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ABSTRACT

This six-lesson unit is designed to familiarize sixth, seventh, and eighth grade students with air traffic safety and the individuals who make air traffic safety possible. Each lesson consists of a statement of the concept fostered, a list of objectives, a brief discussion on the focus of the unit, and instructional strategies for lesson topics and activities. Major lesson topic areas include: (1) the behavior and properties of air; (2) the theory of flight and the physical properties of air that contribute to flight; (3) the growing volume of air traffic and the necessity for air traffic control; (4) visual flight rules; (5) instrument flight rules; and (6) airport terminal facilities. (JN)

SAFETY IN THE AIR

A CURRICULUM ABOUT FLIGHT AND
AIR TRAFFIC CONTROL DESIGNED FOR
MIDDLE SCHOOL STUDENTS

1983

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
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CONTENTS

ABSTRACT

Safety in the Air is designed to be taught as a six-lesson unit to middle school students, preferably sixth, seventh, or eighth grade level.

This curriculum is designed first of all to familiarize both the teacher and the student with some basic principles and concepts of our atmosphere and of the theory of flight. It appears to be more feasible to teach about air traffic systems if both students and teacher have some background information concerning both the vehicles that travel the air routes and the air medium itself as a mass through which aircraft travel.

A lesson on pilot training and certification is designed to foster confidence and establish credibility in personnel flying the aircraft that make up the air transportation system.

Lessons about air traffic safety are introduced and accommodations are made for safety in the air for both general aviation aircraft and commercial aviation flights.

INTRODUCTION

This curriculum is designed to familiarize students with air traffic safety and the people that make air traffic safety possible.

Many of the suggestions throughout this unit are written in the hope that you, the teacher, will be stimulated by the suggestion to go beyond that suggestion and, because of your unique, particular classroom and students, create or design activities that are truly meaningful to your students.

Many of the diagrams are designed to be used as ditto masters or transparencies (or possibly both). Federal Aviation Administration (FAA) education materials and films as listed at the end of this unit are available to you.

Air traffic control has proven to be one of the most efficient systems in operation in the United States and hopefully you and your students will learn to appreciate it and become a part of it.

Ted Colton
Georgia State University
Atlanta, Georgia

Pursuant to contract #DTFA01-80-P-83085, this curriculum material was designed and written by Ted Colton, Associate Professor of Science Education, Georgia State University, Atlanta, Georgia.

LESSON 1

WHAT IS AIR?

Conceptual Scheme

Air is a fluid substance that has specific properties.

Objectives

Upon completion of this lesson, the student should be able to:

1. define air as a fluid substance because it can flow;
2. name the three properties of air as having weight, taking up space, and exerting pressure;
3. demonstrate the properties of air by constructing an experiment for each property; and
4. demonstrate an understanding of the structure of the atmosphere using any technique or strategy of his/her choice.

TO THE TEACHER

Aircraft, much like ships, must ply their way through a medium. With ships, that medium is, of course, water. Aircraft also travel through a medium that acts much like water and, in fact, has many of the properties of water. That medium is air.

Air is a colorless, tasteless, odorless gas that behaves in similar ways to water. Because air has mass and takes up space, it has weight, it exerts a pressure in all directions. Air flows and reacts to temperatures. Air can be compressed, whereas water generally cannot be.

This lesson is concerned primarily with air, how it behaves and what its properties or characteristics are. It is also concerned with the earth's atmosphere and the properties of that atmosphere at various altitudes.

TECHNIQUES AND STRATEGIES

I. Discuss air as matter:

a. having properties of

(1) weight

(2) takes up space

(3) exerts a pressure

b. a gas being odorless, tasteless, colorless.

II. You may want the students working in small groups to conduct the following experiments, or allow students to experiment at learning stations individually.

Prior to these experiments you may want to instruct the class in techniques of keeping observation notes; students may keep a book of experiments and notes of observations.

Example: Problem: Proving Air Has Body

Date:_____ Time:_____

Materials needed: bottle
funnel
straw
modeling clay
water

Observation Notes: (what took place or happened?)

1. I put funnel into top of bottle and stuck it with clay.

2. I poured water into the funnel.

3. The water stayed in the funnel; it went down slowly, the teacher said my clay wasn't tight enough.

or

4. I put the straw through the water into the bottle and the water went into the bottle.

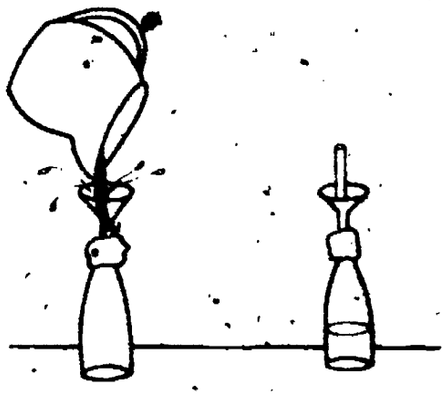
The completion of these experiments should lead students to conclude that air has body.

