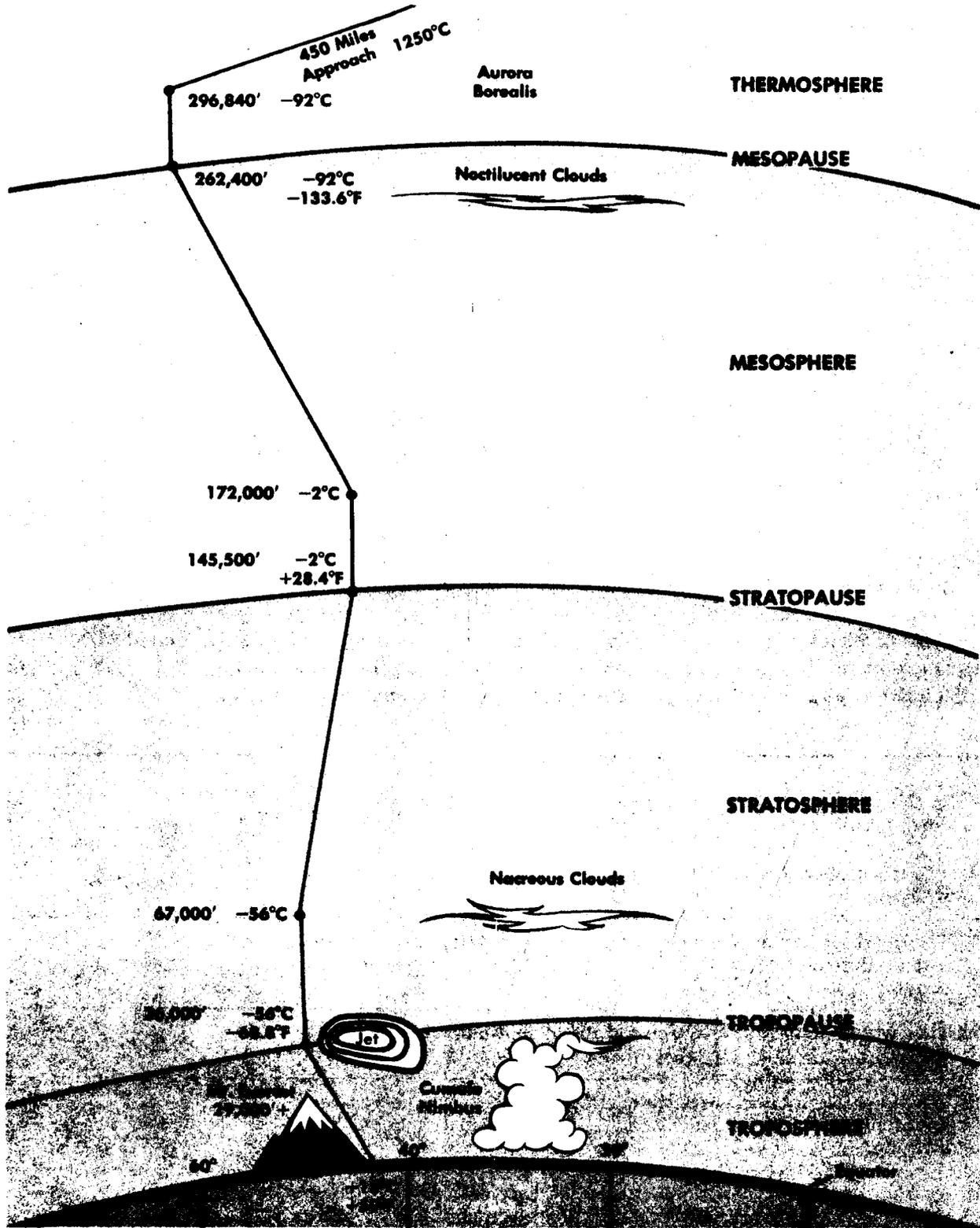


Fig. 2-1 - Atmospheric Layers Surrounding The Earth

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Using the average lapse rate, if the surface temperature at sea level is 60°F., the temperature at 10,000 feet would be \_\_\_\_\_°F.

*computed*

25

### Tropopause

The tropopause is considered to be the upper boundary of the troposphere. By definition, the tropopause is that area where the temperature change does not exceed  $\frac{2}{3}$  of 1°C. per each 1,000 foot increase in altitude over a range of 6,000 feet.

The tropopause is the area where the average lapse rate of 2°C. (3.5°F.) decrease for each 1,000 foot increase in altitude ceases to apply. The tropopause is the area above which very few clouds exist. However, high cirrus clouds do occur at or near the tropopause and occasionally above it and are often associated with the tropopause, especially in the winter. The tropopause is the layer separating the troposphere and stratosphere, it slopes gradually upward from approximately 25,000 feet at the poles to about 60,000 feet at the equator. However, the tropopause is interrupted at various points; one of these breaks occurs at mid-latitude (30° to 50°) and it is here that the Polar Jet develops (Figure 2-1).

When near 30,000 feet, if the temperature variation is no more than  $\frac{2}{3}$  of 1°C. per 1,000 feet over a range of 6,000 feet, the observer is at the (troposphere) (tropopause) \_\_\_\_\_

At the tropopause, the average lapse rate of 2°C. (3.5°F.) \_\_\_\_\_ to apply.

*tropopause*

Above the tropopause, very few \_\_\_\_\_ exist.

*ceases*

At, near and sometimes above the tropopause, high \_\_\_\_\_ clouds occasionally occur.

*clouds*

Near the tropopause at middle latitudes, a high speed stream of air is often found, called the \_\_\_\_\_ stream.

*cirrus*

With respect to the earth, the slope of the tropopause from the poles to the equator is (upward) (downward) \_\_\_\_\_

*jet*

A break occurs in the tropopause in the mid-latitude range of 30° to \_\_\_\_\_°.

*upward*

Near the break in the tropopause is where the Polar \_\_\_\_\_ occurs.

50

*Jet Stream*

### Stratosphere

The region of the atmosphere just above the tropopause is called the stratosphere. This layer is usually considered to extend upward from the tropopause to approximately 28 miles. Near the tropopause, the stratosphere normally has a relatively constant temperature of around -56°C. However, after a few thousand feet, the temperature begins to increase with altitude, until at 28 miles it has

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increased to a  $-2^{\circ}\text{C}$ . This average temperature varies somewhat at the higher latitudes depending on weather and season. Nacreous (mother-of-pearl) clouds are sometimes found in the lower reaches of the stratosphere. Cirrus clouds have also been reported in this area especially in the equatorial region. Cumulonimbus clouds and thunderstorms have been reported as high as 70,000 feet or more.

### Stratopause

The stratopause approximately 28 miles out from the surface, marks the upper reaches of the stratosphere where the temperature tends to stabilize again at about  $-2^{\circ}\text{C}$ .

The layer of the atmosphere just above the tropopause is called the \_\_\_\_\_.

The stratosphere is considered to extend upward from the tropopause to a distance of about \_\_\_\_\_ miles above the earth.

*stratosphere*

The temperature in the stratosphere near the tropopause is around \_\_\_\_\_.

28

Near the top of the stratosphere, the temperature rises to approximately \_\_\_\_\_.

$-56^{\circ}\text{C}$ .

The average temperatures in the upper atmosphere vary somewhat, particularly at high latitudes, depending on \_\_\_\_\_.

$-2^{\circ}\text{C}$ .

The clouds, other than cirrus, sometimes observed in the lower stratosphere, are called \_\_\_\_\_ clouds.

*season*

In addition to nacreous clouds, another crystalline-type cloud sometimes found in the lower stratosphere is the \_\_\_\_\_ cloud.

*nacreous  
(mother-of-pearl)*

On occasion, thunderstorms have been reported which build up as high as \_\_\_\_\_ feet or more.

*cirrus*

The top of the stratosphere is called the \_\_\_\_\_.

70,000

The temperature in the region of the stratopause is approximately \_\_\_\_\_.

*stratopause*

$-2^{\circ}\text{C}$ .

### Mesosphere

In this layer which extends from the stratopause up to about 50 miles, the temperature begins a gradual decrease until about 48 miles, where it reaches approximately  $-92$  degrees centigrade. This figure of  $-92^{\circ}\text{C}$ . varies from source to source, but is considered to be the average temperature that would be encountered near the top of the mesosphere. At an altitude of about 50 miles the noctilucent clouds are found. Both these and the nacreous clouds are rare. The nacreous clouds are believed to consist mainly of ice crystals, while the noctilucent clouds are composed of ice particles or fine cosmic dust accumulations located approximately 50 miles above the surface of the earth.

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## Mesopause

The mesopause is the name given to the top of the mesosphere where the temperature, after stabilizing for a few miles, again commences to rise.

The mesosphere begins at the stratopause and extends to approximately \_\_\_\_\_ miles.

The temperature in the mesosphere drops from about  $-2^{\circ}\text{C}$ . to \_\_\_\_\_

50

In the region about 50 miles above the surface of the earth, \_\_\_\_\_ clouds are sometimes found.

$-92^{\circ}\text{C}$ .

The noctilucent clouds are considered to be an accumulation of cosmic \_\_\_\_\_ or ice particles.

*noctilucent*

The top of the mesosphere occurs around 48 miles and is called the \_\_\_\_\_.

*dust*

The temperature at the mesopause stabilizes around \_\_\_\_\_.

*mesopause*

$-92^{\circ}\text{C}$ .

## Thermosphere

In the thermosphere the temperature begins at about  $-92^{\circ}\text{C}$ . and continues to rise, approaching  $1250^{\circ}\text{C}$ . at about 450 miles above the surface. Unlike the other layers, the thermosphere has no definable outer limit and it is in this region of 80 to 100 miles above the earth that the aurora appear. The temperature rise in the thermosphere is attributed to absorption of radiation in the ultra-violet range causing ionization. In the region of 300 to 600 miles out from earth, molecular escape from the atmosphere of the earth is significant and this region is called the exosphere.

The layer that begins just above the mesopause is the \_\_\_\_\_.

The temperature in the thermosphere continues to rise and approaches  $1250^{\circ}\text{C}$ . at about \_\_\_\_\_ miles above the surface.

*thermosphere*

The thermosphere has no apparent \_\_\_\_\_ limit.

450

The temperature rise in the thermosphere is attributed to absorption of radiation in the ultra-violet range causing \_\_\_\_\_.

*outer*

In the region 300 to 600 miles above the earth, molecular escape from the earth's atmosphere is significant and this region is called the \_\_\_\_\_.

*ionization*

*exosphere*

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The following table provides a quick reference to the comparison of altitude in feet to standard pressure and temperature.

### Adapted In Part From U.S. Standard Atmosphere, 1962

Altitude	Pressure		Temperature	
	Inches Hg.	Millibars	°F.	°C.
0	29.92	1013.2	59.0	15.0
1,000	28.86	977	55.4	13.0
2,000	27.82	942	51.8	11.0
3,000	26.82	908	48.3	09.0
4,000	25.84	875	44.7	07.0
4,782	25.10	850 MB Chart	44.0	06.6
5,000	24.89	843	41.2	05.0
6,000	23.98	812	37.6	03.1
7,000	23.09	782	34.0	01.1
8,000	22.22	752	30.4	-0.84
9,000	21.39	724	26.9	-2.8
9,882	20.67	700 MB Chart	23.8	-4.6
10,000	20.57	697	23.3	-4.8
11,000	19.79	670	19.7	-6.7
12,000	19.03	644	16.2	-8.7
13,000	18.29	619	12.6	-10.7
14,000	17.58	595	09.1	-12.7
15,000	16.89	572	05.5	-14.7
16,000	16.22	549	01.9	-16.6
17,000	15.57	527	-01.5	-18.6
18,000	14.94	506	-05.1	-20.6
18,289	14.76	500 MB Chart	-06.2	-21.2
19,000	14.34	486	-08.6	-22.6
20,000	13.75	466	-12.2	-24.5
21,000	13.18	446	-15.8	-26.5
22,000	12.64	428	-19.4	-28.5
23,000	12.11	410	-22.9	-30.5
23,574	11.81	400 MB Chart	-25.0	-31.7
24,000	11.60	392	-26.4	-32.5
25,000	11.10	376	-30.0	-34.4
26,000	10.63	361	-33.6	-36.4
27,000	10.17	344	-37.1	-38.4
28,000	9.72	329	-40.7	-40.4
29,000	9.30	315	-44.3	-42.4
30,000	8.88	301	-48.0	-44.4
30,065	8.86	300 MB Chart	-48.3	-44.6
31,000	8.49	287	-51.5	-46.4
32,000	8.11	274	-54.9	-48.3
33,000	7.74	262	-58.5	-50.3
33,999	7.38	250 MB Chart	-62.0	-52.2
34,000	7.38	250	-62.0	-52.3
35,000	7.04	238	-65.6	-54.2
36,000	6.71	227	-69.2	-56.2
36,200 Tropopause	6.65	225	-69.7	-56.5
37,000	6.40	217	-69.7	-56.5
38,000	6.10	206	-69.7	-56.5
38,662	5.91	200 MB Chart	-69.7	-56.5
39,000	5.81	197	-69.7	-56.5
40,000	5.54	187	-69.7	-56.5
41,000	5.28	179	-69.7	-56.5
42,000	5.03	170	-69.7	-56.5

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### The Jet Stream Location And Description

The jet stream is a weather phenomenon that was of little concern until airplanes began flying in the upper troposphere. This phenomenon became very apparent during World War II when American bombers encountered it in the vicinity of Japan. Since that time, airplanes have been developed that regularly fly above 30,000 feet, which is near the tropopause and may, on occasion, encounter a jet stream.

Over the United States, during the winter months, there are often three jet streams. These are in order of latitudinal location: The Arctic Jet, The Polar Jet and the Sub-Tropical Jet. The Sub-Tropical Jet usually occurs about 1,000 feet above and to the tropical side of the Polar Jet, Figure 2-2. The Polar Jet is located near the break between the Polar and Sub-Tropical tropopause, Figure 2-2, at about 30° to 50° north latitude. Its location makes the Polar Jet of great significance to pilots flying over the United States.

The Polar Jet stream, Figure 2-2, being located in the region where winds flow predominately from the west, generally flows from west to east; however, it meanders north and south, remaining approximately parallel to the surface cold front but behind it 200 to 300 miles, Figure 2-3. The jet stream is above as well as behind the surface front.

The jet stream may be pictured as a narrow stream of high speed air flowing in the region of the tropopause and imbedded in the normal upper air circulation. To be considered a jet stream, the upper air flow must have a speed at the center (core) of at least 60 knots. It is difficult to give specific dimensions for jet streams but the following will provide some idea of their size. These high speed upper air currents may extend for thousands of miles in length and hundreds of miles in width and from 8,000 to 16,000 feet in depth. The width of the jet is much greater than depth, something like 200 to 1.

The remainder of this discussion will be concerned with jet streams over or near the United States. The speeds within the core of the jet (center portion or nearly so) may vary considerably from one jet to another. Core speeds in excess of 250 knots have been reported but speeds below 200 knots are more common above the United States. Due to the fact that the Polar Jet occurs near the level of discontinuity between the Polar and Sub-Tropical tropopauses, Figure 2-2, the core of the jet is normally near the 300 MB level.

During World War II, American flyers encountered the jet stream near \_\_\_\_\_.

The jet stream may be encountered at altitudes around \_\_\_\_\_ feet.

*Japan*

Three jet streams often occur during the winter months over the \_\_\_\_\_.

*34,000*

In order of latitudinal location, from the south to the north, they are the Sub-Tropical, the \_\_\_\_\_ and the Arctic Jet Streams.

*United States*

The jet stream of most concern to pilots flying over the United States is the \_\_\_\_\_ Jet.

*Polar*

The Polar Jet is usually located at about 30° to \_\_\_\_\_° north latitude.

*Polar*

The jet stream that is to the tropical side of the Polar Jet and about 1,000 feet above it, is the \_\_\_\_\_ Jet.

*50°*

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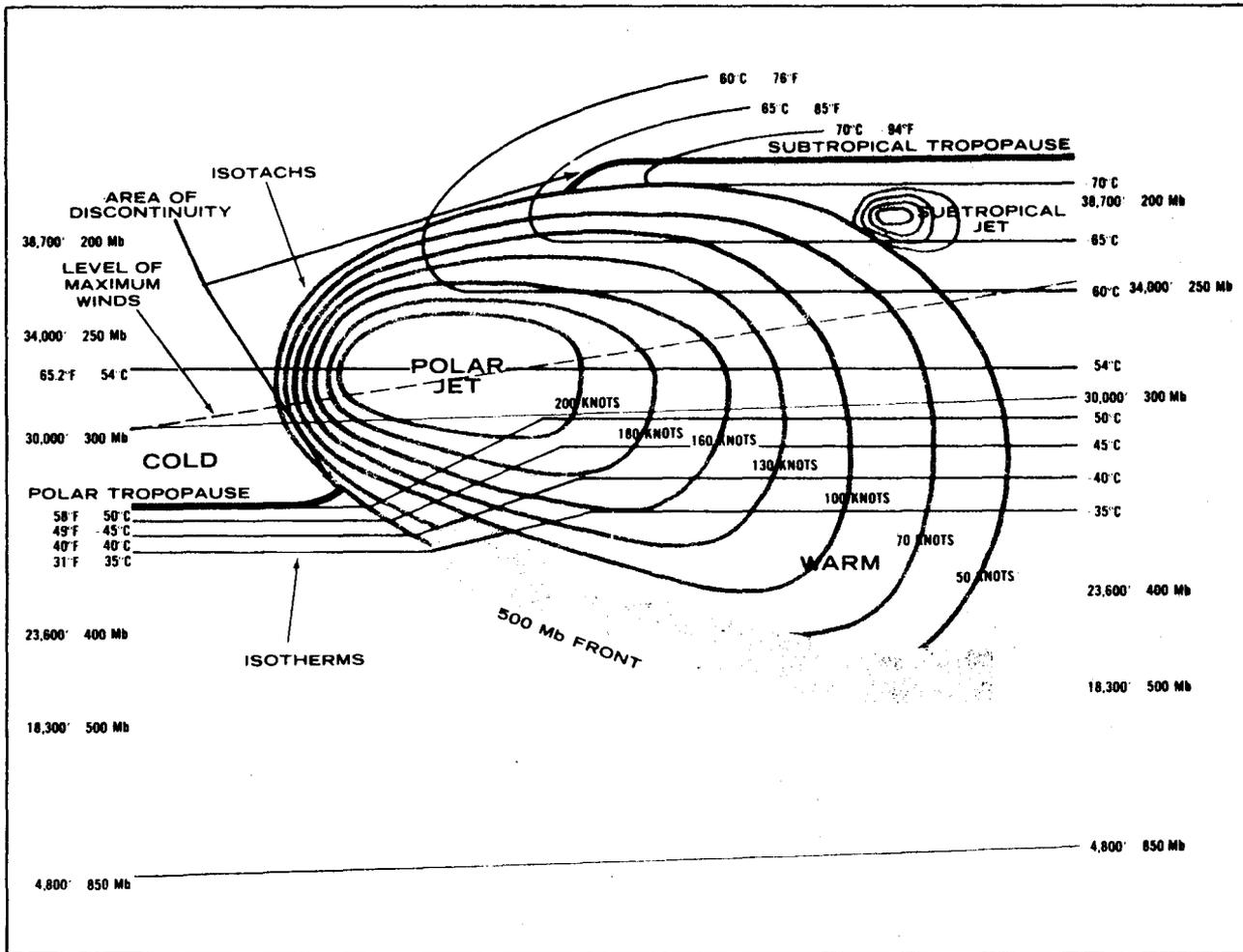


Fig. 2-2 - Jet Stream Viewed Looking Downwind Into Jet

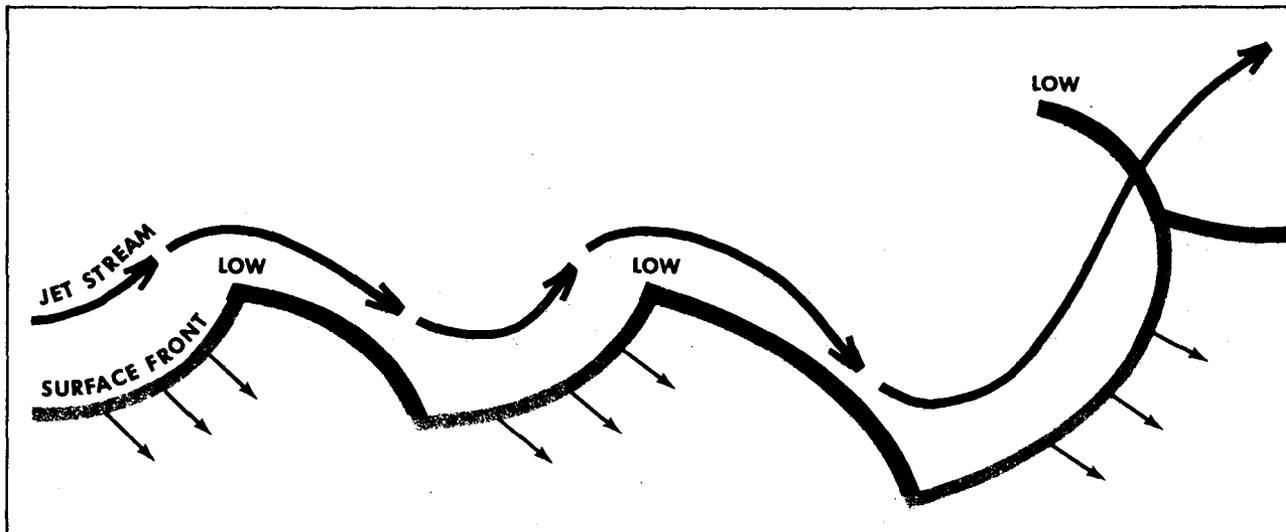


Fig. 2-3 - Jet Stream Paralleling Surface Front

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The Polar Jet normally flows (east to west) (west to east) _____	<i>Sub-Tropical</i>
On its path across the United States, the Polar Jet _____ from north to south.	<i>west to east</i>
The Polar Jet is normally located above the surface front, parallel to the surface cold front, but approximately 200 to _____ miles behind it.	<i>meanders (fluctuates)</i>
The jet stream may be considered as a narrow, high-speed stream of air flowing in the region of the _____	<i>300</i>
The high-speed stream of air is _____ in the upper air circulation.	<i>tropopause</i>
To be considered a jet, the speed of the air stream must be at least _____ knots.	<i>imbedded</i>
The jet stream may be thousands of miles in length, hundreds of miles in width and 8,000 to 16,000 feet in _____	<i>60</i>
When looking down stream into the Polar Jet, the cold side is to the (left) (right) _____. (See Figure 2-3).	<i>depth</i>
Considerable variation can be expected in the jet _____ speeds.	<i>left</i>
The speeds encountered in jet streams over the United States are normally less than _____ knots.	<i>core</i>
The Polar Jet stream over the United States normally appears near the break between the Polar and _____ tropopauses at about 34,000 feet.	<i>200</i>
	<i>Sub-Tropical</i>

### Seasonal Variation Of The Jet Stream

The location of the jet stream varies with the season. As the sun moves north of the equator during the warm months of the year, the Polar Jet moves north, weakens, and its altitude increases. Therefore, during the summer it is of little significance to present day air operations. During the winter, when the sun moves south of the equator, the cyclonic storm activity increases and so does the jet stream activity, which is associated with the cold front. The jet stream is lower, more intense and more prevalent during the winter months.

The change in season affects the Polar Jet stream \_\_\_\_\_

The Polar Jet stream moves north and south with the \_\_\_\_\_ *location*

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During the summer, the Polar Jet rises in elevation and moves (north) (south) _____.	<i>sun</i>
The season of the year during which the Polar Jet has the most affect on flying is (summer) (winter) _____.	<i>north</i>
As cyclonic storm activity increases, the jet stream activity (increases) (decreases) _____.	<i>winter</i>
During the winter months, the jet stream is lower and _____ than during the summer.	<i>increases</i>
Flying from east to west in a jet stream, the winds would be (favorable) (unfavorable) _____.	<i>more intense</i>
	<i>unfavorable</i>

### Temperature Variation Through The Tropopause

The jet stream is usually associated with the level of maximum winds (altitude at which the highest wind speeds are found, usually near the 300MB level, approximately 30,000 feet). When moving away from the earth, as the tropopause is approached, the temperature becomes relatively stable, around  $-56^{\circ}\text{C}$ . and the wind begins to abate. In the stratosphere, above the tropopause, the wind speed decreases rapidly. This is because temperatures in the troughs reverse themselves. The temperature is warmer in the center of the low than it is away from the center. Below the tropopause, the reverse of this is true. The level of maximum winds is found near the tropopause because the winds increase as the temperature decreases and the temperature is normally lowest near the tropopause. It must be remembered that the normal temperature decrease is  $2^{\circ}\text{C}$ . ( $3.5^{\circ}\text{F}$ .) per each 1,000 foot rise above the surface of the earth until the tropopause is reached. At the tropopause, temperatures begin to stabilize and thus winds decrease rapidly above this area.

The jet stream is usually found near the level of _____ winds.	
The level of maximum winds occurs near the tropopause; above this area, winds _____.	<i>maximum</i>
From the surface of the earth up to the tropopause, temperatures decrease and winds _____.	<i>decrease (abate)</i>
The temperature normally averages about $-56^{\circ}\text{C}$ . at the _____.	<i>increase</i>
Above the tropopause, in the stratosphere, the temperature remains fairly _____ to about 68,000 feet.	<i>tropopause</i>
The average temperature decrease above the surface of the earth is $2^{\circ}\text{C}$ . per each _____ foot rise in altitude.	<i>constant</i>
The tropopause is being approached when the temperature reaches _____.	<i>1,000</i>

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During the winter, the tropopause would be reached at a (higher) (lower) \_\_\_\_\_ altitude than during the summer.

-56°C.

*lower*

### Wind Speed And Clear Air Turbulence

The phenomena of most significance associated with the jet stream are high winds and clear air turbulence.

### Wind Shear

When flying in the jet core, the pilot should realize that there are certain recommended procedures to follow if he wishes to depart the jet core. Wind speeds decrease in any direction away from the jet stream core; however, they decrease more rapidly in some directions than in others. Referring to Figure 2-2, it will be noted that the *horizontal wind shear*, denoted by the closed isotachs (lines of equal wind speed), decreases most rapidly to the left side or north side of the jet core. To the north, the decrease may be as much as 100 knots in 100 nautical miles, to the south, it may be only 30 knots in 100 nautical miles. *Vertical shear* (change in wind speed with change in altitude away from the core) may be as much as 30 knots in a 1,000 foot change in altitude. *Vertical wind shears* are normally plotted on charts as lines depicting average shear over a 1,000 foot change in altitude, which provides an average figure that is much lower than 30 knots; usually less than 10 knots.

### Clear Air Turbulence

Clear air turbulence is caused by wind shear. When the horizontal wind shear is 1 knot per 1 nautical mile, or the average vertical shear is 4 to 10 knots per thousand foot change in altitude, clear air turbulence is likely.

Due to the pronounced temperature gradient near the tropopause, Figure 2-2, with a downward slope toward the north or cold side, there is a tendency for the isotherms (lines of equal temperature) to pack or become close together along the north side or left side looking downstream. This rapid change in temperature often produces clear air turbulence in this area of the jet stream.

The areas of greatest turbulence along the left side of the jet stream are in the general altitude ranges of 35,000 to 48,000 feet MSL above the jet core, and 20,000 to 32,000 feet MSL just below the core. The altitude range from 32,000 feet to 35,000 feet MSL to the left of the core, will normally contain turbulence, but usually of a less severe nature than the other two areas.

The phenomena associated with the jet stream of most significance to the pilot, are high wind speeds and clear air \_\_\_\_\_

Clear air turbulence is found most often on the \_\_\_\_\_ side of the jet stream.

*turbulence*

High wind speeds are associated with the jet \_\_\_\_\_

*cold  
(left)*

As the pilot departs from the jet stream in any direction, (lower) (higher) \_\_\_\_\_ wind speeds will be encountered.

*stream*

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When departing the jet stream core to the north, the wind speed may decrease as much as 100 knots in 100 nautical miles. When departing to the south, it would be expected to decrease approximately \_\_\_\_\_ knots per 100 nautical miles.

*lower*

Winds decrease most rapidly when departing the jet stream to the (north) (south) \_\_\_\_\_.

30

The wind speed change right or left of the jet core is considered as \_\_\_\_\_ shear.

*north*

Wind speed change with altitude variation is considered \_\_\_\_\_ shear.

*horizontal*

When horizontal shear is 1 knot per 1 nautical mile, it is likely that \_\_\_\_\_ air turbulence will be encountered.

*vertical*

Vertical wind shear may be as great as \_\_\_\_\_ knots in 1,000 feet.

*clear*

Clear air turbulence is considered likely when the average vertical shear exceeds \_\_\_\_\_ to 10 knots.

30

Due to the packing of isotherms on the cold or left side of the Polar Jet stream, looking downwind, clear air turbulence may be encountered in this \_\_\_\_\_.

4

Clear air turbulence is likely in the altitude range of 35,000 to 48,000 feet MSL just \_\_\_\_\_ and to the left of the jet core.

*area*

The altitude range just below the jet stream where clear air turbulence is likely, is from approximately 20,000 feet to \_\_\_\_\_ feet MSL.

*above*

The clear air turbulence encountered just to the left of the jet core, between 32,000 and 35,000 feet MSL will normally be (more) (less) \_\_\_\_\_ severe than above or below the core.

32,000

*less*

### Temperature Variation And Turbulence

By referring to Figure 2-2, it will be noted that decided temperature variations are associated with the jet stream. The temperature decreases rapidly from the vicinity of the jet stream core toward the left or cold side. Dr. Reiter, a noted meteorologist, proposes that clear air turbulence may be extremely severe in the region above the jet stream and slightly to the left. The reason for this turbulence is the fact that within stable layers, (layers of similar temperatures) which occur above the jet, gravitational waves may be found. When these waves occur, they oscillate between the interfaces of the stable layer and may produce oscillations of such wave length as to cause severe turbulence. The gravitational waves may be caused by terrain differences or airflow over high pressure areas. When the air within the stable layers is caused to be displaced by compression of air flowing over mountains or hills, or is displaced

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due to pressure differences, then gravity exerts a downward pull on the displaced air and creates an oscillation called a gravitational wave.

Clear air turbulence may be severe above and slightly to the left of the jet core due to rapid temperature changes and \_\_\_\_\_ waves.

Gravitational waves within the boundary of a stable temperature layer have definite periods of \_\_\_\_\_

*gravitational*

When the gravitational waves are of sufficient length to cause a disturbance to an object entering the area, clear air turbulence is (likely) (unlikely) \_\_\_\_\_

*oscillation*

Gravitational waves may be caused by mountainous terrain, or by high pressure \_\_\_\_\_

*likely*

When a pressure ridge or mountainous terrain causes a deflection of the air away from the normal path of flow, the earth's gravity tends to pull the deflected air back and a gravitational \_\_\_\_\_ is established.

*areas*

The wave established, oscillates back and forth within the stable layer and is called a \_\_\_\_\_ wave.

*wave*

*gravitational*

## Flying The Jet Stream

The location of the jet would normally be obtained during the weather briefing and the pilot should keep this information in mind when flying in the vicinity of the jet stream. The jet stream can be used to advantage when certain procedures are followed. The following general rules may be helpful when flying the jet stream.

1. When an airplane is flying downstream in a jet stream core, if the airplane begins to leave the core on the left side, clear air turbulence may be encountered. If turbulence is encountered, the course should be altered to the right. This will usually place the airplane in an area of less turbulence and still provide strong tail winds if the down wind course is resumed once clear of the turbulent area.
2. When flying downstream to the left of the jet stream core, if turbulence is encountered, a course alteration to the left will normally clear the turbulent area. Once the turbulent area is cleared, the original course can be resumed.
3. If flying upstream in the jet core and turbulence is encountered, a turn to the left should take the airplane into less turbulent air. However, a decrease in altitude, coupled with the left turn would probably be more advantageous because lighter winds should be encountered at a lower altitude.
4. If flying upstream near but to the right of a jet stream core, and turbulence is encountered, a turn to the right should clear the turbulent area and place the airplane in an area of diminishing winds.

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5. Should the pilot enter the region of stable layers when flying downstream where gravitational waves (waves between the inter-boundaries of similar temperature layers) occur and encounter turbulence, a climb or a descent of several thousand feet will normally relieve the turbulent condition. However, the pilot must consider: (1) In the case of a climb, the possibility of approaching the airplane's maximum performance limit and finding a stall imminent, or (2) Descending into an area of stronger winds. This latter situation is unlikely when below the tropopause. Should neither of these solutions prove satisfactory, a turn to the right will normally produce a lessening of turbulence, Figure 2-2.
6. Since the depth of the jet stream is far less than its width, a descent would be the quickest way to clear the jet stream area.

Information concerning the jet stream would normally be obtained during the \_\_\_\_\_ briefing.

When flying downstream in the Polar Jet core, if clear air turbulence is encountered, the airplane is leaving the core on the (left) (right) \_\_\_\_\_ side.

*weather*

When flying downstream in the jet core, if turbulence is encountered, the situation can usually be alleviated by a course correction to the (right) (left) \_\_\_\_\_.

*left*

When to the left of the jet stream core and flying downstream, turbulence can be alleviated by a course correction to the (right) (left) \_\_\_\_\_.

*right*

While flying upstream in the Polar Jet core, a turn to the left will alleviate \_\_\_\_\_.

*left*

When flying upstream in the jet core, a decrease in altitude coupled with a left turn would place the airplane in an area of (decreased) (increased) \_\_\_\_\_ winds.

*turbulence*

When flying upstream but to the right of the core, a turn to the right should place the airplane in an area of (lesser) (greater) \_\_\_\_\_ turbulence.

*decreased*

If gravitational waves are encountered, a climb or a \_\_\_\_\_ may relieve the situation.

*lesser*

A climb above the area of gravitational waves may place the airplane in a position where, due to operational limitations, a \_\_\_\_\_ is possible.

*descent*

A descent of several thousand feet below the jet from the region of gravity waves would usually place the airplane in an area of (increasing) (decreasing) \_\_\_\_\_ winds.

*stall*

When flying upstream in a jet stream, should neither a climb nor a descent prove desirable, a turn to the left will usually place the the airplane in an area of less \_\_\_\_\_

*decreasing*

*turbulence*

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## Forecasting Jet Streams

Forecasting the location of clear air turbulence associated with the jet stream and other phenomena is difficult because of the scarcity of information on which to make predictions. The information used is the data collected from upper winds observations taken at stations located 200 to 300 miles apart, and pilot reports. The significant information to observe in locating jet streams is the level of maximum winds chart and the 500 millibar chart for the appearance of a cold front at this level. The upper altitude 300 to 200 MB charts are used to locate high speed winds in the region of the tropopause. High cirrus clouds of a wavy pattern also indicate the presence of a jet stream and turbulence.

Forecasting the location of clear air turbulence is difficult due to the _____ of information on which to base predictions.	
Clear air turbulence predictions are based on information taken from stations located 200 to _____ miles apart.	<i>scarcity</i>
In locating the jet stream, the significant information to observe is the location of the front on the 500 MB chart and the level of _____ winds.	<i>300</i>
The upper air charts that are used in locating the level of maximum winds are the 300 MB and _____ MB charts.	<i>maximum</i>
Jet stream turbulence is likely when high cirrus clouds have a _____ pattern.	<i>200</i>
	<i>wavy</i>

## Additional Factors Associated With High Altitude Flying

From the preceding discussion it can be understood that as altitude increases, winds increase and temperatures decrease. This inverse variation between temperature and wind is true up to the tropopause. From the tropopause upward, the temperature tends to stabilize and remain fairly constant for several thousand feet and the wind decreases rapidly. These two factors must be considered when planning flights in the region of the tropopause.

## Rules For Determining Favorable Winds

As a general rule, when flying in the troposphere, since temperature decreases and winds increase with altitude, a higher altitude would generally be advantageous on eastbound flights and a lower altitude would usually be advantageous for westbound flights. When flying in the stratosphere, *since temperature tends to stabilize and winds decrease with altitude*, a lower altitude would be advantageous on eastbound flights and a higher altitude on westbound flights.

## Thunderstorms

Thunderstorms may be encountered at altitudes of 70,000 feet or more. When encountered at these altitudes, the thunderstorm should be treated with just as much respect as when encountered at lower levels.

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## Clouds Near The Tropopause

Cirrus clouds may, on occasion, be encountered at near or even above the tropopause.

## Buffeting

Another factor of significance to flights in the region of the tropopause is the possibility of high speed airplanes, flying on the boundary layer of the tropopause, encountering buffeting. This buffeting may be produced by an airplane flying in and out of different temperature layers. When temperature changes, so does the speed of sound. Therefore, buffeting may occur due to these changes in temperature, which, in turn, changes the speed of sound.

Up to the tropopause, as altitude increases, winds increase and \_\_\_\_\_ decrease.

Above the tropopause, temperatures tend to stabilize and winds \_\_\_\_\_

*temperatures*

When flying in the region of the tropopause, it is usually best to select a (higher) (lower) \_\_\_\_\_ altitude on westbound flights.

*decrease*

In the tropopause, eastbound flights would normally be flown at (greater) (lesser) \_\_\_\_\_ altitudes than westbound flights.

*lower*

The pilot should remember that thunderstorms may be encountered at altitudes of \_\_\_\_\_ feet or more.

*greater*

When flying near the tropopause, \_\_\_\_\_ clouds may be encountered.

*70,000*

Temperature variation near the tropopause may cause considerable variations in the speed of \_\_\_\_\_

*cirrus*

If an airplane flies along a layer of air where the temperature is changing rapidly, \_\_\_\_\_ may occur due to the change in the speed of sound.

*sound*

*buffeting*

## Locating Favorable Winds Near The Jet Stream Core

Looking downwind into a jet stream at altitude, Figure 2-2, if cold air is to the left and warm air is to the right, winds will increase with altitude. When looking downwind, if the temperature is the same or nearly so to the right and to the left, then the observer is near the level of maximum winds and the jet core. If, when the observer looks downwind, temperatures are warmer on the left than on the right, winds would be expected to decrease with altitude.

It must be remembered that during severe winter storm conditions, a jet stream may be present as low as 18,000 feet in the vicinity of the upper low pressure area, and as high as 40,000 feet near the upper high pressure area. This information is of significance to the pilot as he may find himself climbing through a jet stream in an effort to reach a flight level in the 30,000 foot area.

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## Weather Reports, Charts and Meteorological Symbols

It is assumed that the prospective airline transport pilot is quite familiar with general weather information. Therefore, the following materials on weather maps, reports and charts are provided for review purposes.

1. Sample Aviation Weather Reports (sequence reports) and symbols.
2. Sample Terminal Forecasts and symbols (FT.)
3. Sample Area Forecast (FA) de-coded.
4. Sample Regional Freecast (FN) de-coded.
5. Sample Station Model and Cloud Symbols.
6. Sample Surface Weather Map.
7. Sample Winds Aloft Forecast (AW).
8. Sample 200 MB chart.
9. Sample Maximum Wind Analysis chart and Wind Shear chart.

The aviation weather report commonly referred to as a sequence report is depicted in Figure 2-4 along with an explanation and interpretation of symbols. The format now includes winds aloft information reported by numbers rather than arrows, as well as runway visual range information and coded pireps. Figure 2-4.

Terminal forecasts follow essentially the same format as aviation weather reports, except that the ceiling layer is identified by the letter "C"; visibility is forecast in statute miles or factions of a mile, and omitted when more than 8 miles; winds are forecast in knots, but omitted when less than 10 knots. These forecasts are for one airport and cover a 12 hour period. Examples of terminal forecasts are given in Figure 2-5 along with other brief explanations of weather information.

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Jepessen METEOROLOGY US-7

### EXPLANATION OF TELETYPEWRITER WEATHER REPORTS

LOCATION IDENTIFIERS	'SPECIAL' REPORT	SKY AND CEILING	VISIBILITY WEATHER AND OBSTRUCTION TO VISION	SEA-LEVEL PRESSURE	TEMPERATURE AND DEW POINT	WIND	ALTIMETER SETTING	RUNWAY VISUAL RANGE	CODED PIREPS	REMARKS
MKC	S 15 C M25	4R-K	132	/58/56	/1807	/993/	VR32	/ 55	RB05	OV 3

**SKY AND CEILING**

Sky cover symbols are in ascending order. Figures preceding symbols are heights in hundreds of feet above station.

Sky cover Symbols are:

- Clear: Less than 0.1 sky cover.
- Scattered: 0.1 to less than 0.6 sky cover.
- ⊕ Broken: 0.6 to 0.9 sky cover.
- ⊕ Overcast: More than 0.9 sky cover.
- Thin (When prefixed to the above symbols.)
- X Partial Obscuration: 0.1 to less than 1.0 sky hidden by precipitation or obstruction to vision (bases at surface).
- X Obscuration: 1.0 sky hidden by precipitation or obstruction to vision (bases at surface).

Letter preceding height of layer identifies ceiling layer and indicates how ceiling height was obtained. Thus:

A Aircraft	M Measured
B Balloon (Pilot or ceiling).	R Radiosonde Balloon or Radar
D Estimated height of cirriform clouds on basis of persistency.	W Indefinite
E Estimated heights of noncirriform clouds	U Height of cirriform ceiling layer unknown
	/ Height of cirriform non-ceiling layer unknown.
	"V" Immediately following numerical value indicates a varying ceiling.

**VISIBILITY**

Reported in Statute Miles and Fractions. (V = Variable)

**WEATHER SYMBOLS**

A Hail	L Drizzle	SP Snow Pellets
AP Small Hail	R Rain	SW Snow Showers
E Sleet	RW Rain Showers	T Thunderstorm
EW Sleet Showers	S Snow	ZL Freezing Drizzle
IC Ice Crystals	SG Snow Grains	ZR Freezing Rain

INTENSITIES are indicated thus:

-- Very Light   - Light   (no sign) Moderate   + Heavy

### OBSTRUCTION TO VISION SYMBOLS

D Dust	H Haze	BD Blowing Dust
F Fog	IF Ice Fog	BN Blowing Sand
GF Ground Fog	K Smoke	BS Blowing Snow

SUPPLIED BY JEPESSEN & CO

US-8 METEOROLOGY Jepessen

### EXPLANATION OF TELETYPEWRITER WEATHER REPORTS

**WIND**

Direction in ten's of degrees from true north, speed in knots. 0000 indicates calm. G indicates gusty. Peak speed of gusts follows G or Q when squall is reported. The contraction WSHFT followed by local time group in remarks indicates wind-shift and its time of occurrence.

EXAMPLES: 3627 360 Degrees, 27 Knots;  
 0127 010 Degrees, 27 Knots;  
 1027 100 Degrees, 27 Knots;  
 3627G40 360 Degrees, 27 Knots Peak speed in gusts 40 Knots.

**ALTIMETER SETTING**

The first figure of the actual altimeter setting is always omitted from the report.

**RUNWAY VISUAL RANGE (RVR)**

RVR is reported only from selected stations. The value reported is a 10-minute mean of the visual range in hundreds of feet.

**CODED PIREPS**

Pilot reports of clouds not visible from ground are coded with MSL height data preceding and/or following sky cover symbol to indicate cloud bases and/or tops, respectively.

**DECODED REPORT**

Kansas City: Special observation, 1500 feet scattered clouds, measured ceiling 2500 feet overcast, visibility 4 miles, light rain, smoke, sea level pressure 1013.2 millibars, temperature 58°F, dewpoint 56°F, wind 180°, 7 knots, altimeter setting 29.93 inches. Runway Visual Range 3200 feet, pilot reports top of overcast 5500 feet, rain began 5 minutes past the hour, overcast variable broken.

-+ S indicates that report contains important change.

Fig. 2-4 - Excerpt For Training Purposes Only

FORMS-789

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### Sample Area Forecast

The following is an example of an area forecast which covers 12 hours (with a section including the outlook for an additional 12 hours). The extent of coverage is usually for two or more states providing detailed predictions of flying weather at intermediate and lower levels.

### Coded Area Forecast

FA LAX 010045  
17P SUN-05P MON

EXTRM SRN NEV SRN CALIF AND CSTL WATERS

CLDS AND WX. SRN CALIF CSTL WATERS AND IMDT CSTL SECS 6-12 @ TO @ ASL BOMG GENLY @ ALG CST BY 20P AND INLAND OVR CSTL VLYS AFT MIDN. APCHS TO MTN PASSES OBSCD BY MIDN. CLD TOPS 12-20. VSBY BLO CLDS CSTL WATERS AND ALG CST 2-4HK BUT EXTENSV AREAS LESS THAN 2 MIS IN CSTL VLYS.

RMDR SRN CALIF AND EXTRM SRN NEV @ EXCP LCLY @ CU CLDS OWENS VLY AND EXTRM SRN NEV UNTIL SS. VSBY 2-5HK CSTL VLYS VCNTY LOS ANGELES BASIN E OF ST CLDS ELSW UNRSTD.

ICG. NONE. FRZG LVL NEAR 130.

TURBC. LCLY MDT TO BRFLY SVR THERMAL TURBC FOR LGT ACFT MTNS AND DESERTS TO 110 ASL DMSHG AFT SS.

OTLK. 05P-17P MON. ST CLDS DSIPTG IN CSTL VLYS ABT 09P AND DCRSG TO 9-14 @ ASL OVR CSTL SECS BY 11P. ST CONTG MOSTLY 6-10 @ TO @ CSTL WATERS MVG LCLY 1 TO 3 MIS ONSHR DURG AFTN. VSBY CSTL SECS RMNG 2-5H BUT IPVG TO 3H OR MORE IN CSTL VLYS BY ERY AFTN. CONTD UNRSTD CIG AND VSBY MTN AND INTR. RGNS.

### De-coded Area Forecast

FA stands for area forecast  
LAX 010045 LAX 010045 is the Los Angeles station symbol and the date time group. 01 is the first day of the month, and 0045 is 45 minutes past midnight (ZULU).  
17P SUN-05P MON means the forecast is for the period 1700 Pacific time Sunday to 0500 Pacific time Monday.

Extreme southern Nevada and southern California and coastal waters.

### TERMINAL FORECASTS

TERMINAL FORECASTS contain information for specific airports on ceiling, cloud heights, cloud amounts, visibility, weather condition and surface wind. They are written in a form similar to the AVIATION WEATHER REPORT.

CEILING: Identified by the letter "C"  
CLOUD HEIGHTS: In hundreds of feet above the station  
CLOUD LAYERS: Stated in ascending order of height  
VISIBILITY: In statute miles, but omitted if over 8 miles  
SURFACE WIND: In knots but omitted when less than 10

#### Examples of TERMINAL FORECASTS

C1500 Ceiling 1500', broken clouds.

C1500K Ceiling 1500' overcast, visibility 8 miles, smoke.

20DC708011023 Scattered clouds at 2000', ceiling 7000' overcast, surface wind 300 degrees (True), 11 Kts., gusting to 22 Kts.

011/2GF Clear, visibility one and one-half miles, ground fog.

C5X1/4S Sky obscured, vertical visibility 500', visibility one-fourth mile, moderate snow.

AREA FORECASTS are 12-hour forecasts of cloud and weather conditions, cloud tops, fronts, icing and turbulence for an area the size of several states. A 12-hour OUTLOOK is added. Heights of cloud tops, icing, and turbulence are above SEA LEVEL.

SIGMET advises airmen in flight of severe or extreme weather conditions potentially hazardous to all aircraft.

ADVISORIES FOR LIGHT AIRCRAFT advises airmen in flight of weather conditions of less severity than SIGMET but which may be hazardous to light aircraft. Both types of advisories are broadcast by FAA on NAVVAID voice channels.

WINDS ALOFT FORECASTS provide a 12-hour forecast of wind conditions at selected flight levels. Temperatures aloft are included for selected stations.

#### Examples of WINDS ALOFT FORECASTS:

Without Temperature

5-2030 5,000 MSL wind from 200° at 30 knots

With Temperature

10-2540/3 10,000 MSL wind from 250° at 40 knots, Temperature +3°C

PILOTS report in-flight weather to nearest FSS.

Fig. 2-5—Excerpt For Training Purposes Only

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Clouds and weather. Southern California coastal waters and immediate coastal sections 600-1200 broken to overcast above sea level becoming generally overcast along coast by 2000 Pacific and inland over coastal valleys after midnight. Approaches to mountain passes obscured by midnight. Cloud tops 1200 to 2000 MSL. Visibility below clouds coastal waters and along coast 2-4 miles haze and smoke but extensive areas less than 2 miles in coastal valleys. Remainder southern California and extreme southern Nevada clear except locally scattered cumulus clouds Owens Valley and extreme southern Nevada until sunset. Visibility 2-5 miles haze and smoke coastal valleys vicinity of Los Angeles Basin east of stratus clouds elsewhere unrestricted.

Icing. None. Freezing level near 13,000.

Turbulence. Locally moderate to briefly severe thermal turbulence for light aircraft mountains and deserts to 11,000 above sea level diminishing after sunset.

Outlook. 0500 Pacific-1700 Pacific time Monday. Stratus clouds dissipating in coastal valleys about 0900 Pacific and decreasing to 900-1400 feet scattered above sea level over coastal sections by 1100 Pacific. Stratus continuing mostly 600-1000 feet broken to overcast coastal waters moving locally 1 to 3 miles on shore during afternoon. Visibility coastal sections remaining 2-5 miles haze but improving to 3 miles haze or more in coastal valleys by early afternoon. Continued unrestricted ceiling and visibility mountains and interior ranges.

Figure 2-6 is a sample of a surface weather map containing frontal symbols and station model symbols for review.