III. **Demonstrate that air takes up space.**

A. Equipment: soda pop bottle
small funnel
soda straw
modeling clay
cupful of water

Seal the funnel tightly into the neck of the bottle with modeling clay. Pour the cup of water into the funnel *quickly*. The water stays in the funnel because the air in the bottle cannot get out.

Pass the straw through the funnel into the bottle. Suck out a mouthful of air. Some of the water goes down into the bottle, taking the place of the air sucked out.



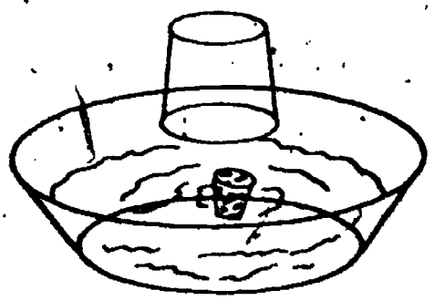
2. Equipment: Wide-necked bottle or jar with an air-tight lid
soda straw
modeling clay
small balloon
thread

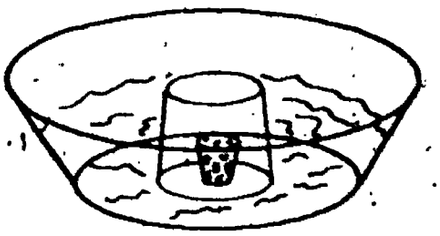
Blow up the balloon just enough to fit very loosely in the bottle. Tie a thread around the neck of the balloon so the air will not escape. Drop the balloon into the bottle. Punch a hole in the lid and insert the straw; seal it with modeling clay. Screw the lid on the bottle. Suck some of the air out of the bottle through the straw and clamp your finger over the top of the straw to prevent air from rushing back into the bottle. The balloon gets larger because the air inside the balloon expands as the air pressure decreases in the bottle.

3. Equipment: water glass
cork
large glass bowl
facial tissue

Remove the glass and the cork. Stuff facial tissue into the bottom of the glass. Invert the glass and push to the bottom of the bowl. The tissue does not get wet.

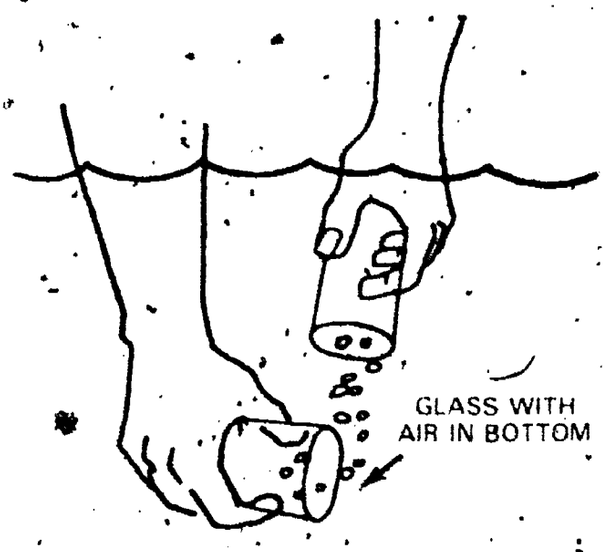
Fill the bowl about three-fourths full of water. Drop the cork on top of the water. Invert the glass over the cork and push to the bottom of the bowl. The cork goes to the bottom of the bowl under the glass. Air in the glass keeps the water out.