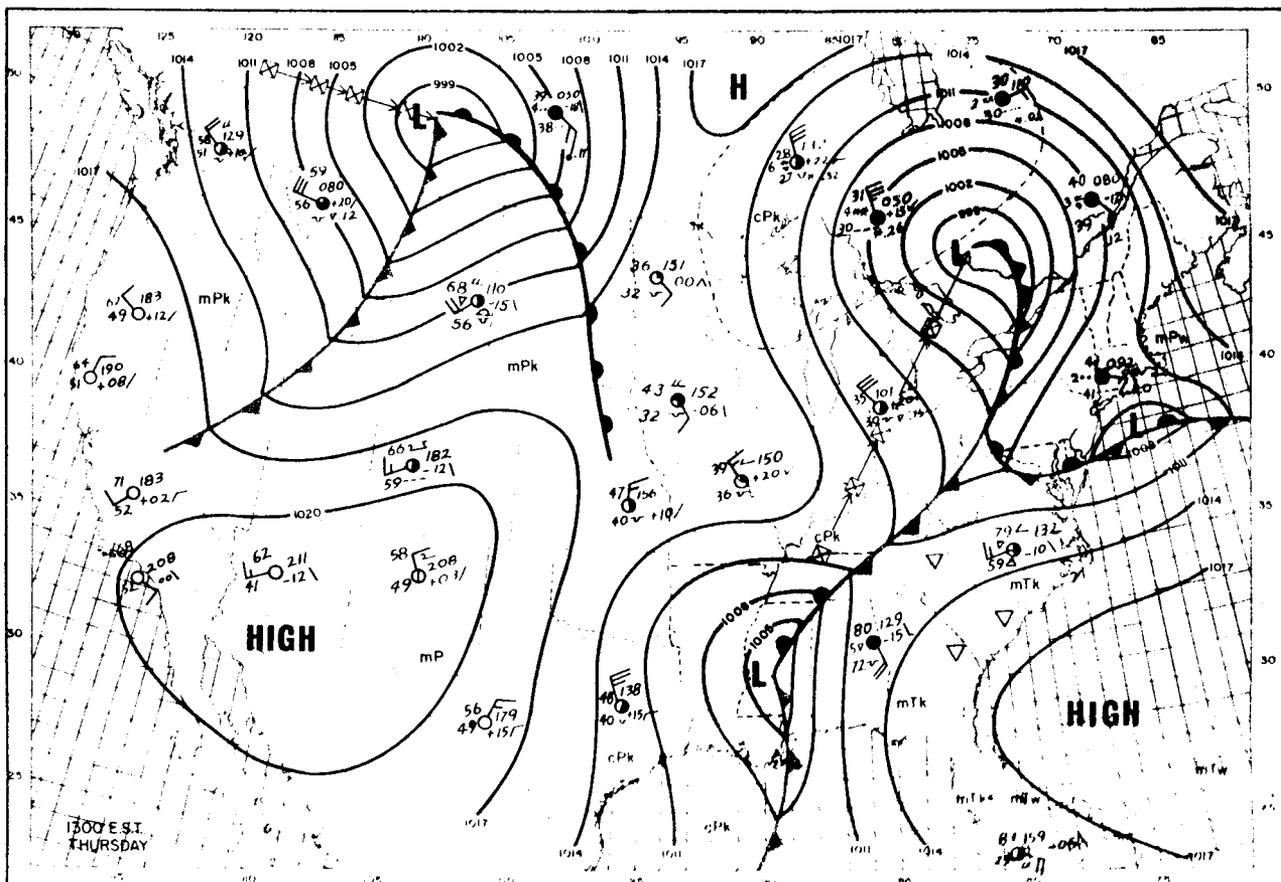


Fig. 2-6 - Sample Weather Map

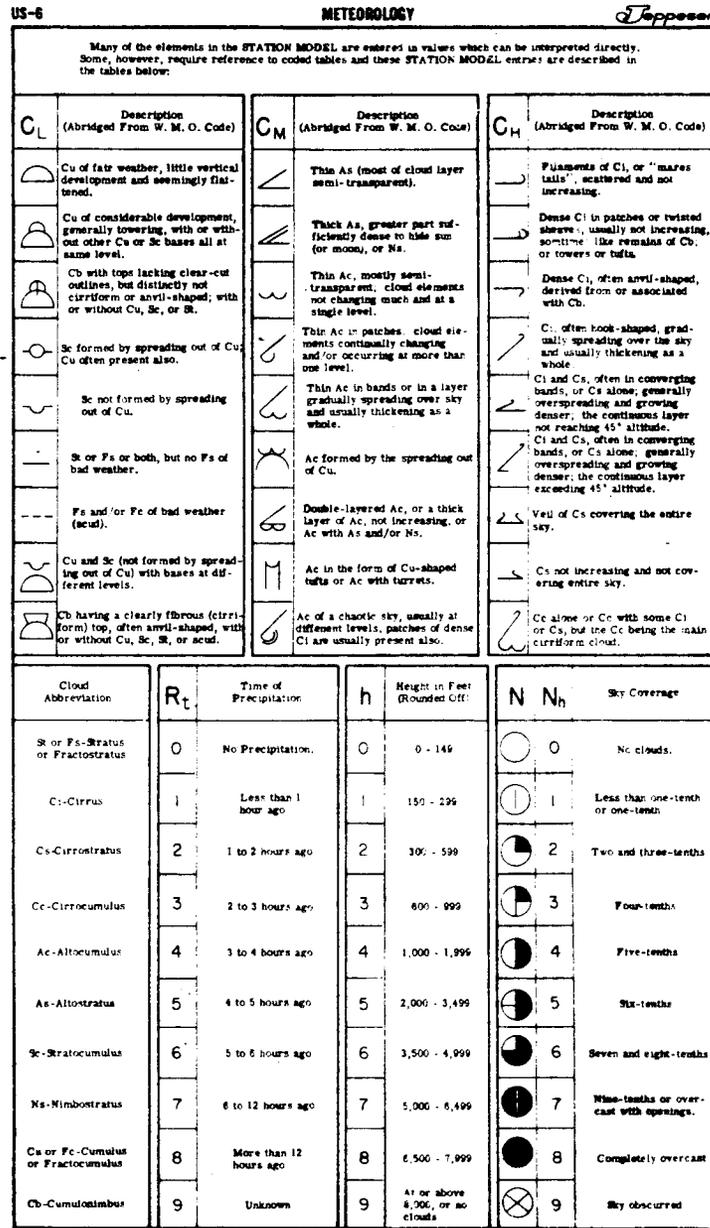
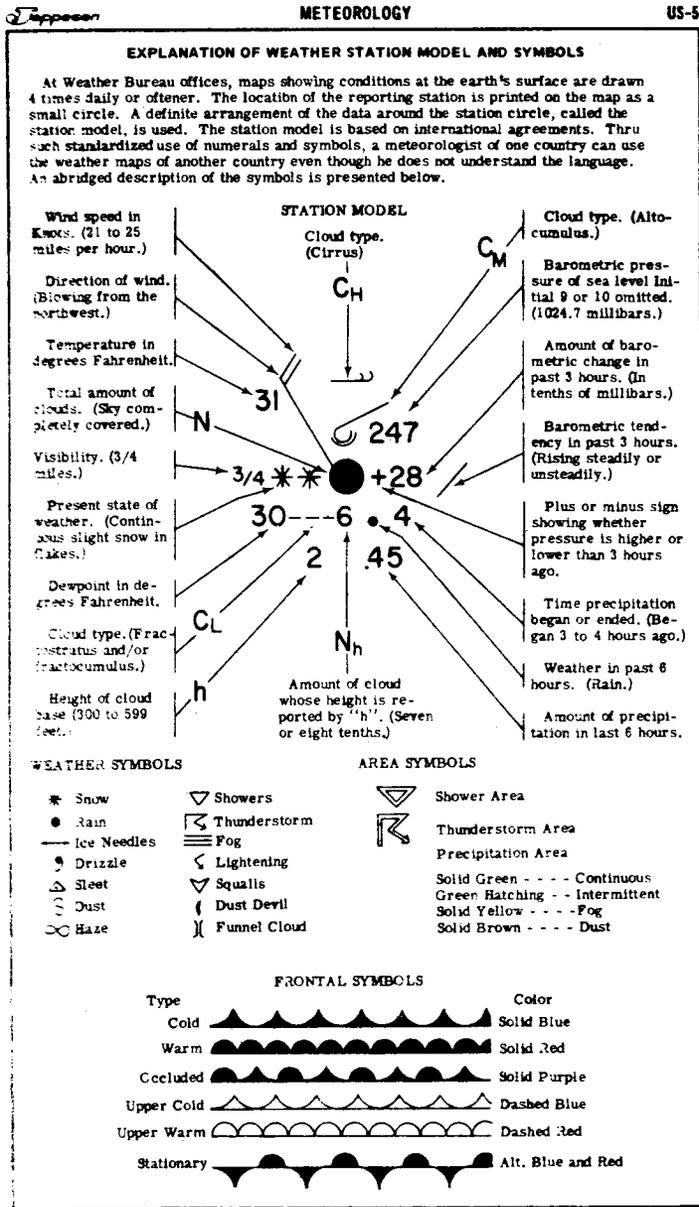


Fig. 2-7 - Excerpt For Training Purposes Only

maps. Figure 2-7 is presented for review of the station model and cloud symbols used on surface weather maps.

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## Sample Regional Forecast

Regional forecasts cover several states and give forecast information for a 24 hour period. They are geared to long haul flights at intermediate and high altitudes.

## Coded Regional Forecast

FN SFO 010550

SAN FRANCISCO REGION 22P SUN-22P

MON

PROG. RDG ALF CALIF NWD INTO CAN. WILL CONT BUT N PTN MOVG EWD OVR NRN RCKYS BY MON AFTN. COLD LOW ALF OFF PAC NW CST. WILL HAVE WK TROF ALF MVG ARND CNTR AND MOVG IN OVR PAC NW STATES MON. NO DFNT FRONTS. INCRG MOISTURE AND INSTBY PAC NW MON. SOME MOISTURE AND INSTBY CONTG WPLTO AND RCKY MTNS BUT DCRG.

SIGNIFICANT WX. A FEW SHWRS NEAR CONTDVD AREA WYO COLO AND NRN NEW MEX MOSTLY ENDG DURG NGT BUT A FEW SHOWRS AND ISOLD TSHWRS NEAR CONTDVD RCKY MTNS GENLY AGAIN MON AFTN AND ERY EVE. A FEW SHWRS AND ISOLD TSHWRS IN LATE AFTN ELSW WPLTO AREA. A FEW SHWRS WRN WASH NWRN OREG PRBL DURG NGT WITH BRKN TO OVC LYRS AND WIDELY SCTD SHWRS AND A FEW TSHWRS BCMG GEN WASH OREG EXTRM NRN CALIF DURG AFTN AND EVE. TOPS TSHWRS TO 400 MSL. BRF HVY ICG SVR TURBC IN TSHWRS

## De-coded Regional Forecast

FN SFO 010550 stands for regional forecast, San Francisco, first day of the month at 0550 ZULU.

SFO RGN 22P SUN-22P MON San Francisco region from 2200 Pacific Sunday to 2200 Pacific Monday

Prognastic. Ridge aloft California northward into Canada. Will continue but northern portion moving eastward over northern Rockies by Monday afternoon. Cold low aloft off Pacific northwest coast. Will have weak trough aloft moving around center and moving in over Pacific northwest states Monday. No definite fronts. Increasing moisture and instability Pacific northwest Monday. Some moisture and instability continuing western plateau and Rocky Mountains but decreasing.

Significant weather. A few showers near Continental Divide area Wyoming, Colorado, and northern New Mexico mostly ending during night but a few showers and isolated thundershowers near Continental Divide Rocky Mountains generally again Monday afternoon and early evening. A few showers and isolated thundershowers in late afternoon elsewhere western plateau area. A few showers western Washington northwestern Oregon probable during night with broken to overcast layers and widely scattered showers and a few thundershowers becoming general, Washington, Oregon extreme northern California during afternoon and evening. Tops thundershowers to 40,000 MSL. Brief heavy icing severe turbulence in thundershowers.

## Winds Aloft

A pilot proposing a flight needs to know the existing and forecast weather along his route and at destination. He must also know the winds for the altitude at which he will be flying. In addition to reporting existing weather, surface winds and the area forecast, some stations report the *wind patterns above the surface*, which are contained in winds aloft reports. Just as the pilot needs to be able to read the hourly sequence reports, he should also be able to read the winds aloft reports.

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An example of a winds aloft report for Dodge City, Kansas, is as follows:

PP 72451 12951 41820 2020 62018 3615 80220 0215 00310 6650

DDC would appear at the beginning of the report, which contains information for the weather observer. Following this information, the winds aloft report will be given preceded by PP. The PP is the identification for a winds aloft report.

The first group of numbers following the PP gives the block number and station identifier (72451). The 72 in the first group is the block number standing for the U.S. The next three numbers stand for the station giving the report—in this case 451 is Dodge City, Kansas.

The second group of numbers gives the ZULU time and the surface winds at the reporting station. The first two numbers in the second group give the ZULU time of the report. The third number, in the second group, gives the method used in determining the winds. When determined by electrical means, Rawin, the number 9 is used. When observed visually, Pibal, the number 4 is used. The fourth number gives the wind direction on an eight-point scale, as follows:

8—north	4—south
1—northeast	5—southwest
2—east	6—west
3—southeast	7—northwest

The last, or fifth number, indicates wind speed—1 for 5 to 14 knots, 2 for 15 to 24 knots, etc. In the report above, the 12 is 1200 ZULU, the 9 stands for Rawin, the 5 for southwest and the 1 for a wind with a 5 to 14 knot speed.

The third group of numbers is the first winds aloft report, in this case for 4,000 feet. On the winds aloft reports, the first number in the case of a five digit number stands for the altitude at which the wind is being reported. This number is only given for *even* altitudes. Therefore, the winds aloft group in a four digit number stands for *odd* altitudes.

In the winds aloft report, the first two numbers after the number designating altitude, stand for wind direction. In the first group for DDC—41820—the 4 stands for 4,000 feet. The 18 stands for 180°. The two numbers following "18"—20—stand for the wind speed 20 knots.

The rest of the DDC report can be interpreted as follows:

2020	—	5,000 feet	200° at 20 knots
62018	—	6,000 feet	200° at 18 knots
3615	—	7,000 feet	360° at 15 knots
80220	—	8,000 feet	020° at 20 knots
0215	—	9,000 feet	020° at 15 knots
00310	—	10,000 feet	030° at 10 knots
6650	—	11,000 feet	160° at 150 knots

When the direction identifying numbers exceed 36, then the wind speed is between 100 and 199 knots. In these cases, 50 has been added to the direction. Also, only the amount in excess of 100 is reported as the speed. Example: a wind of 300° at 175 knots would be coded at 8075 for *odd* thousand feet. To de-code, subtract 50 from the 80 to obtain 30, which would be 300° and add 100 to the 75 to obtain 175 knots.

## Winds Aloft Forecast

When the winds aloft are forecast, they are written as follows:

LVL	3,000 feet	5,000 feet	10,000 feet	15,000 feet	20,000 feet	25,000 feet
BOS	2015	2328+06	2633-01	2936-10	3043-15	3048-21

LVL stands for the standard levels at which winds aloft are forecast.

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Under this system, at stations with elevations of 2,000 feet or below, the first forecast level will be 3,000 feet. For those from 2,000 feet to 4,000, the first forecast level will be 5,000 feet. For those stations above 4,000 feet, the first forecast level will be 10,000 feet. Temperatures will be appended to all reports above 3,000 feet, except that no temperature will be appended to the 5,000 foot wind forecast when this is the lowest level forecast.

The first group of numbers after BOS which stands for Boston is the 3,000 foot winds aloft forecast. The 20 stands for direction 200°, the 15 for wind speed in knots. For each succeeding level above the first level temperature in centigrade follows the wind speed prefixed by a (+) or (-).

The rest of this forecast is interpreted as 5,000 feet, wind from 230° at 28 knots with a temperature of plus 06°C.; 10,000 feet, 260°/33 knots/-01°C.; 15,000 feet, 290°/36 knots/-10°C.; 20,000 feet, 300°/-15°C.; and 25,000 feet, 300°/48 knots/-21°C.

Figure 2-8 is a 200 MB chart giving condition of winds, pressure and temperature at the upper levels and also shows a Polar Jet stream over the U.S.

Figure 2-9 (a and b), consists of two charts showing the analysis of maximum winds and a chart showing the wind shear analysis.

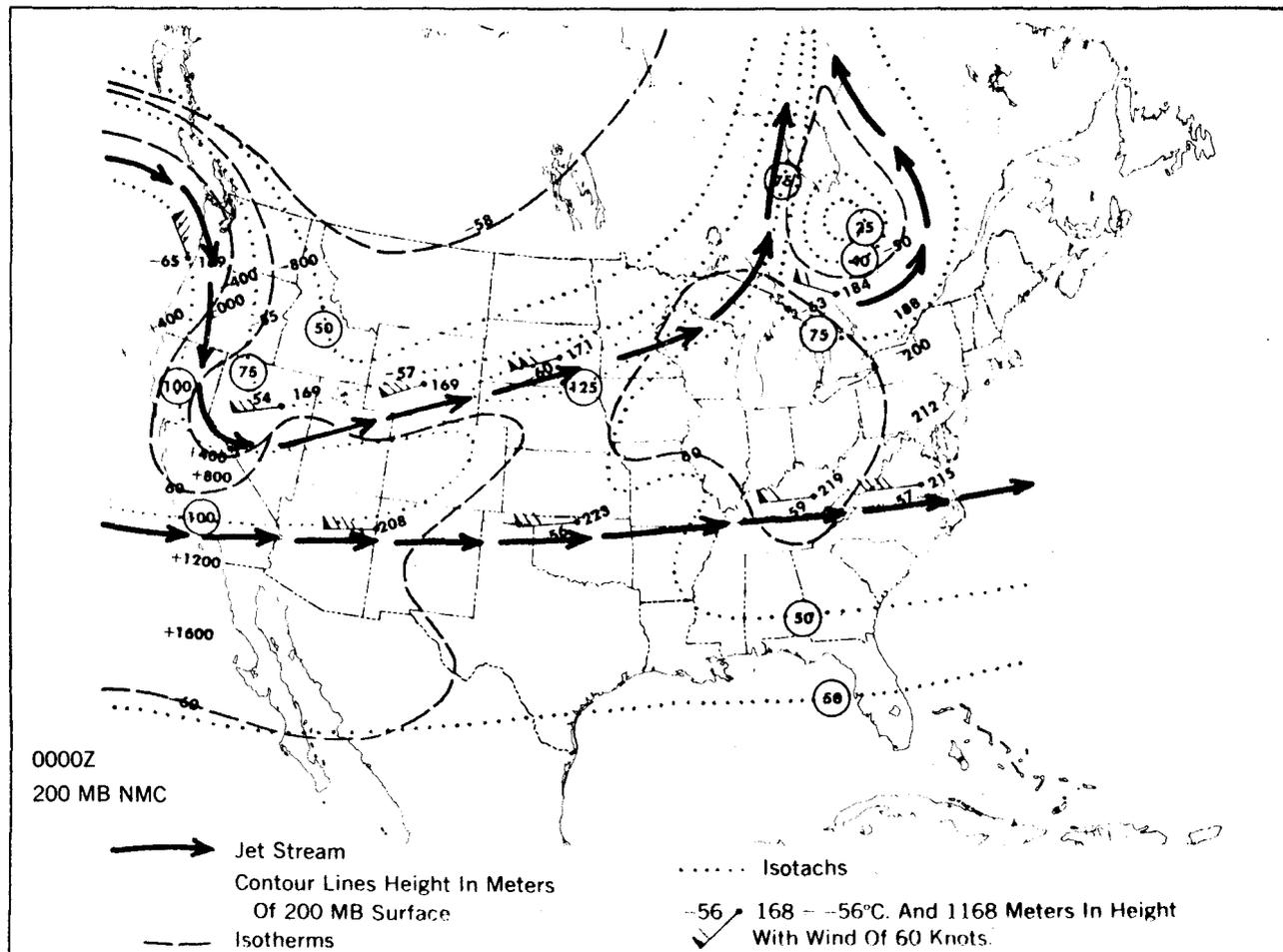


Fig. 2-8 - Sample 200 Mb Chart

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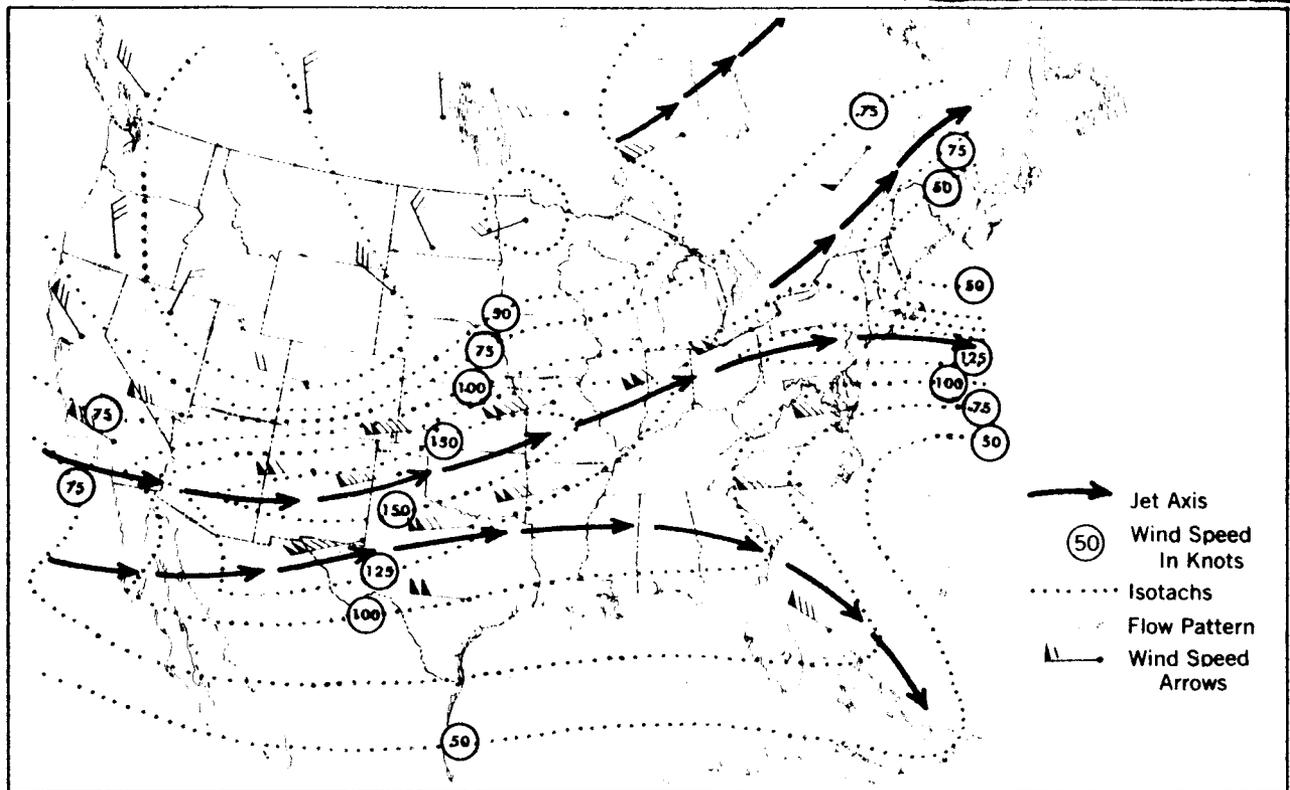


Fig. 2-9A - NMC Maximum Wind Analysis

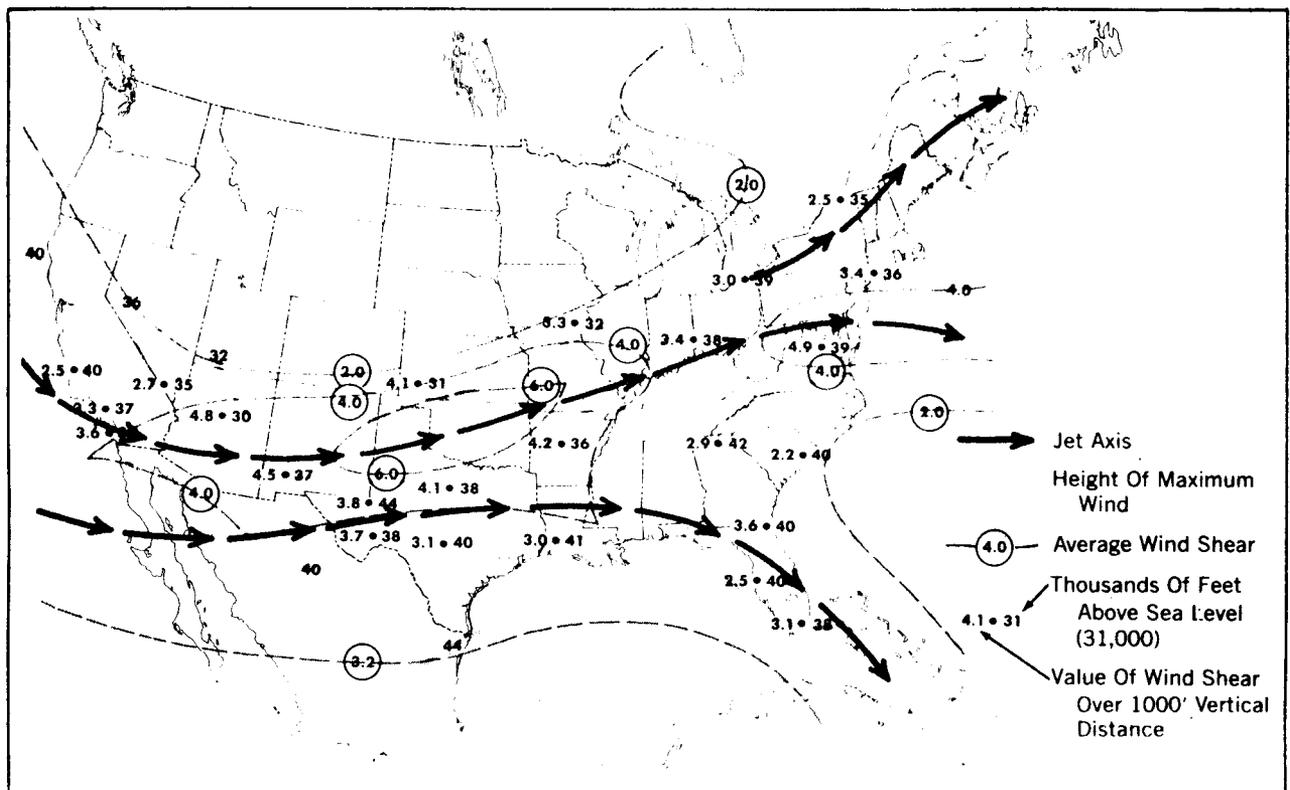
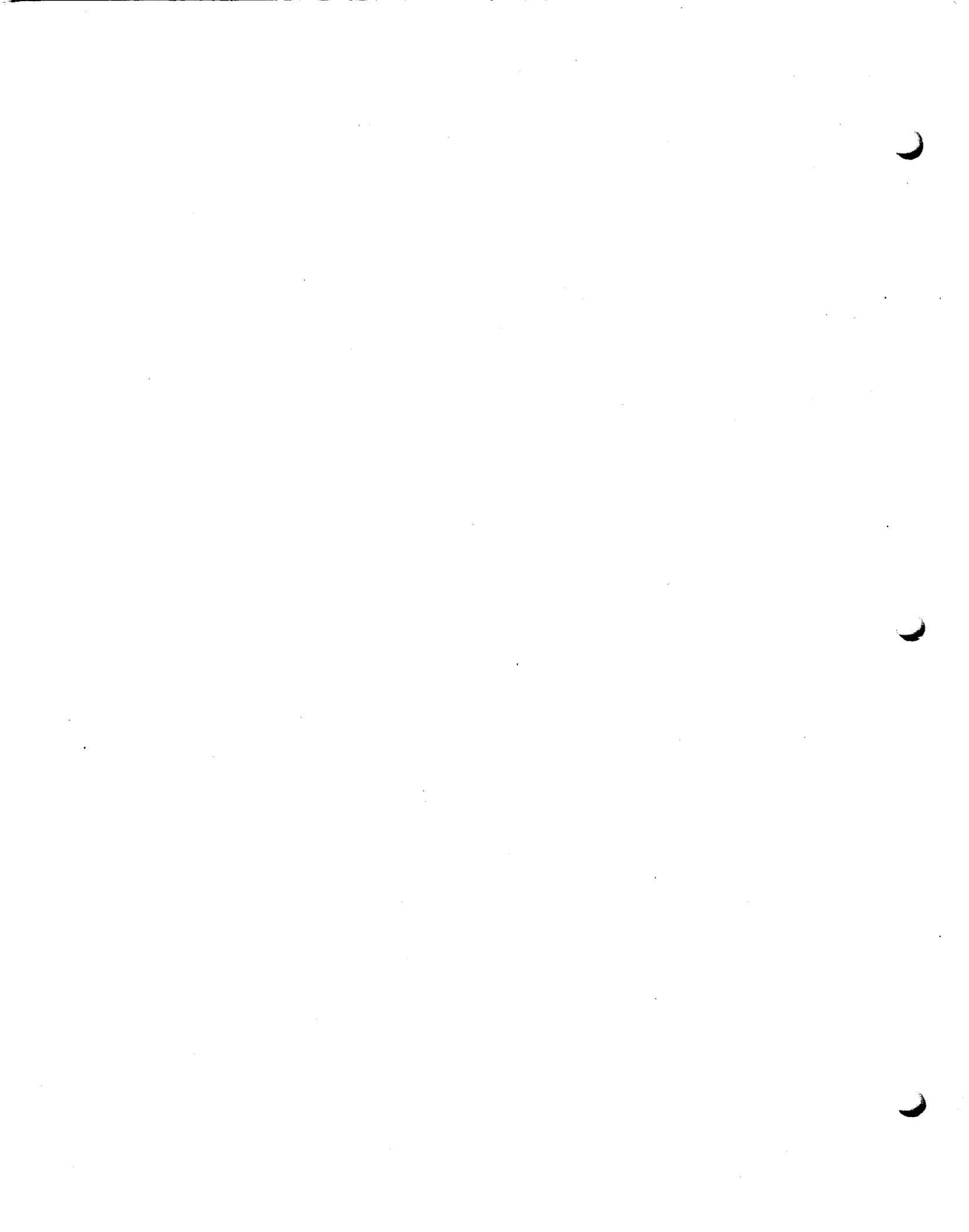


Fig. 2-9B - NMC Wind Shear Analysis



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## PUBLICATIONS

### AIRMAN'S GUIDE

Airman's Guide is published by the Federal Aviation Agency and is issued every two weeks. In relying upon information from this publication, be sure that a current issue is being used. The date of publication is on the front cover (Figure 3-1). The front cover also serves as an index.

#### Directory of Airports and Seaplane Bases

The Directory of Airports of Airman's Guide is issued every three months as a separate publication. Only a current issue of this publication should be used.

*All figures to be used with this section except Figure 3-1 are located on pages 3-11 through 3-22.*

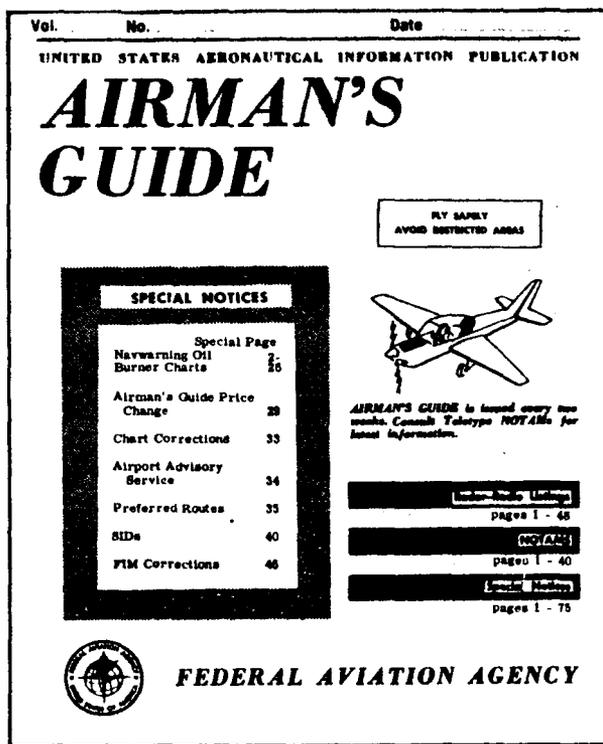


Fig. 3-1 - Excerpt - For Training Purposes Only

Airman's Guide is issued every \_\_\_\_\_

The date of the issue is found on the \_\_\_\_\_

*two weeks*

When using the Airman's Guide for flight planning purposes, only the \_\_\_\_\_ issue should be used.

*front cover*

The index to the content of the Airman's Guide is on the \_\_\_\_\_

*current*

Inside the front cover, in alphabetical order, are the abbreviations used in Airman's Guide (Figure 3-2). "Awy" is the abbreviation for \_\_\_\_\_

*front cover*

Any abbreviations used in Airman's Guide are explained on this page. "rcv" is the abbreviation for \_\_\_\_\_

*airway*

"UFN" is the abbreviation for \_\_\_\_\_

*receive*

If the abbreviation "comsng" is found when reading a section of Airman's Guide, one would refer to the abbreviation page. "Comsng" is the abbreviation for \_\_\_\_\_

*until further notice*

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The first section of Airman's Guide is the RADAR-RADIO LISTINGS. The first page of this section, Figure 3-3, is the legend. The explanation of the symbols and the abbreviations on this page apply strictly to Radio and Radar. An Army facility is designated by (A), (P) designates a \_\_\_\_\_.

*commissioning*

"smi" is the abbreviation for \_\_\_\_\_.

*private facility*

A radio designated as class "H" has a normal reception distance of \_\_\_\_\_ statute miles.

*statute miles*

The Radar-Radio abbreviation MA designates an Adcock Range with a power of less than \_\_\_\_\_ watts.

*180*

"Req" means that the radar or radio operates on \_\_\_\_\_.

*50*

Figure 3-4 is a page from the Radar Listings. Radar units are listed alphabetically by state and city. Notice, under the location column, that a black dot is adjacent to the Los Angeles listing. Referring to Figure 3-3, this dot signifies \_\_\_\_\_ or \_\_\_\_\_ information.

*request*

The "AC" after the city designates an approach control tower. These towers transmit on voice channel or associated ranges and \_\_\_\_\_ in addition to \_\_\_\_\_ listed.

*new  
revised*

The type of radar service available is indicated under the radar Service column. Notice at the top of Figure 3-4, that all of the radar abbreviations are explained. The abbreviation RACS means Radar Approach \_\_\_\_\_.

*ILS  
frequencies*

When arrival, departure and radar traffic information are not all available, those available are indicated by the symbols of the \_\_\_\_\_ available.

*Control  
Services*

In congested areas such as Hawthorne, Calif., (Los Angeles AC), frequencies are listed by \_\_\_\_\_ areas.

*services*

Figure 3-5 is a page from the Instrument Landing System Section. Under the location column, listed in alphabetical order by States, is the airport name, the runway used for ILS and the Approach Light Code. The explanation at the bottom of the page for "L7" is \_\_\_\_\_ approach lights.

*sector*

L5 means \_\_\_\_\_ approach lights.

*high intensity*

The next column gives the localizer frequency and identification. The localizer frequency and identification of Pueblo Memorial Airport, Colorado is \_\_\_\_\_ mc;

*instrument*

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The next column gives the glide slope frequency which is automatically received with the localizer frequency. The next column gives the approach bearing. The approach bearing to Pueblo is \_\_\_\_\_ degrees.

109.5  
I-PUB

After approach bearing, the middle marker information is given. The middle marker is identified by \_\_\_\_\_ dots and dashes.

075

The middle marker column lists the distance of the marker from the end of the runway in nautical miles. The MM at Birmingham Mun., Ala. is \_\_\_\_\_ nautical miles from the runway.

alternate

If there is a nondirectional beacon at the middle marker, its frequency and identifier are listed under the LMM column. The frequency and identifier of the LMM at Ft. Smith, Ark. are \_\_\_\_\_ kc; \_\_\_\_\_.

0.6

The next two columns give the Outer Marker information. The OM at Little Rock, Ark., Adams Field, is \_\_\_\_\_ nautical miles from the runway and the frequency and identifier are \_\_\_\_\_ kc and \_\_\_\_\_.

201  
SM

In the remarks column, BC unusable means (refer to the abbreviation page) \_\_\_\_\_ is unusable.

4.6  
219  
LI

Figure 3-6 is a sample page of Air Navigation Radio Aids. The first column lists the location of the radios alphabetically by states. The second column gives the class code. This code is explained in the Radar-Radio \_\_\_\_\_ (Figure 3-3).

back course

A "B" in the class column means \_\_\_\_\_.

legend

"ML" means range, power less than \_\_\_\_\_ watts.

Scheduled  
Weather  
Broadcasts

The station identifiers are given in the next column. The identifier for Stockton, Calif. is \_\_\_\_\_.

50

The facility's frequencies are divided into two columns, Transmits and Receives. The frequencies are listed or coded; the code is explained in the legend at the bottom of the page. The first frequency in the Transmit column is the primary navigation frequency. The code V in the Transmit column means that the facility transmits on 122.2, 126.7 and \_\_\_\_\_ mc.

SCK

The code (2) in the Receive column means that the facility receives on 3023.5 kc and \_\_\_\_\_ mc. The code (3)-135.9 or (3)-3023.5 means that the facility guards all frequencies listed in group (3) except 135.9 mc or \_\_\_\_\_ kc.

135.9

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In the remarks column for Twenty Nine Palms, "ctld Thermal FSS" means that Twenty Nine Palms is \_\_\_\_\_ by the Thermal FSS.

122.5  
3023.5

Figure 3-7 is a sample page from the NOTAM Section. NOTAMS are listed alphabetically by states and should be checked for each destination or alternate. Checking the NOTAM for Broomfield Jefferson County Airport, Colorado, instructions are given to "contact UNICOM on 122.8 mc prior to \_\_\_\_\_ the \_\_\_\_\_".

controlled

At the Lake Tahoe Airport in Tahoe Valley, Calif., men and equipment are working on both ends of the \_\_\_\_\_ runway.

entering  
traffic  
pattern

Figure 8 is a sample of information contained in the Directory of Airports. The Airport Directory is issued every \_\_\_\_\_ months.

North-South

The Directory of Airports lists, in alphabetical order by states, each airport by City and \_\_\_\_\_ name.

3

The letters in parenthesis after an airport name indicate use for military aircraft. The location column gives the location of the airport by latitude and \_\_\_\_\_.

airport

The next column gives the elevation of the airport in feet above Mean \_\_\_\_\_.

longitude

The next column, Longest Runway and Facilities, gives the length and type of the longest runway at the airport. Runway information is the first two digits less two zeros; if the runway is hard surfaced there will be an "h". Akron, Washington Co., Colorado, has a hard surface runway \_\_\_\_\_ feet long.

Sea Level

Alamosa, Kramer Field, Colorado, has a soft surface runway \_\_\_\_\_ feet long.

4,100

The next information in this column relates to lighting. The code is explained in the legend at the bottom of the page. The lighting facilities at Akron, Washington Co., Colorado, are: \_\_\_\_\_ beacon and a lighted \_\_\_\_\_ or strip.

6,700

The next coded facility relates to servicing. S1 means that \_\_\_\_\_ is available.

rotating  
runway

A "W" after the servicing information indicates the availability of \_\_\_\_\_ reports.

storage

A "U" or "X" indicates the airport \_\_\_\_\_ frequency.

weather

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The UNICOM frequency at Alamosa, Colorado Municipal Airport, is \_\_\_\_\_ mc.

*UNICOM*

Fuel information is coded and explained in the legend. The type fuel available at Canon City, Colorado Fremont Co. is \_\_\_\_\_ and lower.

*122.8*

Practice the interpretation of Runway and Facilities Information, by reading the codes for both Colorado Springs, Petersen Field, and Denver, Stapleton Field, Colorado.

*91/96*

*No Response*

### Jeppesen J-AID

The Jeppesen J-AID is a subscription Airway Manual Service containing a complete list of Navigational Aids and Control Towers, an Airport Directory, a Meteorological Section, an Air Traffic Control Procedures Section, and the Federal Aviation Regulations. The publication is kept current by regular mailing of data revisions to the subscriber.

Figure 3-9 is a sample page from the Radio Facilities Section of J-AID. The first column gives the location and identifier in alphabetical order. The identifier for Dixon, California is \_\_\_\_\_

The next column gives the frequency for the type of NAV-AID available, VOR, Low Frequency Range or Nondirectional Beacon. Dixon, Calif. has a \_\_\_\_\_ and the frequency is \_\_\_\_\_ kc.

*DIX*

The NAV-AIDS at Dickinson, North Dakota are a \_\_\_\_\_ and \_\_\_\_\_.

*Nondirectional  
Beacon  
270*

ILS information is given in the next column. The localizer frequency at Des Moines, Iowa is \_\_\_\_\_ mc.

*VOR  
LFR*

The localizer frequency at Dover, Delaware is \_\_\_\_\_ mc.

*110.3*

The last column gives the frequencies of the Control Tower for local operations, Approach Control and Ground Control. Approach Control at Duluth, Minn. can be contacted on \_\_\_\_\_ mc.

*110.1*

The LFR frequency at Detroit, Michigan Metropolitan Airport is \_\_\_\_\_.

*118.3*

The Ground Control Frequency at Detroit, Willow Run Airport, is \_\_\_\_\_ mc and the Departure Control Frequency is \_\_\_\_\_ mc.

*388 kc*

Figure 3-10 is a sample J-AID page listing NAV-AID's by identifiers. DOW is the identifier for \_\_\_\_\_, \_\_\_\_\_.

*121.9  
118.4*

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ECK is the identifier for \_\_\_\_\_,

*Downey,  
California*

When receiving an identifier from an unknown station, the station can be identified from this section of J-AID. DTA is the identifier for \_\_\_\_\_

*Peck, Michigan*

Figure 3-11 is a sample page from J-AID giving an alphabetical list of all Commercial Broadcast Stations, the call letters, frequency and power (.10 = 100 watts power). The call letters of the Broadcast Station at Dawson, Georgia are \_\_\_\_\_ and the frequency is \_\_\_\_\_ kc.

*Delta, Utah*

The time of operation of each station is given. The dashed lines indicate daylight hours only; unlimited means daylight and any part of the night; continuous means that the stations operate \_\_\_\_\_ hours per day.

*WDWD  
990*

After time of operation, the antenna elevation is given in feet above Mean \_\_\_\_\_

*24*

The antenna of WBSB at Darlington, S. C. is \_\_\_\_\_ feet above Mean Sea Level.

*Sea Level*

The last column gives the distance and bearing from the radio station to the airport listed in parenthesis beside city location. Pryor Airport at Decatur, Ala. is on a bearing of \_\_\_\_\_ degrees from radio station \_\_\_\_\_

*329*

The distance from WMSL to Pryor Airport is \_\_\_\_\_ nautical miles.

*048  
WMSL*

Using the Commercial Broadcast Station at Decatur, Illinois for a navigational aid to the Decatur Airport, Station \_\_\_\_\_ would be tuned on a frequency of \_\_\_\_\_ kc.

*3*

The heading and the distance from Radio Station WDZ to the airport is \_\_\_\_\_ degrees and \_\_\_\_\_ nautical miles.

*WDZ  
1050*

Figure 3-12 is a sample J-AID page of Ground VOR Receiver Check Signals. At Centralia, Ill. Airport, the approach end of Runway 36 is on a bearing of \_\_\_\_\_ from the VOR Station.

*084  
7*

At Owens Field in Columbia, S. C., the VOR Set is checked at the compass rose on the \_\_\_\_\_

*027*

The parking ramp at Owens Field is \_\_\_\_\_ degrees from the VOR Station.

*parking  
ramp*

Figure 3-13 is the legend for the J-AID Airport Directory. The Fuel Code "F 1" is \_\_\_\_\_ octane.

*022*

The service code "A" indicates \_\_\_\_\_ aircraft repair.

*80*

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The letter "P" preceding a service code indicates a part time or irregular day \_\_\_\_\_.

*minor*

Figure 3-14 is a sample of the J-AID Airport Directory which gives airport location alphabetically by \_\_\_\_\_.

*attendant*

The airport locations are listed by city in alphabetical order. The three letter identifiers are for the airport, not a \_\_\_\_\_.

*city*

After the airport identifier, the fuel available at the airport is given by code. This is explained in the legend. The type fuel available at Del Rio International Airport is \_\_\_\_\_ octane only.

*radio*

The fuel available at Delta, Ohio is all fuel ratings at or below \_\_\_\_\_ octane.

*80-100*

Fuel servicing at Delta is on a \_\_\_\_\_ basis.

*91/96*

The service code at Del Rio International Airport is explained in the legend. Services at Del Rio include \_\_\_\_\_ repairs, major \_\_\_\_\_ repairs, storage, and UNICOM on a frequency of \_\_\_\_\_ mc.

*part time*

The last column gives the page number of the airport diagram. Figure 3-15 is a sample J-AID airport diagram page. The elevation of the airport above Mean Sea Level is given beside the airport name. The elevation of Sky Harbor Airport is \_\_\_\_\_ feet.

*major aircraft  
engine  
122.8*

Below the airport name, the airport lighting information is given. "Bcn" indicates that the airport has a rotating \_\_\_\_\_.

*1122*

H. I. means High Intensity. At Sky Harbor Airport, there is a rotating beacon, the runways are lighted and there are high intensity runway lights on Runway 8 Right and \_\_\_\_\_ Left.

*beacon*

"Cone" means that there is a lighted wind sock for determining \_\_\_\_\_ direction.

*26*

"Tet" means tetrahedron. "Tee" means a wind tee. The abbreviation "tet" at Sky Harbor means that Sky Harbor has a \_\_\_\_\_ tetrahedron.

*wind*

In the upper right hand corner of the airport diagram, the distance and direction of the airport from the geographic location is given. Sky Harbor Airport is located 3 nautical miles South-east of \_\_\_\_\_.

*lighted*

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Below the airport location, the latitude and longitude of the airport are given, followed by the magnetic variation. Sky Harbor is in an area of \_\_\_\_\_ variation.

*Phoenix,  
Arizona*

Other codes used on the airport diagram refer to lighting such as approach lighting (VASI 8R) and Runway End Identification Lights (REIL). At Stapleton Airfield, REIL 35 indicates that Runway 35 has \_\_\_\_\_

*14° East*

Obstructions around an airport are given in height above Mean Sea Level. On the approach end of 26R at Sky Harbor, there is an obstruction that is 1189 feet above sea level and \_\_\_\_\_ feet above the terrain.

*runway end  
identification  
lights*

Figure 3-16 is a sample page from J-AID giving the telephone numbers and hours of operation of United States Weather Bureaus. The USWB telephone number at Newark, N. J. is \_\_\_\_\_ and it operates \_\_\_\_\_ hours each day.

*67*

The FSS serving Newark, N. J. is located at Idlewild and the telephone number is \_\_\_\_\_.

*MA 4-8118  
24*

PATWAS (Pilot's Automatic Telephone Weather Answering Service) is available at Newark, N. J. This service is available on a \_\_\_\_\_ hour basis.

*MA 2-0121*

Weather information at Oak Bluffs, Mass. can be obtained by \_\_\_\_\_ from the FSS at \_\_\_\_\_.

*24*

*interphone  
Nantucket*

## Flight Information Manual

The Flight Information Manual is published by the Federal Aviation Agency, and contains much information of interest to the pilot. Of the information contained in the Flight Information Manual, the following are believed to be of most interest to the pilot:

- The Sections on: VOR Receiver Check Points
- Air Navigation Lighting Aids
- Radar
- Weather Bureau Information Service
- Direction Finding (DF) Data
- Emergency Procedures
- Search and Rescue
- Air Traffic Control Procedures
- Altimeter Settings
- Standard Broadcast Stations
- NOTAM Code

Figures 3-17 and 3-18 give examples of information contained in the Flight Information Manual. A major portion of the material contained in the Flight Information Manual is covered in this course.

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### Publications Content Guide

To eliminate the confusion that exists regarding which of these three publications to use to obtain certain information, the following table has been constructed. The information for the performance of an IFR or VFR flight has been listed by publication and the section in which the information is contained.

Information	Airman's Guide	Jeppesen J-AID	Flight Information Manual
Control Tower Frequencies	Air Navigation Radio Aids Section	Navigation Aids & Control Towers	
Navigation Radio Frequencies	Air Navigation Radio Aids Section	Radio Facilities Section	
ILS Frequencies & Information	ILS Section	Radio Facilities Section	
Airport Runways & Facilities	Directory of Airports	Airport Directory	
Radar Facilities	Radar-Radio Listings	Radio Facilities Section	
Direction Finding Stations	Air Navigation Radar Aids	Radio Facilities Section	page number listed in index
Weather Bureau Information and telephone numbers		Meteorology Section	page number listed in index
Commercial Broadcast Stations		Radio Facilities Section	Standard Broadcast Stations Section
VOR Receiver Check Points		Radio Facilities Section	page number listed in index

Control Tower Frequencies are given in both Airman's Guide and \_\_\_\_\_.

ILS information is given in J-AID and \_\_\_\_\_.

*J-AID*

The length of the longest runway and the type of services available at an Airport can be found in \_\_\_\_\_ and \_\_\_\_\_.

*Airman's Guide*

The distance of the Outer Marker from the end of the runway can be found in the Airman's Guide \_\_\_\_\_ Section.

*Airman's Guide  
J-AID*

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The VOR Receiver Check Points are listed in \_\_\_\_\_  
and the \_\_\_\_\_  
\_\_\_\_\_

*ILS*

A list of Commercial Broadcast Stations is contained in the  
Flight Information Manual and \_\_\_\_\_

*J-AID  
Flight Information  
Manual*

The type of fuel available at any airport is listed in Airman's  
Guide Directory of Airports and in J-AID in the \_\_\_\_\_  
\_\_\_\_\_ Section.

*J-AID*

Weather Bureau Telephone Numbers are listed in J-AID and the  
\_\_\_\_\_

*Airport Directory*

*Flight Information  
Manual*

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## AIRMAN'S GUIDE

**Issuance:** The AIRMAN'S GUIDE is issued every two weeks. Every issue contains a Notams section and a Radar-Radio Listings section; and once every three months the Airport Directory appears in an issue containing both Notams and the Radar-Radio Listings.

**Retention:** To enable users to know which issues should be retained, a suitable notice is carried on the front cover indicating which ones are still current.

**Contents:** The contents (by section or other appropriate breakdowns) of each issue are noted by page number on the front cover. The first page of each section carries the Legend for interpreting codified information. Material usually included in each section is as follows:

(1) **Notams (including Special Notices):** Under appropriate geographical headings there is given the current condition (if there has been a temporary or permanent change concerning which a notam has been issued) of facilities and obstructions, plus any special data (including flight regulations or restrictions). Where notams cannot be associated with a specific geographical location or where the application is generalized, they appear in a subdivision of Notams entitled "Special Notices." This section follows the Notams and is separately listed on the cover.

(2) **Radar-Radio Listings:** Lists radar facilities, instrument landing systems, and aeronautical radio facilities with (as appropriate) their transmitting and guarded frequencies, identification, station class, range courses, other appropriate data, and remarks.

(3) **Airport Directory:** This codified directory provides the following data on airports: type, location (with reference to associated city, plus geographical coordinates), elevation, number of runways, length of longest runway (indicating surfacing), lighting, servicing, availability of weather reports and/or Unicom, fuel octanes, and appropriate remarks.

**Price:** See information in box below.

**Reporting Information to Editors:** Data for inclusion in the AIRMAN'S GUIDE should be reported to the editors at the following address: Federal Aviation Agency, Washington 25, D.C., Attention: AT-486. Appropriate instructions for reporting data are contained in FAA's Manual ATM-9-B, entitled "Communications Procedures." However, since some airport data, unlike most other data, may not originate from official sources, the following explanatory information is provided.

The AIRMAN'S GUIDE covers primarily two broad fields of civil airport information: permanent changes and temporary hazardous conditions. The former refer to new airports or changes in field layout, servicing, lighting, restrictions or permanent obstructions on existing airports. Temporary hazardous conditions refer to conditions which make airports temporarily unusable or usable only with caution (such as a field closed due to floods, thaw or construction; or merely a burned-out obstruction light or a runway light or a runway unusable or partially unusable because of construction).

Since the aeronautical public should be immediately advised of such hazardous conditions, reporters should utilize the FAA Flight Service Stations. Therefore, either telephone or mail the item to be reported to the nearest FAA FSS for dissemination as a notam and for further transmission to the editors of the AIRMAN'S GUIDE. If this is not feasible, report the item directly to the FAA, Washington 25, D.C., Attention: AT-486.

Permanent airport data changes should be reported to the appropriate FAA Regional Office for coordination before inclusion in the AIRMAN'S GUIDE.

**Note:** The Federal Government disclaims responsibility for non-Federal air navigation facilities, including airports.

## ABBREVIATIONS USED IN AIRMAN'S GUIDE

**Note:** "s" may be added for plural, or as appropriate.

acft ..... aircraft	adjt ..... adjacent	admin ..... administration	AGL ..... above ground level	Airgl ..... Airguide	alt ..... altitude	amdt ..... amendment	ANEA ..... air navigation radio aids	ant ..... antenna	apch ..... approach	apchg ..... approaching	aprxly ..... approximately	arpt ..... airport	arr ..... arrival/arrive	ARTOO ..... Air Route Traffic Control Center	ARDE ..... airport surface detection equipment	ATC ..... air traffic control	auto ..... automatic	sux ..... auxiliary	avbl ..... available	awy ..... airway	BC ..... back course	bcn ..... beacon	bcst ..... broadcast	bldg ..... building	bdry ..... boundary	brg ..... bearing	btw ..... between	clsd ..... closed	clrnc ..... clearance	ctr ..... center	Co ..... county	comm ..... communication	comand ..... commissioned	commsg ..... commissioning	confg ..... configuration	constr ..... construction	constrd ..... constructed	cont ..... continuous/continuously	CRS ..... course	CS/T ..... combined station/tower	ctc ..... contact	ctl ..... control	ctld ..... controlled	daigt ..... daylight	decomd ..... decommissioned	demol ..... demolition	DF ..... direction finder	discontd ..... discontinued	DME ..... UHF standard (TACAN compatible) distance measuring equipment	dptg ..... departing	dptr ..... departure	efctr ..... effective	elev ..... elevation	emgcy ..... emergency	eng ..... engine	eqpmt ..... equipment	excp ..... except	exten ..... extension	extsv ..... extensive	facil ..... facility	flashg ..... flashing	fld ..... field	fl ..... flight	flwg ..... following	FM ..... fan marker	fone ..... telephone	freq ..... frequency	FSS ..... Flight Service Station	GCA ..... ground controlled approach	gnd ..... ground	GWT ..... gross weight	hi ..... high	hr ..... hour	Co ..... county	hvy ..... heavy	hwy ..... highway	ident ..... identification	IFR ..... Instrument Flight Rules	IFSS ..... International Flight Service Station	ILS ..... Instrument landing system	imdtly ..... immediately	inbd ..... inbound	indef ..... indefinitely	info ..... information	inop ..... inoperative	inst ..... instrument	int ..... intersection	intl ..... international	intsv ..... intensive	J-bar ..... jet runway barrier	kc ..... kilocycles	lat ..... latitude	loc ..... local	locr ..... localizer	lctd ..... located	lctn ..... location	LFR ..... Low/Medium frequency radio range	lgt ..... light	lght ..... lighted	lgtg ..... lighting	LMM ..... compass locator at middle marker ILS	lnd ..... land	lndg ..... landing	LOM ..... compass locator at outer marker ILS	long ..... longitude	M ..... magnetic (after a bearing)	MAA ..... maximum authorized altitude	mag ..... magnetic	maj ..... major	max ..... maximum	mc ..... megacycles	MEA ..... minimum enroute IFR altitude	meml ..... memorial	mi ..... mile	min ..... minimum or minute	MM ..... middle marker ILS	MOCA ..... minimum obstruction clearance altitude	mod ..... modernization/modification	MRA ..... minimum reception altitude	mrkd ..... marked	mrkg ..... marking	MSL ..... mean sea level	mun ..... municipal	natl ..... national	navaid ..... navigational aid	ngt ..... night	nml ..... nautical mile/s	No ..... number	NSM ..... UHF nonstandard distance measuring equipment	obsta ..... obstruction	oct ..... octane	OM ..... outer marker ILS	operg ..... operating	opern ..... operation	outbd ..... outbound	patn ..... pattern	permy ..... permanently	p-line ..... pole line	pwr ..... power	quad ..... quadrant	rad ..... radial	RAB ..... Royal Aircraft Establishment visual glide slope indicator	RAPCON ..... radar approach control	RATCC ..... radar air traffic control center	rhn ..... radio beacon	rcv ..... receive	rcvg ..... receiving	rcvr ..... receiver	rdo ..... radio	reconstr ..... reconstruction	REIL ..... runway end identification lights	relocd ..... relocated	rgt ..... right	rng ..... range	rawy ..... runway	ruf ..... rough	RVE ..... runway visual range	sked ..... schedule	sm ..... statute mile/s	SR ..... sunrise	SS ..... sunset	sta ..... station	sys ..... system	T ..... true (after a bearing)	TACAN ..... UHF navigational facility—omni-directional course and distance information	tet ..... tetrahedron	trfo ..... traffic	tkoff ..... take-off	tmply ..... temporarily	tmpry ..... temporary	trans ..... transcribed	trml ..... terminal	trng ..... training	trans ..... transmit	transg ..... transmitting	transr ..... transmitter	TV ..... television	twr ..... tower	twy ..... taxiway	UFW ..... until further notice	unavbl ..... unavailable	unctrl ..... uncontrolled	unlght ..... unlighted	unmrkd ..... unmarked	venty ..... vicinity	VFR ..... visual flight rules	VOR ..... VHF navigational facility—omni-directional, course only	VOR-DME ..... collocated VOR navigational facility and UHF standard distance measuring equipment	VORTAC ..... collocated VOR and TACAN navigational facilities	VOT ..... a VOR Receiver Testing Facility	vsby ..... visibility	wea ..... weather	WIP ..... work in progress	wt ..... weight
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### RADAR - RADIO LISTINGS

#### (ICAO) INTERNATIONAL PHONETIC ALPHABET

A ALFA	●●●	J JULIETT	●●●●●	S SIERRA	●●●
B BRAVO	●●●●	K KILO	●●●●	T TANGO	●●
C CHARLIE	●●●●●	L LIMA	●●●●	U UNIFORM	●●●●
D DELTA	●●●●	M MIKE	●●●●	V VICTOR	●●●●
E ECHO	●	N NOVEMBER	●●●	W WHISKEY	●●●●
F FOXTROT	●●●●	O OSCAR	●●●●	X IRAY	●●●●
G GOLF	●●●●	P PAPA	●●●●	Y YANKEE	●●●●
H HOTEL	●●●●	Q QUEBEC	●●●●	Z ZULU	●●●●
I INDIA	●●●	R ROMEO	●●●●		

#### ALWAYS CHECK NOTICES TO AIRMEN SECTION

**VOR MONITORING CLASSIFICATION FOR AIR TRAFFIC CONTROL PURPOSES:** Category I=Course alignment and signal level are monitored continuously. VOR has automatic transfer and shutdown unit, and is monitored remotely by a person. Category II=This is a Category I VOR wherein remote monitoring capability has failed and the VOR is temporarily monitored solely through use of automatic equipment which monitors course and signal level and has an automatic transfer unit. Upon receipt of a pilot report that the VOR is operating normally, it is placed in Category II which permits it to be used for air navigation and air traffic control purposes. Category III=VOR monitored solely through use of automatic equipment which monitors course and signal level and has automatic transfer and shutdown unit. Such a VOR may be inoperative for a limited period before a NOTAM is issued. VORs which are not controlled by an FSS, and are located too far from a staffed facility to be monitored with a VHF receiver, will fall into Category III. Category IV=Course alignment and signal level are monitored continuously at an adjacent FSS but there is no automatic transfer and shutdown unit. During periods when the remote control feature is inoperative, a VOR in this category will be advertised, by NOTAM, as out-of-service regardless of its operating condition. **Notes:** Category I, III, IV shown by 1, 3, 4 following name in Location Column.

#### LEGEND

**FSS=Flight Service Station (FAA) (Formerly ATCS) location capitalized.**  
**NOTE:** The Federal Government disclaims responsibility for non-Federal air navigation facilities.

(A)=Army facility.	(S)=State facility.
(AF)=Air Force facility.	(0700-2300)=Hours of operation
(ANG)=Air National Guard facility.	local time
(N)=Navy facility.	3=Monitoring category
(P)=Private facility.	●=New or revised data

#### RADIO CLASS DESIGNATIONS

Identification of VOR/VORTAC/TACAN Stations by Class (Operational Limitations):

Class	Normally Anticipated Altitude Service	Normally Anticipated Inter- ference-free Distance Service
H-	30,000-75,000' MSL	180 smi (156.31 nmi)
M-	15,000-30,000' MSL	90 smi (78.16 nmi)
L-	Up to 15,000' MSL	45 smi (39.08 nmi)

**NOTE:** An H-VOR facility is capable of providing M- and L- service volume and an M- facility additionally provides L- service volume.

AAS	Airport Advisory Service at FSS-located airport.
AB	Continuous automatic transcribed broadcast service.
AC	Approach Control Tower, FAA (transmits on voice channel or associated ranges and ILS in addition to frequencies listed.)
B	Scheduled Broadcast Station (broadcasts weather at 15 and 45 minutes after the hour; Air Force Broadcasts, generally, 29 minutes).
C	Control Tower, FAA.
CI	Control Tower (City, County, Private, etc.).
CM	Control Tower (Military, listing only civil frequencies available).
CONSOLAN	LF/MF long range navigation aid; aircraft must have BFO oscillator.

DME	UHF standard (TACAN compatible) distance measuring equipment.
GCA	Ground Controlled Approach System.
H	Non-directional radio beacon (homing), power 50 watts to less than 2000 watts.
HH	Non-directional radio beacon (homing), power 3000 watts or more.
ILS	Instrument Landing System (voice on localizer channel).
J	L/MF (200-415 kc) voice facility on other than range frequency.
LFM	VHF fan marker, low powered (5 watts).
LMM	Compass locator station when installed at middle marker site.
LOM	Compass locator station when installed at outer marker site.
LRCO	Limited Remote Communication Outlet.
MA	Range (adcock, vertical radiators), power less than 50 watts.
MH	Non-directional radio beacon (homing) power less than 50 watts.
ML	Range (loop radiators), power less than 50 watts.
MM	VHF middle marker.
MRA	Range (adcock, vertical radiators), power 50 watts or more, but less than 150 watts.
MRL	Range (loop radiators), power 50 watts or more, but less than 150 watts.
NSME	UHF nonstandard distance measuring equipment.
OM	VHF outer marker.
RA	Range (adcock, vertical radiators), power 150 watts or more.
RCO	Remote Communications Outlet.
Req	Operates on request.
RL	Range (loop radiators), power 150 watts or more.
S	Simultaneous range, homing signal and/or voice.
SLMM	Simultaneous middle marker compass locator and twr voice transmission.
SLOM	Simultaneous outer marker compass locator and twr voice transmission.
TACAN	UHF navigational facility—omnidirectional course and distance information.
VOR	VHF navigational facility—omnidirectional, course only.
VOR/DME	Collocated VOR navigational facility and UHF standard distance measuring equipment.
VORTAC	Collocated VOR and TACAN navigational facilities.
W	Without voice facilities on range frequency.
Z	VHF station location marker at a LF range station.

#### NOTES

1. Range courses are magnetic in-bearings.
2. All FAA MH facilities operate continuously unless cited as follows: (on req).
3. All FAA ranges operate continuously. Those which are not manned continuously are cited in the remarks column with hours of operation in parentheses, e.g., (0600-2400).
4. LMF and VHF ranges listed at the same location are controlled by the same FSS. The communication frequencies and the controlling FSS are listed with either the LF/LMF or the VOR facility.
5. The controlling facility is shown in the Remarks column for an aid the name of which is NOT capitalized in the Location column and is NOT suffixed by the letter "W" in the Class column; e.g., Eufaula, (Alabama), L-BVOR is controlled by the Columbia, Georgia, FSS. Drake, (Arizona), L-VORW not controlled remotely.

Fig. 3-3 - Excerpt - For Training Purposes Only

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### RADAR APPROACH CONTROL SERVICE

This tabulation lists all approach control facilities in the conterminous United States that are authorized by FAA to provide one or more radar approach control services for their respective airports and/or for satellite airports. Military facilities which provide only Radar Traffic Information Service (RTIS) for civil use are included. Airports restricted solely to military operations are not included.

Radar Approach Control Services (RACS) provided by a terminal radar facility normally consist of: IFR Arrival Control (ARR), IFR Departure Control (DPTR), and Radar Traffic Information Service (RTIS). The abbreviation "RACS" indicates the availability of all three services. Where all three services are not available, only those available are listed.

Additional services provided by certain radar approach control facilities are: Surveillance Radar Approaches (ASR); Precision Radar Approaches (PAR); Expanded Radar Service (ERS); Terminal Radar Service Area (TRSA).

Detailed explanations of these services are contained on the preceding pages and in the Flight Information Manual.

BCN—See "Radar Beacons" page COM 2-1

Radar IFR En Route and Jet Advisory Service is provided by all air route traffic control centers. For RADAR ASSISTANCE when beyond the range of a terminal radar facility (80-60 miles), contact the area FSS for center and frequency information.

Pilots should make initial call to the approach control facility using the name shown in the first column that is followed by "AC", stating service desired.

Only primary frequencies are shown—see Air Navigation Radio Aids for additional frequencies.

Specific frequencies may be assigned to individual sectors for either arrivals or departures. Magnetic bearings from the airport that delineates the clockwise azimuthal coverage of these sectors, are shown under the "Frequency Sector Area."

Location	Service	Primary Frequencies		Frequency Sector Areas
		Approach	Departure	
<b>ALABAMA</b>				
Birmingham (AC) Mun. ....	RACS-ASR .....	119.9	885.6	124.9 819.8
Dothan, Mun. (Cairns AC) .....	RACS .....	125.4	234.4	125.4 237.5
Mobile (AC) Bates .....	RACS-BCN .....	118.5	269.8	125.7 807.1
Montgomery (AC) Dannelly .....	RACS-ASR-BCN .....	121.1	307.8	125.5 819.9
Selma, Selfield (Craig AC) .....	RACS .....	119.5	818.2	119.5 888.8
<b>ARIZONA</b>				
Tucson (AC) Mun. ....	RACS-ASR-BCN .....	118.5	259.1	125.9 297.2
<b>ARKANSAS</b>				
Little Rock (AC) Adams .....	RACS-ASR-BCN .....	119.5	385.6	118.1 838.2
<b>CALIFORNIA</b>				
Burbank (AC) Lockheed .....	RACS-ASR .....	120.9	360.6	118.4 360.6
Van Nuys .....	RACS .....	120.9	360.6	118.4 360.6
Culver City, Hughes (Los Angeles AC) .....	DPTR .....			124.3 363.2 045°-224° 125.2 385.4 225°-044°
Fresno (AC) Air Trml .....	RACS-BCN .....	119.1	297.2	124.1 297.2
Chandler Mun .....	RACS-BCN .....	119.1	297.2	124.1 297.2
Hawthorne (Los Angeles AC) .....	RACS .....	119.8	381.6	225°-044°
		124.9	269.0	045°-224°
				124.3 363.2 045°-224° 125.2 385.4 225°-044°
Lancaster (Edward AC) .....	RACS-BCN .....	124.4	290.3	124.4 291.6
Long Beach (AC) Mun. ....	RACS-ASR .....	124.2	269.6	127.2 343.9
Fullerton .....	RACS .....	124.2	269.6	127.2 343.9
• Los Angeles (AC) Intl. ....	RACS-ASR-PAR .....	119.8	381.6	225°-044°
		124.9	269.0	045°-224°
				124.3 363.2 045°-224° 125.2 385.4 225°-044°

Fig. 3-4 - Excerpt - For Training Purposes Only

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### INSTRUMENT LANDING SYSTEMS

Location	Localizer		Glide slope freq (mc)	Appch brg (deg mag)	MM (alternating & -) *nmi	LMM freq (kc) ident	OM (continuous dashes) *nmi	LOM freq (kc) ident	Remarks
	Freq (mc)	Ident							
<b>ALABAMA</b>									
Birmingham Mun (rwy 5) (L7).....	110.3	I-BHM	333.6	002	0.6	201 HM	4.5	375 BH	BC unusable.
Huntsville (rwy 18).....	100.3	I-HSV	332.0	177	0.6	219 SV	6.9	242 HS	
Mobile, Bates Fld. (rwy 14).....	100.9	I-MOB	333.8	130	0.6	221 OB	4.8	248 MO	BC unusable. LOM is BE factl.
Montgomery Dannelly Fld. (rwy 9) (L7)....	100.9	I-MGM	332.8	003	0.6	219 GM	5.1	245 MG	
<b>ALASKA</b>									
Anchorage Intl. (rwy 6) (L7).....	100.0	I-ANC	333.8	064	0.6	216 NC	4.4	227 AN	BC unusable.
Annette Island (rwy 12) (L7).....	110.3	I-ANN	335.0	122	0.7	300 NN	9.7	227 AN	BC unusable. LOM is Grayson MHW factl.
Cold Bay (rwy 14).....	110.3	I-CDB	335.0	142	0.6	215 DB	5.4	227 CD	BC unusable.
Fairbanks (rwy 19) (L7).....	110.3	I-FAI	335.0	190	0.6	215 AI	5.6	227 FA	
Gustavus (rwy 10) (L7).....	110.3	I-GBT	335.0	106	0.6	201 GT	3.9	219 GB	
King Salmon (rwy 11) (L7).....	110.3	I-AKN	335.0	111	0.5	216 KN	4.8	227 AK	BC unusable.
<b>ARKANSAS</b>									
Ft. Smith Mun (rwy 20) (L7).....	100.5	I-FSM	332.6	253	0.6	201 SM	6.9	223 FS	BC unusable. LOM is HW factl.
Little Rock, Adams Fld. (rwy 4) (L7).....	110.3	I-LIT	335.0	040	0.6	201 IT	4.6	219 LI	
<b>CALIFORNIA</b>									
Arco (rwy 31) (L7).....	100.5	I-ACV	332.6	314	0.6	233 CV	4.1	247 AC	BC unusable. LMM is BMH factl.
Bakersfield, Meadows Fld (rwy 30R) (L7)...	100.9	I-BFL	333.8	290	0.6	227 FL	4.5	278 BF	
Burbank, Lockheed Air Terminal (rwy 7) (L7).....	100.5	I-BUR	332.6	076	1.7		6.0	272 BU	Locator lctd 0.8 mi, on 200 ka.
Fresno Air Terminal (rwy 29) (L7).....	110.3	I-FAT	335.0	288	0.6	231 AT	4.0	206 FA	
Long Beach (rwy 30).....	110.3	I-LGB	335.0	300	0.6	242 GB	4.3	233 LG	LOM voice cld Los Angeles FSS.
Los Angeles International (rwy 25L) (L7)....	100.9	I-LAX	333.8	248	0.7	(278 AX)	5.4	206 LA	
Monterey, Peninsula (rwy 10) (L7).....	110.1	I-MRY	334.4	096	0.5	201 RY	4.1	(278 MR)	
Oakland, Metropolitan-Oakland Intl. (rwy 27R) (L7).....	100.9	I-OAK	333.8	275	0.6	341 AK	4.1		BC unusable.
Oakland, Metropolitan-Oakland Intl (rwy 28) (L7).....	100.7	I-INB	330.5	290	0.5	219 NB	5.2	206 IN	
Ontario International (rwy 25) (L7).....	100.7	I-ONT	333.2	255	0.6	(215 NT)	5.9	227 ON	
Sacramento Mun (rwy 2) (L7).....	110.3	I-SAC	335.0	015	0.5	200 AC	4.0	356 SA	
San Diego, Lindbergh Fld (rwy 9) (L7).....	110.9	I-SAN	332.8	091	0.7	245 AN	2.7	278 SA	
San Francisco Intl. (rwy 28R) (L7).....	100.5	I-SFO	332.8	281	0.6	348 FO	5.7	379 SF	BC unusable.
Santa Barbara Mun (rwy 7) (L7).....	110.3	I-SBA	335.0	073	0.5	388 BA			
Stockton Mun (rwy 29R).....	100.1	I-SCK	331.4	291	0.6	230 CK	5.4	274 SC	BC unusable.
<b>COLORADO</b>									
Colorado Springs, Peterson Fld. (rwy 35) (L7).....	100.0	I-COS	333.8	346	0.5	215 OS	3.7	407 CO	LOM is MHW.
Denver, Stapleton Airfld (rwy 26L) (L7)....	110.3	I-DEN	335.0	206	0.6	335 EN	5.5	362 DE	
Grand Junction, Walker Fld (rwy 11) (L5)...	110.3	I-GJT	335.0	110	0.6	201 JT	3.9		
Pueblo Mesa (rwy 8) (L7).....	100.5	I-PUB	332.6	075	0.6	285 UR	5.4	302 PU	
<b>CONNECTICUT</b>									
Windsor Locks, Bradley Fld (rwy 6) (L7)....	110.3	I-BDL	335.0	058	0.6	239 DL	4.5	388 BD	
<b>DELAWARE</b>									
Wilmington, Grtr Wilmington (rwy 1) (L7).....	110.3	I-ILG	335.0	014	0.6	382 LG	5.3	248 IL	BC unusable.
<b>DISTRICT OF COLUMBIA</b>									
Washington-National (rwy 30) (L7).....	100.9	I-DCA	333.8	003	0.5	(224 CA)	4.6		BC unusable.
Washington (Chantilly, Va.) Dulles Intl (rwy 1R) (L7).....	100.3	I-DIA	332.0	006	0.6	239 IA	4.6	346 DI	
Washington (Chantilly, Va.) Dulles Intl (rwy 19R) (L7).....	100.7	I-DLX	330.5	186	0.5	200 LX	3.6		
<b>FLORIDA</b>									
Daytona Beach Mun (rwy 6).....	100.7	I-DAB	333.2	065	0.6	212 AB	5.0	283 DA	
Jacksonville, Imeson (rwy 3) (L5).....	110.3	I-JAX	335.0	045	0.6	201 AX	4.0	221 JA	
Miami-International (rwy 9L) (L7).....	110.3	I-MFA	335.0	086	0.6	337 FA	4.5	382 MF	
Orlando Mun (Herndon) (rwy 7).....	100.9	I-ORL	333.8	056	0.6	201 RL	5.4	221 OR	
Pensacola Mun (rwy 17) (L7).....	100.5	I-PNS	332.6	163	0.5	257 NS	3.8	400 PN	
St. Petersburg-Clearwater Intl. (rwy 17) (L7).....	100.1	I-PIE	331.4	170	0.5	203 IE	4.3	240 PI	
Tallahassee Mun Arpt (rwy 36) (L7).....	110.3	I-TLH	335.0	258	0.6	358 LH	4.1	392 TL	BC restricted.
Tampa-International (rwy 18) (L7).....	110.3	I-TPA	335.0	180	0.5	227 PA	4.0	251 TP	
W. Palm Beach, Palm Beach Intl. (rwy 9)....	100.3	I-PBI	332.0		0.6	201 BI	5.6	282 PB	

\*Nautical miles from marker to approach end of ILS runway. BC=Back course. BS restricted=Not suitable for approaches. (L5)=Instrument approach lights (noon). (L7)=High-intensity approach lights. Simultaneous compass locators at markers shown in parentheses e.g., (212 AB)=SLMM and (283 DA)=SLOM.

Fig. 3-5 - Excerpt - For Training Purposes Only

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### AIR NAVIGATION RADIO AIDS—Continued

LOCATION	CLASS	IDENT	FREQUENCIES		REMARKS
			TRANSMITS	RECEIVES	
<b>CALIFORNIA—Continued</b>					
San Francisco Gap	MHWZ	SFO	332		
San Jose 1	L-VOR	SJO	108.2		
San Jose Mun.	C(g,7)		227 120.7 243.0 381.8	(1) ♦ 122.4	
San Jose Mun.	VHF/DF			120.1 121.3 123.7 122.4 (req 100-150)	Moffett apch ctd
San Jose Mun.	UNF/DF			322.0 348.0 350.8 (req 223.0-379.9)	Moffett apch ctd
San Luis Obispo 1	M-BVORTAC	SBP	112.4		Paso Robles FSS
San Nicholas (N)	MHW	NSI	203		
Santa Ana, El Toro MCAS	M	NZJ	410 142.74 243.0	(1) ♦	
Santa Ana, El Toro MCAS	M-VOR	NZJ	111.0		
Santa Ana, Orange Co.	L-VOR	SNA	108.8		
Santa Ana, Orange Co.	C(g,7)		326 119.9 243.0 257.8 269.3	♦ 122.5	(0600-2400)
SANTA BARBARA 1	H-BVORTAC	SBA	114.9 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	
Santa Barbara	AD(g,7)		330 119.7 125.4 243.0 269.2 353.9	♦ 122.7	
Santa Catalina 1	L-BVOR	SXC	111.6		Los Angeles FSS
Santa Maria 1	L-VOR	SMX	109.0		Ctd Vandenberg AFB
Santa Monica (P)	L-VORW	SMO	110.8		
Santa Monica Mun.	C(g)		201 120.3 126.2 243.0 257.8	(1) ♦ 122.6	(1700-2300)
Santa Rosa, Sonoma Co.	C(g)		206 118.5 143.0 348.6 363.0	♦ 122.5	(0600-2200)
Seasalito 1	L-BVORTAC	SAU	110.4		Oakland FSS
STOCKTON 1	H-BVORTAC	SKN	116.0 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	
Stockton Metro	AC(g)		299 120.3 126.2 243.0 257.8 363.2	(2) ♦	
THERMAL (AAS) 1	M-BVORTAC	TRM	116.7 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	
Torrance Mun.	C(g)		221 118.1 243.0 319.8	♦ 122.5	(0600-2200)
Twenty Nine Palms	M-BVORTAC	TNP	114.2		Ctd Thermal FSS
UKIAH (AAS) 1	M-BVORTAC	UKI	112.3 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	
Ukiah	BJ	UKI	278		
Van Nuys	C(g,7)		281 120.1 126.2 243.0 383.1	(2) ♦	
Van Nuys	UNF/DF			243.0 257.8 383.1	
Ventura 1	L-BVOR	VTU	108.2		Santa Barbara FSS
Victorville, George AFB	L-VOR	VCV	108.8		
Victorville, George AFB	HW	VCV	376		
Whitmore	MRLWZ	HIT	353		OIA 91M 181A 271M
Williams 1	M-BVORTAC	ILA	114.4 V 243.0 255.4 272.7	(3) - 3023.5 ♦	Marysville FSS
Woodside 1	L-BVOR-DME	OSI	111.4		Oakland FSS

### COLORADO

AKRON (AAS)	SBMRAZ	AK	388 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	64A 154N 230A 334N
Akron 1	M-BVOR	AKO	114.4		
Alamosa 1	H-BVORTAC	ALS	113.9	122.1	Trinidad FSS
Aurora	HW	AUR	281		
Colorado Springs	MHW	CO	407		
Colorado Springs 1	M-BVORTAC	COS	112.5	122.1	Pueblo FSS
Colorado Springs, Peterson	L-VORW	PEF	109.0		
Colorado Springs, Peterson Fld.	AC(g,7)		215 118.3 119.9 120.2 126.2 243.0 269.1 348.6 380.6 362.3 383.1	♦ 122.5	
Colorado Springs, Peterson Fld.	VHF/DF			118.5 119.9 120.2 122.1 122.5 125.9 126.2 126.6 126.7	
DENVER	SABMRAZ	DN	379 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	59N 168A 239N 335A
Denver 1	M-BVORTAC	DEN	116.3		
Denver, Stapleton Airfld.	AC(g)		335 118.3 119.5 119.8 120.5 124.8 126.2 137.65 243.0 257.8 269.3 271.3 284.0 307.0	♦ 122.5	
Denver	Center		See page 50 for center frequencies		
Denver, Stapleton Airfld.	VHF/DF			118.1 118.3 119.3 119.5 120.5 120.9 122.1 122.5 126.2 135.9 137.65	
Dove Creek 1	M-BVORTAC	DVC	114.4		Farmington NM FSS
Durango (P)	L-VOR	DRO	108.2	122.1	(0500-2200)
♦ EAGLE (AAS)		EGE	V 243.0 255.4	(3) - 3023.5 req ♦	
Eagle	BJ	EGE	391		
Ellicott	MHW	ELL	347		
Gill 1	M-BVOR	GIL	108.8		Denver FSS
GRAND JUNCTION 1	H-BVORTAC	GJT	112.4 V 243.0 255.4 272.7	(3) - 3023.5 req ♦	
Grand Junction	MHW	GJT	396		
Grand Junction, Walker Fld.	AC(g)		278 118.1 119.7 243.0 257.8 335.5 385.8	♦ 122.5	
Gunnison 1	M-BVORTAC	GUC	114.9		Grand Jet FSS
Hanover	MHW	HNR	356		
Hugo 1	M-BVOR	HGO	108.4	122.1	La Junta FSS

V=122.2, 126.7, 135.9 mc transmitted. ♦=Guards same VHF and UNF freqs facility transmits except 122.2 mc. (1)=3023.5 kc guarded. (2)=3023.5 kc; 122.5 mc. (3)=3023.5 kc; 122.1, 126.7, 135.9 mc. (g)=(8)-135.9 guards every frequency in group (3) except 185.9 mc. (g)=Tower equipped with 181.8 mc or (g,7)=Tower equipped with 121.7 mc for control of ground traffic. EMERGENCY FREQUENCY (121.5 mc) transmits and guards at all FSS, Towers (FAA and Military), Centers and DF Stations; this frequency is not tabulated in the list above. \* = Automatic voice identification. NOTE: FIRST FREQUENCY LISTED IS THE NAVIGATIONAL AID CHANNEL; OTHERS ARE COMMUNICATIONS CHANNELS LISTED IN NUMERICAL ORDER WITHOUT REGARD FOR ASSIGNMENT. See Legend Page (Radar/Rdo-1) for VOR Monitoring Classification and Radio Class Designations.

Fig. 3-6—Excerpt—For Training Purposes Only

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### 8-Notam

**SAUSALITO RDO:** VORTAC unusable 300-313' beyond 10 mi below 15,000'.  
**STOCKTON-METROPOLITAN ARPT:** Formerly carried Stockton Mun Arpt.  
**STOCKTON METRO ARPT:** Txyw lgtg on txyw B and C inop. Txyw B restricted to acft of 25,000 lbs GWT or less. Txyws C, D and E restricted to acft of 25,000 lbs GWT or less. ILS apch zone rwy 29R has unlit trees and p-lines protruding above a 50:1 plane. Maximum penetration of 35' lctd 1330' from apch end of rwy 29R and 566' rgt of rwy cntrline. Lesser penetrations lctd btm 935' and 2470' from apch end of rwy 29R into apch zone rgt and left of cntrline.

**STOCKTON METRO ARPT TWR:** About Dec 15, freq 299 kc will be replaced by 230 kc.

**TAFT ARPT SPECIAL NOTICE:** About 6 mi N parachute jumping will take place 1800 EST til dusk wkdays and dawn till dusk Sats and Suns below 10,000' MSL.

**TAHOE VALLEY, LAKE TAHOE ARPT:** Rotating bon and rwnys lgtg operg dusk-dawn.

**TAHOE VALLEY, LAKE TAHOE ARPT:** Use caution, men, eqmpt working both ends N/S rwy and along turnoff txyws.

**TEHACHAPI-KERN CO ARPT #4:** Caution, apchg fld, sailplane activity dalt to dusk.

**THERMAL ARPT:** Txyw E side of N/S rwy open for lfc; duster opens lctd to E of N/S txyw; men and eqmpt working adjt to rwnys and txyws; trucks crossing N end of N/S rwy. Caution advised UFN.

**THERMAL RDO:** VORTAC azimuths unusable beyond 40 nmi, 015-040', 15,000' MSL; 060-040', 12,000' MSL; 060-065', 8000' MSL; 150-200', 15,000' MSL; 200-250', 23,000' MSL; 350-015', 12,000' MSL.

**THOUSAND OAKS, RANCHO CONEJO ARPT:** Rwny lgtg avbl prior request, prior to 1800P call 498-2188; after 1800P cto Ventura twr one half hr in advance.

**TORRANCE ARPT SPECIAL NOTICE:** Flight Test Area: lat 33°34', 117°53'; 33°19', 117°34'; 33°21', 117°32'; 33°14', 117°25'; 33°10', 117°30'; 33°31', 117°57'; 33°34', 117°53', the point of beginning. Hrs: dalt. Alt: 20,000' AGL. User: Kirk-Wing Co., c/o Transland Acft. Expires: Jan 4, 1963.

**TORRANCE MUN ARPT:** Due non-vby cll twr unable to determine if the following areas of the fld are clear of obstns and/or acft: all txyws from E end of main txyw to E and S boundaries of fld. All acft use this area at pilot's discretion. Pilots should use caution in using main E/W txyw as twr is unable to provide separation btm acft and vehicle or pedestrian t/c in this area.

**TWENTY-NINE PALMS ARPT:** Caution, sky diving and parachute jumping exercises will be conducted 0600-1700 Sat and Sun, surface to 12,000' UFN.

**TWENTY NINE PALMS RDO:** VORTAC azimuth unusable 010-035', 13,000'; 109-120', 11,500'; 120-240', 10,500' beyond 40 nmi.

**UKIAH SPECIAL NOTICE:** Airborne VOR revr check point unusable.

**UPLAND, CABLE ARPT:** Caution, WIP west end of E/W rwny.

**VAN NUYS ARPT:** See Los Angeles Van Nuys Airport.

**VAN NUYS ARPT TWR:** UHF/DF coverage limited to above 11,000', 290-320'.

**VENTURA ARPK SPECIAL NOTICE:** Flight Test Area: Area #1: From 34°23'30", 119°44'00" to 34°23'30", 119°16'30" to 34°21'00", 119°16'30" to 34°21'00", 119°44'00" to 34°23'30", 119°44'00". Area #2: From 34°23'00", 119°12'00" to 34°23'30", 119°19'00" to 34°34'30", 119°17'30" to 34°19'00", 119°10'00" to 34°23'00", 119°12'00". Altitude: Not to exceed 800' above the surface in Area #1 and not above 8000' above the surface in Area #2. Hours: Dalt. User: Western Engineering Associates. Expires: Dec 25, 1962.

**VENTURA RDO:** DME operg on test basis; channel 19.

**VENTURA ARPK:** Not maintained. Caution, chuck holes in txyw and rwny. Use at pilot's discretion.

**VICTORVILLE SPECIAL NOTICE:** Extav jet t/c conducted by George AFB in the following areas during both dalt and hrs of darkness: (1) at or below 8000' MSL btm the Barstow and Mirage Ints on V-12 and G-4 ays; (2) at or below 12,000' MSL btm the Barstow and Phelan Ints on V-8N ays; (3) at or below 9000' MSL btm V-137 and V-117 on V-8 ays; (4) at or below 12,000' MSL on V-137 ays btm Phelan Int and a point 10 nmi SE of Palm-dale VOR; and (5) on all Federal ays above 24,000'. Pilots practicing George AFB JAL 794 ADF, JAL 794 VOR-2 and JAL 794-TACAN ays are encouraged to cto Edwards AFB Ctl for radar advisory service while operg on ays or jet routes in Daggett Hector area.

**WOODSIDE RDO:** VOR coverage limitations: 250' rad restricted below 5200' acft scalloping. VOR unusable 040-080' beyond 15 nmi; below 5000' MSL; 256' rad below 5500' MSL; 275 thru 285' beyond 15 nmi below 9000' MSL.

### COLORADO

**SPECIAL NOTICE:** Extav military and civil jet trng and acrobatics all hrs in the flw areas. Use extreme caution. Area A-SE Denver within area bounded by direct line Pueblo VORTAC to Rush Int to Hugo VORTAC to Horse Creek Int to Pueblo VORTAC. Unlimited alts and times VFR and IFR flts. Area B-E of Kiowa bounded by V-1638 on E, V-1631 on SW, V-1636 on N. VFR trng and acrobatics surface to 23,000' MSL. Area C-SE Thurman bounded by V-1636 on N, V-108 on S, and V-1633 on W. Unlimited alts and times. This area primarily used by hi-performance fighter acft for acrobatic type maneuvers above 10,000' MSL. Area D-Civil jet and piston type acft trng being conducted periodically 7 days wk during dalt hrs within airspace bounded N by V-138 btm Cheyenne and Sidney; bounded E and S btm Sidney and Gill by V-169, V-172, V-220, and V-207; Victor 89 E btm Gill and Cheyenne; at alts from surface to 23,000' MSL inclusive.

**ALAMOSA RDO:** DME coverage 21 nmi 030-040'; 25 nmi 160-175' at MFA. VORTAC coverage at 40 nmi; 020-050', 19,000'; 050-090', 14,000'; 090-190', 15,000'; 190-225', 12,000'; 225-290', 15,000'; 290-350', 10,000'; 350-020', 15,000'.

**BROOMFIELD, JEFFERSON CO ARPT:** Ctc unicom 122.8 mc prior entering t/c ptn for advisory service.

**CENTER, RODENBECK ARPT:** New listing. Lctd 4 mi NE; at lat 37°47', long 104°02'; elev: 7500'. One strip E/W 3900 x 100' packed sandy soil. 300' p-lne E side; trees middle way S side. No lgtg, fuel or repairs. Un-attended.

**COLORADO SPRINGS SPECIAL NOTICE:** Cld fring for use of Fort Carson, lndtly and S of R-2601, within following area: beginning at lat 38°53'08", long 104°45'00"; thence to 38°24'00", 104°45'00"; 38°25'00", 104°58'00"; 38°27'00", 104°58'00"; 38°27'00", 105°01'00"; 38°24'00", 104°58'30"; 38°26'30", 104°51'40"; 38°26'00", 104°49'18"; to point of beginning. Max ordinate of fring: 34,000' MSL. Time of use: Continuous, 24 hrs daily. Controlling agency: Commanding General, Fort Carson.

**COLORADO SPRINGS, PETERSON FLD:** Twr clearance required before entering t/c pattern, lndg and thof. Rgt t/c rwnys 30, 17 and 08. Caution: ADC Hq based and transient military t/c including jets conducting penetrations from 25,000' MSL, actual and simulated GCA/ILS apchs to rwy 15, VFR simulated Same-outs and 350' eye-head lndg apchs. Simulated Same-outs from 12,000' MSL. Jet t/c patterns 7700' MSL. Jet barrier rwy 12. Use paved areas nly. First 500' rwy 21 permly cld, due nonvisibility twr unable to determine if flw areas are clear of obstns and/or acft: SE end of ramp area vcty of Kansair, Seeline, Interstate, and V1A1 hangars. Use of these areas is at pilot's discretion. Inland VFR flgts with appropriate rdo capability make initial cto with apch cti aprty 25 miles out on 115.5 or 269.1 mc. Apch cti will provide wind information, rwy in use, t/c advisories and specify point where flg will change to twr freq. T/c advisory service for departing flgts also avbl. Departures use 120.2 or 352.3 mc.

**COLORADO SPRINGS, PETERSON FLD:** Rwy 21 cld for lndgs to all military jet acft by order base commander. Rwny 17-35 cld for rebuilding and lengthening.

**COLORADO SPRINGS, PETERSON FLD TWR:** VHF/DF coverage 30 nmi at MEA excep 24 nmi 340-055' and 15 nmi 245-270' mag from facil. ILS glide slope certified for auto acft to 300' above rwy. ILS glide slope shut down indefinitely due rwy constr.

**COLORADO SPRINGS RDO:** Peterson VOR restricted to 30 nmi at MEA within arc 340 thru 030'. VOR unusable beyond 40 nmi below 15,200' MSL 300-340'; below 14,300' MSL 340-065'; below 13,200' MSL 005-020'; below 12,100' MSL 020 030' account recession.

**CREEDE MUN ARPT:** New listing. Lctd 2 mi SSE at lat 37°49', long 105°55'; elev: 8700. One turf strip 3000 x 100'. Remarks: P-line N. Winter months—ski acft only, land at own risk.

**DENVER ARTCC:** North Platte, Nebraska ARSR and BCN restricted at and above FL-240 except on following transition routes at and above 15,000' MSL: Wolbach VORTAC direct North Platte VORTAC direct Akron VOR, Wolbach VORTAC direct Hayes Center VORTAC direct Akron VOR, Grand Island VOR direct Wolbach VORTAC direct O'Neill VORTAC. En-route radar service at and above FL-240 within a radius aprly 130 mi North Platte VORTAC inaugurated. Lunk, Wyo ARSR restricted to use at and above FL 240 excep flw transition routes at and above 15,000' MSL Ellsworth AFB TVOR via 803 rad to int Dupree 245'. Ellsworth AFB TVOR via 123 rad and Smithwick 017 rad to Smithwick VOR.

**DENVER, LOWRY AFB SPECIAL NOTICE:** Cld fring (demolition) area in use daily except Sat, Sun and holidays 1430-2300Z within a radius of 2500' of point lctd 104°41'11W, 39°36'30"N up to 1000' above surface.

**DENVER, STAPLETON AIRFLD:** Due to lctn unable to determine whether acft are on correct final apch to rwnys 1L-26R and 1R-26L. Do not land on concrete txyw lctd btm these two rwnys, ends of txyw have large signs displaying the word "TAXI". Due non vby twr unable to determine if the following areas of the arpt are clear of obstns and/or acft: Terminal ramp within a radius of aprly 400' from base of twr, parking areas, and taxi routes N of hangars 3, 4, 5 and 6; all use of these areas is at pilot's discretion. Extensive simulated IFR apchs on all apch stds by all types of acft operg from Stapleton, Lowry AFB, and Buckley ANG base. Very congested vcty ILS OM and E of Lowry AFB. Acft lndg Stapleton avoid that portion of Lowry AFB and Buckley ANG Base airport traffic areas S of main E-W highway unless approval to transient areas received from Stapleton Twr.

**DENVER, STAPLETON AIRFLD:** Two strobe lgtg serving rwy 35 lctd 20' either side of threshold, controlled by twr. Caution, constr various areas of arpt. New N/S rwy and parallel txyw under constr from N edge trml ramp N aprly 2 miles. Caution. No lndgs. Rwny will not accommodate any class acft even in emrgy.

**DENVER, STAPLETON AIRFLD TWR:** Twr operns relctd to new twr adjacent to trml bldg.

**DENVER, STAPLETON AIRFIELD TOWER:** About January 1, 1963, ILS will be consrd, serving runway 36. Lctz frequency: 108.1 mc. Ident: SPO. Lctd 1074' from end rwy. Apch brg: 349°. Max variation: 14°E. Glide slope freq: 334.7 mc. Lctd 400' E of cntrline and 800' from apch end rwy. Glide slope angle 2°52'. MM lctd 0.69 nmi from apch end rwy. LMM freq: 205 kc. Ident: PO. OM lctd 5.63 nmi from apch end rwy. LOM freq: 236 kc. Ident: SP. LOM lctd 10.5 nmi from apch end rwy. Twr comms on 267.8, btm 200 and 330' unreliable due interference.

**EAGLE SPECIAL NOTICE:** Cld fring, ectv 21 Jan 61 for use of Camp Hale. Area is 5 nmi radius from point lat 39°27'00", long 106°19'20", max ordinate of fring 15,000' MSL. Time of use: continuous 24 hrs daily. Controlling agency: Commanding General, Fort Carson.

**GRAND JUNCTION RDO:** H facil usable for apchs and transitions to apchs only due excessive ADF needle oscillations most brg beyond 10 nmi.

**GREELY, CROSBIE FLD:** Formerly carried as Greely Mun Arpt.

**HANOVER RDO:** H facil bearings unreliable beyond 25 nmi in shadow area of Pikes Peak.

**MONTROSE-COUNTY ARPT:** Rwny 12-30 usable now 7000 x 100' hardsurface, acft restricted to rwnys and txyws; rwny lgtg and bcn operg hrs of darkness.

**NORWOOD ARPT:** Reactivated. Lctd: 2 NE. Lat 35°09'30", long 108°18'15"; elev: 7250'; one strip 2740 x 170', terrain drops at each end of strip. Tie-downs avbl. Oil burning flares.

Fig. 3-7 - Excerpt - For Training Purposes Only

# DIRECTED STUDY PROGRAM

## USFAA EXAMINATION GUIDE

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### DIRECTORY OF AIRPORTS-

CITY AND AIRPORT NAME	LOCATION	ELEV.	LONGEST RWNY FACILITIES	FUEL	REMARKS
<b>COLORADO</b>					
Akron, Washington Co	1N; 40°10', 103°13'	4695	h41-BL4-S1-W	F4	
Alamosa, Kramer Fld	3NW; 37°29', 105°55'	7558	67-L4-S3	F4	
ALAMOSA MUN (P)	2S; 37°26', 105°52'	7535	h59-BL4-W-U	F4	NE/SW rwy ruf.
Aroya, Maurer Ranch	1E; 38°51', 103°07'	4600	30-S1	F3	Unattended.
ASPEN, SARDY FLD	3NW; 39°13', 106°52'	7773	h52-S5-U	F4	See footnote.
Blanca	3SW; 37°24', 105°33'	7730	58		P-line S.
Boulder-Insurance Group Bldg Heliport	In city; 40°01', 105°16'	5500	25 x 30		
Boulder Mun (P)	3NE; 40°02', 105°14'	5288	h41-L4-S5-U	F4	Under calm winds, ind & tkof to the E.
Briggsdale, Cass Field	Adj SW; 40°36', 104°21'	4800	40		P-line NE.
Broomfield, Jefferson Co	1SW; 39°55', 105°67'	5655	h60-BL4-S5-U	F4	Ctc unicom prior entering ttc patn.
Buena Vista Mun	2SW; 38°49', 106°09'	8080	36		P-line SE.
Burlington Mun	1NW; 39°19', 102°17'	4160	38-S1	F4	N, NW bldd. P-line NE, S, SE.
Canon City, Fremont County (P)	7E; 38°26', 105°07'	5436	h54-BL4-S1	F3	
Center, Rodenbeck	4NE; 37°47', 106°03'	7600	39		P-line E.
COLORADO SPRINGS, PETERSON FLD (P, AF, A)	7SE; 38°48', 104°42'	6172	h91-BL4, 6, 7a-S5-W	F5, 6	See footnote.
CORTEZ-MONTEZUMA CO (P)	3SW; 37°19', 108°37'	5911	h59-BL4-S5	F4	
Craig, Mesa View Ranch	18N; 40°46', 107°325	6900	31-S3	F2	Unattended. Skis winters.
Craig Mun (P)	2SE; 49°29', 107°31'	6197	h56-S5	F4	Caution-ditch. Use strip.
Creede Mun	2SE; 37°49', 106°55'	8700	30		P-line N. Winters-ski acct only, land at own risk.
Del Norte Mun	2N; 37°43', 106°21'	7900	60		Hills SW, W, & N.
Del Norte, Scheel Ranch	7NE; 37°42', 106°14'	7600	104-S3	F3	P-line E & W.
Delta, Blake Fld	3N; 38°47', 108°04'	5200	h45		
Delta, Starr Nelson	4E; 38°45', 108°00'	5240	59-S1	F2	Unattended.
Denver, Sky Ranch	11E; 39°45', 104°45'	5478	42-S5-U	F4	Rgt ttc strips 26, 30, 36. Ditch W.
DURANGO, LAPLATA FLD (P)	11SE37°09', 107°45'	6684	h72-BL4-S5	F4	
DENVER, STAPLETON AIRFLD (P)	5E; 39°49', 104°53'	5331	h100-BL4-7a-S5-W-X	F5, 6	See footnote.
Eagle-County	5SW; 39°395, 106°55'	6539	51-BL2-W	F3	
Eaton, Bernetts Air Fld	3E; 40°30, 104°93'	4750	26-S5		Bldg S.
Elizabeth, Pine View	1S; 39°21', 104°35'	6520	44		
Flagler Aviation Service	1S; 39°17', 103°04'	4975	40-S1	F2	P-line E. Unattended.

### SERVICING

- S1: Storage
- S2: Storage, minor airframe repairs
- S3: Storage, minor airframe and minor powerplant repairs
- S4: Storage, major airframe and minor powerplant repairs
- S5: Storage, major airframe and major powerplant repairs

### WEATHER

W: Weather reports available from Weather Bureau or FAA communications station on field.

### UNICOM

Unicom (Aeronautical Advisory Station transmitting and receiving, during the airport hours only, as follows):  
 U—122.8 mc (for airports without a control tower); and  
 X—123.0 mc (for airports with a control tower).

### FUEL

- Civil Fuel:
- F1: 80 oct., at least
  - F2: 80/87 oct., and lower
  - F3: 91/96 oct., and lower
  - F4: 100/130 performance rating, and lower
  - F5: 115/145 performance rating, and lower
  - F6: Kerosene

### LIGHTS

B: Rotating Light (Rotating beacon)  
 (Green and white, split-beam and other types.) Omission of B indicates rotating light is either not available or not operating standard hours (sunset sunrise).

NOTE: Code lights are not codified, and are carried in Remarks Column.

L: Field Lighting (when code L 4 7 is indicated, lighting 4, 5, 6, 7 is available).

\*An asterisk preceding an element indicates that it operates on prior request only (by phone call, telegram or letter). Where the asterisk is not shown, the lights are in operation or available sunset to sunrise by request (refueling the field or radio call).

- 1—by itself indicates temporary lighting, such as flares, smudge pots, lanterns.
- 1—Portable lights (Electric)
- 2—Boundary
- 3—Runway floods
- 4—Runway or Strip
- 5—Instrument approach (neon)
- 6—High intensity runway
- 7 or 7a—High intensity instrument approach

Because the obstructions on virtually all lighted fields are obstruction lighted, obstruction lights have not been included in the codification.

Fig. 3-8—Excerpt—For Training Purposes Only

US-10

RADIO FACILITIES

*Jeppesen*

NAVIGATIONAL AIDS AND CONTROL TOWERS										
LOCATION and IDENT	VOR	LFR	NDB	ILS		TOWER				
				LOC	L	Local	APC	DPT	GND	
D (Cont'd)										
DENVER, COLO	DEN	116.3	379	---	110.3	362	110.3	119.5 N	124.8	121.9
(Sky Ranch)								120.5 S		
DERBY, OHIO	DBX	---	---	224	---	---	---	Denver		
DES MOINES, IOWA	DSM	114.1	---	---	110.3	219	110.3	124.9	110.6	121.9
DES MOINES, IOWA	DZ	---	212	---	---	---	---	---	---	---
DESTIN, FLA	DES	---	---	201	---	---	---	---	---	---
DETROIT, MICH (Metro)	DTW	---	300	---	109.3	257	121.1g7	Willow Run		121.7
(Metro)	DWC	---	---	---	110.7	367	---	124.9	110.4	---
(Willow Run)	YIP	111.4	---	---	109.5	359	121.3g6	123.7	110.4	121.9
DETROIT CITY, MICH	DET	---	---	338	---	---	110.7	120.0	127.3	121.9
DICKINSON, N DAK	DIK	112.9	300	---	---	---	---	---	---	---
DILLON, MONT	DLN	113.0	---	---	---	---	---	---	---	---
DILLON, MONT	DW	---	379	---	---	---	---	---	---	---
DIXON, CALIF	DIX	---	270	---	---	---	---	---	---	---
DOBBINS, GA	MGE	---	296	---	---	---	---	---	---	---
DODGE CITY, KAN	DDC	100.2	---	---	---	---	---	---	---	---
DOGWOOD, MO	DGD	109.4	---	---	---	---	---	---	---	---
DONNER SUMMIT, CALIF	DOS	---	---	375	---	---	---	---	---	---
DOTHAN, ALA	DHN	111.6	---	---	---	---	---	Cairns	125.4	125.4
DOUGLAS, ARIZ	DUG	110.0	---	---	---	---	---	---	---	---
DOUGLAS, WYO	DGW	100.6	---	---	---	---	---	---	---	---
DOVE CREEK, COLO	DVC	114.4	---	---	---	---	---	---	---	---
DOVER, DEL	DOV	---	---	---	110.1	375	---	---	---	---
DOWNNEY, CALIF	DOW	---	---	371	---	---	---	---	---	---
DRAKE, ARIZ	DRK	110.4	---	---	---	---	---	---	---	---
DRUMMOND, MONT	DRU	117.1	296	---	---	---	---	---	---	---
DUBLIN, GA	DBN	113.1	---	---	---	---	---	---	---	---
DUBOIS, IDAHO	DBS	116.9	---	---	---	---	---	---	---	---
DU BOIS, PA	DUJ	---	356	---	---	---	---	---	---	---
DUBUQUE, IOWA	DBQ	116.1	---	---	---	---	---	---	---	---
DUGWAY, UTAH	DPG	---	284	---	---	---	---	---	---	---
DULUTH, MINN	DLN	112.6	---	379	110.3	201	110.3	110.3	---	121.9
DUNCANVILLE, TEXAS	DCV	---	287	---	---	---	---	---	---	---
DUNKIRK, N Y	DKK	111.6	---	239	---	---	---	---	---	---
DUNOIR, WYO	DNW	113.4	---	---	---	---	---	---	---	---
DU PAGE, ILL	DPA	100.4	---	---	---	---	120.9	---	---	121.7
DUPREE S DAK	DPR	116.0	---	---	---	---	---	---	---	---
DURANGO, COLO	DRO	100.2	---	---	---	---	---	---	---	---
DYERSBURG, TENN	DYR	116.0	---	---	---	---	---	---	---	---
DYESS, TEXAS	DYS	109.2	---	201	109.9	---	---	---	---	---
E										
EAGLE LAKE, TEXAS	ELA	100.6	---	---	---	---	---	---	---	---
EAGLE MTN, TEXAS	EWX	100.4	---	---	---	---	---	---	---	---
EAST TEXAS, PA	ETX	110.2	---	---	---	---	---	---	---	---
EAU CLAIRE, WIS	EAU	112.9	---	---	---	---	---	---	---	---

Fig. 3-9 - Excerpt - For Training Purposes Only

US-38

RADIO FACILITIES

*Jeppesen*

NAVIGATIONAL AIDS LISTED BY IDENTIFIER			
Ident	Location	Ident	Location
	D (CONTD)		E (CONTD)
DN	DENVER, COLO	ELN	ELLENSBURG, WASH
DNV	DANVILLE, ILL	ELP	EL PASO, TEXAS
DNW	DUNOIR, WYO	ELX	KEELER, MICH
DNY	DE LANCEY, N Y	ELZ	WELLSVILLE, N Y
DOS	DONNER SUMMIT, CALIF	EM	ELMIRA, N Y
DOV	DOVER, DEL	EMI	WESTMINSTER, MD
DOW	DOWNNEY, CALIF	EMP	EMPORIA, KAN
DPA	DU PAGE, ILL	EN	ELKINS, W VA
DPG	DUGWAY, UTAH	END	VANCE, OKLA
DPK	DEER PARK, N Y	ENE	KENNEBUNK, MAINE
DRP	DUPREE, S DAK	ENL	CENTRALIA, ILLINOIS
DRK	DRAKE, ARIZ	ENO	KENTON, DEL
DRO	DURANGO, COLO	ENP	ENTERPRISE, UTAH
DRU	DRUMMOND, MONT	EO	EUGENE, OREG
DSM	DES MOINES, IOWA	EOL	NEOLA, IOWA
DTA	DELTA, UTAH	EON	PEOTONE, ILL
DTN	DOWNTOWN, LA	EOS	NEOSHO, MO
DTW	DETROIT, MICH	EPG	WEeping WATER, NEBR
DU	DRUMMOND, MONT	EPH	EPHRATA, WASH
DUG	DOUGLAS, ARIZ	EPT	WEST POINT, IND
DUJ	DU BOIS, PA	ERI	ERIE, PA
DVC	DOVE CREEK, COLO	ESC	ESCANABA, MICH
DW	DILLON, MONT	ESF	ALEXANDRIA, LA
DWC	DETROIT, MICH	ESL	KESSEL, W VA
DWN	DARWIN, MINN	ESR	WEST CHESTER, PA
DYR	DYERSBURG, TENN	ETG	KEATING, PA
DYS	DYESS, TEXAS	ETP	ENTERPRISE, ALA
DZ	DES MOINES, IOWA	ETX	EAST TEXAS, PA
		EUF	EUFALA, ALA
		EUG	EUGENE, OREG
		EVE	EVERETT, WASH
		EVG	EVERGREEN, CALIF
		EVM	EVELETH, MINN
EAR	KEARNEY, NEBR	EVR	EVERGREEN, ALA
EAT	WENATCHEE, WASH	EVV	EVANSVILLE, IND
EAU	EAU CLAIRE, WIS	EW	KEY WEST, FLA
EBY	NEAH BAY, WASH	EWB	NEW BEDFORD, MASS
ECB	NEWCOMBE, KY	EWG	ELLWOOD CITY, PA
ECG	ELIZABETH CITY, N C	EWM	NEWMAN, TEXAS
ECK	PECK, MICH	EWN	NEW BERN, N C
ED	NEEDLES, CALIF	EWO	NEW HOPE, KY
EDW	EDWARDS, CALIF	EWR	NEWARK, N J
EDX	MEAD, WASH	EWX	NEW CASTLE, DEL
EED	NEEDLES, CALIF	EYW	EAGLE MTN, TEXAS
EEN	KEENE, N H		KEY WEST, FLA
EFD	ELLINGTON, TEXAS		
EFD	PEARLAND, TEXAS		
EFK	NEWPORT, VT		
EH	EPHRATA, WASH		
EHA	NEWHALL, CALIF		
EKN	ELKINS, W VA	F	FARALLON I, CALIF
EKO	ELKO, NEV	FA	FT WAYNE, IND
EKR	MEEKER, COLO	FA	OTIS, MASS
EL	ELLENSBURG, WASH	FAK	FLAT ROCK, VA
ELA	EAGLE LAKE, TEXAS	FAM	FARMINGTON, MO
ELC	EL CENTRO, CALIF	FAR	FARGO, N DAK
ELD	EL DORADO, ARK	FAT	FRESNO, CALIF
ELL	ELLICOTT, COLO	FAY	FAYETTEVILLE, N C
ELM	ELMIRA, N Y	PB	FT BRIDGER, WYO

Fig. 3-10 - Excerpt - For Training Purposes Only

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RADIO FACILITIES

US-67

COMMERCIAL BROADCAST STATIONS

LOCATION	RADIO LOCATION	CALL	FREQ (KC)	POWER (KW)	TIME	ANTEN ELEV (MSL)	RADIO TO APT BRG (DEG)	DIST (N M)	
D (CONTD)									
Darlington, S C (Co)	Bennettsvill	WBSC	1550	10.00	unltd	329	217	17	
Davenport, Iowa	-----	KSTT	1170	1.00	unltd	-----	-----	-----	
Davenport, Iowa	-----	WOC	1520	5.00	unltd	-----	-----	-----	
Davenport, Iowa (Apt)	-----	WQVT	1580	1.00	unltd	1305	300	6	
Davis, Calif (University)	Sacramento	KFBK	1530	50.00	cont	715	199	24	
Dawson, Georgia	-----	WDWD	990	1.00	unltd	-----	-----	-----	
Dayton, Ohio	-----	WAVI	1210	.25	unltd	-----	-----	-----	
Dayton, Ohio	-----	WHIO	1290	5.00	unltd	-----	-----	-----	
Dayton, Ohio	-----	WONE	980	5.00	unltd	-----	-----	-----	
Dayton, Ohio (Apt)	-----	WING	1410	5.00	cont	1450	351	13	
Dayton, Ohio (Dahio)	-----	WING	1410	5.00	cont	1450	300	10	
Dayton, Ohio (Patterson)	-----	WING	1410	5.00	cont	1450	034	10	
Dayton, Ohio (Wright)	-----	WING	1410	5.00	cont	1450	023	6	
Dayton, Tennessee	-----	WDNT	1280	1.00	unltd	-----	-----	-----	
Daytona Beach, Fla	-----	WROD	1340	1.00	unltd	185	-----	-----	
Daytona Beach, Fla (Apt)	-----	WVFJ	1450	1.00	cont	164	236	3	
Dearborn, Michigan	-----	WDMR	1310	5.00	unltd	-----	-----	-----	
Decatur, Ala	-----	WAJF	1490	1.00	unltd	-----	-----	-----	
Decatur, Ala (Pryor)	-----	WMSL	1400	.25	unltd	979	048	3	
Decatur, Ga	-----	WAVO	1420	1.00	unltd	-----	-----	-----	
Decatur, Georgia	-----	WQUN	1010	50.00	unltd	-----	-----	-----	
Decatur, Illinois	-----	WSOY	1340	1.00	unltd	1147	-----	-----	
Decatur, Ill (Apt)	-----	WDCZ	1050	1.00	unltd	914	084	7	
Decorah, Iowa	-----	KDEC	1240	1.00	unltd	1170	-----	-----	
Decorah, Iowa	-----	KWLC	1240	.25	unltd	-----	-----	-----	
Deerfield, Va	-----	WABR	1150	1.00	unltd	2085	-----	-----	
Defiance, Ohio (Bryan-)	-----	WONW	1280	1.00	unltd	895	340	4	
De Funiak Springs, Florida	-----	WDSP	1280	5.00	unltd	-----	-----	-----	
De Funiak Springs, Fla (Apt)	-----	WZEP	1460	1.00	unltd	379	249	2	
De Kalb, Ill (Apt)	-----	WLBK	1360	1.00	unltd	1043	093	1	
Deland, Florida	-----	WDOO	1310	5.00	unltd	250	-----	-----	
Deland, Fla (Apt)	-----	WJBS	1490	.25	unltd	359	360	3	
Delano, Calif (Kern Co No 3)	-----	KCHJ	1010	5.00	unltd	534	125	4	
Delaware, Ohio	-----	WDLR	1550	.50	unltd	-----	-----	-----	
Delray Beach, Fla	-----	WDBF	1420	5.00	unltd	222	-----	-----	
Del Rio, Tex (Intl)	-----	KDLK	1230	.25	unltd	-----	250	2	
Del Rio, Texas (Laughlin AFB)	-----	KDLK	1230	.25	unltd	-----	085	6	
Delta, Colorado	-----	KDPA	1400	.25	unltd	-----	-----	-----	
Deming, N Mex (Apt)	-----	KOTS	1230	.25	unltd	4490	072	3	
Demopolis, Ala (Boykin Fld)	-----	WYAL	1400	.25	unltd	305	244	7	
Denham Springs, Louisiana	-----	WLBI	1220	.25	unltd	-----	-----	-----	
Denison, Iowa (Apt)	Carroll	KCIM	1380	1.00	unltd	1450	253	22	
Dennmark, Ore (Curry Co)	Coquille	KWRO	630	5.00	unltd	319	198	23	
Denton, Texas	-----	KDNT	1440	5.00	unltd	902	-----	-----	
Denton, Texas (Apt)	Dallas	WFAP	820	50.00	cont	1221	324	19	
Denver, Colo	-----	KFTR	710	5.00	unltd	5275	-----	-----	
Denver, Colorado	-----	KDEN	1340	1.00	unltd	5791	-----	-----	
Denver, Colorado	-----	KFWL	1390	1.00	unltd	-----	-----	-----	
Denver, Colorado	-----	KFSC	1220	1.00	unltd	-----	-----	-----	
Denver, Colorado	-----	KROW	630	5.00	unltd	-----	-----	-----	
Denver, Colo	-----	KINW	950	5.00	cont	5403	-----	-----	
Denver, Colorado	-----	KLIR	990	1.00	unltd	-----	-----	-----	
Denver, Colo	-----	KLZ	560	5.00	unltd	5582	-----	-----	
Denver, Colorado	-----	KPOF	910	5.00	unltd	-----	-----	-----	
Denver, Colorado	-----	KTLN	1280	5.00	unltd	-----	-----	-----	
Denver, Colo (Buckley ANGB)	-----	KOA	850	50.00	unltd	6540	349	12	
Denver, Colo (Lowry AFB)	-----	KOA	850	50.00	unltd	6540	321	14	
Denver, Colo (Sky Ranch)	-----	KOA	850	50.00	unltd	6540	349	15	
Denver, Colo (Stapleton)	-----	KOA	850	50.00	unltd	6540	326	16	
Denver City, Texas	-----	KKAL	1580	.25	unltd	-----	-----	-----	
De Queen, Arkansas	-----	KDQN	1390	.50	unltd	-----	-----	-----	
De Ridder, La (Beauregard Pch)	-----	KDLA	1010	1.00	unltd	436	210	3	
Des Moines, Iowa	-----	KCBQ	1390	1.00	unltd	-----	-----	-----	
Des Moines, Iowa	-----	KIOA	940	10.00	unltd	-----	-----	-----	
Des Moines, Iowa	-----	KSD	1460	5.00	unltd	1311	304	6	
Des Moines, Iowa	-----	KWKY	1150	1.00	unltd	-----	-----	-----	
Des Moines, Iowa (Apt)	-----	WBO	1040	50.00	cont	1710	237	15	
Des Moines, Iowa (Dodge)	-----	WBO	1040	50.00	cont	1710	239	16	
Detroit, Michigan	-----	WJBK	1500	10.00	unltd	-----	-----	-----	
Detroit, Michigan	-----	WJLB	1400	1.00	unltd	1080	-----	-----	
Detroit, Michigan	-----	WXYZ	1270	5.00	unltd	-----	-----	-----	
Detroit, Mich (Detroit City)	-----	WJR	760	50.00	cont	1311	036	17	
Detroit, Mich (Metro Wayne)	-----	WJR	760	50.00	cont	1311	204	6	
Detroit, Mich (Willow Run)	-----	WJR	760	50.00	cont	1311	189	15	
Detroit Lakes, Minn	-----	KDLR	1340	1.00	unltd	1557	-----	-----	
Devils Lake, N D (Apt)	-----	KDLR	1240	.25	unltd	1648	241	2	
Dexter, Maine (Apt)	Bangor	WABI	910	5.00	unltd	400	322	24	

Fig. 3-11 - Excerpt - For Training Purposes Only

Jeppesen

RADIO FACILITIES

US-67

VOR RECEIVER CHECK SIGNALS

GROUND
ABERDEEN, S. DAK. (Standers):--204'; Midway & center of N/S taxi strip leading from S edge ramp on E side Airport.
ALBANY, GA. --148.5'; center of the down area on N edge of ramp.
ALICE, TEXAS (Jim Wells Co. Man.):--270'; on taxi strip N of hangar.
ALLENTOWN, PA. (Allentown-Bethlehem-Easton):--178'; on runway 17 near the intersection of runway 24.
AMARILLO, TEXAS (AFB/Man.):--207'; located 945' SE of centerline on NE end of 322/W runway.
ANDERSON, S. C. --038'; on ramp in front of term. bldg.
ARDMORE, OKLA. --045'; adjacent to S end of N/S runway.
ATHENS, GA. --016'; 0.3 mi. on circle in front of apt terminal bldg. cross.
ATLANTIC CITY, N. J. (Pomona) NAPEC:--Lctn #1--313'; on ramp pad at spt and rwy 13, 250' from centerline rwy 13-31. Lctn #2--230'; on ramp pad at spt and rwy 4, 500' from centerline rwy 4-22. Lctn #3--208'; on ramp pad at spt and rwy 25, 250' from center line of rwy 17-25. Lctn #4--131'; on ramp pad at spt and rwy 31, 250' from centerline of rwy 13-31.
BALTIMORE, MD. (Friendship Int'l.):--Lctn #1--293'; 450' N of centerline of runway 10-22 on old run up pad. Lctn #2--290'; 400' N of centerline of runway 10-22 on ramp pad.
BARTLESVILLE, OKLA. (Phillips):--Lctn #1--107'; S and parallel taxi strip. Lctn #2--150'; N end parallel taxi strip. Lctn #3--160'; opposite terminal parallel taxi strip.
BEAUMONT, TEXAS (Jefferson County):--061'; west edge of N end of parking ramp.
BIG SPRING, TEXAS (Howard Co. Apt.):--143'; NW corner of taxi strip to runway 14.
BINGHAMTON, N. Y. (Broome County):--078'; South ramp.
BIRMINGHAM, N. DAK. --275'; intersection of N/S taxi strip and the spt end of runway 13.
BLTYNE, CALIF. (Riverside County Apt.):--046'; on ramp 500' in front of FAA FMS building.
BOISE, IDA. (Air Terminal):--064'; center N/S taxiway between runways 24L-108 and 24R-101 on field.
BOWLING GREEN, KY. (Bowling Green-Warren County):--021'; taxiway in front of Administration Building.
BRISTOL, TENN. (Tri-City):--242'; on SW end of ramp in front of term. bldg.
BROWNSVILLE, TEXAS (Rio Grande Valley Int'l.):--248'; approach and runway 13L.
CARLETON, N. MEX. --334'; immediately W of FMS and tower building on ramp.
CENTRALIA, ILL. (Apt.):--027'; at approach and runway 23.
CHATTANOOGA, TENN. (Lowell Field):--323'; centerline south taxiway at point 175' northward of centerline runway 22.
CHEYENNE, WYO. --192'; on yellow line on taxi strip immediately SE of approach and runway 2.
CHILDRESS, TEXAS--234'; intersection of edge of ramp at center taxi strip.
CINCINNATI, OHIO:--(See Covington, Ky.).
COLLEGE STATION, TEXAS:--093'; on W edge of parking ramp on Eastwood Airport.
COLUMBIA, S. C. (Man.):--331'; circle 450' S of control tower.
COLUMBIA, S. C. (Owens Fld.):--023'; compass rose on parking ramp.
COLUMBUS, GA. (Muskogee County): Lctn #1 --147.5'; taxiway at junction of approach and runway 11. Lctn #2--146'; center of intersection formed by taxiways leading to runways 5 and 20.
COLUMBUS, MISS. (Lowndes County):--087'; at center taxiway between parking ramp and runway.
COVINGTON, KY. (Greater Cincinnati):--043'; runway 27, S of intersection runways 27 and 22.
CRESTVIEW, FLA. --100'; center of concrete circle at intersection of runways.
CROSS CITY, FLA. (Sta 58, MEM-TPA):--290'; taxiway near wind indicator and rotating beacon light.
DALHART, TEXAS:--170'; SE corner of main ramp.
DALLAS, TEXAS (Addicks):--159'; int. of center and parallel taxiways.
DANVILLE, VA. (Mun):--325'; S of term. bldg. center of int. of taxiway to runway 6 and taxiway to runway 2.
DICKINSON, N. DAK. --182'; intersection of E/W taxiway and N/S taxiway.
DODGE CITY, KAN. --150'; center of NW end of NW/SE runway.
DOTHAN, ALA. --090'; intersection of ramp and taxi strip NW of terminal building.
DULUTH, MINN. --013'; center of intersection formed by taxi strips leading to rwy. 21 & 2 just off SE corner of ramp.
DYERSBURG, TENN. --250'; intersection of ramp and center taxi strip.
E. HARTFORD, CONN. (Rustchler):--247'; located at taxi strip near N side of Control tower.
EAU CLAIRE, WIS. --180'; center of concrete ramp 150' W of old Administration Building.
ELIZABETH CITY, N. C. (CGAS):--Lctn #1--023'; located on taxiway leading from CG ramp.
ELKO, NEV. --329'; on NE end of runway 5-23.
ELMIRA, N. Y. (Chemung County):--060'; equal dist. from rwy. 10 & 34 on short taxi strip NE of but across the int. of runways 10 and 34.
ERIE, PA. (Erie-Port Erie):--059'; on taxiway approaching runway 8.
EUENGE, OREG. (Mablow-Swag):--053'; approach to apron immediately W of the Administration Building.
FAYETTEVILLE, N. C. (Grannis):--305'; on runway turn-off in front of control tower.
FLORENCE, S. C. --139'; on arrow point on taxiway in front of Airline Terminal Building.
PORT DODGE, IOWA:--118'; 6.1 mi. from VOR on W edge of terminal building.
PORT MYERS, FLA. (Paga):--043'; on handstand off E and S E/W taxi strip adjacent to SW end rwy 4, approximately 1000' N of Terminal Building.
PT. RILEY, KAN. (Marshall AAF):--030'; on SE corner of the down area and taxiway approaching runway 04.
PORT STOCKTON, TEXAS:--119'; on ramp N of terminal.
GARDEN CITY, KAN. (New):--010'; 125' S of W edge N/S ramp directly E of tetrahedron.
GREEN BAY, WIS. (Austin-Strubel):--141'; int. of circular taxi strip, W of Adm. Bldg. & taxi strip leading to int. of S & SE runways.
GREENSBORO, N. C. (High Point):--036'; on compass rose on SE ramp.

Fig. 3-12 - Excerpt - For Training Purposes Only

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INDEX - UNITED STATES  
(Civil and Military Airports)

LEGEND

All airports are listed by city name and are cross-indexed by airport name where needed. To conserve space, a hyphen is used when the location name is part of the airport name.

The three-letter location identifier is the official identifier assigned to the airport rather than to any radio facilities.

A fuel code only is shown where all octane ratings below the coded rating are available; otherwise the lean octane rating is shown for each fuel available. A letter P preceding the fuel listing indicates part-time availability.

FUEL CODE : F1 80 oct. F4 100 130 oct.  
F2 80/87 oct. F5 115 145 oct.  
F3 91/96 oct. J Jet

A letter P preceding the services listing indicates a part-time or irregular day attendant.

SERVICES CODE: A Minor Aircraft S Storage  
E Minor Engine T UNICOM 123.0  
MA Major Aircraft U UNICOM 122.8  
ME Major Engine H Helicopter

If the page reference is to "US-201," no drawing of the airport is available within J-AID, but in the listing following that page can be found the location of the airport, elevation, number of runways and length, and the airport lighting. A page reference to "IFR" means that the airport drawing is within the group for which standard instrument approach procedures are on issue in the Jeppesen Airway Manual, and a pilot entering such a field might expect more traffic, traffic control, aircraft on IFR flight plans, etc. A page reference to "VFR" means that the airport drawing is within the group of airports for which no standard instrument approach procedure is on issue in the Jeppesen Airway Manual.

AIRPORT CHARTS AREA MAP



Airports within the IFR and VFR groups are further subdivided by these geographic areas to reduce unnecessary page-turning and to increase ease of reference.

Fig. 3-13 - Excerpt - For Training Purposes Only

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LOCATION	IDENT	FUEL	SERVICES	PAGE
D (CONTD)				
(Del Norte)Crescent City,Cal	CEC	F80,100	S	IFR D-2
(Del Rentzel)Nacogdoches,Tex	OCH	F4	SU	VFR E-1
Del Rio, Texas (Davis Ranch)	---	P F3	---	US-201
Del Rio, Texas (Intl)	---	F80,100	MAMESU	VFR E-20
Del Rio, Texas(Laughlin AFB)	DLF	JF91,115	---	IFR E-15
Del Rio, Texas(Townsend Rch)	---	---	---	US-201
Del Rio,Texas (V Askew Rch)	---	---	---	US-201
(Delta AB) Charlotte, N C	---	---	MAME	US-201
Delta, Colo (Blake Fld)	---	---	---	US-201
Delta, Colo (Starr Nelson)	---	P F2	P AES	US-201
Delta, Ohio (-Bee-Line)	---	P F3	---	US-201
Delta, Utah (Apt)	DTA	F80,100	S	IFR D-3
Deming, N Mex (Mun)	DMN	JF4	MAMES	VFR D-4
Demopolis, Ala (Boykin Fld)	---	F4	AESU	VFR F-29
(Dempsay Farm) Rantoul, Kan	---	P F2	P AES	US-201
DeMotte, Ind (Cheever)	---	P F2	P S	US-201
Dendron, Va (Cockes)	---	---	---	US-201
Denison, Iowa (Mun)	---	F4	MAMESU	VFR B-7
Denmark, Oreg (Curry Co)	---	P F2	S	VFR A-2
Denton, Mont (Apt)	---	F2	S	US-201
Denton, Texas (Mun)	---	F80,100	AS	VFR E-19
Denver, Colo (Buckley ANGB)	BKF	JF115	AS	IFR D-17
Denver, Colo (Lowry AFB)	LRV	JF115	MAMES	IFR D-13
Denver, Colo (Sky Ranch)	---	F4	MAMESUH	VFR D-31
Denver, Colo(Stapleton Airfld)	DEN	JF80,100,115	MAMEST	IFR D-10
Denver City, Texas (City)	---	---	P S	US-201
DePere, Wis (Nicolet)	---	P F2	S	US-201
Deposit, N Y (Apt)	---	P F1	P AESU	US-201
(Depperman) Owensville, Mo	---	P F1	---	US-201
Dequeen, Ark (Apt)	---	F2	A	US-201
Derby, Kan (Cook)	---	F80,100	MAMES	US-201
Derby, Kan (Hamilton)	---	F2	AE	US-201
(Derby) Lovelock, Nev	LOL	F3	S	IFR D-5
De Ridder,La(Beaugard Psh)	DRI	F80,100	AESU	VFR E-28
(Derrick Rch) Eldorado, Texas	---	---	---	US-201
Desert Center, Calif (Apt)	DSC	P F2	---	VFR D-22
Desert Rock, Nev (AAF)	DRA	---	---	VFR D-45
Deshler, Ohio (Mun)	---	---	---	US-201
De Smet, S Dak (Apt)	---	---	---	US-201
Des Moines, Iowa (Apt)	DSM	JF5	MAMEST	IFR B-2
Des Moines, Iowa (Dodge)	---	F4	MAMES	VFR B-14
Des Moines, Iowa (North)	---	P F2	PS	US-201
Des Moines, N Mex (Smith)	---	---	---	US-201
De Sota, Mo (Apt)	---	F2	S	US-201
(De Soto Parish)Mansfield,La	MSV	P F80,100	P S	VFR E-32
DeSoto, Texas (Carroll)	---	---	S	US-201
(De Soto Arpk)HornLake, Miss	---	F2	MAMESU	US-201
Destin, Fla (Airpark)	---	F1	---	US-201
Detroit, Mich (-City)	DET	JF4	MAMEST	IFR C-6
Detroit, Mich(-MetroWayne Co)	DTW	JF5	MAMEST	IFR C-6
Detroit, Mich (Willow Run)	YIP	JF5	MAMEST	IFR C-23
Detroit Lakes, Minn (Apt)	---	F80,100	S	US-201
(Devener) Hanover, Pa	---	F80,100	MAMES	VFR C-44
Devils Lake, N Dak (Mun)	DVL	F80,100	AS	VFR B-2
Devon, Mont (-Hellinger)	---	F2	---	US-201
DeWitt, Ark (Commercial)	---	F2	MAMES	US-201
DeWitt, Ark (Lakeside)	---	F2	SA	US-201
Dewitt, Iowa (Apt)	---	P F2	P SU	US-201
Dexter, Maine (Apt)	---	---	---	VFR C-68
Dexter, Mo (Mun)	---	F80,100	MAMESU	VFR E-20
Diagonal, Iowa (Stephens)	---	---	---	US-201
(Dickey) Earle, Ark	---	P F80,100	P SU	US-201
Dickey, N Dak (Mun)	---	---	---	US-201
Dickinson, N Dak (Apt)	DIK	F80,100	MAMESU	IFR B-2
(Dickson) Due West, S C	---	---	P S	US-201
(Dickson) Vernon, Colo	---	F100	---	US-201
(Dienst Ranch) Lakin, Kan	---	F2	---	US-201
Dietrich, Idaho (Apt)	---	P F2	P S	US-201

Fig. 3-14 - Excerpt - For Training Purposes Only

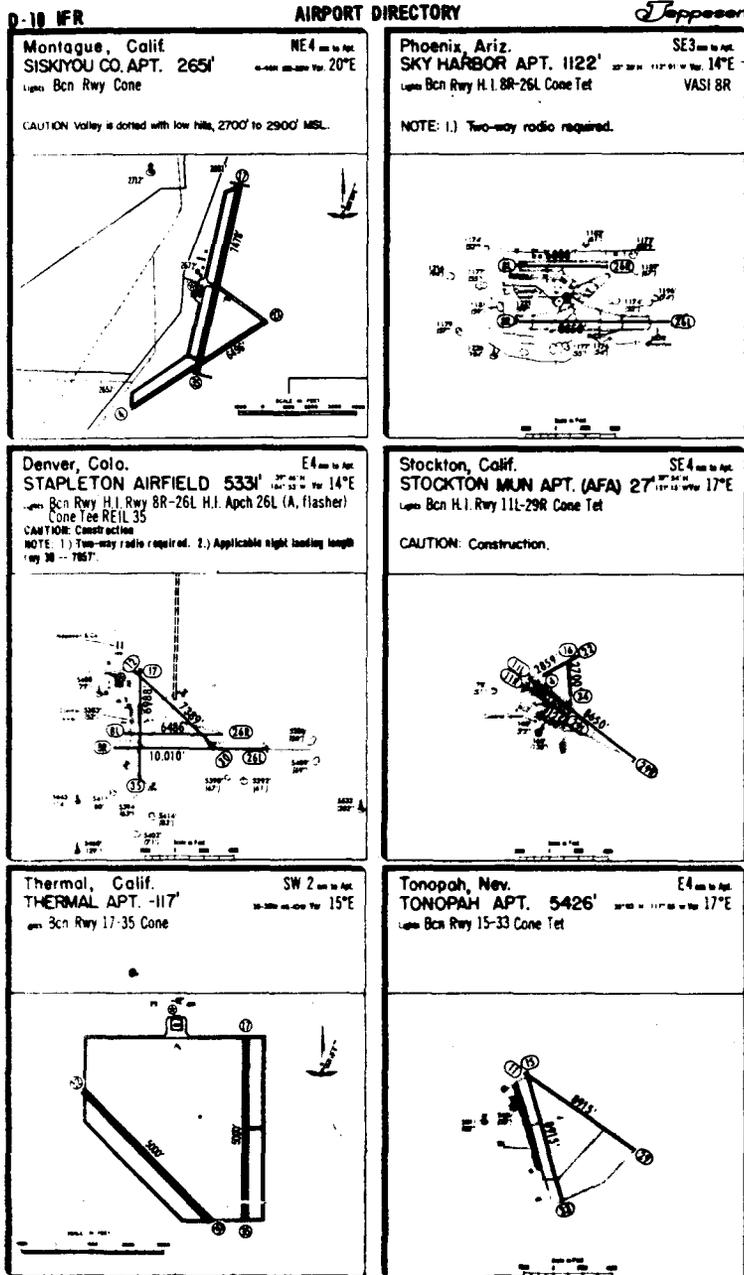
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For RADIO. See Avigation Charts or RADIO FACILITIES in J-AID.  
**Fig. 3-15 - Excerpt - For Training Purposes Only**

**METEOROLOGY** *Jeppesen*

**SERVICES AND TELEPHONE NUMBERS**

LOCATION	USWB		FSS Tel. No. (local or FX) or Interphone	FSS Location	PATWAS	
	Tel. No.	Hrs. of Op.			*Tel. No.	Hrs. of Op.
<b>N</b>						
NANTUCKET, MASS	228-0971	(24hrs)	228-0815	Nantucket		
NAPA, CALIF (Co)			Interphone	Oakland		
NASHVILLE, TENN	*256-0333	(24hrs)	AL 4-6552	Nashville		
NEEDLES, CALIF			EA 4-6550	Nashville		
NEVADA, MO (Apt)			EA 6-3511	Needles		
NEWARK, N J	MA 4-8118	(24 hrs)	Interphone	Kansas City		
NEW BEDFORD, MASS (Apt)			MA 2-0121	New York (IDL)	MA 4-7272	(24 hrs)
NEW BERN, N C			Interphone	Nantucket		
NEW CASTLE, DEL			ME 7-2080	New Bern		
NEW HAVEN, CONN	*HO 9-2141	(0700-1700)	OL 2-5419	Millville, N J		
NEW LONDON - GROTON, CONN			CI 3-3245	Providence, R I		
NEW ORLEANS, LA	*729-2520	(24 hrs)	WH 5-3842	New Orleans	523-4311	(24 hrs)
NEWPORT NEWS, VA			288-5120	New Orleans		
NEW YORK, N Y	*OL 6-5364	(24hrs)	TR 7-0743	Newport News		
	(loc at IDL)		TR 7-2402	Newport News		
	*NE 1-2117	(24hrs)	OL 6-5370	New York (IDL)		
	(loc at LGA)				OL 6-7474	(24 hrs)
			Interphone	New York (IDL)	(loc at LGA)	
NEW YORK, N Y (Flushing)			BU 4-7686	Buffalo, NY		
NIAGARA FALLS, NY						
NORFOLK, NEBR	FR 1-3386	(0530-2130)				
NORFOLK, VA	*853-4369	(24hrs)	MA 7-7084	Newport News		
NORMAN OKLA			JE 6-0757	Oklahoma City		
NORTH BEND, OREG			756-4916	North Bend		
NORTHBROOK, ILL (Sky Harbor)			Interphone	Joliet		
NORTH PLATTE, NEBR	*LE 2-9677	(24hrs)	LE 2-4034	North Platte		
NORWOOD, MASS			762-6644	Boston		
NOVATO, CALIF (Marin Co)			Interphone	Oakland		
<b>O</b>						
OAK BLUFFS, MASS (Apt)			Interphone	Nantucket		
OAKLAND, CALIF	*LO 8-3823	(24hrs)	NE 8-5714	Oakland		
OCEAN CITY, N J			967-3230	Millville		
ODESSA, TEXAS	FE 7-7832	(24hrs)	FE 2-4992	Midland		
OGDEN, UTAH			EX 4-8712	Salt Lake City		
OKLAHOMA CITY, OKLA	*MU 5-6350	(24 hrs)	MU 5-8377	Oklahoma City	MU 5-7736	(24 hrs)
	*MU 5-8025	(24 hrs)	*MU 5-3447	Oklahoma City		
OLD TOWN, MAINE			827-4010	Old Town		
			827-2363	Old Town		
OLYMPIA, WASH	FL 7-8386	(24hrs)				
OMAHA, NEBR	*341-5436	(24hrs)	341-6176	Omaha	342-3603	(0530-2400)
ONTARIO, CALIF			YU 4-6631	Ontario		
ONTARIO, OREG			34	Ontario		
ORLANDO, FLA	GA 2-7286	(24hrs)	CH 1-4484	Orlando		
OSHKOSH, WIS (Winnebago Co)			Interphone	Green Bay		
OTTUMWA, IOWA			MU 2-1846	Ottumwa		
OWENSBORO, KY (-Daviness)			Interphone	Evansville, Ind		
OXNARD, CALIF (-Ventura)			Interphone	Santa Barbara		
<b>P</b>						
PADUCAH, KY			442-1551	Paducah		
PALACIOS, TEXAS			824-2218	Palacios		
PALMDALE, CALIF			947-3502	Palmdale		
PALO ALTO, CALIF (Apt)			Interphone	Oakland		
PAMPA, TEXAS			MO 4-3360	Amarillo		
PANAMA CITY, FLA			SU 5-6651	Tallahassee		
PARKERSBURG, W VA	422-3661	(0700-1400) Mon-Sat	485-6421	Parkersburg		
			485-6422	Parkersburg		

**Fig. 3-16 - Excerpt - For Training Purposes Only**

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## RADIOTELEPHONE PROCEDURES

### AIR TRAFFIC CONTROL PROCEDURES

**SECTION II - RADIOTELEPHONE PHRASEOLOGY AND TECHNIQUES:**  
**AIRCRAFT CALL SIGNS** - During the initial contact with a ground station, the complete aircraft call sign is used. Civil (Itinerant aircraft and irregular air carriers shall use the make or type name of their aircraft, followed by the complete certification number. Example: "CESSNA ONE THREE FIVE SIX TWO - Y".

Air carrier aircraft whose companies operate a communications system covering their route of flight may utilize their company name or abbreviated name, followed by their trip number. Example: "UNITED TWENTY-FIVE".

Military aircraft utilize the name of the service, followed by ("Jet" when appropriate) and the last five digits of the serial number of the aircraft. Example: "AIR FORCE ("JET" when appropriate) FOUR FOUR NINER THREE TWO."

After radio contact has been established, and when conditions warrant, the call signs of itinerants may be reduced to the prefix followed by not less than the last three digits or letters of the full call sign. Example: "CESSNA SIX TWO-Y."

**GROUND STATION CALL SIGNS** - Ground station call signs shall comprise the name of the location or airport, followed by the appropriate indication of the type of station:

OAKLAND TOWER (airport traffic control tower);  
MIAMI GROUND CONTROL (ground control position in tower);  
DALLAS CLEARANCE DELIVERY (IFR clearance delivery position);  
IDLEWILD APPROACH CONTROL (tower radar or nonradar approach control position);

ST. LOUIS DEPARTURE CONTROL (tower radar departure control position);

WASHINGTON RADIO (FAA flight service station);  
NEW YORK CENTER (FAA air route traffic control center);  
LANOLEY AIRWAYS (USAF AACS station).

**RADIOTELEPHONE CONTACT PROCEDURE** - Each contact generally comprises four parts as follows:

- (1) The Call-up, consisting of the call sign of the station being called, the words "THIS IS", the call sign of the caller, and the word "OVER";
- (2) The Reply, consisting of the call sign of the station being replied to, the words "THIS IS", the call sign of the replying station, and the word "OVER";
- (3) The Message, is that portion of the contact which conveys information or requests same.

When a message is short or when it is probable that the call-up will be heard without difficulty, the message may be transmitted following the call-up without waiting for a reply or invitation to go ahead.

In the following example the words which may be omitted under abbreviated procedures are enclosed within parentheses.

Aircraft - CLEVELAND TOWER (THIS IS) BEECHCRAFT ONE EIGHT FOUR ONE, OVER.

Tower - BEECHCRAFT ONE EIGHT FOUR ONE (THIS IS) CLEVELAND TOWER. (OVER).

Aircraft - (CLEVELAND TOWER) (THIS IS) BEECHCRAFT (ONE) EIGHT FOUR ONE, FOUR MILES SOUTH (AT) ONE THOUSAND, LANDING AT CLEVELAND, OVER.

Tower - BEECHCRAFT EIGHT FOUR ONE, FOUR MILES SOUTH (AT) ONE THOUSAND (CLEARED TO ENTER TRAFFIC PATTERN) RUNWAY ONE EIGHT, WIND SOUTH ONE TWO, OVER.

Aircraft - BEECHCRAFT EIGHT FOUR ONE (ROGER) (OUT).

Tower - (CLEVELAND TOWER, OUT).

After contact has been definitely established, it may be continued without further call-up or identification.

**RADIOTELEPHONE TECHNIQUE** - Proper microphone technique is important in radiotelephone communications. Transmissions should be concise and in a normal conversational tone.

**NOTE:** Identification of Aircraft - Pilots are requested to exercise care that the identification of their aircraft is clearly transmitted in each contact with an ATC facility. Also pilots should be certain that their aircraft are clearly identified in ATC transmissions before taking action on an ATC clearance. Garbled aircraft identifications in radiotelephone transmissions should never be taken for granted but should always be checked.

When originating a radiotelephone call-up to any air-ground facility, indicate the channel on which reply is expected, if other than normal.

### Radiotelephone Procedures

Fig. 3-17 - Excerpt - For Training Purposes Only

## RADAR

**RADAR CONTROLLED APPROACHES, PRECISION AND SURVEILLANCE (FAA RADAR FACILITIES ONLY)** - The only airborne radio equipment required for radar controlled approaches is a functioning radio transmitter and receiver. By means of radar, the controller closely follows the flight path of aircraft and issues instruction to align them with the center line of the runway, and keep them on course until the pilot can complete his approach and landing by visual reference to the surface.

**A PRECISION APPROACH** - A precision approach is one in which the controller provides highly accurate navigational guidance in azimuth and elevation to a pilot. Pilots are given headings to fly which direct them to and keep their aircraft aligned with the extended center line of the landing runway. They are told to anticipate glide slope interception approximately 15 to 30 seconds before it occurs, when to start descent and they may be given a rate of descent based on the glide slope angle and the approach speed of the aircraft. If the aircraft is observed to deviate above or below the glide slope, the pilot is given the amount of deviation and asked to adjust his rate of descent to return to the glide slope. Range from touchdown is given at least once each mile. If an aircraft is observed to proceed outside of specified safety zone limits in azimuth and/or elevation and continuing to operate outside these prescribed limits, the pilot will be directed to climb to a specified altitude and to fly a specified course if he is not navigating by visual reference to the surface. Navigational guidance in azimuth and elevation is provided to the pilot until the aircraft passes over the approach end of the runway, at which point he is advised of any deviation from the runway center line and directed to take over visually and complete his landing.

**A SURVEILLANCE APPROACH** - A surveillance approach is one in which the controller provides navigational guidance in azimuth only. The pilot is furnished with headings to fly to align his aircraft with the extended center line of the landing runway, but since the radar information used for surveillance approach is considerably less precise than that used for a precision approach the accuracy of the approach will not be as great and

higher weather minimums will apply. Guidance in elevation is not possible, but the pilot will be given a point at which to start a rate of descent based on a desirable glide angle and the speed of the aircraft concerned. In addition, the pilot will be advised of his distance from the end of the runway each mile of final and concurrently what the recommended altitude (mean sea level) is at each mile, except that no altitude will be specified for the point one mile from the end of the runway. A pilot may be guided to any runway having an approved surveillance approach. Navigational guidance is provided to the pilot until the aircraft reaches a point one mile from the approach end of the runway. At that point, he is given his distance from the runway and directed to execute a missed approach if he does not have the runway in sight at landing minimums.

Radar approaches will be given upon request and may be suggested to pilots of aircraft in distress or to expedite traffic. Acceptance of a precision or surveillance approach by a pilot does not waive the prescribed weather minimums for the airport or for the particular aircraft operator concerned. The decision to make a radar controlled approach when the reported weather is below the established minimums rests with the pilot.

Precision and surveillance approach minimums are published on AL (Approach Landing) charts.

FAA radar facilities are listed in the RADAR Section of the Airman's Guide, and operate on a continuous basis.

**RADAR ARRIVAL AND DEPARTURE CONTROL** - Radar is utilized by certain radar equipped facilities to control the flight paths of arriving or departing IFR aircraft for the purpose of expediting the flow of traffic. Aircraft operating on IFR flight plans will be afforded a minimum of three miles horizontal separation unless standard non-radar vertical, lateral or longitudinal separation exists. This should not be confused with GCA which is an instrument approach aid.

Fig. 3-18 - Excerpt - For Training Purposes Only

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## Charts - Radio Navigation Types

In Radio Navigation, a number of different charts are in use. In general, there are two sources for these charts—Jeppesen & Co. and the United States Coast & Geodetic Survey. The charts referenced in this program are those produced by Jeppesen & Co. These are the Standard Instrument Departure Charts (SID's); Low and High Altitude Enroute Charts; Low and High Altitude Area Charts; Approach Charts and the Low Altitude Flight Planning Chart. In the Enroute Chart series, only the Low Altitude Enroute Charts will be discussed. The Low Altitude Area Chart will also be discussed. Samples of charts referred to in this section are contained in the pocket in the back of this course. Remove these charts and refer to them as you study this section.

### Standard Instrument Departure Charts (SID's)

The Standard Instrument Departure Chart (SID) is prepared for certain airports that have Standard Instrument Departure Routes. The SID for a particular field will include the magnetic bearings, distances, altitude and special instructions to be followed in a specific departure. A SID is included in the pocket in the back of this course.

### Low Altitude Enroute Chart

Jeppesen Aviation Low Altitude Enroute Charts cover the United States in thirty-two (32) charts. These charts show low frequency airways, L/MF Ranges, VOR Stations, Victor Airways, minimum altitudes, some commercial broadcasting stations and associated radio navigation information. Topographic and cultural features in general are not shown. The communication tabulation on the chart lists ground communication frequencies at stations shown on the chart. Air Route Traffic Control Centers are listed along with the contact frequency. The Low Altitude Chart covers the area from the surface up to but not including 18,000 feet MSL.

### High Altitude Enroute Charts

The High Altitude Enroute Charts cover the altitude range from 18,000 feet MSL up to and including flight level 450. There are four High Altitude charts which cover the United States. The High Altitude Route Structure is composed of a system of Jet Routes which are based on VOR, VOR-DME and VORTAC facilities.

### Area Charts

Area Charts are Terminal Area Charts and are identified by the name of the major city of the area they cover.

They include all information contained on Aviation Charts (Enroute) for the area and holding areas, obstructions above 1,000 feet, direct routes, every known arrival and departure route including SID's, communications, VHF and UHF, airports, intersections, reporting points, radio facilities, controlled airspace, orientation features, restricted airspace and holding entry diagrams.

### Approach Charts

The Approach Charts contain instrument let-down procedures designed to enable pilots to follow, by radio navigation, a safe procedure for descent to a minimum flight altitude over an airport and, if visual contact with the ground is not established, to make a safe missed approach maneuver. The charts are identified by the name of the city concerned in the upper right hand corner; immediately below this is the specific field and below this the type of procedure. The charts include appropriate frequencies and approach diagrams. Approach Charts are discussed in more detail in the Radio Navigation Section.

### Jeppesen Enroute Planning Chart

The Low Altitude Flight Planning Chart is designed for pre-flight planning primarily of IFR flights. All Victor Airways may not be represented, due to the limited space available. The primary purpose is to

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provide planning data based on the FAA Preferred Route Structure, supplemented by airways to major terminals. In general, the chart is designed to serve the following VFR and IFR pre-planning purposes:

- a. Over-all "Trip Planning" information such as mileages, possible service, business stops and estimated flight time, etc.
- b. Orientation of desired "direct" and "off-airways" routes where such routes are to be plotted on "adjoining" Jeppo Avigation Enroute Charts.
- c. Determination of major FAA Low altitude "Preferred Routes" for IFR Flight Plans.
- d. Sample Flight Plan.
- e. Recommended Position Reporting Procedures.
- f. Other important information for pilots.

### Other Charts Used In Radio Navigation

The Sectional Chart, the World Aeronautical Charts, Local Aeronautical Charts and Aeronautical Planning Charts may also be used in Radio Navigation.

- a. Each Sectional Chart shows a part of the United States and is identified by the name of a principal city or prominent geographical feature. The Scale of these charts is 1:500,000 or about 8 miles to the inch. The Sectional Chart shows fairly complete detail and is commonly used for pilotage.
- b. World Aeronautical Charts (WAC's) are smaller in scale than Sectional Charts—1:1,000,000 (about 16 miles to the inch) and omit much detail. WAC charts are usually used by relatively fast planes on longer trips. They are identified by number.
- c. Local Aeronautical Charts are large scale charts which show many details of highly congested areas. The scale is 1:250,000 or about four miles to the inch and each chart is identified by the name of a city such as Chicago-Local.
- d. Aeronautical Planning Charts are usually used for planning long flights, rather than actual navigation. The scale on a Planning Chart is 1:5,000,000 or about 80 miles to one inch.

On the Jeppesen Low Altitude Enroute Chart, Sample Segment, Figure 3-19, Arrow 8, points to a circle. The symbol indicates a radar beacon. The code of the beacon shown in the box is \_\_\_\_\_

The shaded area, Arrow 38, with the number 26 indicates the limit of coverage of an overlapping chart. The overlapping chart is number \_\_\_\_\_

X-1-2-1

Arrow 19 points to V-888. On Low Altitude Enroute Charts V-800 series routes are the Preferred Routes. The 800 series airways overlay existing airways and are shown by a shaded arrow showing the direction of use. The direction of use for V-888 is \_\_\_\_\_

26

The V-800 series airways are \_\_\_\_\_

west

Arrow 1 points to a VOR Station. In the center of the compass rose is a solid colored triangle indicating the station is a \_\_\_\_\_ reporting point.

Preferred  
Routes

The compass rose is orientated to \_\_\_\_\_ North.

compulsory

Arrow 11 points to a box enclosing the VOR Station information. The name of the VOR radio is Durward, the frequency is \_\_\_\_\_ mc and the station identifier is \_\_\_\_\_

magnetic

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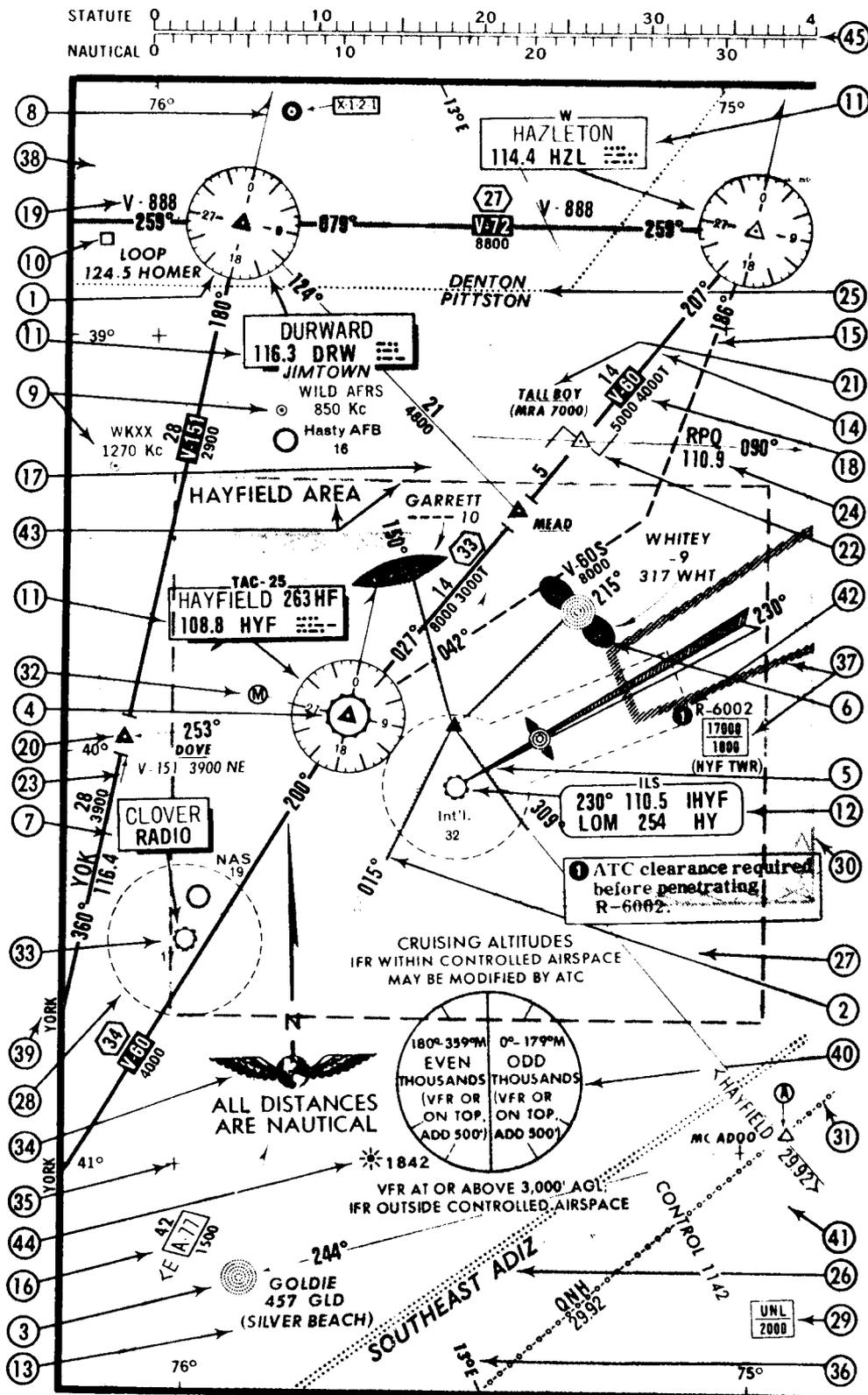


Fig. 3-19 - Excerpt - For Training Purposes Only

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A box is used to denote an airway navigation facility. The heavy line along the bottom and right side indicates that the facility has complete FSS standard frequencies. A box without the heavy line indicates that limited \_\_\_\_\_ are available.

116.3  
DRW

A geographic location name differing from the facility name is shown in the bottom box line when needed as a reference to instrument approach charts. The instrument approach associated with Durward is listed under \_\_\_\_\_.

frequencies

Arrow 9 points to the symbol used for Commercial Radio Broadcast Stations. WILD is an Armed Forces Radio Station that transmits on \_\_\_\_\_.

Jimtown

The Broadcast Station West of WILD transmits on 1270 kc and the call letters are \_\_\_\_\_.

850 kc

The space between the two white lines, Arrow 17, is an uncontrolled air route. This is also used to show uncontrolled Advisory Routes which are given a number. For uncontrolled Advisory Routes, an ADR will precede the route \_\_\_\_\_.

WKXX

Arrow 43 points to the dashed line and the name of an Area Chart. The Area Chart may give navigational aids, reporting points, etc., which may exist for terminal operations that are not shown on the Enroute \_\_\_\_\_.

number

The coverage of an Area Chart which may give additional navigation information is contained within the \_\_\_\_\_ line enclosing the area.

Chart

Arrow 11 points to the box for Hayfield. The heavy line on the box indicates that Hayfield has complete FSS standard \_\_\_\_\_.

dashed

When a low frequency radio serves the same airport, the frequency and identifier are contained in the same box with VOR. The frequency of Hayfield low frequency radio is \_\_\_\_\_ kc and the identifier is \_\_\_\_\_.

frequencies

An arrow points from the box to the facility to which it applies. The location of Hayfield Low Frequency Range is shown with a solid colored triangle indicating that it is a \_\_\_\_\_ reporting point.

263  
HF

Hayfield VOR is also a compulsory reporting point shown by a solid color \_\_\_\_\_.

compulsory

Around the VOR triangle is a scalloped edged circle, Arrow 4; this is the symbol for TACAN. At the top of the Hayfield box, the TACAN information is given. The TACAN channel is number \_\_\_\_\_.

triangle

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<p>When the TACAN symbol circles the VOR symbol, the two are co-located. This provides both azimuth and _____ information.</p>	<p>25</p>
<p>Arrow 20 points to a _____ point.</p>	<p><i>distance</i></p>
<p>Arrow 7 points to a radio communications box that is associated with an airway for communications. The box indicates a full compliment of _____ for communications.</p>	<p><i>compulsory reporting</i></p>
<p>The symbol indicated by Arrow 33 is an airport without a control tower but with an FSS Station for airport advisory service. When the name of an airport is the same as the radio facility, only the elevation is given. The elevation of Clover Airport is _____</p>	<p><i>frequencies</i></p>
<p>When an airway continues on another chart, the name of the next facility is given if the airway does not bend. If the airway does bend, the name of the intersection is given. The next facility at Arrow 39 is York, the identifier is given on the airway as YOK and the frequency is _____ mc.</p>	<p><i>not given</i></p>
<p>Arrow 28 indicates the Control Zone for _____ Airport.</p>	<p>116.4</p>
<p>The series of dotted circles, Arrow 3, is the symbol for a non-directional radio beacon. The name of the beacon is _____</p>	<p><i>Clover</i></p>
<p>The information for Goldie Radio is not enclosed in a box because it is not used in conjunction with an airway for communications or for airway _____</p>	<p><i>Goldie</i></p>
<p>Instrument Approach Charts involving Goldie Radio, Arrow 13, will be listed under _____</p>	<p><i>navigation</i></p>
<p>Arrow 11 points to Hazelton radio. The "W" at the top of the box indicates that the station has no voice transmission capability on the Navigational Aid Frequency (114.4 mc). The absence of a heavy line on the box indicates that Hazelton has very limited FSS _____ available for communications.</p>	<p><i>Silver Beach</i></p>
<p>Arrow 25 points to the division of the Air Route Traffic Control Areas. The dotted line shows the division of the Control Centers; the names are given on either side. Pittston is the control center on the South and _____ on the North.</p>	<p><i>frequencies</i></p>
<p>Arrow 15 points to an alternate airway. This one is the alternate to _____</p>	<p><i>Denton</i></p>
<p>Arrow 21 points to Tallboy, the name of the airway reporting point. MRA stands for Minimum Reception Altitude. The MRA at Tallboy is _____ feet.</p>	<p>V-60</p>
<p>Tallboy is a _____ reporting point.</p>	<p>7,000</p>

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Arrow 18 points to 5,000 4,000 T. 5,000 feet is the minimum enroute altitude for the airway. The suffix of "T" on 4,000 indicates that 4,000 feet is the minimum altitude for obstruction (terrain) clearances. 7,000 6,000 T on an airway would mean that 7,000 feet is the minimum altitude for \_\_\_\_\_ and 6,000 feet is the minimum for \_\_\_\_\_ clearance.

*non-compulsory*

Arrow 24 points to the frequency and identifier of the station that locates Tallboy. If the station is off the chart, this information is indicated with a thin-lined arrow. The minimum reception altitude for RPQ at Tallboy is \_\_\_\_\_ feet.

*enroute flight obstruction (terrain)*

Arrow 22 points to the symbol for a VOR change-over point. When tracking from Hazelton on V-60, at the changeover point, the frequency would be changed from Hazelton radio to \_\_\_\_\_ radio.

7,000

The changeover point is the point at which the optimum VOR signal can be received from the next radio. South of Tallboy on V-60, the optimum signal comes from Hayfield, North of Tallboy from \_\_\_\_\_.

*Hayfield*

The 5 between Tallboy and Mead is the distance between the two reporting points. Mead is a \_\_\_\_\_ reporting point.

*Hazelton*

The position of an airplane at Mead is determined from \_\_\_\_\_ radio.

*compulsory*

Mead is on the \_\_\_\_\_ degree radial of Durward.

*Durward*

The distance between Durward radio and Mead is \_\_\_\_\_ nautical miles.

124

The mileage between each reporting point, compulsory or non-compulsory, is given. The total airway mileage between two radios is given in a six-sided box. The 33 in the box between Mead and Hayfield is the total distance between Hayfield and \_\_\_\_\_.

21

The total airway distance between Hazelton and Durward is \_\_\_\_\_ nautical miles.

*Hazelton*

At the Mead reporting point, the airway is broken by two short lines, this indicates a change in the minimum enroute altitude. Flying to Hayfield from Hazelton, the MEA changes at Mead from 5,000 feet to \_\_\_\_\_ feet.

27

The minimum obstruction clearance changes at Mead from 4,000 feet to \_\_\_\_\_ feet.

8,000

The obstruction clearance within the airway airspace provides for 1,000 feet clearance in *normal terrain* areas and 2,000 feet in *mountainous areas*. If 6,000 T is published along an airway, then the height of the highest obstruction in mountainous terrain is \_\_\_\_\_ feet.

3,000

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When the obstruction clearance altitude is less than MEA, that altitude can be safely used within 25 miles of a VOR station. Assuming normal terrain around Hayfield, an altitude of 3,000 feet will give a clearance of \_\_\_\_\_ feet along the airway and within \_\_\_\_\_ miles of Hayfield VOR.

4,000

Between Hazelton and Durward, the MEA is 8800 feet. 8800 feet is also the minimum \_\_\_\_\_ clearance altitude.

1,000  
25

When only one figure is published for an airway, this is both MEA and minimum clearance altitude. The MEA, or Minimum En-route Altitude, between Durward and Dove is \_\_\_\_\_ feet.

*obstruction*

Along V-151 and within 25 miles of Durward radio, the minimum obstruction clearance altitude is 2,900 feet, a clearance of \_\_\_\_\_ feet in normal terrain and \_\_\_\_\_ feet in mountainous terrain.

2,900

Arrow 42 points to a solid circle with the number "one" inside. This symbol indicates that information pertinent to its location is contained on the chart where there is room for it to be printed. In a box below the symbol is the information that applies. The box is marked with the same symbol and applies to \_\_\_\_\_

1,000  
2,000

Arrow 37 points to a hashed marked line. This line outlines areas of \_\_\_\_\_ flight.

R-6002

The altitudes of control for restricted flight areas are contained in a box under the area identification. The altitude of control for R-6002 is between \_\_\_\_\_ and \_\_\_\_\_ feet.

*restricted*

The controlling agency for areas of restricted flight is listed below the affected altitudes. The controlling agency for R-6002 is \_\_\_\_\_

1,000  
17,000

Arrow 6 points to a Fan Marker. The Fan Marker is combined with a \_\_\_\_\_ Beacon (NDB).

*Hayfield  
Tower*

The navigation information for the NDB is indicated by an arrow. The name, distance from facility, frequency and identifier are given. The distance from the facility is \_\_\_\_\_ miles.

*Non-directional*

The frequency and identifier for the NDB is \_\_\_\_\_

9

Fan Markers identify themselves in Morse Code. In a CLOCK-WISE direction. A Fan Marker on the first leg to the right of 360° will identify with one dash, the second leg will identify with \_\_\_\_\_ dashes.

317kc WHT

The dash identification is flashed on the marker beacon light on the cockpit instrument panel. A code of four dashes flashing on the beacon would indicate that the airplane is over a Fan Marker on the \_\_\_\_\_ leg.

*two*

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Arrow 5 points to the ILS leg; Arrow 12 to the ILS information box. The inbound heading of the ILS course is \_\_\_\_\_.

*fourth*

The frequency of the ILS is \_\_\_\_\_ and the identifier is \_\_\_\_\_.

*230°*

The low frequency outer marker (LOM) is identified by \_\_\_\_\_ and the frequency is \_\_\_\_\_.

*110.5 mc  
IHYP*

Arrow 36 points to the magnetic variation value. These values are marked at the top and bottom of the chart only. The magnetic variation marked at the top of the chart is \_\_\_\_\_.

*HY  
254 kc*

*13° E*

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## THE RADIO COMPASS

Many new and improved types of direction finding and navigational equipment have been introduced in the last few years. However, the radio compass still remains a basic and necessary item of equipment for radio navigation.

The radio compass will receive any frequency within a range of 100 to 1750 kc. This frequency range includes non-directional beacons, low frequency ranges, and most commercial broadcast stations. The radio compass can be used for automatic direction finding (ADF), manual direction finding (MDF) or simply as a low frequency receiver.

### Basic Equipment

The basic equipment includes a low frequency receiver, a loop antenna, a bearing indicator and a cockpit control box. The control box differs with the type of installation, however, most units incorporate the following controls (Figure 5-1).

The *tuning control* may be either of the "coffee grinder" type or may incorporate knobs for the purpose of selecting individual digits of the desired frequency. The latter type is illustrated in Figure 5-1.

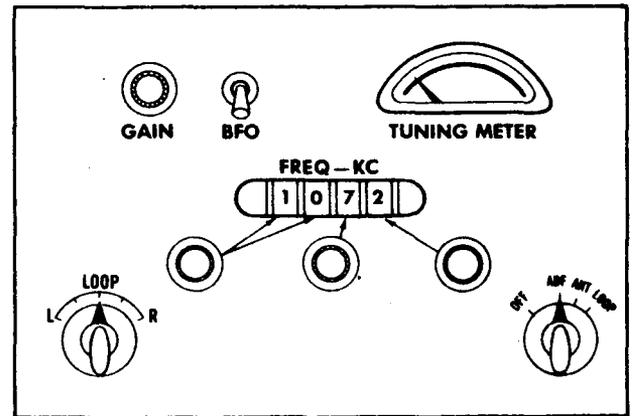


Fig. 5-1 - Radio Compass Control Box

A *tuning meter* is utilized to aid in accurate

tuning of the radio. A full right deflection of the tuning needle indicates the most accurate tuning.

The *function switch* is a four position switch which controls the manner in which the radio compass will be used. When the function switch is in the *OFF* position, the set is inoperative. Turning the switch to the *ADF* position, makes possible the use of the sensing and loop antennas. Under this condition the bearing indicator in the cockpit will automatically point to the station selected. The *ANT* (antenna) position provides only for the use of the sensing antenna, and is selected when the radio compass is used only as a radio receiver. The *LOOP* position provides only for the use of the loop antenna. In this case the loop and bearing indicator are operated manually by the use of the L-R switch. The *LOOP* position is used when manual direction finding (MDF) operations are desired.

The radio compass is used for radio direction finding and as a standby receiver for \_\_\_\_\_

It receives frequencies in the range of 100 kc to \_\_\_\_\_ kc.

communications

This frequency band includes low frequency ranges, non-directional beacons and most \_\_\_\_\_ broadcast stations.

1750

After tuning a station utilizing the tuning meter, make sure the station is positively \_\_\_\_\_

commercial

The tuning meter is used to aid in accurate tuning by obtaining a full deflection of the \_\_\_\_\_

identified

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The function switch on the control panel has positions of OFF, ADF, ANT, and _____.	needle
To operate the radio compass, the function switch must be in any desired position except _____.	LOOP
Both the sense and loop antennas are used when the function switch is in the _____ position.	OFF
The function switch has positions of LOOP, OFF, _____ and ANT.	ADF
The loop antenna is used for manual direction finding (MDF) when the function switch is in the _____ position.	ADF
The sense antenna, with the function switch in _____ position, is used to receive _____.	LOOP
If the LOOP position is selected for manual direction finding (MDF), the loop must be rotated manually by use of the _____ switch.	ANT communications

L-R

The L-R (left-right) switch controls the loop antenna and the bearing indicator when the function switch is set to LOOP.

A volume control or gain knob regulates the audio volume level in the headset or speaker.

Turning the BFO switch to ON energizes a beat frequency oscillator in the ANT and LOOP positions. This modulates the carrier wave and gives it a steady hum for use in MDF operations.

### The Bearing Indicator

The panel instrument most often used for ADF operations in transport airplanes is the radio magnetic indicator (RMI) illustrated in Figure 5-2. The single bar needle (#1 needle) in the RMI is generally used for ADF (or MDF) and will be referred to here as the bearing indicator. The double bar needle is generally used for the VOR or VORTAC.

The RMI utilizes a rotating compass card which always indicates the magnetic heading of the airplane under the index at the top of the dial. When the function switch is set to ADF, the #1 needle will indicate the magnetic bearing to the station to which the radio is tuned.

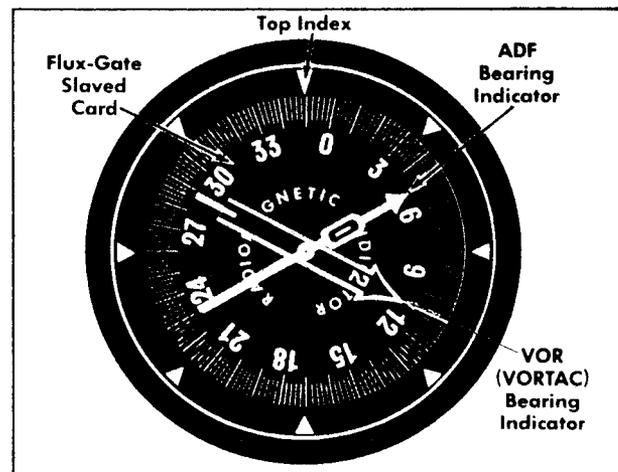


Fig. 5-2 - Radio Magnetic Indicator

The loop antenna and bearing indicator are both controlled by the L-R (left-right) switch when the function switch is in \_\_\_\_\_ position.

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The radio compass may be used for automatic direction finding when the function switch is in \_\_\_\_\_ position.

*LOOP*

The "beat frequency oscillator" modulates the carrier wave to a steady "hum" for use with (ADF) (MDF) \_\_\_\_\_

*ADF*

The radio magnetic indicator has (one) (two) \_\_\_\_\_ bearing indicators.

*MDF*

The RMI is linked to the flux gate compass so that the compass card always indicates the magnetic \_\_\_\_\_ at the top index.

*two*

The single bar needle of the RMI indicates radio \_\_\_\_\_ when ADF or LOOP functions are used.

*heading*

The heavy double bar needle of the RMI is generally associated with the \_\_\_\_\_

*bearings*

*VOR  
(VORTAC)*

## The Loop Antenna

The direction finding function of the radio compass is principally dependent on the characteristics of the loop antenna. As seen in Figure 5-3, the loop provides maximum signal reception when it is parallel to the direction of radio wave travel. When the loop is rotated from this position, the strength of the signals gradually decreases until the plane of the loop is perpendicular to the signal direction. With the loop in this position, the signal strength is at a minimum.

The loop antenna exhibits these reception characteristics because the input to the receiver from the loop antenna is the resultant of the opposing voltages in opposite halves of the loop. When the plane of the loop is parallel to the station, one half of the loop receives the signal first and creates an impulse which is relayed to the receiver. However, when the plane of the loop is perpendicular to the station, the signal reaches both halves of the loop at the same instant. In this case, the opposing voltages result in a net induced voltage to the receiver of zero or near zero. Thus the strength of the signals heard in the headset is at a minimum. This lets the pilot know the loop antenna is in the *null* or minimum signal position.

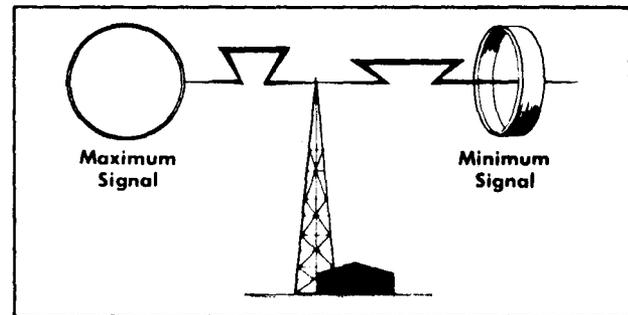


Fig. 5-3 - Loop Antenna Signal Reception

As shown in Figure 5-3, the loop antenna receives the minimum signal when it is (parallel) (perpendicular) \_\_\_\_\_ to the direction of radio wave travel.

The loop antenna is manually rotated by the \_\_\_\_\_ switch.

*perpendicular*

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The loop antenna, when parallel to the direction of radio wave travel, provides the (maximum) (minimum) \_\_\_\_\_ signal.

*L-R*

The single bar needle of the RMI is rotated along with the loop antenna when the function switch is in the \_\_\_\_\_ position.

*maximum*

When the loop antenna is in the minimum signal position, this is known as the N \_\_\_\_\_ position.

*LOOP*

When the loop antenna is in the null position, the bearing indicator is pointing to the \_\_\_\_\_ station tuned.

*(N)ULL*

*radio*

When the function switch is set to the ADF position, the loop is automatically rotated to the null, thus causing the ADF needle to automatically point to the station. However, when the ADF function is not used or is inoperative, the loop must be operated manually by turning the spring loaded *L-R* switch. When the null is located, the pilot is sure that the loop is perpendicular to the station, but the direction to the station may be either of two directions which are 180° apart. This ambiguity can be easily solved by positioning the airplane so that the null (or bearing indicator) is at the wing tip position. When this is accomplished, a straight course should be flown and the bearing indicator observed. If the station is to the left, the null moves behind the left wing. If the station is on the right, the null will move behind the right wing. Navigation utilizing MDF (sometimes called aural null) is generally considered to be an alternate method of navigation. MDF is normally not used unless other means of navigation are not operational. General procedures incident to MDF navigation are the same as in ADF navigation. However, the direction to the station must be located aurally as well as visually which presents problems to the busy pilot.

The ADF bearing indicator will automatically point to the station when the function switch is in the \_\_\_\_\_ position.

When the function switch is in LOOP position, the loop antenna and ADF bearing indicator must be rotated to get a null in order that the indicator will point to the \_\_\_\_\_

*ADF*

In the MDF function (LOOP), the bearing indicator may be aligned with the station but may indicate \_\_\_\_\_ degrees from the station.

*station*

This is known as ambiguity and is solved by flying in a straight line, perpendicular to the station, and noting which end of the bearing indicator moves to the \_\_\_\_\_

*180*

If the bearing indicator moves behind the right wing position, the station is to the \_\_\_\_\_

*rear*

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The station is to the left if the bearing indicator moves aft of the \_\_\_\_\_ wing position.

*right*

*left*

### Homing with ADF

After tuning the radio compass and placing the function switch in the ADF position, the ADF needle will point to the tuned station. Homing to a station consists only of keeping the nose of the airplane oriented to the station. Homing, however, is generally considered poor pilot technique since any cross wind will displace the airplane from the shortest route to the station. The curved track made by a homing airplane in a cross wind is illustrated in Figure 5-4.

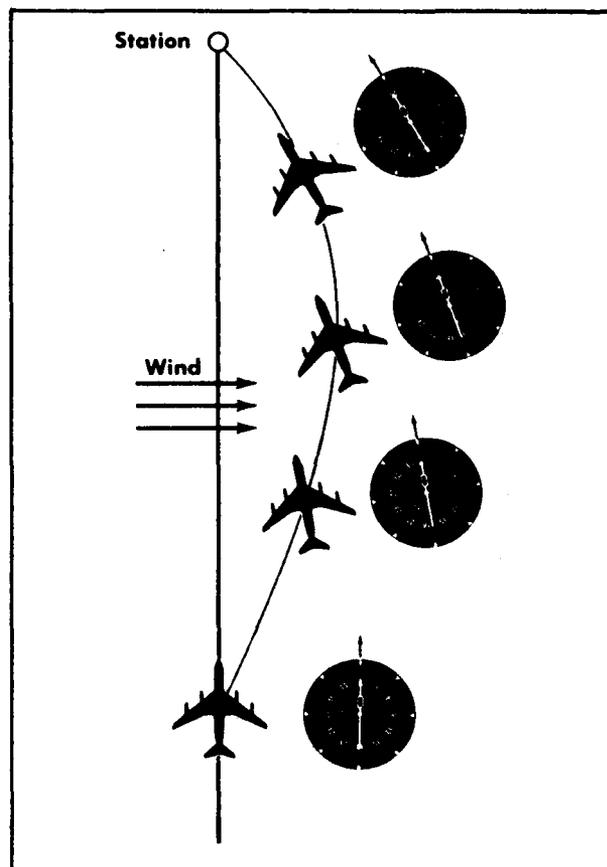


Fig. 5-4 - ADF Homing

Homing to a station is accomplished by maintaining a \_\_\_\_\_ toward the station.

Homing by means of ADF is accomplished by keeping the airplane heading coinciding with the ADF \_\_\_\_\_

*heading*

As illustrated in Figure 5-4, homing by ADF with a cross wind will cause the airplane to follow a \_\_\_\_\_ path to the station.

*bearing indicator*

With a strong cross wind, ADF homing will require a (longer) (shorter) \_\_\_\_\_ route to the station.

*curved*

*longer*

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## Tracking Inbound

Tracking is usually more expeditious since this method corrects for existing cross wind conditions. To track inbound to the station, first turn the airplane to position the desired course and the bearing indicator under the top index of the RMI. This heading should be maintained until the bearing indicator registers a deflection from the desired course. Relative movement of the bearing indicator is evidence of a cross wind for which the heading must be corrected. When a definite deflection is noted, a corrective turn should be made in the direction the bearing indicator is moving. If the bearing indicator is moving to the right, the corrective turn will be to the right; if the bearing indicator is moving to the left, the corrective turn will be to the left. The angle of interception must always be greater than the number of degrees drifted in order to reintercept the desired course.

The magnitude of the corrective turn depends on the distance from the station, true airspeed, existing wind and how quickly it is desired to return to the desired course. When the airplane is a great distance from the station, large angles of interception may be used to return to course rapidly. When close to the station, small angles of interception should be used to prevent overshooting.

A rapid rate of departure from the track, at 50 miles from the station, indicates a strong cross wind. The same rate of departure will occur with only half the wind at approximately 25 miles from the station. The faster the airplane speed, the less the relative effect of the wind. When the airplane is moving fast, the wind will not have as long to act on the airplane while it is covering a given distance.

The airplane is back on course when the desired course and bearing indicator are located under the top index. However, the desired course will not be maintained unless an "in to the wind" heading correction is made. The amount of wind correction applied depends on the cross wind condition. If, after the wind correction has been applied, the bearing indicator moves away from the index, the correction is too great. If the bearing indicator moves toward the index, the correction is too small.

Tracking is ordinarily preferred to homing because in tracking, correction is made for the _____ effect.	
In using ADF for tracking inbound, first turn the airplane to coincide with the bearing _____ and the desired course on the RMI card.	wind
In the above procedure, the bearing indicator will be positioned at the top _____.	indicator
The airplane should be turned so the desired course will be indicated by the rotatable compass card in the radio magnetic _____.	index
In the foregoing procedure, so long as the bearing indicator remains stationary, the airplane is making good the desired _____.	indicator
If the bearing indicator is moving to the left or right, this denotes that there is a cross _____.	track
If the bearing indicator moves to the right, the correct procedure is to make a small wind correction to the _____.	wind
A small wind correction to the left is made if the bearing indicator moves to the _____.	right
If the airplane drifts off course, the angle of interception to return to the course must be (smaller) (greater) _____ than the number of degrees drifted off course.	left

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When an airplane is distant from the station, (smaller) (larger) \_\_\_\_\_ angles of interception may be used to get back on course sooner.

*greater*

When close to the station small angles of interception should be used to prevent \_\_\_\_\_.

*larger*

The rate of departure of the airplane from the track, denoted by slow or fast movement of the bearing indicator, denotes a weak or strong cross \_\_\_\_\_.

*overshooting*

A rapid rate of departure, indicated by a fast moving bearing indicator, denotes a (weak) (strong) \_\_\_\_\_ cross wind.

*wind*

The faster the speed of the airplane, the less the relative effect of the \_\_\_\_\_.

*strong*

After making a wind correction and the airplane is back on course, the angle (degrees) of wind correction is indicated by the angle between the bearing indicator and airplane \_\_\_\_\_.

*wind*

If the bearing indicator moves *away from* the top index, the wind correction is too (small) (great) \_\_\_\_\_.

*heading*

If the bearing indicator moves *toward* the index, the wind \_\_\_\_\_ has been too small.

*great*

*correction*

## Tracking in a Cross Wind

Figure 5-5 illustrates the recommended method for tracking in a cross wind.

- (1) Position 1 shows an airplane on a course of  $0^\circ$  to the station.
- (2) Position 2 shows the heading is still  $0^\circ$ , however, the bearing indicator is drifting to the left, indicating a cross wind from the left.
- (3) To return to the desired course, the airplane must be turned toward the bearing indicator but beyond the course indicated by the bearing indicator. Position 3 shows the proper method of applying the wind correction. Since the bearing indicator shows a course of  $355^\circ$  to the station, the heading is altered to  $350^\circ$  to put the airplane on an interception course.
- (4) Position 4 shows the airplane back on course with the bearing indicator showing a course of  $0^\circ$  to the station. Notice that the heading is  $355^\circ$ , indicating that a cross wind correction of  $5^\circ$  has been applied.

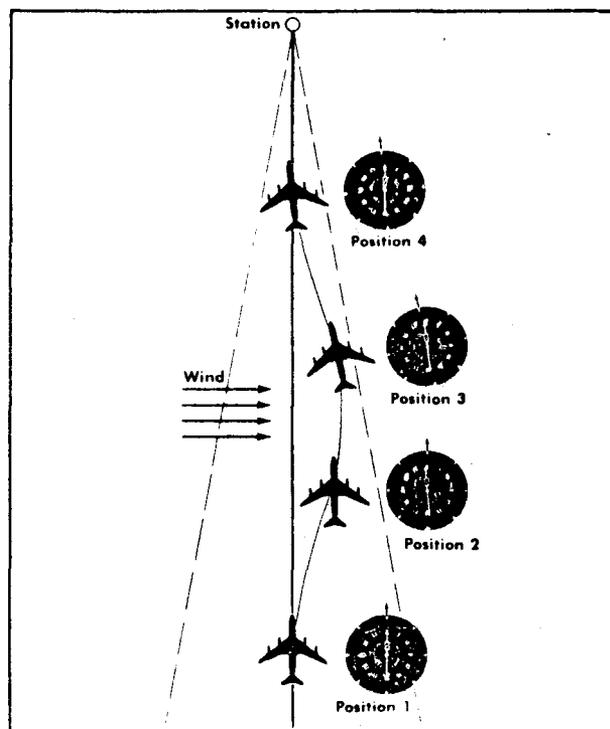


Fig. 5-5 - ADF Inbound Tracking

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In Figure 5-5, position 1, the airplane RMI shows the bearing indicator and compass card aligned with the desired \_\_\_\_\_.

The same heading is maintained in position 2, but the airplane has drifted off course to the right. With the left cross wind, the bearing indicator has moved to the \_\_\_\_\_.

*course*

In position 3, the airplane is headed back toward the desired course. The heading is \_\_\_\_\_° and the bearing indicator points to \_\_\_\_\_°.

*left*

In the above case, position 3, the course interception angle is \_\_\_\_\_°.

*350  
355*

In Figure 5-5, position 4, the bearing indicator reads 0° denoting that the airplane is back on \_\_\_\_\_.

*10*

In position 4, the wind correction is \_\_\_\_\_° to the \_\_\_\_\_.

*course*

*5  
left*

## Station Passage

As the airplane approaches near the station, a small departure from the desired course will cause a large deviation of the bearing indicator. As the station is passed, the bearing indicator will fluctuate from side to side and finally swing around to indicate a bearing of approximately 180° from the course of the airplane. Station passage is definitely established by noting the time at which the bearing indicator swings through either wing tip position.

## Tracking Outbound

Tracking outbound is similar to tracking inbound except that the *tail* of the bearing indicator is used to establish the airplane on course. After the airplane heading is adjusted for wind correction, if the tail of the bearing indicator moves toward the top index, the correction is too large. If the indicator moves away from the top index, the correction is too small.

Station passage, using ADF, is denoted when the bearing indicator swings toward the rear past either \_\_\_\_\_ position.

As the station is approached, the \_\_\_\_\_ will swing from side to side before reversing direction.

*wing tip*

On a timed procedure, the timing is started when the bearing indicator passes through either \_\_\_\_\_ position.

*bearing indicator*

When tracking outbound from a station, the pointer end of the bearing indicator is in the aft (bottom) half of the RMI and the \_\_\_\_\_ of the pointer is at the top.

*wing tip*

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The tail of the bearing indicator is used in this case to establish the airplane on the \_\_\_\_\_.

*tail*

When the tail of the bearing indicator is used to determine the wind correction, the rule is reversed. If the tail of the indicator moves toward the top index, the wind correction is too (small) (large) \_\_\_\_\_.

*course*

If the tail of the indicator moves away from the top index, the amount of \_\_\_\_\_ is too small.

*large*

*wind correction*

## Course Interception

On some occasions, it may be necessary to intercept a predetermined bearing in order to correctly approach the station. Ordinarily, only one turn is necessary to position the airplane on an intercept heading. First, notice where the desired course is located on the RMI compass card, then locate the position of the bearing indicator. In order to intercept the desired course, it is necessary to turn to a heading which is on the other side of the bearing indicator from the desired course. Turn beyond the bearing indicator a sufficient number of degrees to give a desirable intercept angle; normally this is about 30°. When the bearing indicator closely approaches the desired course as indicated on the RMI, start a turn so as to roll out on heading and on course.

When using ADF to intercept a predetermined course (bearing) to a station, first locate the airplane in relation to the desired inbound \_\_\_\_\_.

To intercept a predetermined course to the station, a turn must be made *past* the bearing indicator a sufficient number of degrees to give a desirable \_\_\_\_\_ angle.

*course*

An angle of interception often used is \_\_\_\_\_ degrees.

*interception*

After turning toward the course to be intercepted, start another turn to roll out on course when the bearing indicator approaches the desired \_\_\_\_\_.

*30*

*course*

Figure 5-6 graphically illustrates the method utilized to intercept a predetermined course. Notice in position 1 that the airplane heading is 270° and that the bearing to the station is 290°. Assume that the pilot is required to approach the station on a magnetic course of 280°. To accomplish this, the heading is changed in the direction of, but past the bearing indicator by 30°. In position 2, notice that the bearing indicator still registers 290°, however, the heading has been changed to 320° or 30° past the bearing indicator. In position 3, the bearing indicator has altered position to the desired course (280°) and the airplane heading has been changed so as to fly inbound on a course of 280°.

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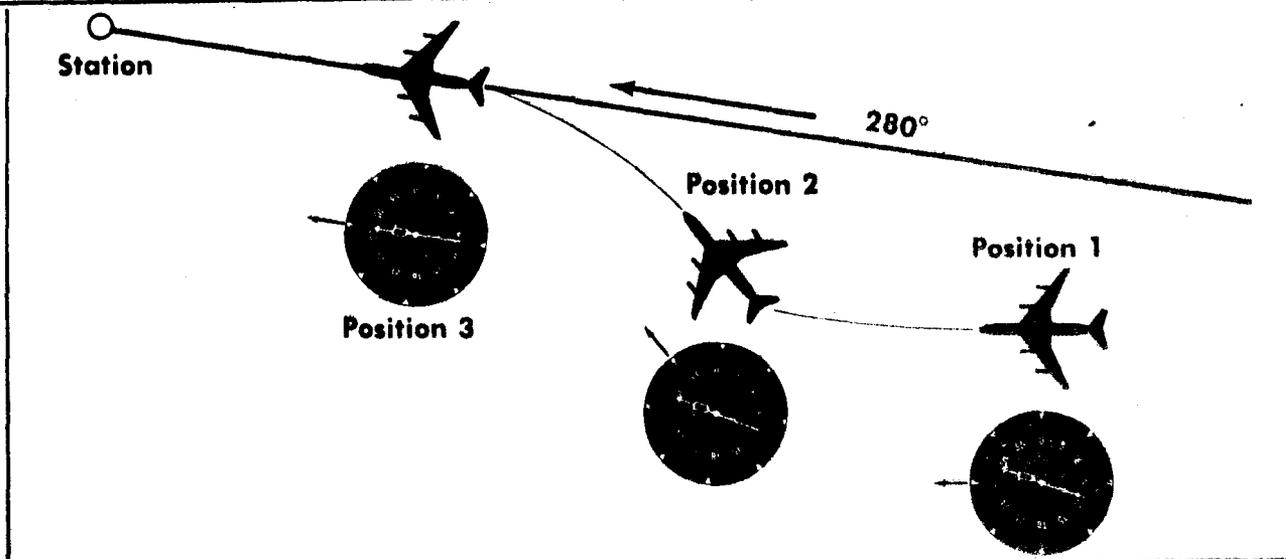


Fig. 5-6 -- ADF Bearing Interception

In Figure 5-6, position 1, the bearing indicator shows that the bearing to the station is \_\_\_\_\_ degrees.

To intercept a predetermined course of 280°, the airplane should be tuned to the right past 290° to achieve the desired interception \_\_\_\_\_

The new heading to be turned to for a reasonable interception angle will be \_\_\_\_\_°.

Turn to the heading of the predetermined course at the time the bearing indicator reaches \_\_\_\_\_° (or slightly before).

290

angle

320

280

## The Time Distance Check

The homing characteristics of the radio compass make it possible to calculate the approximate time and distance to the station to which the radio compass is tuned.

Before starting the time-distance check, be sure that the desired station is tuned and identified and that the function switch is set to the ADF position. Next, position the airplane so that the bearing indicator is placed at either of the 90° indices (wing tip position) on the face of the RMI. For example, notice in Figure 5-7 that the airplane in position 1 is heading 330°. In position 2, the heading is changed to 0° in order to place the station on the wing tip position. The time should be noted as the bearing indicator passes by the 90° indices. A constant heading and airspeed should be maintained until the bearing indicator registers a 5° to 20° bearing change. A 10° bearing change is usually used because the number 10 provides for easy computation.

After the bearing indicator registers the desired bearing change, again note the time. The number 3 position in Figure 5-7 shows the airplane still on a heading of 0°, but with the bearing indicator 10° behind the 90° indices indicating a 10° bearing change.

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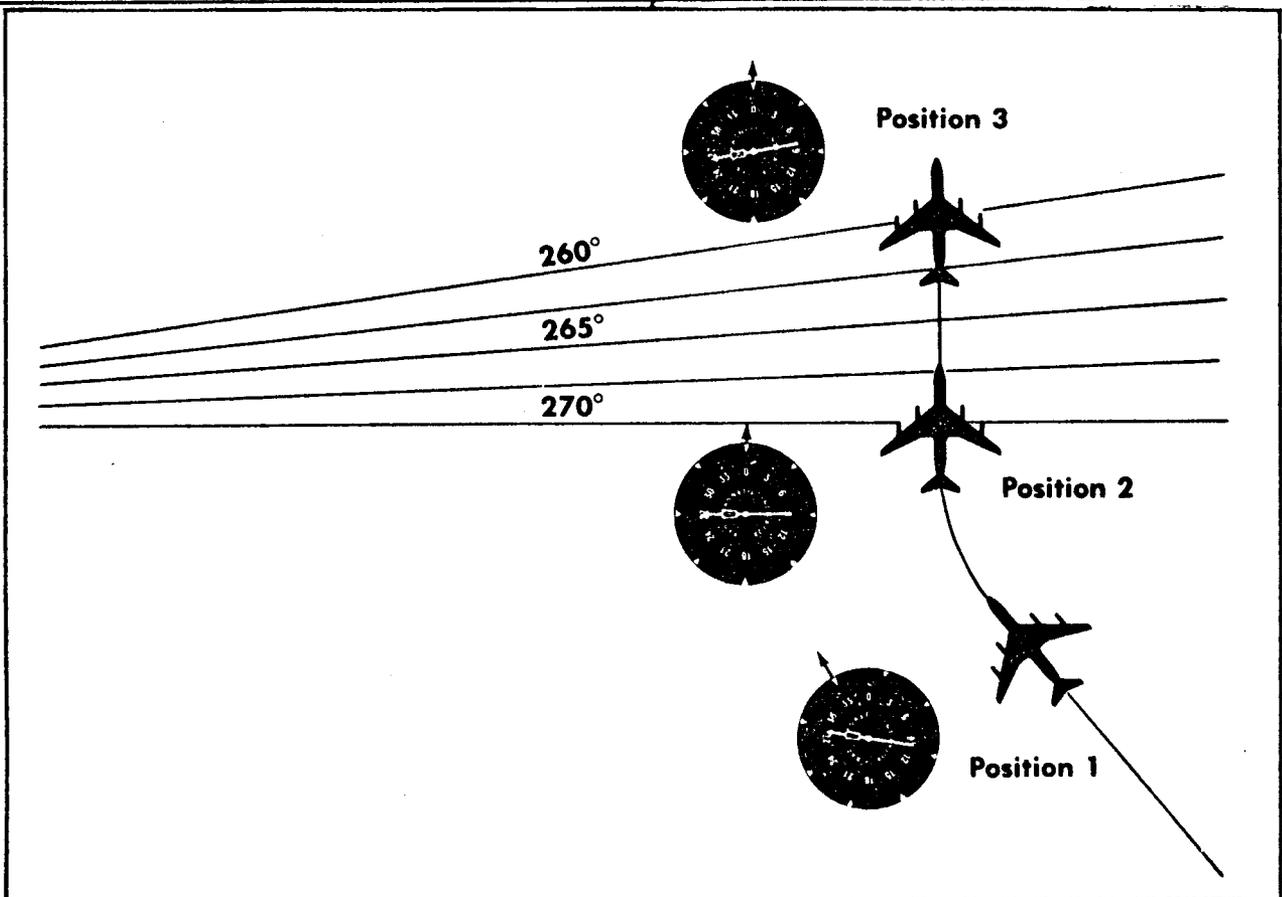


Fig. 5-7 - The ADF Time Distance Check

To perform a time-distance check by use of ADF, first tune and identify the radio station and set the function switch to the \_\_\_\_\_ position.

Next, turn the airplane until the RMI bearing indicator is in either of the \_\_\_\_\_ positions (90° or 270° position).

In Figure 5-7, position 2, the bearing indicator reads \_\_\_\_\_°, which is a \_\_\_\_\_ position when heading 0°.

When performing a time-distance check, begin timing when the bearing indicator is on a wing tip bearing as shown by position \_\_\_\_\_ in Figure 5-7.

Then fly for a suggested 10° bearing change, in this case to \_\_\_\_\_° as shown in position \_\_\_\_\_, Figure 5-7.

ADF

wing tip

270  
wing tip

2

260  
3

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## Time

Use the following formula to calculate the approximate *time* to the station.

$$\text{MINUTES TO STATION} = \frac{\text{TIME BETWEEN BEARINGS (SECONDS)}}{\text{DEGREES OF BEARING CHANGE}}$$

Assume, for example, that 90 seconds is required for an airplane to fly through a 10° bearing change. When these values are substituted in the above equation, the problem would look like this.

$$\text{MINUTES TO STATION} = \frac{90 \text{ seconds}}{10 \text{ degrees}} = 9 \text{ minutes}$$

## Distance

Use the following formula to determine the *distance* to the station.

$$\text{DISTANCE TO STATION} = \frac{\text{GROUND SPEED} \times \text{TIME BETWEEN BEARINGS (MINUTES)}}{\text{DEGREES OF BEARING CHANGE}}$$

Assume, for example that the ground speed is 300 knots and that 1.5 minutes were required for the bearing indicator to change 10°. When these values are substituted in the above equation, the problem would look like this.

$$\text{DISTANCE TO STATION} = \frac{300 \text{ knots} \times 1.5 \text{ minutes}}{10 \text{ degrees change}} = 45 \text{ nautical miles}$$

In this type of problem, TAS may be substituted for ground speed, however, the answer will not be quite so accurate.

The formula for time out from a station is:

$$\frac{\text{Time between bearings (seconds)}}{\text{Degrees of bearing change}} = \text{minutes to station}$$

If 60 seconds were required for a bearing change of 10 degrees, the minutes to fly to station would be \_\_\_\_\_

no response

If a bearing change of 15 degrees required 75 seconds, then the airplane would be \_\_\_\_\_ minutes from the station.

6

The formula for distance out from a station is:

$$\frac{\text{Ground speed} \times \text{time between bearings (minutes)}}{\text{Degrees of bearing change}} = \frac{\text{Distance}}{\text{to station}}$$

5

If the ground speed were 240 knots and the bearing changed 15 degrees in 1 minute, the distance from the station = \_\_\_\_\_ NM.

no response

If the ground speed is 180 MPH and the time between a bearing change of 10 degrees is 1 minute, the distance from the station is \_\_\_\_\_ miles (statute).

16

An approximate distance out may be found using

True airspeed = 120 knots  
 Bearing change = 10 degrees  
 Time = 1.5 minutes  
 The distance from the station = \_\_\_\_\_ NM.

18

18

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VOR SYSTEM OF NAVIGATION

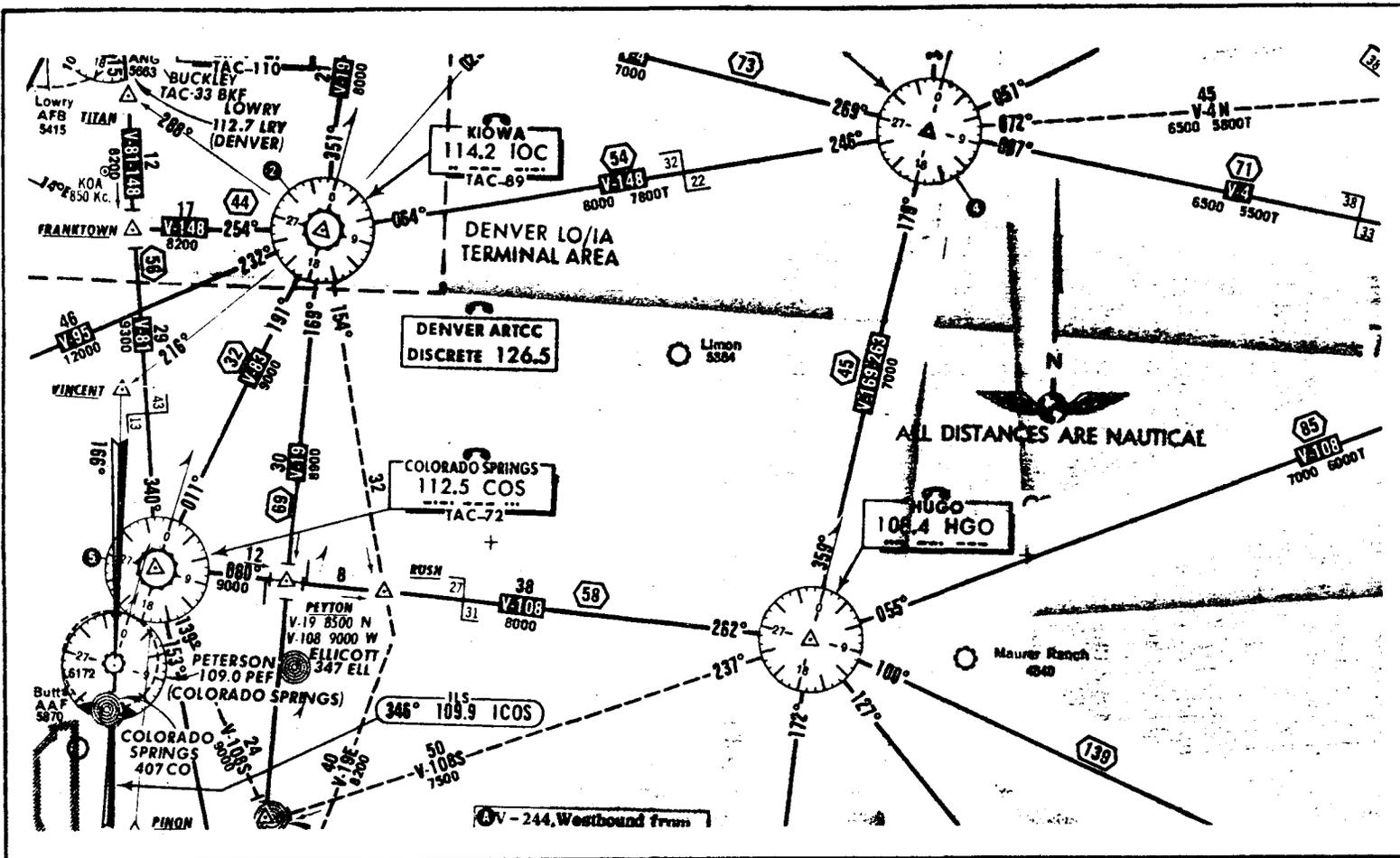


Fig. 5-8 - VOR Airways System

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## General Features of a VOR Radio Navigation System

The term "VOR" is a symbol for

V = VHF (Very High Frequency)

O = OMNI (OMNI Directional, or All Directions)

R = Range (Range Station).

The VOR Station is the ground radio facility (radio station) component of the Victor Airways System of radio navigation. This system is operative throughout the United States for use of pilots in radio-navigation both on and off "Victor" Airways.

Figure 5-8 illustrates a portion of the VOR Airways System. The VOR stations are symbolized by the compass rose circles as shown on the Jeppesen Avigation Enroute Charts. Victor Airways are represented by a "V", followed by the airway number, such as "V-108".

## Patterns Transmitted by a VOR Station

Each VOR Station transmits signals in all directions (OMNI-Directional). The signals are arranged to produce an infinite number of courses, 360 of which can be selected and identified by the airplane VOR receiver. Each bearing from a VOR Station is called a *radial*.

It is possible for several different airways to converge or intersect at a single VOR Station. Theoretically, airways could approach a VOR Station from 360 different directions.

## Station Identification

Audio signals from VOR Stations are used only for station identification and communications. Visual indications are used only for Navigation.

**IDENTIFY THE STATION BEFORE USING IT FOR NAVIGATIONAL PURPOSES!**

VOR Stations have three-letter identifiers in code. Example—"DEN" coded (— ·) (·) (— ·). The Morse Code may be learned easily by using the Jeppesen & Co. Morse Code Course (Briefing Booklet BMC-1).

## VOR Line of Sight Transmission

VOR radio transmissions are comparatively free of atmospheric disturbances and static. They are, however, limited to "line-of-sight" transmission. This characteristic is depicted by Figure 5-9. Any obstacles, including curvature of the earth, mountains and buildings, block VOR signals and restrict the distance the signals can be received at certain altitudes. Thus, as depicted by line AX in Figure 5-9, the lower limit of radio transmissions from Station "A" is a line tangent to the earth and above the mountains shown.

The lower limit of transmission from Station "B" is line BY. Since the lower limits of Stations "A" and "B" are respectively defined by lines AX and BY, the airplanes in the illustration receive VOR signals as follows:

- #1—receives signals from Station B only
- #2—receives signals from A and B
- #3—receives signals from A only
- #4—receives signals from neither station.

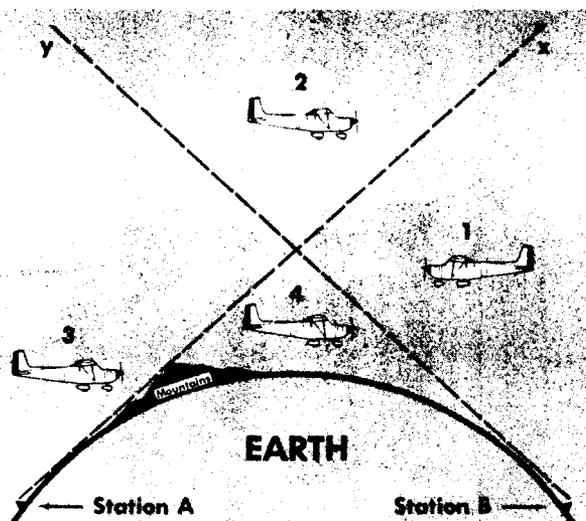


Fig. 5-9—Line of Sight Transmission

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The letter "V" is a symbol for VHF (Very High Frequency Radio Signals); the letter "O" is a symbol for OMNI-Directional (all directions); and "R" is a symbol for Range Station. The coded symbol "VOR" stands for \_\_\_\_\_

Victor Airways utilize \_\_\_\_\_ navigational aids.

*VHF OMNI-  
Directional  
Range Station*

Victor Airways are designated by the letter "V" and a number. "V-263" would be the designation of a \_\_\_\_\_

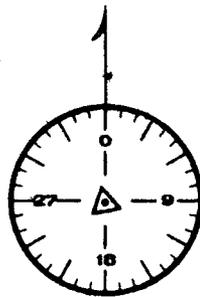
*VHF*

Airways Systems which use VOR navigational facilities are called \_\_\_\_\_ Airways.

*Victor Airway*

On the Jeppesen Avigation Enroute Charts, a common symbol for a VOR Station is a compass rose with a small triangle in the center. The symbol pictured here represents a \_\_\_\_\_ Station.

*Victor*



A circle contains 360 degrees. A VOR Station radiates signals defining radials for each degree of its compass rose. A VOR Station establishes (how many) \_\_\_\_\_ radials.

*VOR*

Radio beams from a VOR Station follow a \_\_\_\_\_ of \_\_\_\_\_ path.

*360*

Just as our "line of sight" does not curve over the horizon, \_\_\_\_\_ radio signals cannot be received over the horizon.

*line  
sight*

VOR Signals cannot ordinarily be received at distances over 70 to 80 miles at low altitudes because the airplane would be below the \_\_\_\_\_ of \_\_\_\_\_ from the station.

*VOR  
(VHF)*

When a pilot is flying within reception distance of a VOR Station, he may select any one of 360 \_\_\_\_\_ for navigational use.

*line  
sight*

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VOR radials are defined as bearings, or courses, in a direction *FROM* a VOR Station, and measured clockwise from *MAGNETIC NORTH*. An airplane directly *EAST* (magnetic), of a VOR Station would be on the \_\_\_\_\_ degree radial.

*courses  
(radials)*

If an airplane was positioned on a course in a magnetic direction of 300° "FROM" a VOR Station, the airplane would be considered to be on the \_\_\_\_\_ degree radial, which would be \_\_\_\_\_ the station.

90

All VOR Compass Roses drawn on Jeppesen Avigation Enroute Charts are referenced to Magnetic North, and all radials and/or bearings used by the pilot with reference to a VOR Station will be (TRUE) (MAGNETIC) radials or bearings: \_\_\_\_\_

300  
FROM

Before using a VOR Station for navigational purposes, it is imperative that the station be positively \_\_\_\_\_

Magnetic

The Victor Airway between Hugo and Colorado Springs indicated on the Jeppesen Avigation Enroute Chart, Figure 5-8, is identified by the symbol V-108. The outbound radial from Hugo on V-108 is \_\_\_\_\_ degrees.

identified

262

## VOR Ground Station

A VOR Station is a circular building with a "cupola" on top, and contains a fixed omni-directional antenna and a rotating antenna. Each antenna transmits a signal which makes it possible for the airplane's receiver to detect from which direction the signal is emanating relative to the station.

## Radials Transmitted from a VOR Station

The two signals broadcast by a VOR (by the two antennas) are "in phase" at the position of *MAGNETIC NORTH*. Thus, Magnetic North is the base reference for all other directions used relative to the VOR Station. In simple words, as the rotating antenna's signal makes its 360 degree sweep, this signal is out of phase with the signal from the fixed antenna by a *different amount for each degree of travel*. The receiver in the airplane is able to detect "out-of-phase" relationship as a different degree of direction measured from the reference at Magnetic North. As an example, the signals are 180 degrees apart (out-of-phase) at a point 180 degrees from Magnetic North and the airplane equipment senses this condition as a direction of 180 degrees from the station. Although, technically, the station broadcasts an infinite number of radials, the airplane's receiver generally detects only one full degree of difference. The VOR is accurate to a tolerance of one full degree - hence, we assume 360 radials.

REMEMBER, EACH "RADIAL" IS A MAGNETIC DIRECTION "FROM" A VOR STATION.

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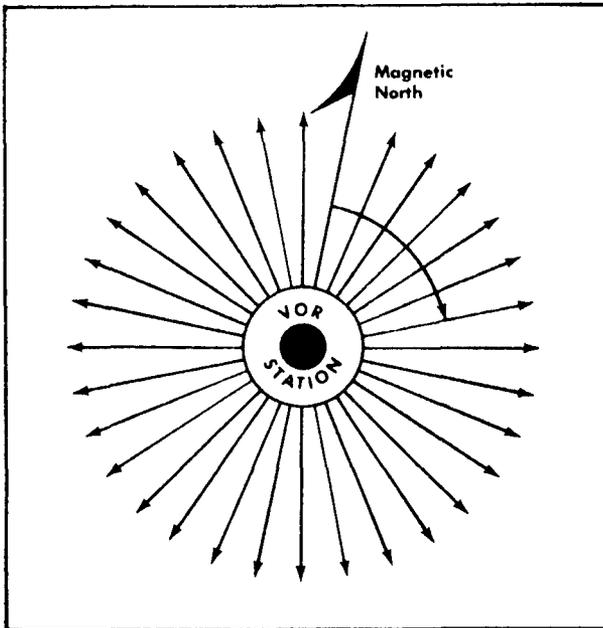


Fig. 5-10 - VOR Radials

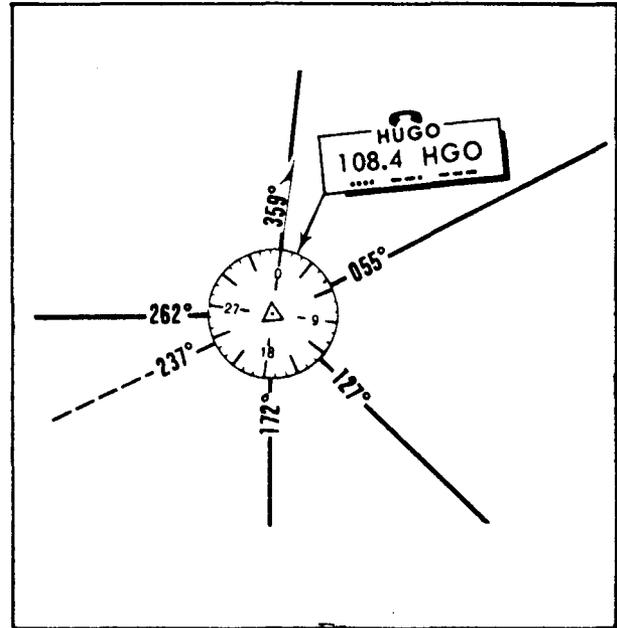


Fig. 5-11 - VOR Station Azimuth

Radials are like spokes of a wheel, as depicted by Figure 5-10, and are considered to point in a direction FROM the station.

In Figure 5-11, a representative VOR Station Azimuth is reproduced. A radial of 90° FROM the station is indicated; another radial of 300° is shown as a direction FROM the station. These are only two of the possible 360 radials available to the pilot from this station.

The airplane VOR receiver is able to receive each radial, one at a time, and can identify the one being received as previously selected by the pilot. Thus, the pilot is able to determine a bearing or line of position *at any direction from the VOR Station*, if the airplane is within reception distance of the station.

Radio bearings are "directions" measured from Magnetic North. Bearings may be considered to be lines of direction from an airplane to a radio station (or other reference point), or from a radio station to the airplane. In radio navigation, all bearings are considered to be \_\_\_\_\_ directions unless otherwise specified.

A bearing may be referred to as an airplane's "line of position", if the airplane is located any place on an imaginary line coinciding with the bearing. A radial of a VOR Station may be considered to be a line of \_\_\_\_\_.

*magnetic*

To establish a "line of position", any radial of a VOR may be used as a \_\_\_\_\_.

*position*

VOR Station transmissions are desirable for radio navigation in "bad weather" because of their \_\_\_\_\_ characteristics.

*bearing*

VOR Stations are ordinarily located along Airways.

*static free*

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A VOR Station transmits signals in all directions. A VOR Station is said to transmit \_\_\_\_\_-directional signals through a range of 360 degrees.

*Victor*

In addition to transmitting navigational signals, many VOR Stations are equipped to transmit and receive \_\_\_\_\_ communications.

*omni*

Identifications of VOR Stations are broadcast in \_\_\_\_\_ Code and in some cases by voice.

*voice*

Each radial of a VOR Station is measured clockwise from Magnetic North because this is the reference used in signal identity. An airplane flying on a radial of 225° relative to a VOR Station has a position which is in a magnetic direction of \_\_\_\_\_ from the station.

*Morse*

VOR radials extend in all directions from the station like the \_\_\_\_\_ of a wheel.

*225°*

The basic directional reference (datum) used for a VOR Station Compass Rose is \_\_\_\_\_ North.

*spokes*

The airplane VOR receiver can detect signals to identify each radial of a VOR Station measured from Magnetic North in a \_\_\_\_\_ direction.

*Magnetic*

The airplane VOR receiver is able to receive the signal of any radial selected, which allows the pilot to establish or determine a \_\_\_\_\_ in any direction to or from the VOR Station.

*clockwise*

*bearing  
(course)*

## VHF Frequency Band

That portion of the VHF Frequency Band used for VOR transmission is 108.0 to 117.9 mc. The signals broadcast by VOR's fall within the VHF Frequency Band of 30 to 300 megacycles.

Each VOR channel is one-tenth (0.1) megacycle apart. Since one megacycle equals 1,000 kilocycles, channels are 100 kc apart. Frequencies are on the order of 108.0, 108.2, etc., in the range 108.0 to 112.0 mc and both even and odd tenths from 112.0 to 117.9 mc. ILS uses the odd tenth mc from 108.1 to 111.9 mc.

Distance Measuring Equipment (DME) associated with some of the VOR Stations employs frequencies within the UHF band in the range of 962 to 1213 mc.

To clarify designation of frequencies used by the instrument pilot, the following reference table is included:

1 kilocycle = 1,000 cycles (cycles per second)

1 megacycle = 1,000 kilocycles (1,000,000 cycles per second)

## Airborne VOR Equipment

The VOR Airborne Equipment includes the Radio Receiver, Antenna, Frequency Selector, OMNI

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Bearing Selector (OBS) called the "Course Selector", the TO-FROM Indicator, associated controls, and warning devices.

## VHF Frequency Selector

A typical VHF (VOR) Frequency Selector and Control Panel is illustrated in Figure 5-12. This equipment is placed in operation by the ON-OFF Switch. The frequency which is displayed in the "window" is 108.4. Audio volume for station identification and voice is controlled by the volume control knob.

## Tuning and Identifying the VOR Station

The VOR Stations used for navigational purposes are depicted on the Jeppesen Avigation Enroute Charts and U. S. Coast & Geodetic Survey Charts. A portion of a Jeppco Avigation Enroute Chart is produced in Figure 5-8.

Assume the pilot wishes to "tune in" the HUGO (HGO) VOR shown on this chart. The HUGO station frequency and identifier are shown in a small rectangle adjacent to the station, as in Figure 5-13.

## TO TUNE AND IDENTIFY A VOR STATION

- (1) VOR ON-OFF Power Switch—ON (See Figure 5-12).
- (2) Determine station frequency from Jeppesen Avigation Enroute Chart, Figure 5-13, or from Jeppesen J-AID or Airman's Guide.
- (3) Rotate tuning controls of Frequency Selector until published frequency appears in "window" (see Figure 5-12).
- (4) Adjust Volume Control Knob to receive code and/or voice identification.
- (5) Identify station by checking coded identifier (Figure 5-12), or by voice identification if used by station. Some stations have both types of identifiers.

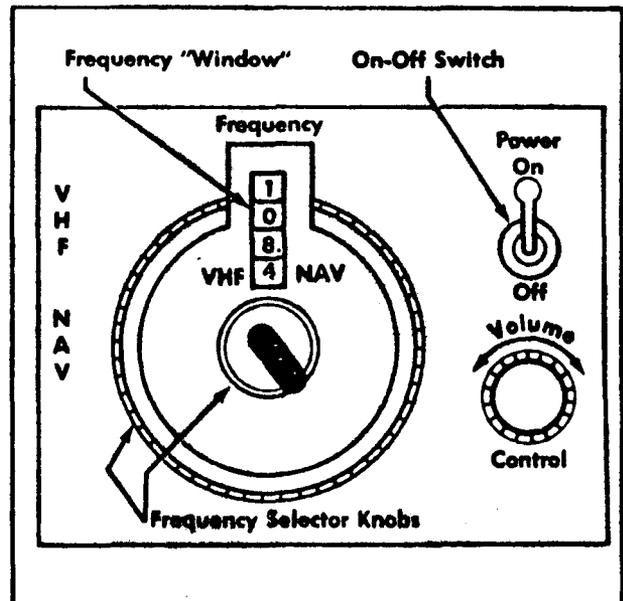


Fig. 5-12 - VOR Frequency Panel

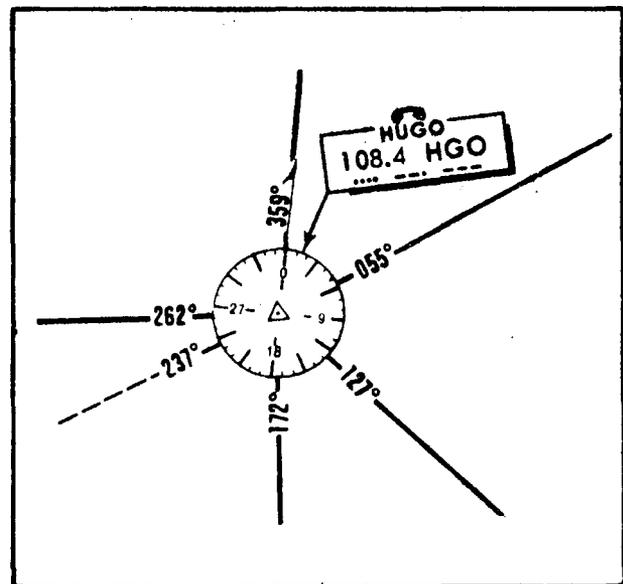


Fig. 5-13

VOR Stations transmit on a band of radio frequencies from 108.0 megacycles to 117.9 \_\_\_\_\_

The frequency band is from 108.0 megacycles to \_\_\_\_\_ megacycles.

VOR Stations can be received on a frequency band of \_\_\_\_\_ to \_\_\_\_\_

megacycles

117.9

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The VHF Radio Band is used for VOR transmissions because of its comparatively \_\_\_\_\_ characteristics.

108.0  
117.9

The VOR Frequency Selector is used to tune in the desired VOR Station according to the frequencies published on Jeppesen Aviation Enroute Chart and in Jeppesen J-AID. To make sure the correct station has been tuned in, it is necessary to listen to the station in order that the station is \_\_\_\_\_

static free

The volume control on the VOR Frequency Selector Panel is used to control the volume level of the \_\_\_\_\_

identified

receiver

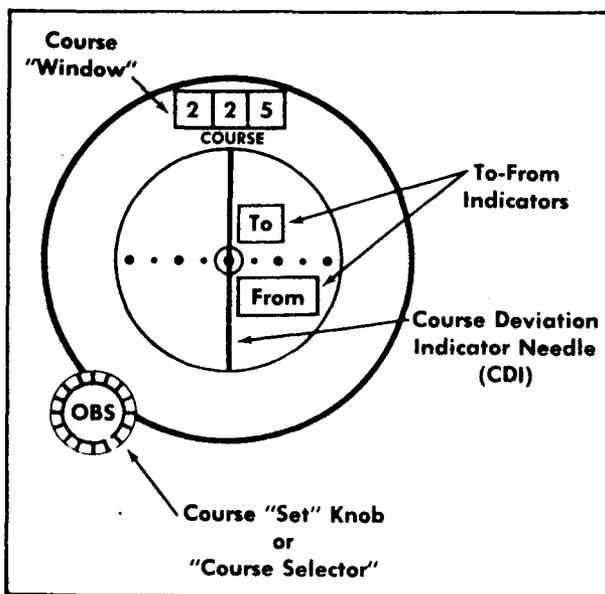


Fig. 5-14

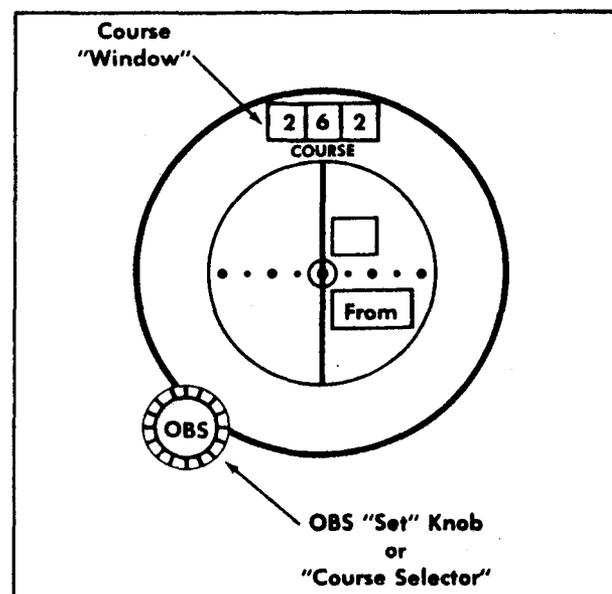


Fig. 5-15

## Course Selector or OMNI Bearing Selector (OBS)

Any one of the 360 radials (courses) of a VOR can be selected with the OBS (Course Selector) as illustrated in Figure 5-14. By rotating the OBS Knob the course desired is set in the window, where you see "225". The OBS Knob is shown in the lower left corner of the figure. Thus, the pilot may choose and "SET" the instrument for any magnetic radial (course) he desires to use as part of his navigational data.

## Selecting VOR Radials

Assume a pilot wishes to select the radial of 262° (FROM) the HUGO VOR Station. The following procedure is used:

### TO SELECT A RADIAL (BEARING) FROM A VOR STATION

- (1) Tune in and identify the station.
- (2) ROTATE the OBS (SET) Knob until the desired radial (bearing) appears in the Course "Window" as shown in Figure 5-15.

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## Course Deviation Indicator (CDI)

After the pilot selects a course (radial) on the Course Selector (OBS), the relative position of the airplane, with respect to the desired course, is indicated by a vertical needle on the Course Deviation Indicator. If the vertical needle is centered, the airplane is on the course selected. (See Figure 5-16). This may be only momentarily if the airplane is crossing the course.

To add a safety factor, a small "flag" is provided which comes into view if the vertical needle is undependable, or the VOR system is unreliable.

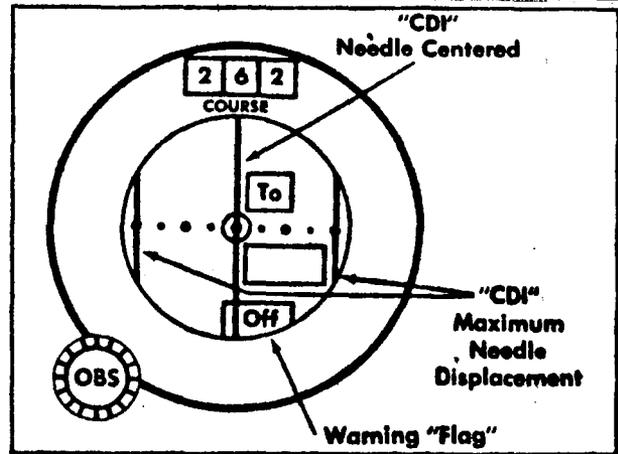


Fig. 5-16 - Course Deviation Indicator (CDI)

If a VOR Station is not identified, it is possible to tune to the wrong station. It is imperative for safety that each station be \_\_\_\_\_ after it is tuned in, before being used for navigation.

The Course Selector is used to select a course (radial) of a VOR for navigational purposes; the pilot may select any of 360 VOR courses (radials) by the use of the \_\_\_\_\_

*identified*

The vertical needle of the Course Deviation Indicator (CDI) is centered when the airplane is "on" the course selected which appears on the Course Selector. The pilot can tell when the airplane is on the course selected by reference to the \_\_\_\_\_ needle.

*Course Selector*

A flag warning device warns the pilot if the vertical needle indication is unreliable. To be sure that the indications of the CDI needle are reliable, check the warning \_\_\_\_\_

*Course Deviation Indicator*

"Normal" needle sensing of the CDI (Course Deviation Indicator) vertical needle means that, if the course selected is to the left of the airplane, the needle position will be to the \_\_\_\_\_ of center.

*flag*

If the Course Selector is set to the same general direction as the airplane heading, the CDI needle will indicate whether the course selected is left or right of the airplane position, or whether the airplane is on course. When the course is right of the airplane, the needle is \_\_\_\_\_ of center.

*left*

When the course is left of the airplane, the needle is \_\_\_\_\_ of center.

*right*

When the course coincides with the airplane's position, the needle is \_\_\_\_\_

*left*

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When the airplane's heading is in a direction opposite to the course selected on the OBS, the pilot must "fly away from the needle" (CDI) in order to intercept the selected course. This is a situation of "reverse needle sensing". In reverse needle sensing, the pilot should turn \_\_\_\_\_ the needle to intercept the course selected.

*centered*

"Reverse" (CDI) needle sensing means that when the airplane is right of course the needle will be \_\_\_\_\_ of center.

*away from*

Left of Course, the needle will be \_\_\_\_\_ of center.

*right*

When the airplane heading is in the same general direction as the selected course, to get on course the pilot should fly \_\_\_\_\_ the CDI needle.

*left*

*toward*

## TO-FROM Indicator

The VOR "TO-FROM" Indicator is designed to indicate whether or not the *bearing or course selected* is in a direction *toward* (TO) the station or *away* (FROM) the station which is tuned in. It is a bearing direction!

THE TO-FROM INDICATION HAS NOTHING TO DO WITH DIRECTION OF AIRPLANE HEADING!

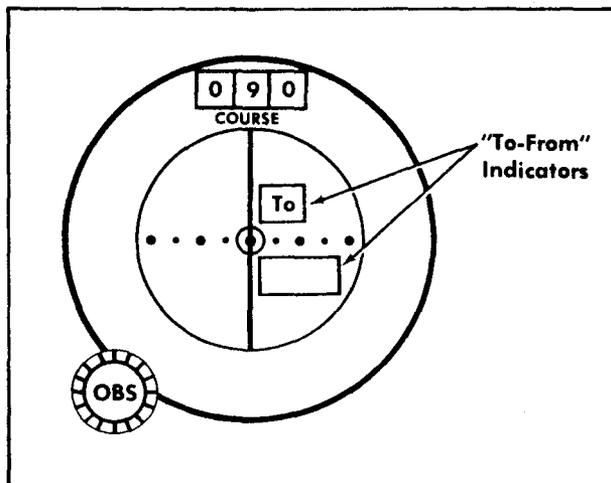


Fig. 5-17

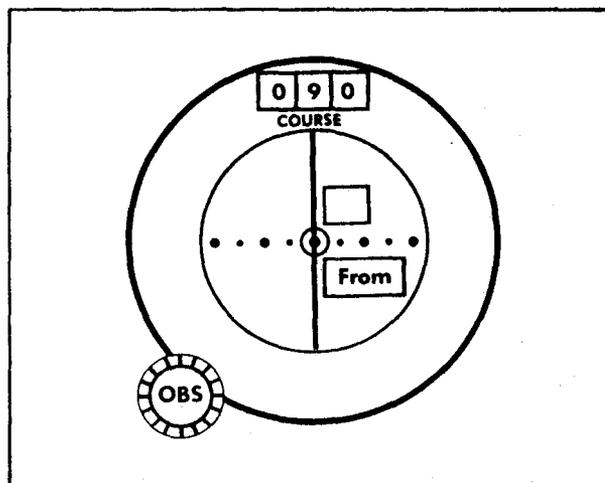


Fig. 5-18

If, as in Figure 5-17, the Indicator reads *TO* with a course of 90° selected on the Course Selector, this indicates to the pilot that the VOR Station is in a direction of 90° relative to the position of the airplane when the needle is centered. In other words, the pilot would reach the station if he flew in a direction of 90° (Magnetic).

Referring now to Figure 5-18, we see a course of 90° selected by the Course Selector, with the "TO-FROM" Indicator reading *FROM* and the needle centered. This tells the pilot that the airplane position

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is in a direction of 90° FROM THE STATION; or the airplane is on a course, the direction of which is 90° (Magnetic) away from the VOR Station. In this case, the direction to the station would be 270°, the reciprocal of the bearing shown by the Course Selector. A simple rule may be of use here:

**WHENEVER A BEARING IS SELECTED ON THE COURSE SELECTOR (OBS) AND THE "TO-FROM" INDICATOR READS:**

- (a) "TO" - The Bearing is *Toward* station relative to airplane's position.
- (b) "FROM" - The Bearing is *FROM* station relative to airplane's position.

Another way to visualize the use of the "TO-FROM" Indicator is to think of a bearing, or course, as *passing through the VOR Station*. When the bearing, or course, is drawn *toward* the station, the indicator reads *TO*; after the bearing passes through the station, the indicator reads *FROM* for the same identical course or bearing.

**AGAIN REMEMBER!**

The "TO-FROM" Indicator *does not indicate* the heading or direction of travel of the airplane; it indicates *only* the direction of a course or bearing **TO** or **FROM** the station.

The VOR "TO-FROM" Indicator indicates whether or not the radial selected (or bearing selected) has a direction **TO** or \_\_\_\_\_ the VOR Station.

The "TO-FROM" Indicator of the VOR equipment does not indicate that the airplane's heading is **TO** or **FROM** the \_\_\_\_\_.

If a VOR course (radial) of 270° is selected with the CDI needle centered and the TO-FROM Indicator indicates *TO*, the location of the airplane's position is (WEST) (EAST) of the station.

In the previous statement, the pilot will fly a magnetic heading of \_\_\_\_\_° to reach the station (no wind).

If a VOR course (radial) of 90° is selected with the CDI needle centered and the TO-FROM Indicator reading *FROM*, the location of the airplane's position is \_\_\_\_\_ of the station.

In the previous statement, the pilot would fly a magnetic heading of \_\_\_\_\_° to reach the VOR Station (no wind).

Whenever a bearing (radial) is selected on the Course Selector and the TO-FROM Indicator reads *TO*, the bearing direction relative to the airplane's position is \_\_\_\_\_ the station.

Whenever the direction of a bearing is away from the station, toward the airplane's position, this bearing (if correctly selected) will be indicated on the TO-FROM Indicator as \_\_\_\_\_ the VOR Station.

**FROM**

*station*

**EAST**

**270**

**EAST**

**270**

*toward*

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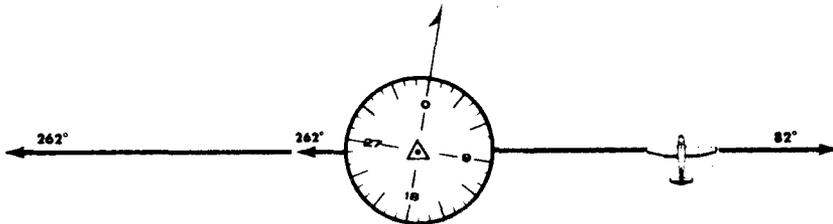
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In the situation indicated by this diagram;



with the Course Selector set to read 262°, and the CDI needle centered, the TO-FROM Indicator will read \_\_\_\_\_

FROM

In the previous situation, if the Course Selector was set to read a selected course (radial) of 82°, the TO-FROM Indicator would read \_\_\_\_\_

TO

FROM

## CDI Interpretation

The Course Deviation Indicator (CDI) is essentially represented by a vertical needle which is centered on the instrument dial when the airplane's position coincides with a radial (or bearing) selected by the pilot by means of the Course Selector.

Full displacement of the vertical needle to one side or the other occurs when the airplane is 10° (or more) off the selected course. Needle displacement between center and either side denotes proportionate displacement of the airplane from the course, from 0° to 10°.

For example, if the airplane were off course 5°, the needle would be half way between center and one side. Two or four dots (· · · ·) are usually provided on the instrument dial, each side of center, to indicate increments of degrees off course (Figure 5-19). If two dots are provided, each represents 5°; if four dots are used, each represents 2½° course displacement (from airplane). The airplane is imagined to be at the center of the dial, for purposes of "needle sensing".

Again using the example of HUGO VOR, with the 262° radial selected by the pilot, comparative CDI indications are shown. Note in the diagram, Figure 5-20, that a bearing is drawn in a magnetic direction of 262°, with HUGO VOR Station located at the approximate center of the line representing the bearing. Therefore, on the left side (west) of the station, the bearing extends "FROM" the station; on the right side of the station (east), the bearing 262° runs "TO" the station.

Airplanes are represented in six different positions and headings, three West and three East of the station, denoted by Letters A, B, C, D, E, F, Figure 5-20. Although headings differ, each airplane is either "on course" or has momentarily intersected the course.

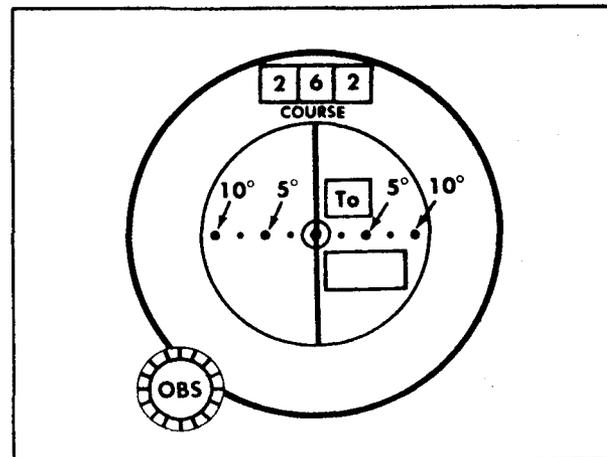


Fig. 5-19

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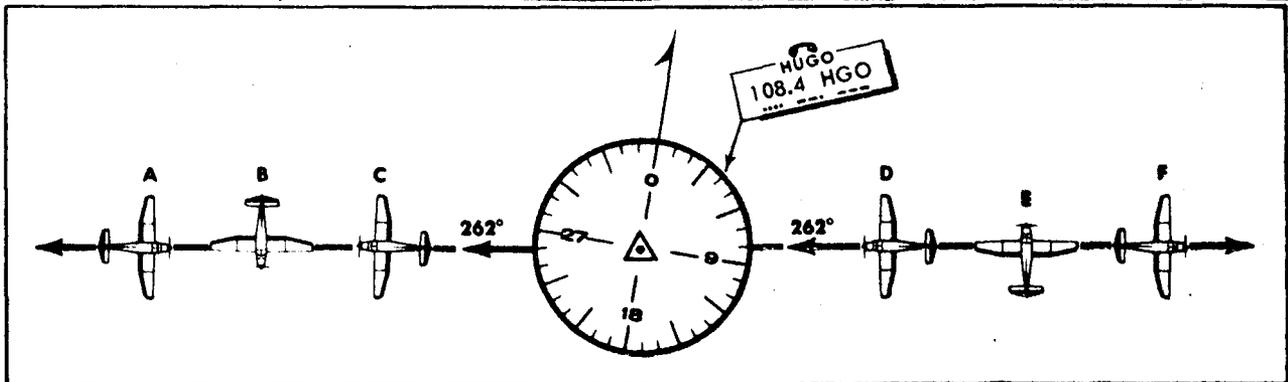


Fig. 5-20

In Figure 5-21, the left-hand instrument represents the CDI and TO-FROM indications that pilots of airplanes A, B, and C will see in the cockpit in this situation. It is significant to note that, regardless of airplane heading, each has the CDI needle centered and each reads "FROM". Each is on a line of position which is in a direction of 262° FROM the station, HUGO.

Also in Figure 5-21, the right-hand instrument shows that each of the airplanes D, E, and F has its CDI needle centered and the indicator reads "TO". This means that each of these airplanes is, at the moment, on a line of position which lies in a direction of 262° TO the station.

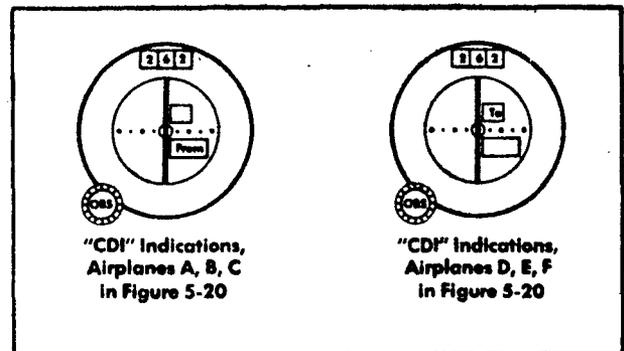


Fig. 5-21

In Figure 5-20, if the line drawn were designated as being in a direction of the reciprocal of 262°, which is 82°, the difference in cockpit indications would be that the TO-FROM indications are reversed. Airplanes West of the station would now have a "TO" indication—those East would have a "FROM" indication.

**EXERCISE:** Draw Figure 5-20 with an 82° bearing and show instrument indications for the six airplanes.

## Course Deviation Indicator (CDI) with its relation to the "TO-FROM" Indicator

This subject is described in conjunction with graphic portrayal of various airplane positions, beginning with those shown in Figure 5-22. The airplane is progressing from Position 1 through Position 3 and the Course Selector (OBS) is set to a bearing of 280° "TO" the station shown. (This is the same as a radial of the bearing reciprocal, 100°, but in this instance we are using a bearing.)

Note that the "TO-FROM" Indicator reads "TO" in this case. Also, since the airplane heading is in the same general direction as the bearing selected, CDI needle sensing will be "normal".

**Airplane Position No. 1:** The vertical needle (CDI) is displaced full travel to the left.

**Airplane Position No. 2:** Instrument indications have not changed; the airplane has reached a position of 10° from the selected course, hence the needle is displaced full travel left (course left of airplane).

**Airplane Position No. 3:** Here, the airplane has intercepted the selected bearing; therefore, the CDI needle has become "centered" with other indications unchanged.

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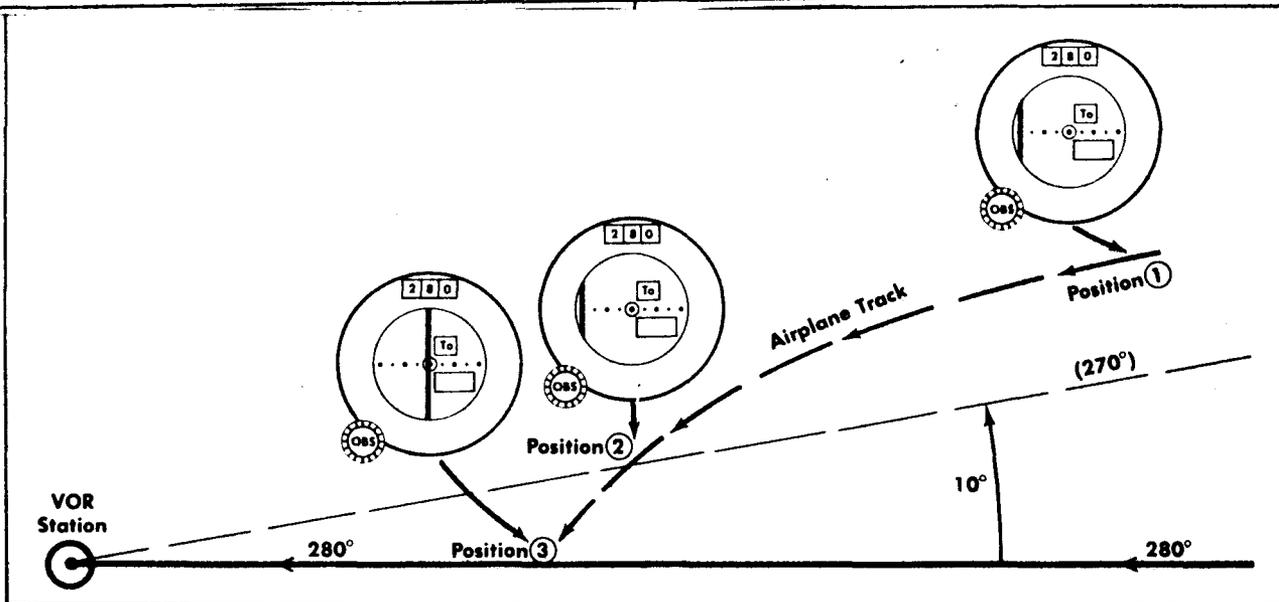


Fig. 5-22

The demonstration is now continued, using Figure 5-23. Here, the track is continued "outbound" followed by a turn to intercept the course, headed toward the station. Note that during the outbound segment of flight, the heading of the airplane is opposite to the selected course. This causes a condition of "reverse needle sensing".

*Airplane Position No. 4:* Here, the airplane is 10° from the course with a heading in the *opposite direction*. The needle is full *right*.

*Airplane Position No. 5:* The airplane track has again reached a position of 10° off the selected course, and the CDI needle is fully displaced *to the right*, (reverse needle sensing). The TO-FROM reading is *TO*.

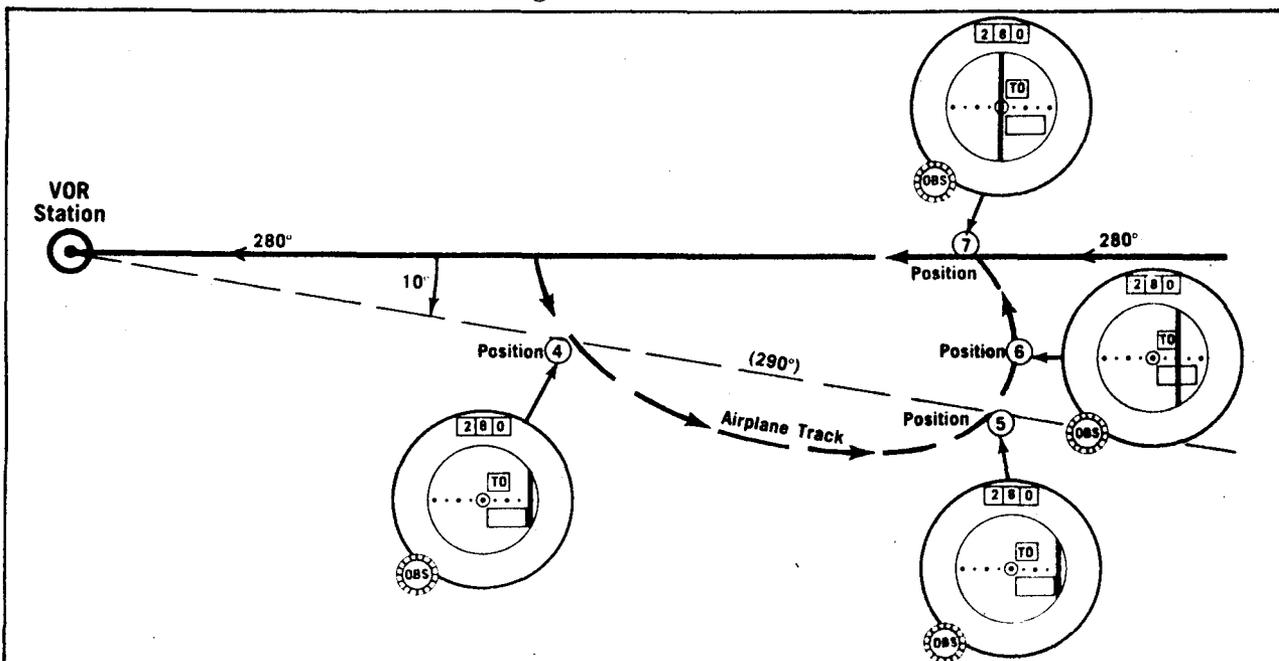


Fig. 5-23

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**Airplane Position No. 6:** The airplane is approximately 5° off the selected bearing; the CDI needle is about half way between center and full displacement *to the right*, reverse sensing. The TO-FROM reading is *TO*.

**Airplane Position No. 7:** The airplane has intercepted the selected course inbound toward the station; heading corresponds approximately to the bearing selected; CDI needle is centered. The TO-FROM reading is *TO*.

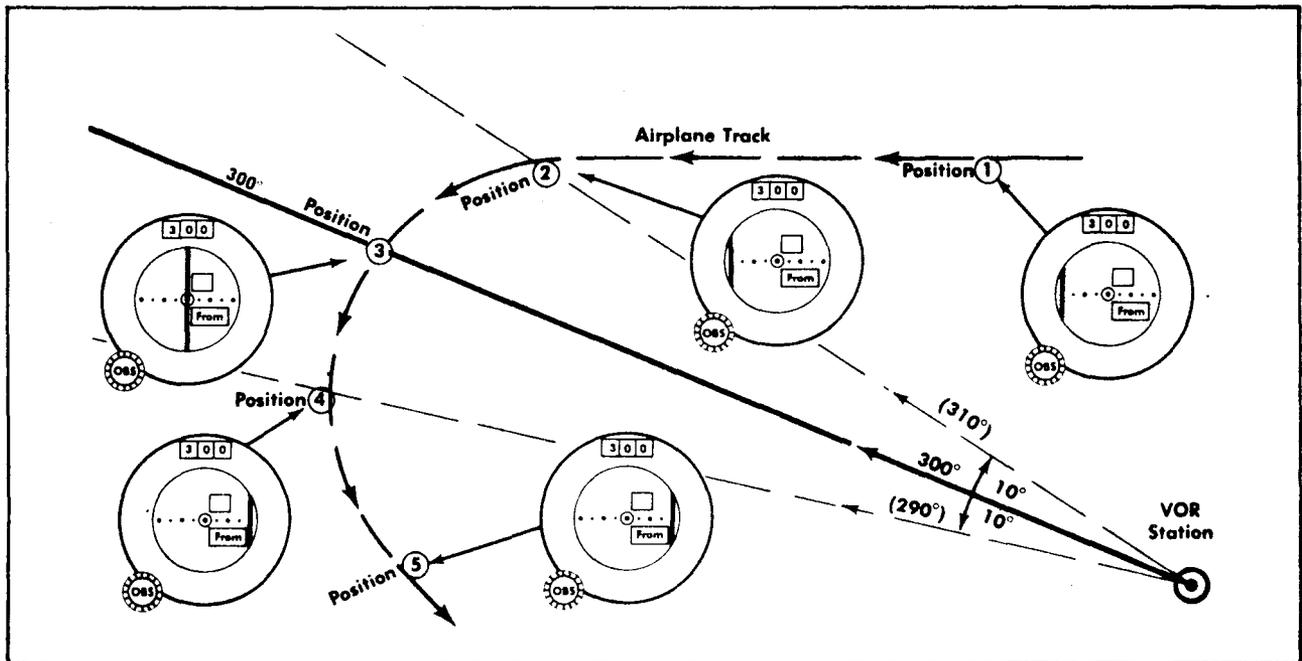


Fig. 5-24

## Airplane Position Vs. Instrument Indications, using Radials

The examples described here will use *radials* as opposed to the previous example using *bearings*. Again, graphic portrayals are used, the first in Figure 5-24. Note that the airplane at Position No. 1 is headed in a direction generally the same as the 300° radial which is drawn "FROM" the VOR Station. (Radials emanate from the station like the spokes of a wheel.) OBS (Course Selector) is set to 300°.

**Airplane Position No. 1:** (Figure 5-24) The airplane is more than 10° from the radial of 300°, and with a course of 300° selected, the CDI needle is displaced full *left* denoting that the course is left of the airplane's position (normal sensing). The TO-FROM Indicator reads *FROM* because the radial of 300° is a direction "FROM" the station.

**Airplane Position No. 2:** (Figure 5-24) Airplane is approximately 10° from the course selected and all instrument indications remain the same as they were for Position No. 1.

**Airplane Position No. 3:** The airplane has intercepted the 300° radial; the CDI needle is centered; other indications remain the same.

**Airplane Position No. 4:** The airplane has changed heading to the quadrant opposite the direction of the 300° radial; therefore, the CDI needle has moved to full travel on the *right*, although the course is to the left; this is caused by "reverse" needle sensing brought about by changing the general airplane heading opposite to course selected. The needle is fully displaced from center because the airplane is 10° off the course selected.

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*Airplane Position No. 5:* (Figure 5-24) Instrument indications are the same as in Position No. 4. The airplane is more than  $10^\circ$  off course; therefore, the CDI needle will remain at full displacement (reverse sensing).

## Station Crossing

The indications which denote that an airplane has passed over a VOR Station which is "tuned in" are generally as follows:

- The Vertical CDI Needle fluctuates to one side and returns to its original position, assuming no change has been made in the course selected.
- The TO-FROM Indicator changes to the opposite reading, TO to FROM or FROM to TO, again assuming no change was made in course selected.

Two examples of "station crossing" are portrayed in Figure 5-25. Positions 1 and 2 denote passage over the station, and Positions 3 and 4 denote passing by the station - not directly over it.

*Airplane Positions No. 1 and 2:* (Figure 5-25) When the airplane is at Position No. 1 "on course", the selected course is a bearing of  $60^\circ$  "TO" the station; the CDI needle is centered; and the "TO-FROM" Indicator reads *TO*.

As the station is approached, the vertical needle fluctuates to one side during station crossing. After crossing the station, the TO-FROM Indicator changes to *FROM*. This is true because the selected bearing of  $60^\circ$  now has become a radial of  $60^\circ$  "FROM" the station.

*Airplane Positions No. 3 and 4:* (Figure 5-25) This example represents an airplane which is passing by (not over) the station. Since the Course Selector is set to  $60^\circ$  and the airplane is right of the station (but not yet opposite the station) in Position No. 3, the vertical needle is displaced full *left* (normal sensing) and the TO-FROM Indicator reads *TO*. As the station is passed, the needle fluctuates side to side, and after passage the TO-FROM Indicator changes to a reading of *FROM*.

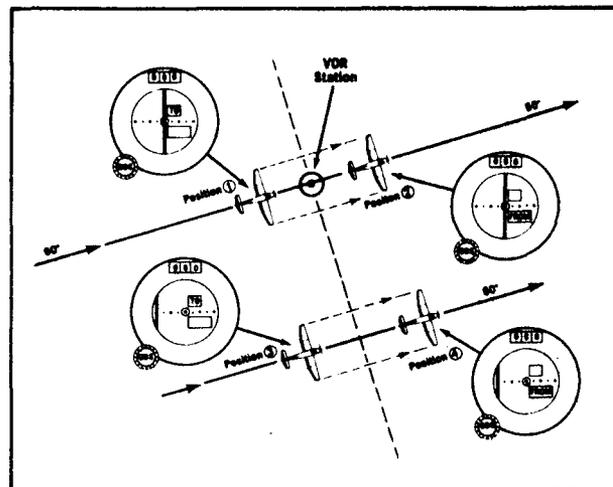


Fig. 5-25

Since the visual indications of the VOR cockpit equipment do not require use of the volume control, this control is used for volume level, code identifiers and \_\_\_\_\_ communications.

The pilot should positively identify the VOR Station "tuned in" by listening to the voice or \_\_\_\_\_ identifier.

voice

The pilot may select any one of 360 courses, or radials, of a VOR Station by use of the \_\_\_\_\_.

code

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The procedure for tuning and identifying a VOR Station is as follows:

- (1) VOR Power Switch \_\_\_\_\_
- (2) Determine published station, frequency and identifier from \_\_\_\_\_  
(name of source)
- (3) ROTATE tuning control knobs of Frequency Selector until published \_\_\_\_\_ appears in the Frequency Selector "window".
- (4) Turn UP Volume Control level to receive clearly \_\_\_\_\_ and/or \_\_\_\_\_ identifiers.
- (5) Positively \_\_\_\_\_ the station by listening to voice and code identifiers.

Course  
Selector

On Jeppesen Avigation Enroute Charts, the names of VOR Stations, their frequencies and identifiers are published within a small rectangular box located adjacent to the \_\_\_\_\_

- (1) ON
- (2) Jeppo Chart  
or RF Chart,  
J-AID, Airman's  
Guide
- (3) Frequency
- (4) Voice  
Code
- (5) identify

After a bearing or radial has been selected by means of the Course Selector, and the airplane is positioned on the bearing or radial selected, the Course Deviation Indicator vertical needle will be \_\_\_\_\_. (Give position of needle.)

VOR Station

To locate the airplane relative to a station, rotate the Course Selector until the needle is \_\_\_\_\_. The course now selected indicates direction to the station if the TO-FROM Indicator reads \_\_\_\_\_.

centered

Full displacement either side of center of the CDI vertical needle occurs when the airplane is displaced \_\_\_\_\_ degrees or more from the course selected.

centered  
"TO"

If an airplane is displaced from the selected course by an angle of 5° (relative to the VOR Station), the vertical CDI needle will be positioned \_\_\_\_\_ (where?) between center and one side of the instrument.

10

Two airplanes, each having selected 90° on the Course Selector, are positioned on a radial of 90° FROM the same VOR Station. One airplane is headed East, the other West.

- a. The vertical CDI needle of the airplane headed East will be \_\_\_\_\_
- b. The vertical CDI needle of the airplane headed West will be \_\_\_\_\_

half-way

In the previous exercise, the "TO-FROM" Indicator

- a. of the airplane headed East will read \_\_\_\_\_
- b. of the airplane headed West will read \_\_\_\_\_  
(Answer "TO" or "FROM".)

- (a) centered
- (b) centered

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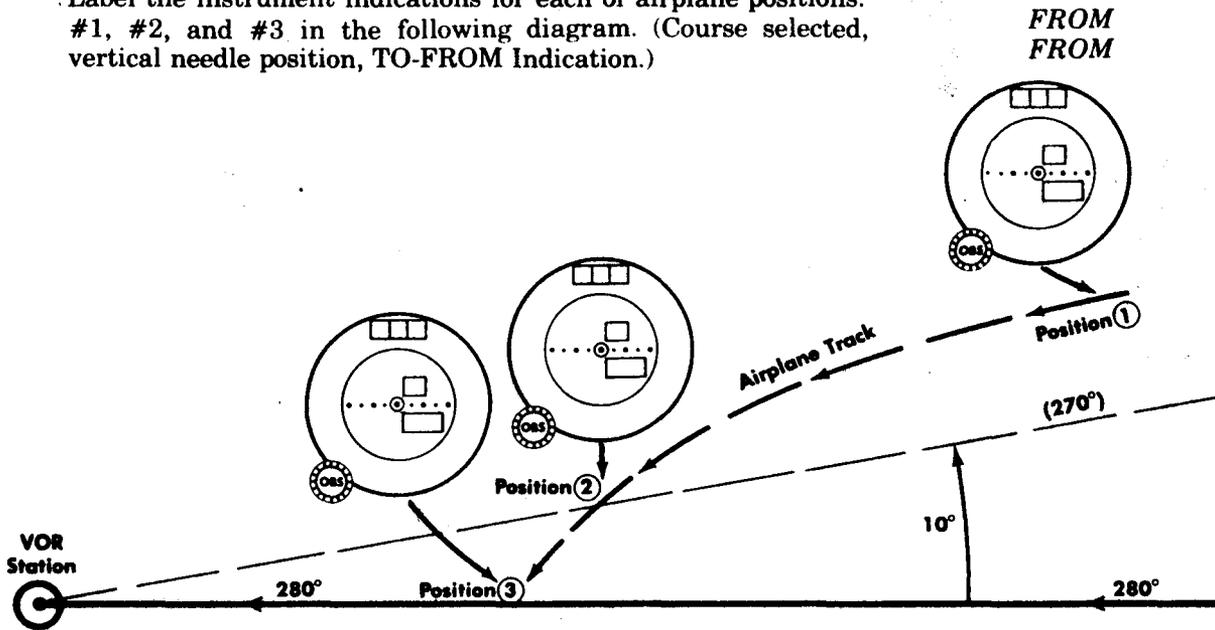
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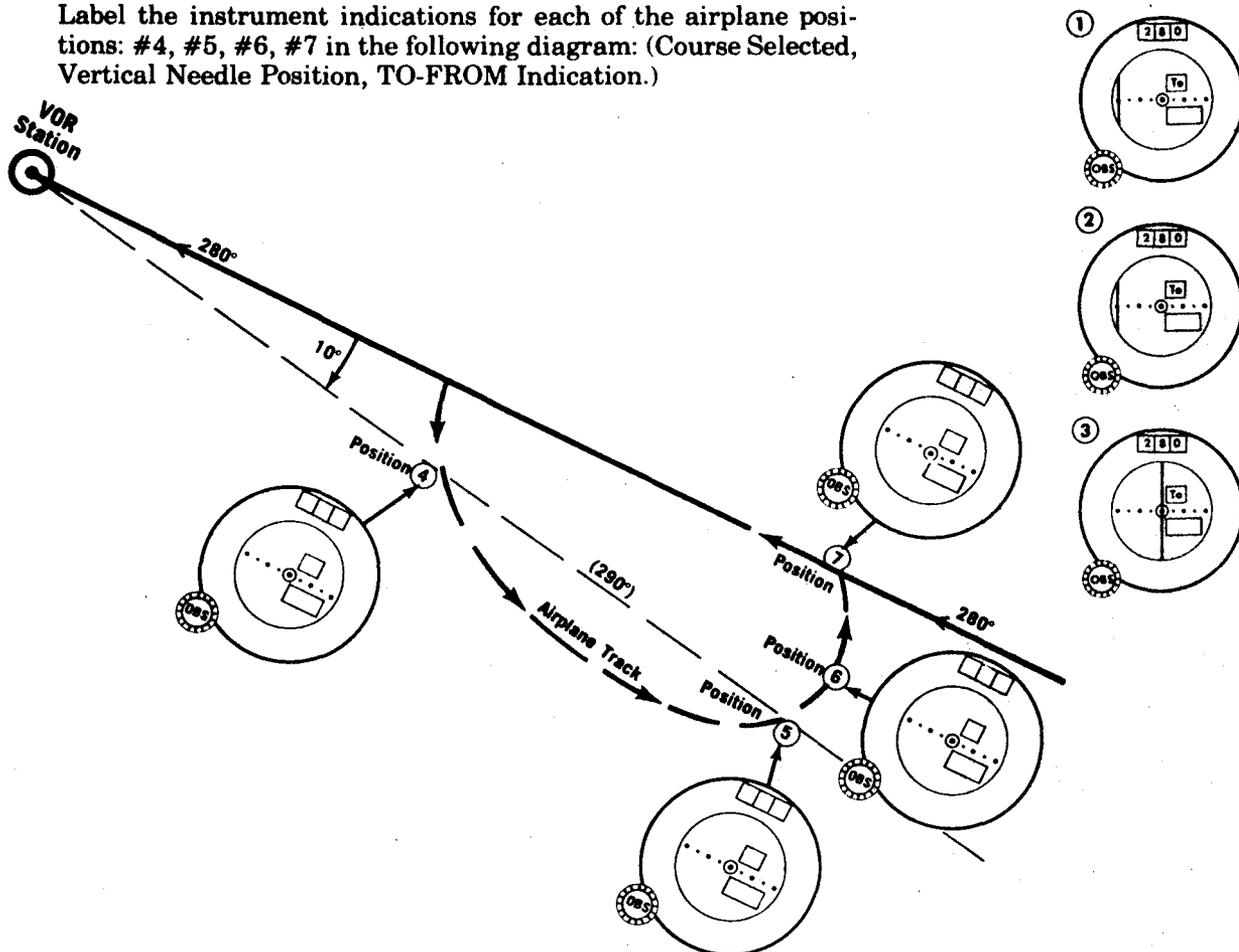
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Label the instrument indications for each of airplane positions: #1, #2, and #3 in the following diagram. (Course selected, vertical needle position, TO-FROM Indication.)



Label the instrument indications for each of the airplane positions: #4, #5, #6, #7 in the following diagram: (Course Selected, Vertical Needle Position, TO-FROM Indication.)



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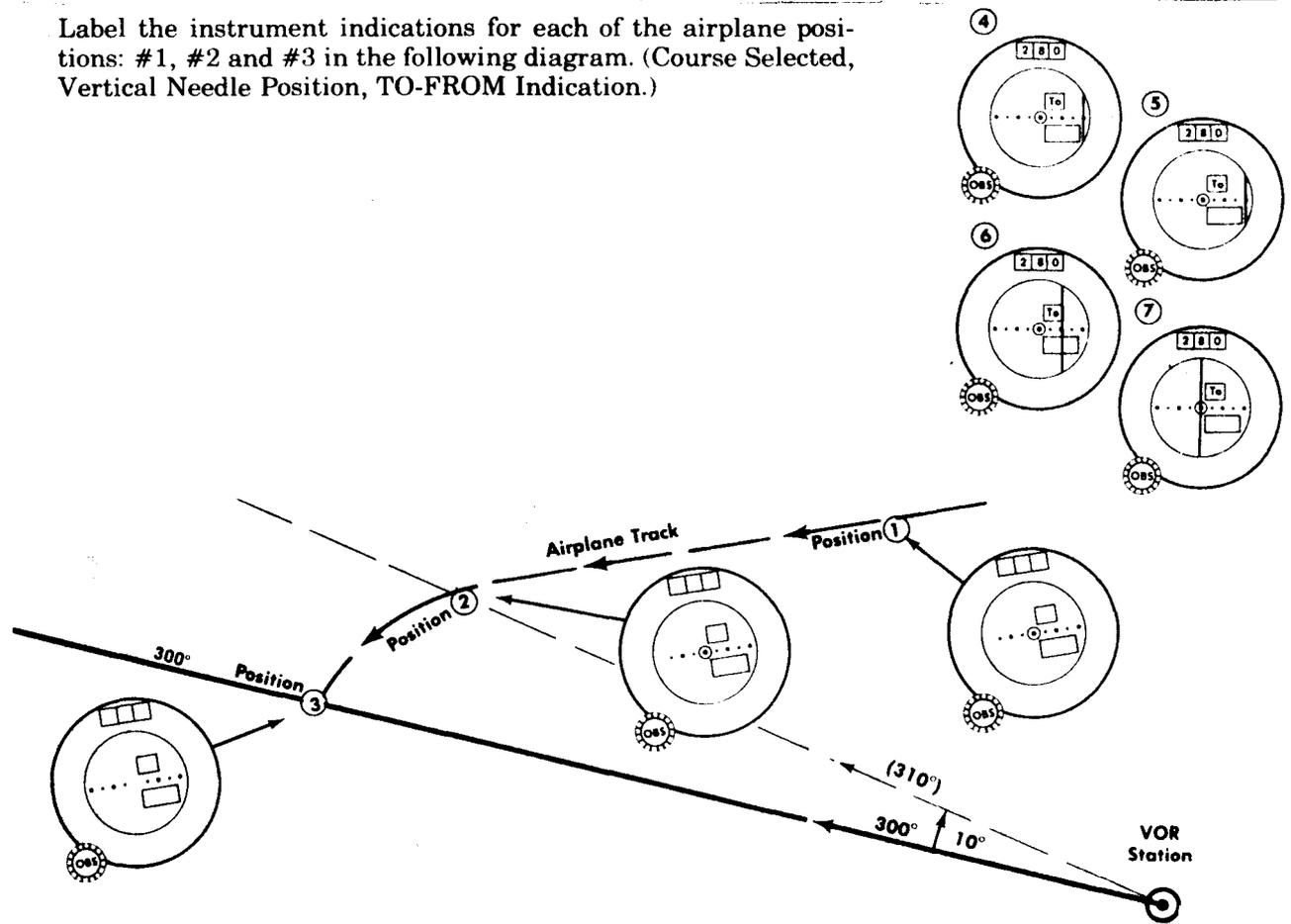
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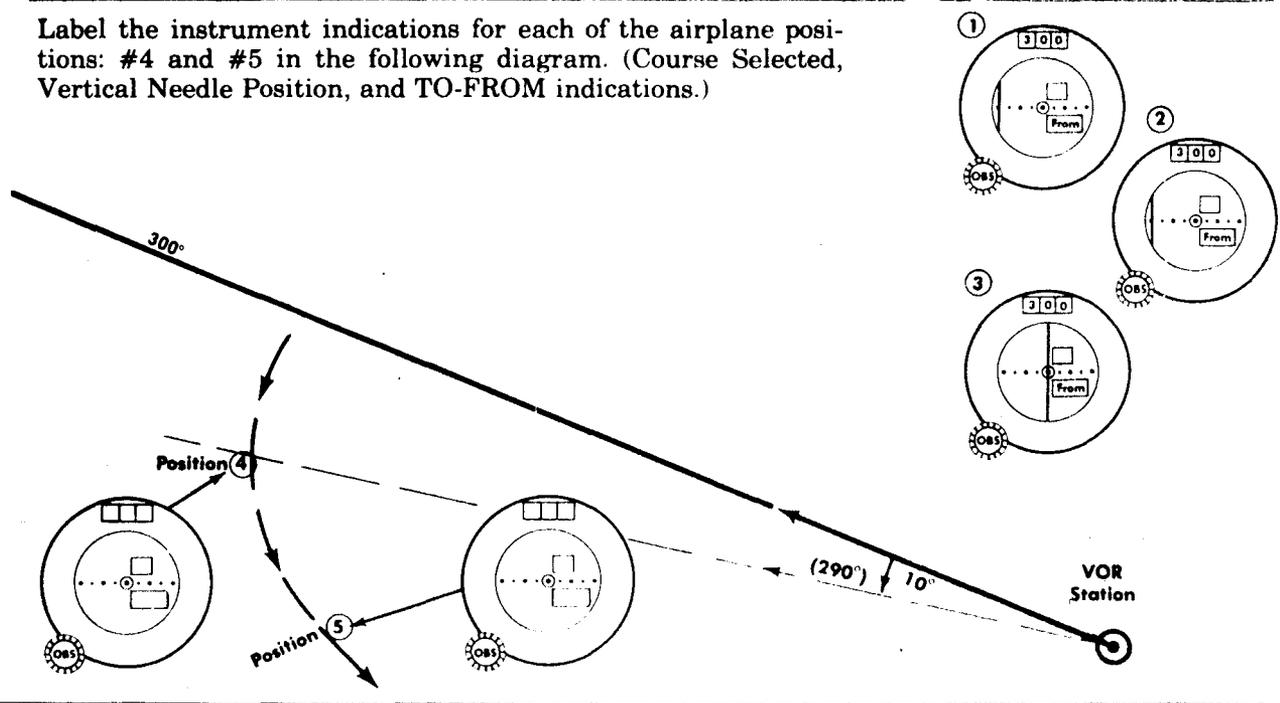
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Label the instrument indications for each of the airplane positions: #1, #2 and #3 in the following diagram. (Course Selected, Vertical Needle Position, TO-FROM Indication.)



Label the instrument indications for each of the airplane positions: #4 and #5 in the following diagram. (Course Selected, Vertical Needle Position, and TO-FROM indications.)



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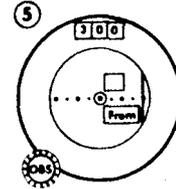
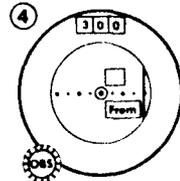
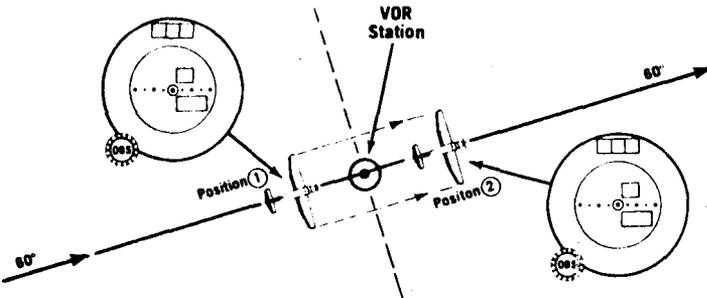
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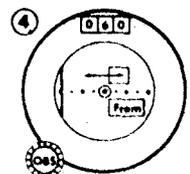
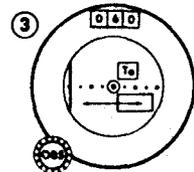
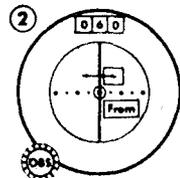
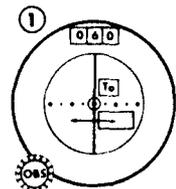
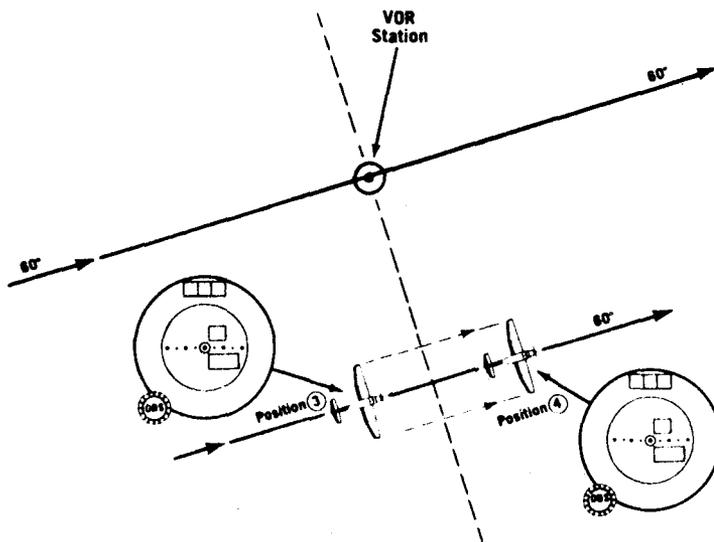
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Label the instrument indications for each of the airplane positions: #1—before flying over the VOR Station; and #2—after crossing the station, in the following diagram. (Course Selected, Vertical Needle Position, and TO-FROM indications.)



Label the instrument indications for each of the airplane positions: #3—before flying past the VOR Station; and #4—after passing the station, in the following diagram. (Course Selected, Vertical Needle Position and TO-FROM indications.)



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## VOR Position Fix

In using two VOR Stations to obtain a position fix, it is necessary to tune and identify the desired stations. Center the needle with the Course Selector by rotating it until the needle centers with the TO-FROM Indicator reading FROM. If the airplane has a single VOR receiver, draw the outbound bearing of the first station from the station and use the same procedure for the second station. The position of the airplane is at the point of intersection of the two outbound bearings you have drawn on your chart, Figure 5-26.

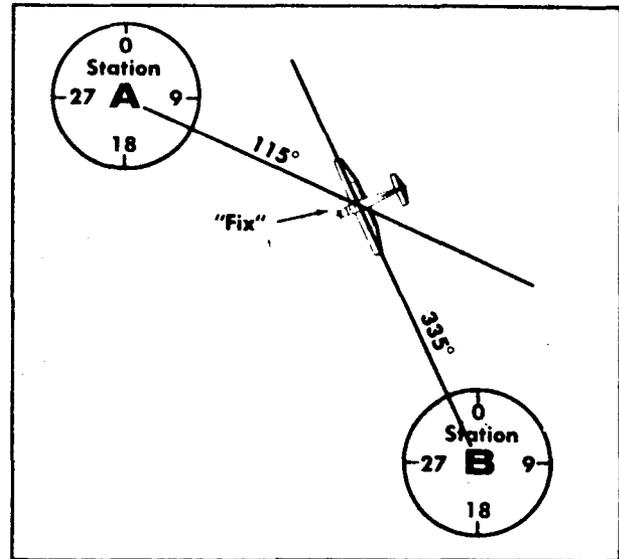


Fig. 5-26 - VOR "Fix"

In using a VOR Station to establish a position fix, with bearings from two stations, each station must be respectively tuned and \_\_\_\_\_

The Course Deviation Needle must be \_\_\_\_\_

*identified*

With the CDI needle centered, the TO-FROM Indicator should read \_\_\_\_\_

*centered*

With the needle centered and indicating FROM, you will have the \_\_\_\_\_ from the station.

*FROM*

After taking a bearing from a second station, the position of the airplane will be at the point where the two bearings \_\_\_\_\_, Figure 5-26.

*bearing (radial)*

*intersect*

## TACAN

### General Information

The term TACAN means: TAC = Tactical  
A = Air  
N = Navigation

The TACAN system provides OMNI-Directional Azimuth and distance information to a pilot for relatively short range enroute air navigation. It has the added capability of being used as an instrument letdown and approach aid.

TACAN ground equipment consists of either a fixed or mobile transmitting station, or unit. The airborne equipment, in conjunction with the ground unit, changes the transmitted signals to a visual presentation of both azimuth and distance information. TACAN operates in the UHF band of radio frequencies.

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The Azimuth, directional, portion of TACAN measures the phase angle between two radiated signals and provides information of Magnetic Azimuth (bearings) between the station and the point where the phase difference is measured. This information is usually presented to the pilot on his Radio Magnetic Indicator (RMI) and/or on the Course Deviation Indicator (CDI).

## Distance Measuring Equipment (DME)

The distance portion continuously measures the time interval between an "interrogating" signal transmitted by the airplane equipment and a "reply" transmitted by the ground station — *and converts the time interval into distance.* This information is presented to the pilot on either a "counter" type or an "indicating" type instrument in the form of a dial, Figure 5-27. DME operates on UHF but is often paired with a VHF-VOR Azimuth frequency so that a constant position may be obtained. Tune to a VOR Station that has

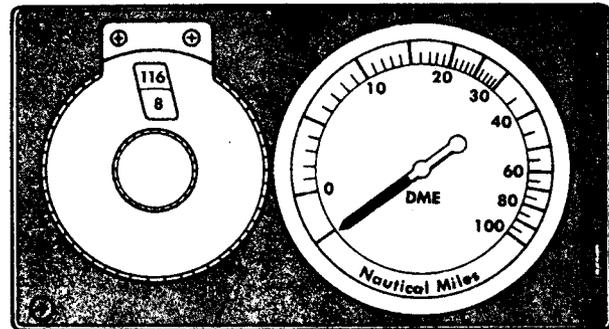


Fig 5-27 - DME Panel

DME and, if your airplane is equipped with a DME Receiver, you can obtain your distance from the station and with the VOR Receiver the magnetic bearing (radial) from the station. To get your distance from a VOR Station that has DME equipment, simply note the distance read on the airplane DME Indicator. This is the distance along the radial on which you are flying.

## VORTAC

### General Information

The term VORTAC means

VOR—VHF OMNI-Directional Range (Conventional VOR)

TAC—TACAN (Tactical Air Navigation System)

The VORTAC is a combination facility incorporating azimuth information from *both* the VOR and the TACAN, plus distance information as provided by TACAN.

Like each counterpart of its system, it has the added capacity of being usable as an instrument letdown and approach aid.

Although consisting of more than one component, incorporating more than one operating frequency, and using more than one antenna system, VORTAC is considered to be a unified aid for navigation.

Standby ground equipment is usually provided, and provision is made for switch over to standby, in event of failure or malfunction of primary ground equipment.

This system is subject to the same line-of-sight limits as VOR and the transmission has similar characteristics.

### VOR Test Facilities

Regulations state that all VOR receivers must be periodically checked for accuracy when they are used for IFR operations. This may be accomplished in several ways, one of which is the *VOR test facility* (VOT). These test facilities are located at many large airports throughout the United States.

The VOT transmits a test signal on frequencies within the VOR receiver range. The signal is aurally identified by a continuous stream of dots or a continuous 1020 cycle tone. All VOT's transmit a signal which will cause the course deviation indicator to center only when the course selector is

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set to 180° or 360°. Regardless of where the airplane is actually located on the airport, the TO-FROM indicator will always indicate *TO* when 180° is set in the course selector and *FROM* when 360° is set in the course selector. If an automatic bearing indicator is associated with the VOR receiver, it will always indicate 180° when the test frequency is tuned.

Other methods of testing VOR accuracy both in the air and on the ground are outlined in the appropriate regulations. The pilot should be aware of each of these methods and the degree of VOR accuracy which applies to each.

.. The mandatory VOR receiver check is applicable to (IFR) (VFR) _____ operations.	
.. The symbol for VOR test facility is _____	<i>IFR</i>
.. VOT's transmit on frequencies within the _____ receiver range.	<i>VOT</i>
.. VOT's transmit a signal which causes the course deviation _____ to center when the course selector is set to 360° or _____	<i>VOR</i>
.. Regardless of where the airplane is located on the airport, if the course selector is set to 180°, the TO-FROM indicator will indicate _____	<i>indicator</i> <i>180°</i>
.. When using a VOT, a course selector setting of 360° will produce a TO-FROM indication of _____	<i>TO</i>
.. When the VOR receiver is tuned to a VOT frequency, the course deviation indicator will not center unless the course selector is set to _____ or _____	<i>FROM</i>
.. The instrument indication associated with the use of a VOT is not affected by the location of the _____ on the airport.	<i>360°</i> <i>180°</i>
.. If an automatic bearing indicator is incorporated in the airborne VOR equipment, it will indicate _____ degrees when the VOT is tuned.	<i>airplane</i>
	<i>180°</i>

## INSTRUMENT APPROACHES

### Instrument Landing System (ILS)

The Instrument Landing System (ILS) employs radio transmitting equipment on the ground and receiving equipment in the airplane to provide the pilot with a visually indicated path to the runway. Marker beacons are located on the ILS front course and their distance to the airport is published on the approach chart.

The ground equipment may be divided functionally into three parts—the localizer, the glide slope and the marker beacons.

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The Instrument Landing System employs radio transmitting equipment on the ground and radio \_\_\_\_\_ equipment in the airplane.

ILS gives the pilot a visually indicated path to the \_\_\_\_\_

*receiving*

The airplane receiving equipment gets information from three sources—localizer, glide slope and marker \_\_\_\_\_

*runway*

The marker beacons are nondirectional beacons and their distance from the runway is \_\_\_\_\_ on approach charts.

*beacons*

The ground transmitting equipment for the ILS includes the marker beacons, the localizer and glide \_\_\_\_\_ transmitters.

*published*

*slope*

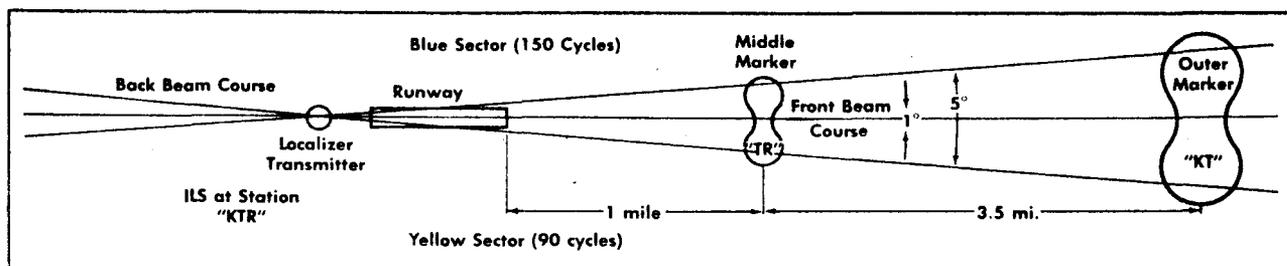


Fig. 5-28—ILS Localizer Pattern

## Localizer

The localizer transmitter provides the azimuth directional information for ILS. It is located at the far end of the runway from the front course approach end. The transmitter, operating on any one of twenty frequencies within the band of 108.0 mc to 111.9 mc, sends out two patterns modulated at 150 and 90 cycles per second. These two signal patterns overlap along a line formed by an extension of the runway. This line, or course, is identified by the airplane receiving equipment as the area of equal signal strength between the two patterns. The course formed by the localizer signals has an overall width of 5° (Figure 5-28).

For reference, the 150 cycle area to the right of the "in-bound" approaching airplane on the ILS "front course" is designated the "blue" area, and the 90 cycle area to the left of the approaching airplane is called the "yellow" area. The approach course of the localizer is called the front beam, or course, and the course along the centerline of the runway in the opposite direction (and on opposite end) is called the back course. The localizer transmitter has a range of approximately 40 miles at an altitude of 5,000 feet and 80 miles at 10,000 feet. A typical localizer course is depicted in Figure 5-28.

Azimuth (directional) information for ILS is provided by the \_\_\_\_\_ transmitter.

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The ILS localizer is located at the end of the runway opposite the front course \_\_\_\_\_ end.

*localizer*

The localizer transmits on any one of ten frequencies between 108.0 and \_\_\_\_\_ mc.

*approach*

The frequency band of the ILS localizer is within \_\_\_\_\_ and \_\_\_\_\_

*111.9*

The transmitter sends out two signal patterns, 150 and 90 cycles per second. The 150 and 90 cycle signals overlap along a line projected from the center of the \_\_\_\_\_

*108.0 mc  
111.9 mc*

The airplane equipment identifies the on-course by sensing the area of equal strength between the 150 and \_\_\_\_\_ cycle signals.

*runway*

The two signal patterns are given a color designation, yellow and blue. The 150 cycle signal area is blue, the 90 cycle signal area is \_\_\_\_\_

*90*

The blue designation is to the right of in-bound approaching airplanes, the yellow designation is to the \_\_\_\_\_

*yellow*

The localizer transmits two signal patterns, one is \_\_\_\_\_ cycles per second and the other is \_\_\_\_\_ cycles per second.

*left*

The 150 cycle signal area is designated by \_\_\_\_\_ color and is on the \_\_\_\_\_ side of a front course approach.

*150  
90*

The 90 cycle signal area is on the \_\_\_\_\_ side of a front course approach and the color designation is \_\_\_\_\_

*blue  
right*

The area of equal signal strength between the two signals is on a line projected from the \_\_\_\_\_ of the runway.

*left  
yellow*

The frequency of the localizer is in the band between \_\_\_\_\_ and \_\_\_\_\_ mc.

*center*

The localizer transmits signals in both directions to form two courses. The two courses are termed the front course and the \_\_\_\_\_ course.

*108.0  
111.9*

The localizer transmitter has a range of 40 miles at 5,000 feet, 80 miles at 10,000 feet and transmits on a frequency of 108.0 to \_\_\_\_\_

*back*

At 5,000 feet, the localizer has a range of \_\_\_\_\_ miles.

*111.9 mc*

The localizer has a range of 40 miles at 5,000 feet and \_\_\_\_\_ at 10,000 feet.

*40*

*80*

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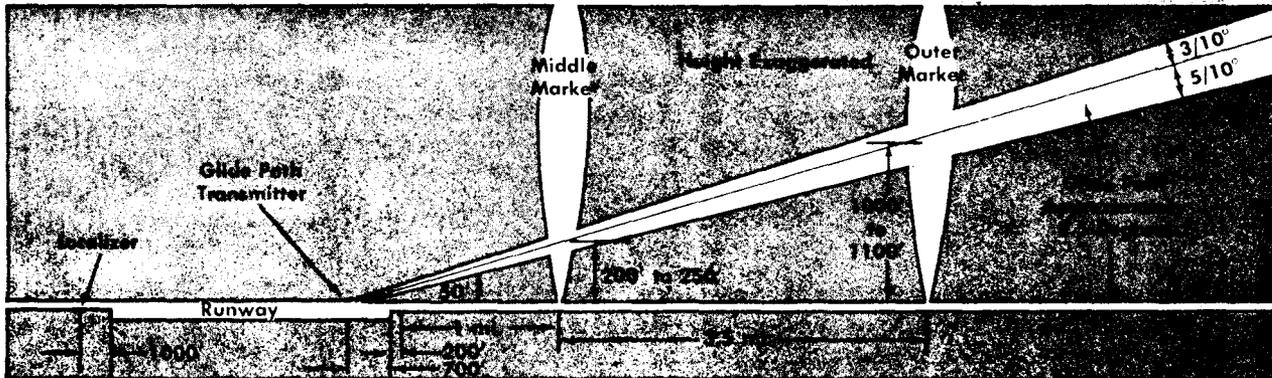


Fig. 5-29 - ILS Glide Slope Pattern

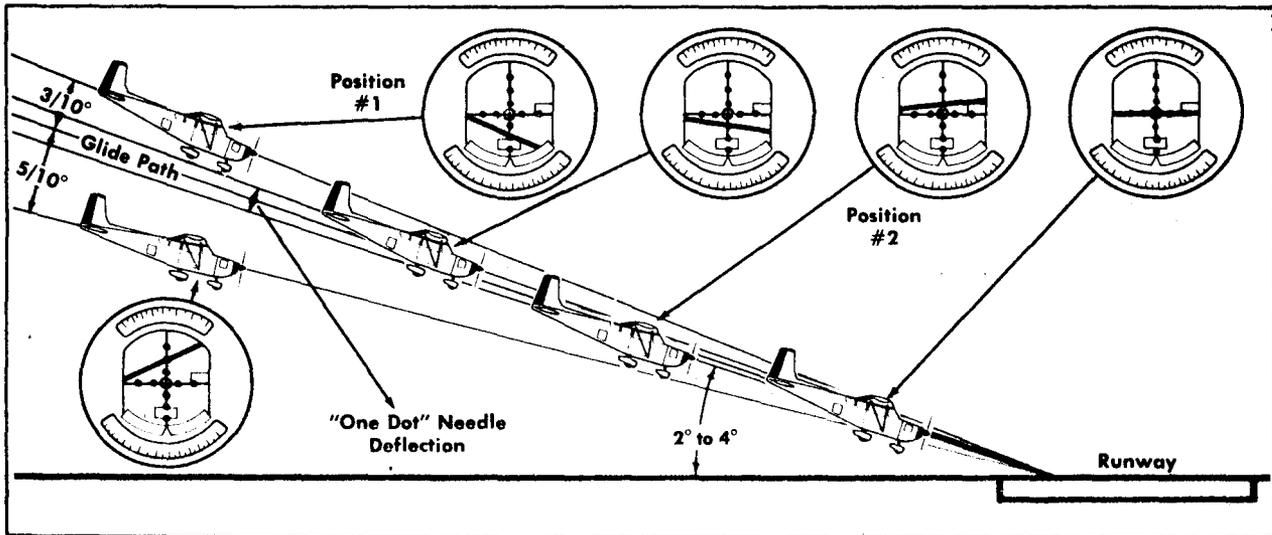


Fig. 5-30 - ILS Glide Slope with Airplane Positions and Cockpit Instrument Indications

## Glide Slope

The glide slope transmitter is normally located approximately 750 feet from the approach end of the runway and approximately 400 feet from the center line of the runway. It transmits a beam of  $0.8^\circ$  in width at an angle of approximately  $2.5^\circ$  from the horizontal. The glide slope beam may be adjusted to angles between  $2^\circ$  and  $4^\circ$ . The glide slope transmitter emits its signals in the direction of the final approach and sends practically no signal toward the back course. The glide slope transmitter operates on any one of 20 channels in the band of 329.3 mc to 335.0 mc, sending out vertical patterns which are modulated at 90 cycles and 150 cycles. The airplane receiver identifies the glide slope as a line of equal signal strength between the 90 and 150 cycle patterns. Figures 5-29 and 5-30 depict a typical glide slope.

The glide slope transmits the same type of signal pattern as the localizer, except patterns are vertically arranged. One signal is 90 cycles and the other is \_\_\_\_\_ cycles.

The glide slope "beam" is an area of equal strength between the two \_\_\_\_\_

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The angle of the glide slope is approximately 2.5° and is transmitted in the direction of the _____ end of the runway.	<i>signals (patterns)</i>
The ILS approach angle is approximately _____ degrees.	<i>approach</i>
A glide slope of approximately 2.5 degrees is transmitted to the approach end of the runway. There is no useable glide slope for the back _____.	<i>2.5</i>
The glide slope frequency band includes 20 frequencies between 329.3 mc and 335.0 mc. These frequencies are paired with the localizer frequencies 108.0 to _____.	<i>course</i>
When a localizer frequency is tuned-in (or selected), the matching slide slope frequency is automatically _____ in.	<i>111.9 mc</i>
	<i>tuned</i>

## Marker Beacons

The ILS normally has two marker beacons—an outer marker (OM) and a middle marker (MM). Usually the outer marker or middle marker also has a low or medium power *compass locator transmitter* to aid in orientation with the ILS course. The outer marker normally is located 4 to 10 miles from the approach end of the runway and within 250 feet of an extended center line of the runway and emits a signal keyed at two dashes (--) per second. The middle marker is located between approximately 3,500 feet and one mile from the runway and within 250 feet of the center line, and transmits a series of alternate dots and dashes (---). The compass locator transmitter usually has a power output of 25 watts and a maximum range of 15 miles. Most of these transmitters emit varying signals according to their position. The outer marker usually transmits the first two letters of the three letter station identifier and the middle marker usually transmits the last two letters of the same identifier. Figure 5-28 shows a hypothetical arrangement with Station KTR—(OM) KT, (MM) TR.

The ILS normally has two marker beacons, an outer marker and a middle _____.	
Usually the markers include compass locators. The compass locators aid in orientation to the _____ course.	<i>marker</i>
The outer marker is located from 4 to 10 miles from the approach end of the _____.	<i>ILS</i>
The outer marker, located on the front course of the ILS is from 4 to _____ miles from the runway.	<i>runway</i>
The middle marker is approximately one mile from the runway; the outer marker is between _____ and _____ miles from the runway.	<i>10</i>

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The middle marker is approximately _____ mile from the runway.	4 10
Outer marker compass locators are identified by the first two letters of the station _____.	1
The compass locator at the middle marker is identified by the _____ two letters of the station identifier.	identifier
	last

## ILS Airborne Equipment

Figures 5-31 and 5-32 are representative of the approach indicator and the outer and middle marker indicators used in many airplanes. Figure 5-32 shows the lights that blink when over the respective markers indicated in the figure.

The approach indicator is usually the same as the one used for VOR. The same tuning equipment is used for ILS as is used in tuning VOR stations. As shown on Figure 5-31, the approach indicator has two "crossed" indicating needles. The vertical needle supplies a visual indication of the lateral position of the localizer on-course signal with respect to the airplane when flying inbound on the front course or outbound on the back course. The horizontal needle represents the glide slope and gives fly-up and fly-down indications which enable the pilot to locate and keep the airplane on the glide slope.

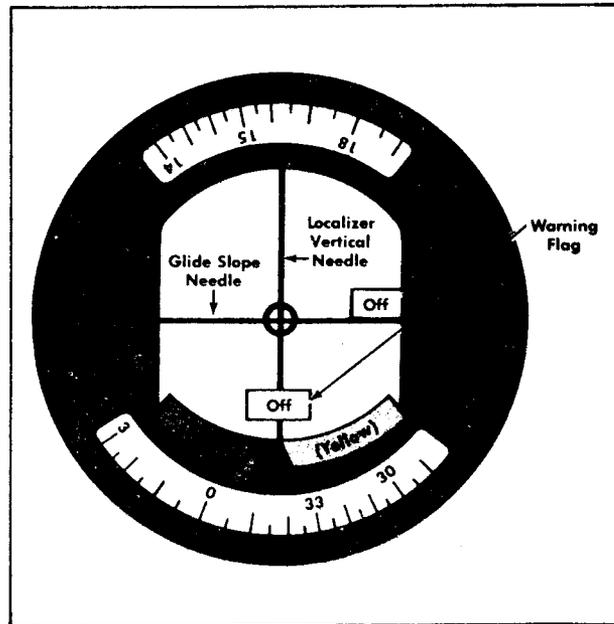


Fig. 5-31 - ILS Cockpit Indicator

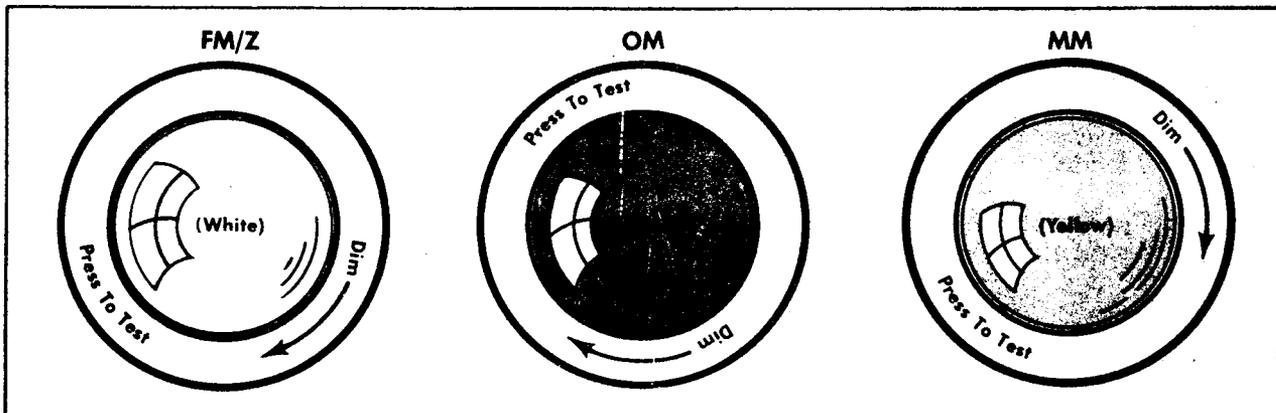


Fig. 5-32 - Marker Beacon Cockpit Indicator Lights

## Use of ILS Airborne Equipment

When using the ILS, the vertical needle indicates the "yellow" or "blue" color area of the sector in which the airplane is flying (Figure 5-33). If the airplane is flying off course in the yellow area of the transmitter, the needle is deflected into the yellow area of the indicator. If it is flying in the blue sector,

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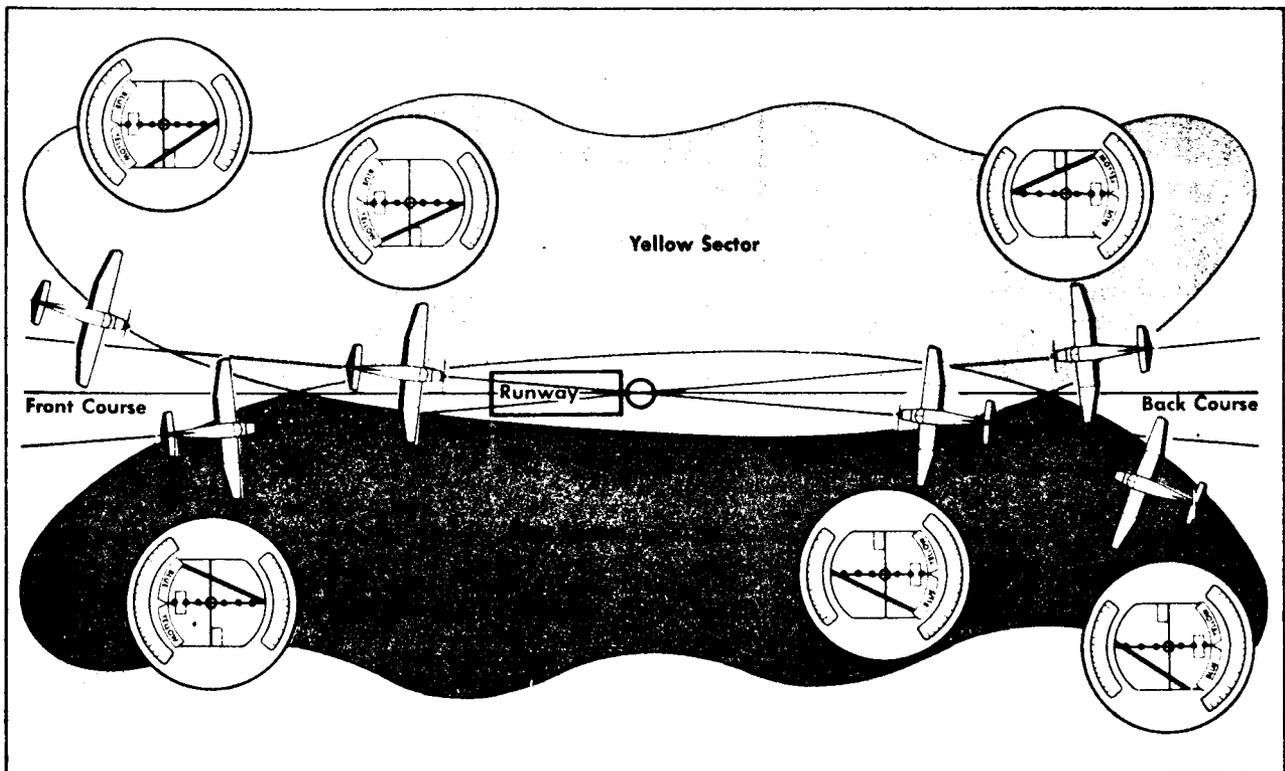


Fig. 5-33--ILS Localizer Front Course and Back Course, Airplane Positions and Cockpit Instrument Indications

the needle is deflected into the blue area of the indicator. The needle is very sensitive and gives a full-scale deflection when the airplane is  $2.5^\circ$  to either side of the on-course. A one-fourth scale deflection indicates a distance of 75 feet from the center of the on-course when the airplane is 5,000 feet from the localizer. A one-fourth deflection at one-half mile from the localizer indicates the airplane is approximately 38 feet from the center of the on-course.

The direction toward the beam is not always indicated by the direction of needle deflection. The indicator has its blue area on the left and yellow on the right, in order to make the needle directional *when the airplane is approaching the runway on the front course*. When the airplane is flying toward the runway on the front course, or away from the runway on the back course, *follow the needle*. When the airplane is flying away from the runway on the front course, or toward the runway on the back course, *fly away from the needle*. Regardless of the position or heading of the airplane, the needle is always deflected to that color area in which the airplane is flying. The blue area is on the left side of the indicator, the yellow area is on the right side.

In tuning the ILS, most airplane receivers are arranged so that it is only necessary to tune the localizer. This is possible because these radios are crystal tuned. When the localizer frequency is tuned, if the airplane is equipped with glide slope receiver, the glide slope is automatically tuned to its frequency. The glide slope operates in the frequency band of 329.3 mc to 335.0 mc and is selected and tuned automatically when the localizer is tuned.

During an approach, when the airplane is above the glide slope, the horizontal needle (Figure 5-31) is deflected downward (Figure 5-30, Position 1); and when the airplane is below the glide slope, the horizontal needle is deflected upward (Figure 5-30, Position 2). The glide slope needle is always displaced in the direction the airplane must be flown to approach the glide slope. This is true regardless of the heading of the airplane.

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ILS indicators which are most often used in transport airplanes give an "on glide slope" indication when the receiver is off or not functioning properly, however, in this situation an "OFF" flag is displayed over the horizontal needle. When reliable glide slope signals are being received, the flag rotates out of sight.

The glide slope needle gives a full-scale deflection when the airplane is  $0.5^\circ$  below or  $0.3^\circ$  above the glide slope. Figure 5-30 shows typical indications of the glide slope needle when the airplane is above and below the glide path. The great sensitivity of the needle requires that the airplane be aligned accurately on the glide slope at a given distance from the field. Only very minor corrections are recommended near the ground.

The pilot must remember that, when using ILS, he must align the horizontal and vertical needles as soon as possible after intersecting the glide slope and keep them centered for the entire approach.

ILS signals are usually received on the _____ receiver.	
Azimuth and glide slope information are usually presented on the combination VOR and glide slope _____.	VOR
The vertical needle gives directional information from the ILS _____.	indicator
The horizontal needle gives _____ slope information.	localizer
The vertical needle always indicates the color sector in which the _____ is flying.	glide
Flying toward the runway on the front course, the needle is directional. With the airplane off course to the right, the needle will be in the (blue) (yellow) _____ sector.	airplane
Flying in the blue sector, approaching the runway on the front course, the correction would be made (toward) (away from) _____ the needle.	blue
Flying away from the runway on the back course, the needle remains _____.	toward
When flying toward the runway on the back course, the needle is not directional. The needle always indicates the color sector in which the airplane is located, therefore, inbound on the back course corrections are made away from the _____.	directional
Corrections are made away from the needle when inbound on the back course, this is also true when flying outbound on the _____ course.	needle
The blue sector is on the right side of the approach bearing on the _____ course and on the left for the _____ course.	front

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The azimuth (vertical) needle always indicates the color sector in which the airplane is \_\_\_\_\_.

*front  
back*

The azimuth indicator will be fully deflected when the airplane is 2.5 degrees either side of the \_\_\_\_\_ line.

*flying*

The azimuth needle indicates a full scale deflection from the center line when the airplane is at least \_\_\_\_\_ degrees off the center line.

*center*

The glide slope needle indicates a full scale deflection when the airplane is 0.5° below or 0.3° \_\_\_\_\_ the glide slope.

*2.5*

The glide slope needle indicates a full scale deflection when the airplane is \_\_\_\_\_° below and/or \_\_\_\_\_° above the glide slope.

*above*

The glide slope is automatically received when the receiver is tuned to the \_\_\_\_\_.

*0.5  
0.3*

*localizer*

## Approach Charts

All Jeppesen Approach Charts follow the same format. Refer to Figure 5-34 and complete the following programmed exercises.

On the left side of the Approach Chart, arrow #7 points to the block of tower frequencies. The name of the tower is given along with the controlling agency in parenthesis. The controlling agency of Airpark Tower is the \_\_\_\_\_.

The black dot indicates the availability of a group of frequencies common to all control \_\_\_\_\_ of the specified type.

*FAA*

The common FAA frequencies are 121.5, 122, 5G, 243.0, and 257.8. The black dot indicates that the tower has all of these \_\_\_\_\_.

*towers*

All additional frequencies used by the tower are listed. The absence of the black dot would mean that the tower has only the frequencies \_\_\_\_\_.

*frequencies*

An X after a frequency means that the frequency is used on request. A G after a frequency means that the frequency is guarded by the tower. A T after a frequency means that the tower cannot receive on that frequency but can \_\_\_\_\_ on it.

*listed*

An X after a frequency means that the frequency can be used on \_\_\_\_\_.

*transmit*

G stands for \_\_\_\_\_, T stands for \_\_\_\_\_.

*request*

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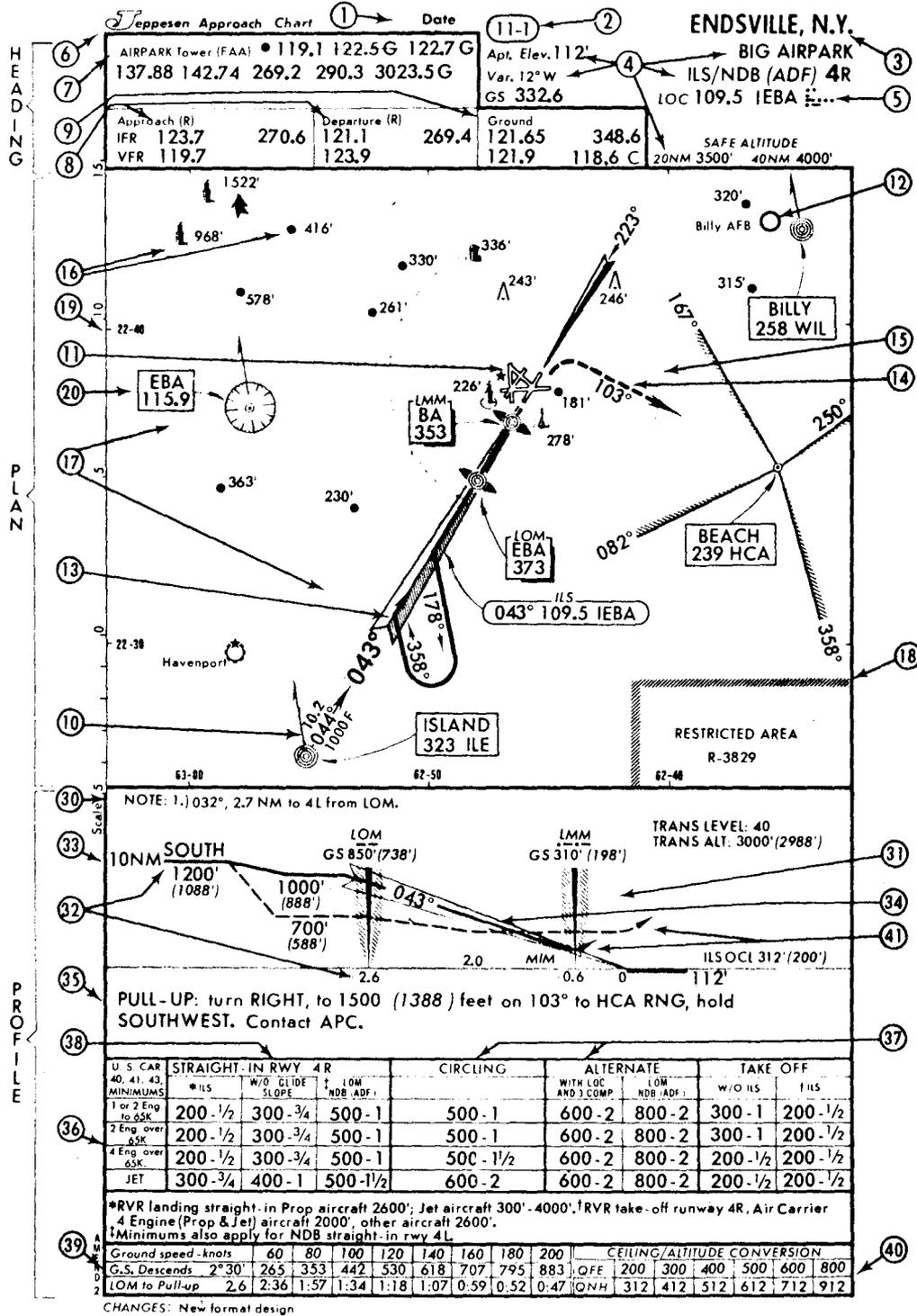


Fig. 5-34 - Excerpt - For Training Purposes Only

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Arrow #9 points to the frequencies used for Ground

*Guard  
Transmit*

The frequency used for Clearance Delivery is followed by a C. The Clearance Delivery frequency at Airpark is

*Control*

Arrow #8 points to the two groups of frequencies used by Approach Control and Control.

*118.6*

Arrow #16 points to obstructions. The obstruction altitudes given are the height of the obstruction above sea

*Departure*

The heavy arrow indicates the highest obstruction on the chart. The height of the highest obstruction on this chart is above sea level.

*level*

Arrow #19 points to an increment of latitude. Both latitude and longitude are given on the chart. Arrow #11 points to the layout of the airport.

*1522 feet*

Arrow #20 points to the VOR facility, giving the identifier and the

*runway*

Arrow #17 points to the orientation detail including major building areas, roads, railroads, rivers and shore lines. This chart shows that the area of least ground congestion is the immediate vicinity of the airport in the quadrant.

*frequency*

Arrow #13 points to the procedure turn recommended for the approach at this airport.

*northeast*

Arrow #10 points to a non-beacon.

*ILS  
(ADF)*

The nondirectional beacon in this case is used in the transition to the ILS approach and is located nautical miles from the LOM.

*directional*

Arrow #30 points to notes applicable to this approach chart. This covers information that cannot be adequately shown by other means, but is pertinent to the to the airport.

*10.2*

Arrow #33 points to the procedure turn which gives the direction of the turn away from the outbound course. In this case it is

*approach*

The distance given, 10 nautical miles, is the distance within which the procedure turn should be completed from the outer

*south*

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Arrow #32 points to the schematic detail of the profile diagram of the ILS. The indicated altitude of the procedure turn is 1,200 feet; the height above the airport elevation \_\_\_\_\_ feet.

*marker*

The distance of the outer marker from the end of the runway is \_\_\_\_\_ nautical miles.

*1,088*

The distance of the middle marker from the end of the runway is \_\_\_\_\_ nautical miles.

*2.6*

Arrow #35 indicates the missed approach procedure. The altitude of the missed approach procedure is \_\_\_\_\_ feet.

*0.6*

Arrow #38 points to the straight-in-minimum altitude (above ground) for runway 4 right. A one or two engine airplane which is fully ILS equipped and which has a stalling speed of over 65 knots, can land when the ceiling is no lower than \_\_\_\_\_ feet.

*1,500*

Arrow #39 points to the airplane speed, rate of descent and time from fix chart. This chart deals with the \_\_\_\_\_ pattern.

*200*

A Low Frequency Approach Chart would give the time from the radio facility to the airport. A VOR approach chart would give the time from the VOR to the \_\_\_\_\_.

*ILS*

Arrow #4 points to the general airport information and the minimum safe altitudes. Safe altitude provides for a 1,000 foot clearance of known obstacles. The safe altitude within 20 miles of the airport is \_\_\_\_\_ feet.

*airport*

Arrow #5 indicates the primary letdown radio. In this case, the localizer frequency is \_\_\_\_\_.

*3,500*

Arrow #12 points to an active IFR \_\_\_\_\_ airport.

*109.5*

Arrow #15 points to the reference circle of 5 statute mile radius. The reference circle does not indicate an airport traffic area or a control \_\_\_\_\_.

*military*

Arrow #14 points to the initial portion of the \_\_\_\_\_.

*zone*

Arrow #31 indicates the profile of the radio facilities; arrow #34 points to the ILS \_\_\_\_\_ slope.

*missed approach*

Arrow #41 indicates the point of pull-up for the missed approach. The word MIM is used where a missed approach must be immediately executed if not contact at the authorized landing \_\_\_\_\_.

*glide*

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Arrow #37 points to the circling minimums and to the minimums for which the airport can be listed as an \_\_\_\_\_ *minimum*  
airport.

Arrow #40 points to the ceiling/altitude conversion table. A ceiling of 200 feet is 312 feet above sea level; a 500 foot ceiling is \_\_\_\_\_ *alternate*  
is \_\_\_\_\_ feet above sea level.

612

## VOR Approach

The cross section of the approach in Figure 5-35 shows that the outbound descent is no lower than 6,500 feet MSL and that the procedure turn must be made within 10 nautical miles. The procedure turn is made by turning left to 346° and flying the heading approximately one minute, depending on existing wind conditions. At the end of the time period, a 180° turn to 166° would be made. During the procedure turn, the pilot should change the heading of the course selector of the VOR to the inbound heading of 211° and fly the VOR to get on the inbound radial to the station. When established inbound, after the procedure turn, Approach Control should be notified; then a descent can be made to 6,000 feet MSL. 6,000 feet is 669 feet above the terrain. Circling minimums are used because the approach course is more than 30° off the runway heading.

Report to Approach Control when over the station. In this case, the distance for the VOR station to the airport is 8.1 nautical miles. After flying past the VOR the amount of time required (scale on bottom of page), if the airport is not visible, follow the missed approach procedure; notify Approach Control of the missed approach, start a climb to 8,000 feet while turning left to fly outbound on the 160° radial of Denver VOR. A pilot should be on the 160° radial at 8,000 feet MSL within 15 nautical miles. Follow the instructions of Approach Control after a missed approach.

## L/MF and Nondirectional Beacon Approaches

Approaches made, using a published Approach Chart for L/MF ranges and non-directional beacons, are completed using the same type of procedure as for VOR. Become thoroughly familiar with the pattern, altitudes, and minimums before arrival at the destination and follow the chart, and the instructions from Approach Control.

Approach Charts for a VOR or a low frequency range station follow the same format. Both a top and \_\_\_\_\_  
view of the approach are given.

Referring to the Stapleton VOR approach, Figure 5-35, the VOR station is \_\_\_\_\_ nautical miles from the airport. *side*

If the groundspeed is 120 knots, the time from the VOR station to the boundary of the airport is \_\_\_\_\_ *8.1*  
minutes.

The minimum safe altitude within 20 nautical miles of the airport is \_\_\_\_\_ *4:03*  
feet.

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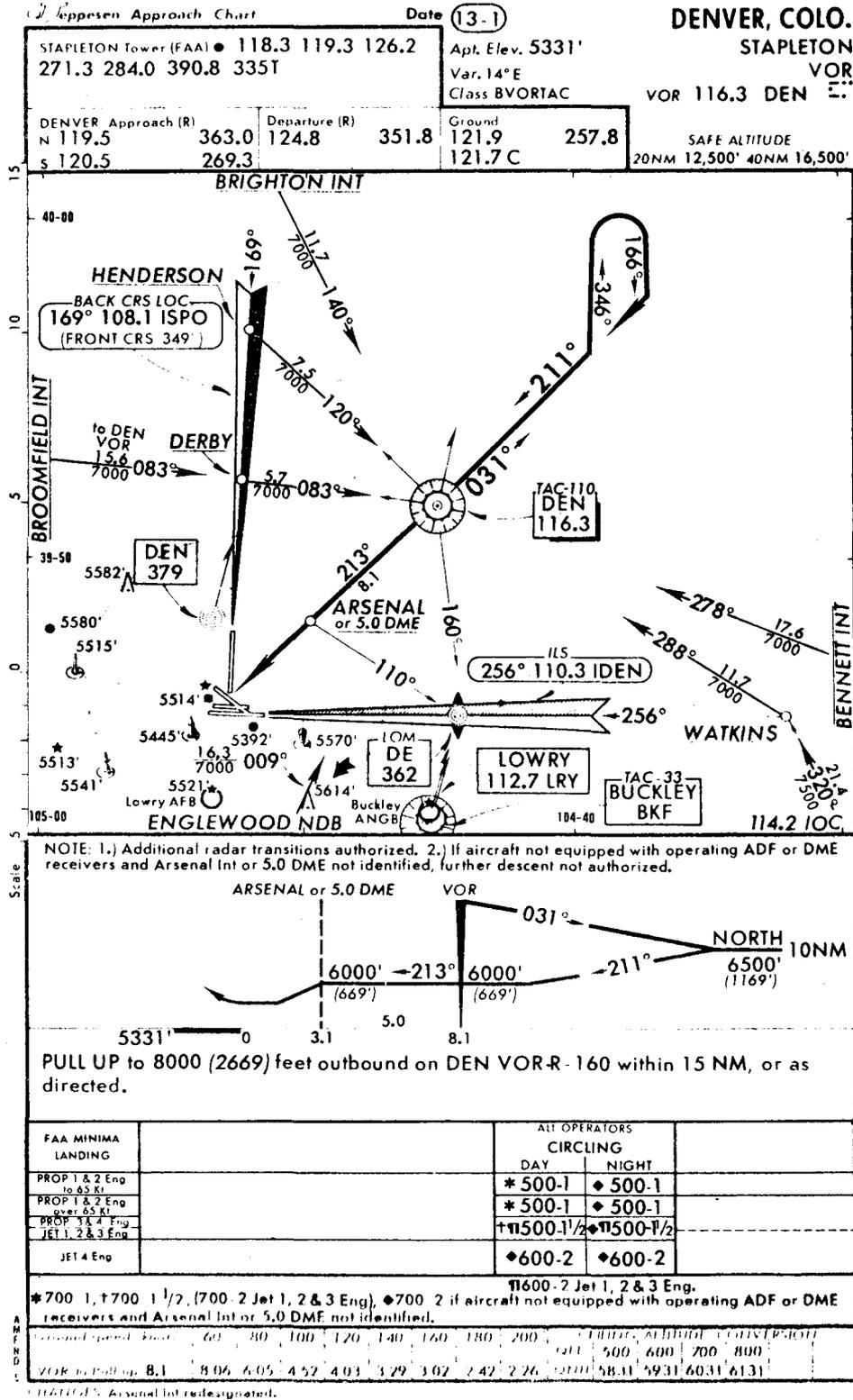


Fig. 5-35 - Excerpt - For Training Purposes Only

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Are all common FAA tower frequencies available at Stapleton? (yes) (no) _____	12,500
The weather minimums for a two engine or less airplane with operating VOR and ADF at Stapleton are _____ feet and one mile.	yes
For a three or four engine propeller aircraft not equipped with operative DME or ADF, the minimum day ceiling at Stapleton is _____ feet, and the minimum day visibility is _____ miles.	500
The VOR missed approach (pull-up) procedure must be com- pleted within _____ nautical miles of the airport.	700 one and one-half
	15

## Radar Vectored Approaches

For convenience, to expedite traffic, or for more positive control of arriving traffic, radar vectoring is often used by Approach Control. Arriving airplanes are contacted and identified by the radar unit and instead of making the standard approach, airplanes are controlled by radar. In this case, the pilot follows all instructions, acknowledges all transmissions, and repeats heading and altitude assignments issued by the radar controller.

The acceptance of radar vectoring does not change the authorized minimums. A pilot is advised of the existing weather and it is his responsibility to determine if the airport minimum will allow him to legally make a landing. Violations of authorized minimums are the sole responsibility of the pilot.

For more positive control or to expedite the movements of arriving traffic, Approach Control may use _____ vectoring.	
When radar vectoring is used to control an airplane, the pilot follows all _____ given by the controller.	radar
In addition to following all instructions, the pilot acknowledges all _____	instructions
A pilot not only acknowledges all transmissions from Approach Control, but repeats all assigned headings and _____	transmissions
The acceptance of a radar vectored approach does not change the authorized _____	altitudes
A pilot is given the existing weather and it is his responsibility to determine if he can legally make an approach and _____	minimums
Violations of authorized minimums are the sole responsibility of the _____	landing

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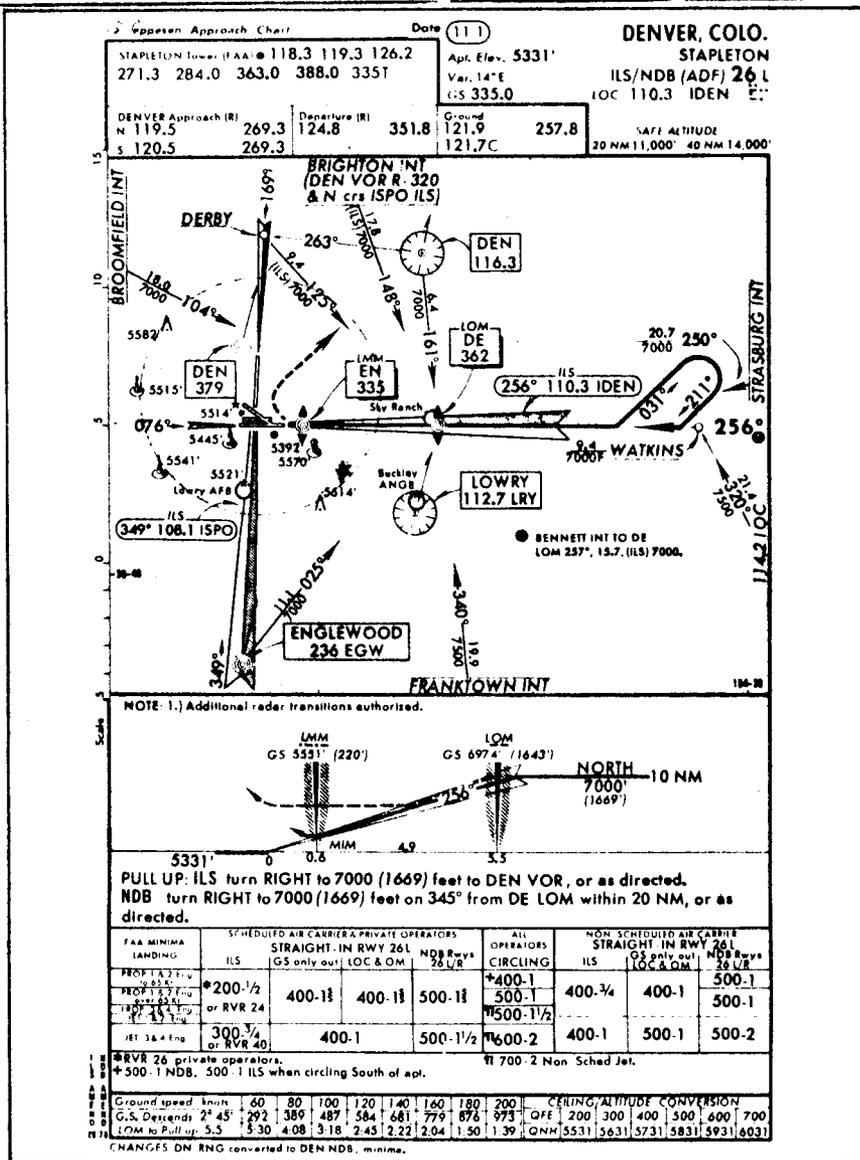


Fig. 5-36 - Excerpt - For Training Purposes Only

On a radar vectored approach, the pilot repeats all assigned \_\_\_\_\_ and \_\_\_\_\_

*pilot*

The responsibility to comply with FAA minimums rests with the \_\_\_\_\_

*headings  
altitudes*

*pilot*

## ILS Approach

When an ILS approach is desired by the pilot, he should make the request to Approach Control during the first radio contact. This is accomplished in order to aid Approach Control with traffic planning.

When a radar vector to the final ILS approach course is expected, the pilot must be prepared by having all appropriate navigational radios on and tuned to the correct navigational aids. A typical ILS approach chart is illustrated in Figure 5-36. If this particular approach were being utilized in

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conjunction with a radar vector, the pilot would be directed to the final approach course of 256°. Upon interception of the localizer course, the pilot would complete the approach by reference to his own ILS instruments. Even though radar vectors are given, the pilot is still responsible for providing position reports and observing landing weather minimums.

In cases where radar is not available or is not desired, the pilot may be directed to the ILS pattern via the VOR or L/MF station associated with the airport. As an example, assume that a pilot is inbound to the Denver VOR and desires an ILS approach at Denver. Denver Approach Control directs the pilot to proceed from the VOR direct to the localizer outer marker (LOM) for an ILS approach to runway 26L (Figure 5-36). The pilot will tune the radio compass to the LOM which has a frequency of 362 kc and an identifier of DE. After passing the Denver VOR, the pilot turns outbound to intercept the 161° radial and reports to Denver VOR, to Approach Control. At the LOM, a left turn is made to track on the ILS outbound course of 076°. The ILS receiver (which should be warm and ready for immediate use) is tuned to the localizer frequency of 110.3 mc. This portion of the approach must be conducted at 7,000 feet MSL or above as shown by the approach cross section on the approach chart.

The procedure turn must be completed within 10 miles of the airport and the airplane should be rolled out of the procedure turn on the localizer course of 256°. A descent is started as the ILS horizontal needle reaches the centered position on the instrument and a position report is made passing the LOM. From this point to touch down, the localizer and glide slope needles are referenced to maintain the position of the airplane on glide slope and aligned with the runway.

## General Approach Instructions

For any approach, it is necessary that the pilot remain on the assigned radio frequencies, follow all ATC instructions and generally acknowledge all transmissions. However, the pilot should never sacrifice basic instrument flying for radio transmissions. It is unnecessary to rush radio procedure since instantaneous replies are not expected by ground facilities.

At no time are published minimum altitudes to be violated. If the airplane is inadvertently allowed to descend lower than the minimum altitude, a correction should be made immediately. The airplane should never be allowed to descend lower than the published weather minimums for the type of approach being made unless clear of the clouds. If the runway or runway lights are not in sight upon reaching the minimum altitude, the pilot must execute the published missed approach procedure and follow the instructions of Approach Control for another approach or for departing to the alternate airport.

The pilot should not be hesitant to request a specific type of approach if he so desires. Normally, Approach Control will attempt to grant reasonable requests if traffic conditions permit.

---

If a pilot intends to use the ILS for landing, Approach Control should be notified of this intent during the first radio

---

When a pilot expects a radar vector to the approach course, he must have the appropriate navigational \_\_\_\_\_ tuned to the correct frequencies.

---

*contact*

The use of radar does not excuse the pilot from complying with mandatory voice reports and landing weather \_\_\_\_\_.

---

*radios*

In cases where radar vectors are not utilized, the pilot may be directed to the approach course via navigational \_\_\_\_\_ associated with the airport.

---

*minimums*

Published approach procedures must be complied with unless other instructions are received from the controlling \_\_\_\_\_.

---

*radio  
(aid)*

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If the airplane is not clear of the clouds upon reaching the published minimum, the pilot must execute the \_\_\_\_\_ approach procedure.

*agency*

If a missed approach is executed, the instructions from Approach Control are followed for commencing a new approach or proceeding to an alternate \_\_\_\_\_.

*missed*

*airport*

## Precision Approach Radar (PAR)

A radar controller is able to safely and accurately direct a pilot to a landing in inclement weather. The controller has at his disposal, a radar map of the area which continuously shows the range and azimuth of airplanes in the vicinity of the radar installation. With this information, the controller can direct airplanes to a landing by supplying heading and altitude instructions to the pilot.

The first phases of a PAR approach include the establishment of a radio frequency acceptable to both pilot and controller and positive radar identification of the airplane. In the radar pattern, the pilot is instructed to fly headings and altitudes which will provide for interception of the final approach flight path. In this stage of the approach most pilots repeat heading and altitude information to insure understanding between pilot and controller. Also, at this time, landing information, weather conditions, altimeter setting, and missed approach procedures will be relayed to the pilot. Since the procedure to be executed in case of communications failure or missed approach is not published, it is given verbally to the pilot.

While in the radar pattern, turns and altitude transitions must be executed with care and precision. All turns should be standard rate unless instructions otherwise are received from the controller. At least one time in the approach prior to intercepting the glide path, the controller will advise the pilot as to the relative position of the airplane in the approach pattern.

The interception of the final approach course is usually accomplished at a sufficient distance from the airport to allow for any needed heading corrections before the pilot is instructed to initiate the descent on the glide slope. Prior to glide slope interception, the airplane is picked up on the precision scope which provides altitude information in addition to azimuth and range.

After intercepting the glide slope, the pilot is instructed not to acknowledge further transmissions. A correct position on the glide slope is maintained by making small, precise corrections.

It is the responsibility of the pilot to execute the missed approach procedure if not clear of the clouds when reaching the published approach minimum.

A safe, accurate approach and landing can be made with the aid of \_\_\_\_\_ approach radar.

A radar controller supplies both heading and \_\_\_\_\_ instructions to the pilot.

*precision*

Initially, the controller must establish positive radar contact and a mutually acceptable radio \_\_\_\_\_.

*altitude*

The headings supplied by the controller direct the pilot to the final approach \_\_\_\_\_.

*frequency*

Prior to interception of the glide slope, all heading and altitude information provided by the controller is usually repeated by the \_\_\_\_\_.

*course*

The radar controller transmits to the pilot landing information, weather conditions and the altimeter \_\_\_\_\_.

*pilot*

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The procedure to be executed in case of loss of communications is given to the pilot by the \_\_\_\_\_.

*setting*

When executing a radar approach, it is necessary to be accurate in altitude changes and \_\_\_\_\_.

*controller*

Unless directed otherwise, all turns in the radar pattern should be at a standard \_\_\_\_\_.

*turns*

Precision radar equipment provides azimuth, range and \_\_\_\_\_ information.

*rate*

On final approach, the pilot is instructed to not acknowledge further \_\_\_\_\_ from the controller.

*altitude*

Any corrections made on the final approach should be small and \_\_\_\_\_.

*transmissions*

The decision to execute a missed approach is the responsibility of the \_\_\_\_\_.

*precise*

A missed approach must be executed if the pilot is not clear of the clouds at the landing weather \_\_\_\_\_.

*pilot*

*minimum*

### Airport Surveillance Radar (ASR)

The ASR approach is similar to the PAR approach with the exception that a precision radar scope is not used and therefore, no altitude information is available.

The ASR and PAR approaches are usually identical up to the point of glide slope interception. Since the controller has no glide slope information, he can only advise the pilot of the recommended altitudes throughout the approach. When the airplane is on final approach, appropriate altitude information is provided by the controller at one mile intervals.

An advantage of the ASR equipment is that it can be used for an approach to any runway on the airport as well as for controlling air traffic in the general vicinity of the airport. However, a disadvantage associated with ASR is that better weather conditions are required for an ASR approach as compared to PAR or an ILS approach.

The abbreviation for airport surveillance radar is \_\_\_\_\_.

The ASR and PAR approaches are similar except that no altitude information is associated with the \_\_\_\_\_ approach.

*ASR*

The ASR is not considered to be a \_\_\_\_\_ approach.

*ASR*

The pilot is directed down the glide slope by the controller who transmits appropriate altitude information at \_\_\_\_\_ mile intervals.

*precision*

Unless otherwise instructed, turns in the radar pattern are executed at a standard \_\_\_\_\_.

*one*

*rate*

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## VISUAL APPROACH SLOPE INDICATORS (VASI)

The following information is provided to explain a relatively new FAA system called Visual Approach Slope Indicator (VASI) formerly called Visual Glide Slope Indicator (VGSI).

VASI provides the same information visually that the glide slope unit of an ILS provides by electronic means.

The visual glide path is inclined  $2\frac{1}{2}^\circ$  to  $3^\circ$  from the horizontal. This visual reference is used by a pilot in an aircraft during an approach and landing. Course alignment is maintained by reference to the runway or runway lights.

Use of VASI by pilots of all types of aircraft will:

1. Improve landing approaches during daylight and night conditions.
2. Improve safety especially at night by giving the pilot a visual descent pattern that assures proper clearance of obstructions in the approach area.
3. Provide visual reference for approaches over water and featureless terrain where adequate references are not available or are misleading.
4. Provide optimum guidance on descent and landing of large aircraft, especially turbojet and reduce to a minimum the possibility of overshooting and undershooting.
5. Reduce ground noise level by reducing the necessity for low level approaches at high power settings.
6. Provide guidance for a safe approach and landing within the first third of the runway.

The standard VASI is usually on the ILS back course or a runway not served by the ILS front course and consists of 12 light source units arranged in light bars. Three each of these light bars are placed on either side of the runway at the 600 foot point inside the threshold and three each on either side of the runway at the 1300 foot point. The bars at the 600 foot point are considered the downwind group and those at the 1300 foot point, the upwind group. The visual glide slope reference point is midway between the upwind and downwind groups.

Light intensity can be controlled by the ground operator and will be adjusted on request of the pilot. The pilot can normally see the VASI from a distance of 4 to 5 miles from the end of the runway. At night the distance the VASI can be seen is increased somewhat. In bright sunlight and snow conditions, the distance the pilot can see the VASI is reduced to about 3.5 nautical miles.

The unit has an integral fail safe feature, as failure of all units on one side or parts of units on different sides will still allow a safe approach. The color relationship between the remaining units will still provide glide slope information.

The basic principle of the VASI is that of color differentiation between red and white. Each VASI bank of lights consists of two rows of lights. One row points upward at an angle and is white. The other row of lights in each VASI set is aimed at a lower angle and is red.

The lights are arranged so that on the approach a pilot will see the following:

- |                                     |       |       |                      |
|-------------------------------------|-------|-------|----------------------|
| 1. above the glide slope            | white | white | upwind light banks   |
|                                     | white | white | downwind light banks |
| 2. transition to above glide slope  | pink  | pink  | upwind light banks   |
|                                     | white | white | downwind light banks |
| 3. on glide slope                   | red   | red   | upwind light banks   |
|                                     | white | white | downwind light banks |
| 4. transition below the glide slope | red   | red   | upwind light banks   |
|                                     | pink  | pink  | downwind light banks |
| 5. below glide slope                | red   | red   | upwind light banks   |
|                                     | red   | red   | downwind light banks |

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The VASI information should not be used prior to final approach as only this area has been protected for obstruction clearance. The procedure to use for a VASI approach is to align the aircraft with the runway or runway lights at approximately 4 or 5 nautical miles from the runway. The altitude above the runway or airport should be approximately 250 feet for each mile out or about 1,000 feet at 4 miles from the runway. As the aircraft approaches glide slope interception, the downwind or near VASI lights will transition from the red through pink to white; at this point the descent should be initiated. When properly aligned and on the glide slope the pilot will see the downwind VASI lights as white and the upwind or 1300 foot lights as red.

On the approach, if both bars of light at the 600 foot and 1300 foot positions are red, the airplane is too low, if both are white, the airplane is too high. A transition from on the glide slope to high, will cause a change in the upwind lights (1300 foot) from red to pink to white, and the pilot will see only white (too high). A transition from on the glide slope to low, will cause the downwind lights (600 foot) to change from white to pink to red and the pilot will see both lights as red (too low).

On nearing the threshold, some deterioration of system guidance will occur due to the spread of the light source at close range. However, VASI will bring the pilot safely through a "gate" at the threshold from which a normal flare-out and landing can be made.

The FAA visual approach slope indicator is abbreviated _____	
The VASI provides the same information visually that the ILS glide slope provides _____	VASI
The glide slope provided by VASI is inclined ( $2\frac{1}{2}^{\circ}$ - $3^{\circ}$ ) ( $3^{\circ}$ - $5^{\circ}$ ) from the horizontal. (Select the correct angle range.) _____	electronically
VASI is used by a pilot during the _____ and landing.	$2\frac{1}{2}^{\circ}$ - $3^{\circ}$
Course alignment is accomplished by reference to the _____ or runway lights.	approach
Approaches made at night or during daylight can be _____ by using VASI.	runway
Obstruction clearance is provided in the VASI descent area; this increases _____ especially at night.	improved
VASI improves safety because the glide slope is arranged to include clearance of _____	safety
Approaches over water or featureless terrain using VASI are improved because a _____ reference is available.	obstructions
The optimum guidance provided for large aircraft will reduce the possibility of _____ and undershooting.	visual

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In the case of jet aircraft, VASI will aid in reducing noise by allowing approaches at a _____ power setting.	<i>overshooting</i>
Landings are directed to the first _____ of the runway.	<i>lower</i>
Standard VASI is usually located on the ILS _____ course.	<i>one-third</i>
The light sources are arranged 6 on each side of the runway, three lights are located on each side of the runway at the 600 foot point from the threshold and three on each side at the _____ foot point.	<i>back</i>
The light source at the 600 foot point from the threshold of the runway is called the _____ group.	<i>1300</i>
The light source at the 1300 foot point is called the _____ group.	<i>downwind</i>
Midway between the upwind and downwind light sources is the visual glide slope _____ point.	<i>upwind</i>
The light source intensity can be adjusted and adjustment will be made on the pilot's _____.	<i>reference</i>
Bright sunlight and snow may reduce the distance VASI can be seen to 3.5 nautical miles, but it can normally be seen _____ to _____ miles from the end of the runway.	<i>request</i>
The system provides a fail safe feature because it may be used when part of the lights are _____.	<i>4-5</i>
The basic principle of the VASI is color differentiation between red and _____ lights.	<i>inoperative</i>
The upper part of the light banks in VASI emit _____ light.	<i>white</i>
The lower part of the light banks emit _____ light.	<i>white</i>
When correctly intercepting the VASI glide slope, a pilot would see _____ light from the downwind lights.	<i>red</i>
When correctly positioned on the glide slope the pilot would see _____ light from the downwind lights.	<i>red</i>
When moving to a position of too high on the glide slope, the pilot would notice a transition from red to pink to _____ from the upwind lights.	<i>white</i>

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The light color that a pilot will see from both upwind and downwind lights when too low on the glide slope is \_\_\_\_\_

*white*

When both banks of lights are white, the pilot is (too high) (too low) \_\_\_\_\_ on the glide slope.

*red*

When the pilot sees a transition from white to pink to red for the downwind lights, he is getting (too high) (too low) \_\_\_\_\_ on the glide slope.

*too high*

For each one mile of distance from the end of the runway, the pilot should be approximately \_\_\_\_\_ feet above the field.

*too low*

On the approach, as the glide slope is intercepted the downwind lights transition from red to pink to white. At this point the pilot should initiate the \_\_\_\_\_

*250*

When properly aligned on the glide slope the upwind lights will be \_\_\_\_\_ and the downwind lights will be \_\_\_\_\_

*descent*

VASI will bring the pilot through a gate at the threshold from which a normal flare-out and \_\_\_\_\_ can be made.

*red  
white*

*landing*

## RUNWAY VISUAL RANGE (RVR)

Aviation weather reports at many stations now carry information designated as Runway Visual Range (RVR). This information is included in the remarks section of the aviation weather report. The main advantage of RVR over former weather information on ceiling and visibility is that RVR provides the pilot with the visibility at the threshold of the runway based on the sighting of high intensity lights. The actual measurement is accomplished by use of a transmissometer.

At fields where RVR is authorized, it can be used as the sole minimum and replaces meteorologically derived values of ceiling and visibility.

Runway Visual Range (RVR) in the United States is an instrumentally derived value, based on standard calibrations, which represent the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either high intensity runway lights or on the visual contrast of other targets—whichever yields the greatest visual range.

Another value that may be derived in a similar manner is Runway Visibility (RVV). RVV is the meteorological visibility along an identified runway where a transmissometer is used for measurement. The instrument is calibrated in terms of a human observer; i.e., the sighting of dark objects against the sky horizon during daylight, and the sighting of moderately intense unfocused lights on the order of 25 candlepower at night.

The symbol that represents Runway Visual Range is \_\_\_\_\_

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RVR is carried on aviation weather reports in the \_\_\_\_\_ section.

*RVR*

An advantage of RVR over meteorologically derived data is that it provides the pilot with visibility information at the runway \_\_\_\_\_.

*remarks*

When RVR is authorized it may be substituted for meteorological data of ceiling and visibility as the \_\_\_\_\_ minimum.

*threshold*

The meteorological visibility that is determined by sighting moderately intense lights is called \_\_\_\_\_.

*sole*

When the pilot receives a visibility report that is designated as RVR, he knows that it was determined (meteorologically) (instrumentally) \_\_\_\_\_.

*RVV*

The value that is derived instrumentally and that represents the horizontal distance a pilot will see down the runway from the approach end is called \_\_\_\_\_.

*instrumentally*

RVR is determined by use of a \_\_\_\_\_.

*RVR*

RVR is based on the sighting of \_\_\_\_\_ lights.

*transmissometer*

The transmissometer determines the visibility along the runway at the \_\_\_\_\_ end.

*high intensity*

*approach*

## Determining RVR

RVR is a measure of the transparency of the atmosphere, and is determined by use of a transmissometer. The transmissometer consists of a projector, a detector and meter or recorder. The meter measures how well light is being transmitted through the atmosphere. The value determined by this instrument is converted to visibility in feet (RVR). The projector and receiver are located parallel to the runway at the approach end. The projector and receiver are spaced 500 feet apart in recent installations and 750 feet apart in older installations.

## RVR Approval

Before a runway can be approved for landing using RVR in lieu of reported meteorological ceiling and visibility, the following conditions must be met:

- (1) High intensity lights spaced not more than 200 feet apart must be installed along the runway.
- (2) Full configuration "A" approach lights with condenser discharge flashers must be installed.
- (3) Complete ILS or PAR facilities must be available.
- (4) RVR must have a transmissometer and associated control tower display equipment calibrated in feet.
- (5) All-weather runway markings or runway centerline lighting must be installed.
- (6) There must be a compass locator at the outer marker.

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The transmissometer measures the intensity of light transmitted through the atmosphere and converts this factor to \_\_\_\_\_

Certain requirements must be met before a runway can be \_\_\_\_\_ for RVR.

*RVR (feet)*

The runway must have high intensity runway lights spaced along the runway at least every \_\_\_\_\_ feet.

*approved*

To be approved for RVR, the runway must have condenser discharge flashers and full configuration \_\_\_\_\_ approach lights.

*200*

To be approved for RVR, the runway must have complete facilities for ILS or \_\_\_\_\_

*"A"*

The RVR equipment must include a transmissometer, and control tower \_\_\_\_\_ equipment calibrated in feet.

*PAR*

Requirements for RVR approval also include either all-weather runway marking or the installation of runway \_\_\_\_\_ lighting.

*display*

When RVR is used with the ILS approach, there must be a \_\_\_\_\_ locator at the outer marker.

*centerline*

*compass*

## Takeoff Aids (RVR)

For RVR to be approved for takeoff without considering reported ceiling, the following aids must be available:

- (1) High intensity runway lights spaced not more than 200 feet apart along the runway.
- (2) Transmissometer and associated control tower display equipment calibrated in feet.
- (3) All-weather runway markings or runway centerline lighting.

To use RVR on takeoff, instead of reported ceiling, the runway must have high intensity runway lights spaced at least every \_\_\_\_\_ feet along the runway.

For takeoff, using RVR, a transmissometer must be installed at the runway and the control \_\_\_\_\_ must have operating display equipment.

*200*

For takeoff with RVR as the sole minimum, the runway must have installed either \_\_\_\_\_ runway markings or \_\_\_\_\_ lighting.

*tower*

*all-weather  
centerline*

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## RVR Minimums

RVR minimums may be obtained from part 97 of FAR's or published approach charts. When the runway meets the requirements stipulated above, and meteorological landing minimums of 200/½ have been approved, an RVR of 2600 feet can be substituted for the meteorological data.

In cases where RVR is approved as the sole factor for approach and landing without regard to ceiling and visibility, the approved minimums must be 300/¾ or less. In instances where the minimums for landing are greater than 300/¾, such as 400/1, RVR is not authorized for substitution in lieu of ceiling requirements.

When the reported weather data received by the pilot includes a visibility value specified as runway visual range (RVR) or runway visibility (RVV) for a particular runway, such visibility value will govern takeoff and landings on this runway. This is regardless of the prevailing meteorological visibility reported for the airport on which the runway is located.

## Runway Visual Range Approval

At runways where RVR is approved for landing, the RVR can be used in lieu of meteorological data for both visibility and ceiling. However, in this case, the pilot must have the approach lights in sight by the time he reaches the minimum approach altitude. If he does not, he must immediately execute a missed approach. The minimum approach altitude on approach charts is the altitude given as the minimum altitude to which an airplane can descend. This minimum altitude is converted to altitude above sea level. A conversion table is available in the lower right portion of the Jeppesen Approach Charts that will give the minimum descent altitude in feet MSL (QNH).

RVR minimums may be obtained from FAR 97 or published \_\_\_\_\_ charts.

When the field minimums are 200/½ and RVR has been approved, an RVR of 2600 feet can be substituted as the \_\_\_\_\_ minimum.

*approach*

RVR is only used as the sole minimum at runways where the approved meteorological minimums are \_\_\_\_\_ or less.

*sole*

When the pilot receives RVR or RVV as part of the weather report for a given runway, this information will be used as the runway \_\_\_\_\_.

*300/three-fourths*

At airports where RVR is approved, RVR can be used in place of both ceiling and \_\_\_\_\_.

*visibility*

When the pilot uses RVR as the sole minimum for an approach, he must have the approach lights in sight when he reaches the \_\_\_\_\_ approach altitude in order to land.

*visibility*

The minimum approach altitude on approach charts is the minimum altitude above the field to which an airplane can descend, converted to \_\_\_\_\_.

*minimum*

In instances where the published minimums are greater than 300/¾, such as 400/1, RVR, (is) (is not) \_\_\_\_\_ authorized for ceiling minimums.

*MSL*

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*is not*

The conversions usually used for converting visibility in miles to RVR in feet are indicated below:

<i>Meteorological Visibility</i>	<i>RVR</i>
½ mile	2600 feet
¾ mile	4000 feet
1 mile	5200 feet
1¼ mile	6000 feet

The pilot should know the conversion of meteorological data to RVR, ½ mile = 2600 feet RVR, ¾ mile = 4000 feet RVR, 1¼ mile = 6000 feet RVR, and 1 mile = \_\_\_\_\_ RVR.

When approaching a field, the pilot receives an RVR of 4000 feet, he would know that the visibility at the approach end of the runway is at least \_\_\_\_\_ mile.

*5200 feet*

*three-fourths*

In situations where RVR is authorized as the sole minimum, a pilot could legally make an approach and landing when the station ceiling is being reported zero, provided the Runway Visual Range is at least the minimum stipulated for that field.



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## FACILITIES AND FREQUENCIES

### Radio Facilities Available to the Pilot

The radio facilities available to the pilot are many and varied. The significant facilities and their use for navigation (NAV), or communications (COMM), or both, are:

- (1) The nondirectional beacon (NDB), commonly called a "homer" (NAV);
- (2) The low and medium frequency ranges (L/MF) which are rapidly disappearing and being replaced by VOR's (NAV & COMM);
- (3) Commercial broadcast stations which can be used to "home on" (NAV); (Be sure of identification when using these stations as they are only required to identify themselves every 30 minutes.)
- (4) The very high frequency OMNI directional range (VOR) (NAV & COMM);
- (5) Flight Service Stations (FSS) (COMM);
- (6) Air Route Traffic Control Center (ARTCC) (COMM & NAV);
- (7) Instrument Landing System (ILS) (NAV & COMM);
- (8) Airport Surveillance Radar (ASR) (NAV & COMM);
- (9) Precision Approach Radar (PAR) (NAV & COMM);
- (10) Control Towers at individual fields (COMM & NAV);
- (11) Compass locator stations (LMM and LOM) are low powered nondirectional beacons and are associated with ILS. Middle markers (MM) and outer markers (OM) are VHF devices operating on 75 mc that transmit a signal almost straight up and are also associated with ILS (NAV);
- (12) Fan markers, formerly associated only with low frequency ranges, are now being associated with VOR stations (NAV);
- (13) The "Z" marker, a 75 mc transmitter, transmits a signal in the cone of silence of the L/MF range (NAV); and
- (14) The distance measuring equipment (DME) which provides the pilot with "slant range" distances (slant range is the line of sight distance from the airplane to ground station) from a facility when the airplane and ground facility are equipped for this operation. The DME operates in the UHF frequency band but is paired with VHF frequencies and is usually associated with VOR stations, where indicated (NAV).

### Control Facilities

A typical ground control system, with which the pilot will normally deal, is as follows: (Usually all these facilities will be located in the tower.)

- (1) *Ground Control* is the function that controls airplanes on the ground from the runway to parking space, and from the parking space to the runup area, and also obtains clearances for IFR flights. Ground Control can usually be contacted on 121.9 or 121.7 mc.
- (2) The *tower* controls airplanes on and in the vicinity of the airport for takeoff and landing. However, Ground Control and Departure Control may be handled by the tower frequency at some stations. Normally, all FAA control towers guard one of three frequencies (122.5 mc, 122.6 mc, and 122.7 mc), along with their other assigned frequencies.
- (3) *Departure Control* handles airplanes after takeoff and prior to their being handed off to the Air Route Traffic Control Center (ARTCC). Departure Control may be located in the tower, the IFR room in a nearby building, or RAPCON, etc.
- (4) *Enroute Control* is accomplished by Air Route Traffic Control Centers (ARTCC's) which are responsible, in each individual case, for a large section of the United States. These sections, when combined, cover the entire United States.

The proper designation of the Air Route Traffic Control Center is ARTCC; however, it is commonly referred to as Air Traffic Control (ATC). ATC is also used to refer to any controlling agency. Within each of the center areas, several sectors are established and as a pilot progresses along a route, he is

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handed off from one sector to the next. When he reaches the boundary of a Control Center (ARTCC), he is handed off to the next Center along the route.

Flight Service Stations (FSS) are located at, or near, many of the navigation facilities throughout the United States. The FSS facilities are advisory. Actual control of airplanes flying in controlled airspace is exercised by ATC and by the ground control facilities at a specific field. Either of the latter has complete authority over flights in their area.

The control tower controls traffic on and in the vicinity of the \_\_\_\_\_

At some airports, the control of airplanes on the ground is handled by Ground Control and during departure it is handled by \_\_\_\_\_ Control.

*airport*

Ground Control may direct an airplane from the parking area to the \_\_\_\_\_ area.

*Departure*

The IFR clearance is normally delivered on a Ground Control \_\_\_\_\_

*runup*

Sometime after the IFR clearance is received, Ground Control will transfer the pilot to the tower for clearance to \_\_\_\_\_

*frequency*

When the airplane becomes airborne, the tower will transfer the pilot to a \_\_\_\_\_ Control frequency.

*takeoff*

Departure Control will issue the necessary instructions to get the airplane out of the airport vicinity and to the enroute course and then transfer the pilot to an Air Route \_\_\_\_\_ Control Center.

*Departure*

Air Traffic Control will control the airplane during the enroute portion of the flight. Enroute Control is handled by an Air Route Traffic Control \_\_\_\_\_

*Traffic*

Each Center is divided into sectors. A pilot may be passed from one sector to another for \_\_\_\_\_

*Center*

When a flight reaches the boundary of a Control Center, it is "handed off" to the next \_\_\_\_\_ for control.

*control*

Flight Service Stations (FSS) are located at, or near, navigation facilities throughout the United States. If contact is lost, or cannot be established with the Center, Enroute Control is relayed through the \_\_\_\_\_ Stations.

*Center*

As an example, assume an aircraft is over the Lubbock, Texas VOR and is unable to contact the El Paso Center to make a position report. In this situation, the report should be given to the Flight Service Station at \_\_\_\_\_ for relay to the Center.

*Flight Service*

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Position reports, flight plan changes, requests or other information given to the FSS are relayed to the Center, and any messages from the Center are in turn relayed through the \_\_\_\_\_

*Lubbock*

*FSS*

- (5) *Approach Control* handles flights which are approaching an airfield for landing or are elsewhere in the airport vicinity. Approach Control may transfer control of inbound flights to the tower prior to landing. However, it is normal procedure for Approach Control to maintain control of inbound flights when inclement weather prevails. In this case, it becomes the responsibility of Approach Control to secure landing clearance from the tower for flights under its control.
- (6) If control of a flight has not been transferred to tower or ground control before landing, it will be accomplished upon roll out.

As an aircraft nears its destination, the Center that has controlled the last enroute portion of the flight will transfer control of the airplane to the destination \_\_\_\_\_ Control.

Approach Control will handle the airplane during the \_\_\_\_\_

*Approach*

Approach Control may either control an inbound flight to landing or transfer control to the \_\_\_\_\_

*approach*

*tower*

## Airplane Call Signs

The complete aircraft call sign is used on the initial contact with any ground station. Irregular air carriers and civil aircraft shall use the name of the manufacturer of the aircraft followed by the complete certification number. Example: "Douglas Seven Six Four Eight Six".

After radio contact has definitely been established, the call signs of itinerant aircraft can be reduced to the prefix followed by not less than the last three digits (or letters) of the full call sign.

Air Carrier aircraft may use the abbreviated or full name of the company followed by the number of the flight. Example: "Trans Global Two Niner".

## General Procedures

The identification of all aircraft must be clearly transmitted in each contact with an Air Traffic Control facility. Also, pilots should be certain that their aircraft is clearly identified by ATC transmissions before taking action on an ATC clearance. Garbled radio transmissions should never be taken for granted, but should be rechecked.

On the initial radio transmission to a ground facility, the pilot should indicate the frequency on which a reply is expected if other than the normal frequency is to be used. Also, pilots must be certain that all transmissions are acknowledged and that all acknowledgements are understood.

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On first contact with a ground station, pilots should use the full aircraft \_\_\_\_\_.

Air Carrier aircraft will use the full or abbreviated company name followed by the number of the \_\_\_\_\_.

*call sign*

Irregular air carrier and civil aircraft shall utilize the manufacturer's name followed by the complete \_\_\_\_\_ number.

*flight*

Upon establishment of contact, call signs of itinerate aircraft can be reduced to the prefix followed by not less than \_\_\_\_\_ digits (or letters) of the full call sign.

*certification*

Pilots must be certain that their aircraft is clearly identified in ATC transmissions prior to acting upon an ATC \_\_\_\_\_.

*three*

If other than a common frequency is to be used, a pilot should indicate the frequency to the ground facility in the initial radio \_\_\_\_\_.

*clearance*

Pilots must acknowledge all appropriate \_\_\_\_\_.

*transmission*

*transmissions*

## Obtaining Weather or Air Traffic Control Information

A pilot may obtain scheduled weather reports by listening to a FSS radio at 15 and 45 minutes past the hour. He may also obtain special weather information by requesting it from any FSS station at any time.

If a pilot desires to change his IFR flight plan in any manner, he will contact ATC and request the change. Upon receipt of an amended clearance from ATC, the pilot should read back the amended clearance to be sure that there is no misunderstanding.

## Listening Watch

All pilots operating on IFR clearances are required to maintain a constant listening watch on the frequency assigned by the controlling agency. If for some reason the pilot desires a temporary change in frequency, he is authorized to request such a change from ATC. However, at any time a pilot is off an assigned frequency, he must report to ATC when he resumes the listening watch on the assigned frequency.

Flight Service Station scheduled weather broadcasts are made at \_\_\_\_\_ and \_\_\_\_\_ minutes past the hour.

Weather information may be obtained at any time upon the \_\_\_\_\_ of the pilot.

*15  
45*

If a pilot desires to change an IFR flight plan enroute, he may request the change from the controlling Center or through a \_\_\_\_\_.

*request*

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It is mandatory for all pilots on IFR clearances to maintain a listening watch on the assigned \_\_\_\_\_.

*FSS*

If it becomes necessary to change the frequency for any reason, the pilot must first advise the \_\_\_\_\_ agency before the change is made.

*frequency*

The controlling agency must also be advised when the pilot is back on the assigned \_\_\_\_\_.

*controlling*

*frequency*

### Radar Assistance or DF Steer

In the event a pilot becomes temporarily disoriented or his navigation equipment becomes inoperative, he may contact civil or military facilities and request radar assistance or a DF steer. The frequencies to be used for contacting radar facilities are listed in the communications tabulation of Jeppesen Avigation Enroute Charts and in the Airman's Guide.

In order to obtain a DF steer, the pilot must first determine the facilities that have DF equipment. This information can be found in the Airman's Guide or the Jeppesen J-AID. When the pilot has determined the facility that has DF equipment, he should contact the tower or DF facility and request a DF steer.

If using L/MF with CW, the pilot should transmit two 10 second dashes for a period of five minutes, interspersed several times by call letters.

If only voice transmission is available, the pilot must depress the microphone button to make long dashes, frequently giving call signs by voice.

If the airplane is equipped with VHF and not equipped with a tone button on VHF, a 10 to 20 second voice signal (ah-h-h) will be transmitted (with volume remaining as nearly constant as possible) followed by airplane call sign.

The tower or DF facility will take a bearing and give the pilot an inbound heading to a facility. It is always advisable to obtain a bearing from two or more stations, if possible, to establish an actual position.

The frequency for contacting civil or military radar or DF facilities may be found in Airman's \_\_\_\_\_ or in the communications tabulation of the Jeppesen Avigation Enroute \_\_\_\_\_.

In order to obtain a DF steer, the pilot must first determine the facility that has \_\_\_\_\_ equipment.

*Guide  
Charts*

DF Stations are listed in the \_\_\_\_\_ or in the Jeppesen \_\_\_\_\_.

*DF*

If radar assistance is obtained, follow the directions of the controller. In using DF, it is desirable to obtain a \_\_\_\_\_ from more than one station to establish a position.

*Airman's Guide  
J-AID*

*bearing*

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## Morse Code and Phonetic Alphabet

A - ALPHA	--	J - JULIET	----	S - SIERRA	...
B - BRAVO	----	K - KILO	---	T - TANGO	-
C - CHARLIE	----	L - LIMA	----	U - UNIFORM	...
D - DELTA	---	M - MIKE	--	V - VICTOR	....-
E - ECHO	.	N - NOVEMBER	..	W - WHISKEY	---
F - FOXTROT	----	O - OSCAR	----	X - XRAY	....-
G - GOLF	---	P - PAPA	----	Y - YANKEE	----
H - HOTEL	....	Q - QUEBEC	----	Z - ZULU	....
I - INDIA	..	R - ROMEO	---		

## VHF Reception Distance

Feet Above Ground	Statute Miles	Nautical Miles
500	30	26
1,000	45	39
3,000	80	69
5,000	100	87
10,000	140	122
15,000	175	152
20,000	200	174

The above table is based on zero elevation of the facility and no intervening physical obstruction.

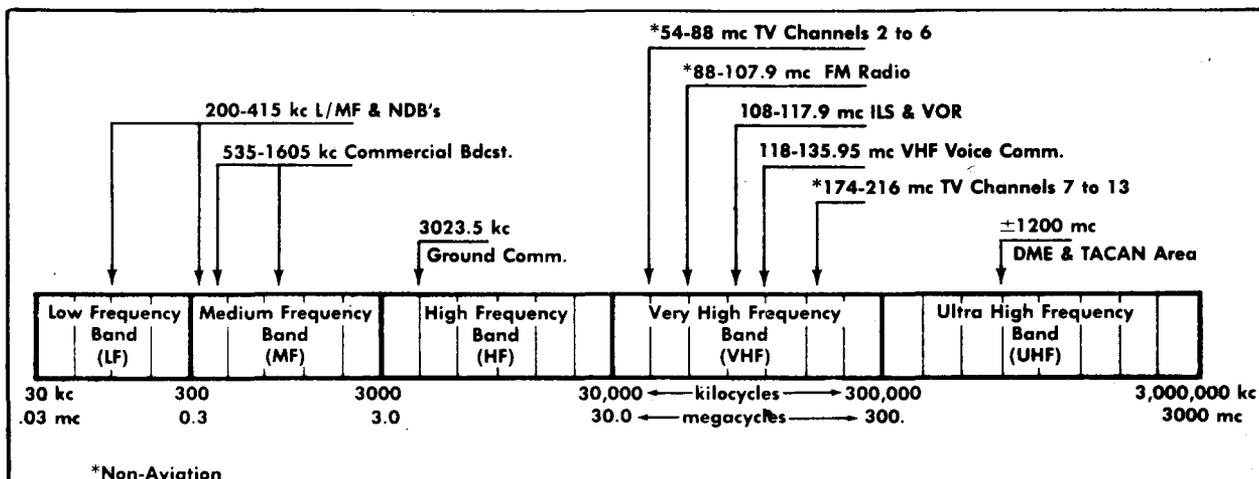


Fig. 6-1 - Radio Frequency Bands in General Use in Aviation

## Frequency Bands - Low, Medium and VHF

The low frequency band is between 30 to 300 kilocycles (kc). The medium frequency band is between 300 to 3,000 kc, Figure 6-1. The radio compass is ordinarily usable from 100 to 1,750 kilocycles. Nondirectional beacons (NDB's) and L/MF's operate in the range 200 to 415 kc. Commercial broadcasting stations operate in the range of 535 to 1,605 kc. A listing of all current U.S. commercial broadcasting stations, with power of 100 watts or more, is contained in the Jeppesen J-AID.