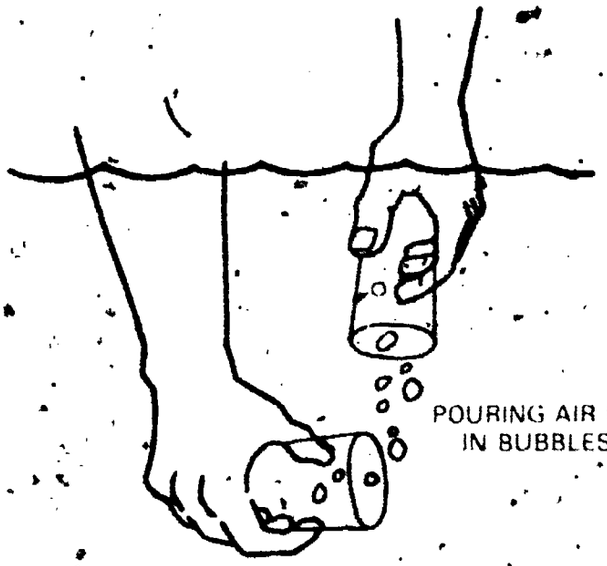




4. Equipment: 2 water glasses
large dishpan or other container filled with water

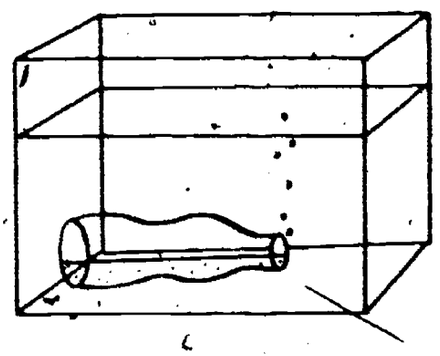
Air, like water, is fluid—you can pour it. Place one glass into the container so that it fills up with water. Place a second glass into the water upside down so that the air does not escape. Carefully tilt the air-filled glass *under* the water-filled glass. By doing this, you can pour the air up in bubbles. Each bubble is a little package of air made visible by being in the water. With a little practice you can keep pouring the air back and forth between the glasses without losing any of it.





5. Equipment: soda pop bottle
pan of water

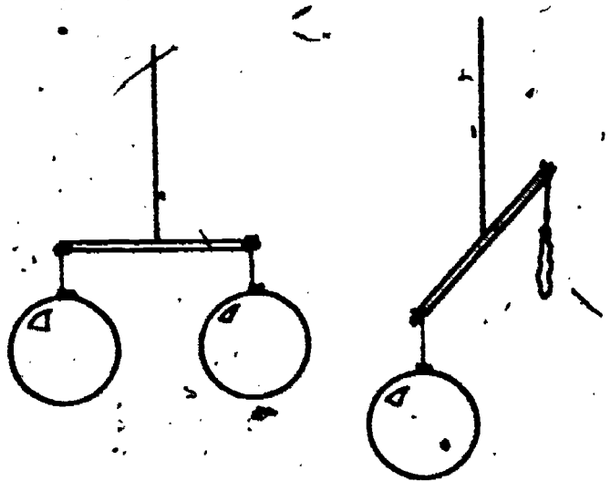
Put the bottle into the pan so that it fills up with water. Before the water can get into the bottle, air must flow out. Watch the air bubbles as they rise to the surface of the water.



IV. **Demonstrate that air has weight.**

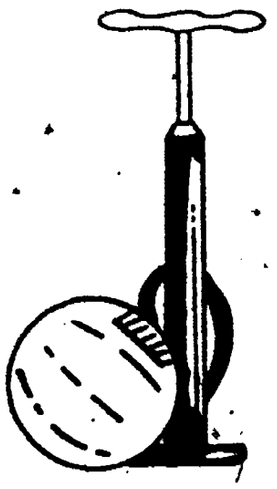
1. Equipment: wooden dowel or tinker toy stick about one foot long
string, 1 yard
2 balloons exactly alike

Blow up the balloons to the same size, and tie them at their necks with a piece of string. Tie one balloon to each end of the dowel stick. Attach another piece of string to the center of the dowel stick and suspend it from some convenient place. Balance the dowel stick. Prick one balloon with a pin. As the air rushes out, the pricked balloon shoots up and the heavier, air-filled one drops down.



2. Equipment: football or basketball
good scale

Squeeze all the air possible out of the ball; then weigh the ball. Blow the ball up again and weigh it. The inflated ball should weigh a few ounces more.



3. Equipment: wooden upright
rod about 4 feet long
pail
sand or gravel
deflated ball (basketball, volleyball, or soccerball)
bicycle pump

Nail the rod at the center to the upright. Suspend deflated ball at one end and the pail at the other. Using the sand, balance the two. Inflate the ball, pumping as much air as the ball will take. Replace it.

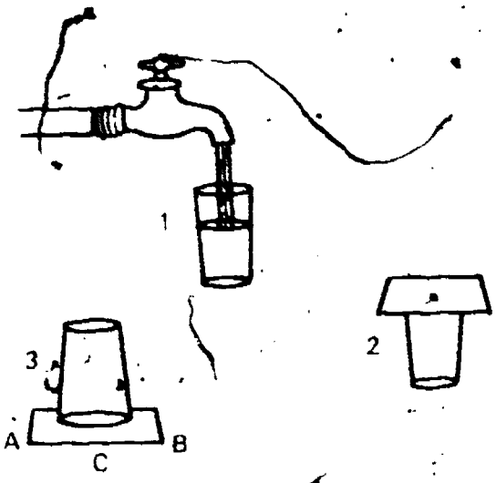
The ball pulls down and unbalances the pail of sand, showing that air does have weight.

V. **Demonstrate that air exerts pressure.**

Since moving air particles have weight, they press with force against whatever they touch. Air presses upward, downward, sideways—every way. Air presses on all sides of our bodies, but we do not notice it because our bodies are made to withstand this pressure.

1. Equipment: water glass
piece of thin, flat cardboard

Fill glass to the top with water. Place the cardboard over the glass. Carefully turn the glass upside down, holding cardboard tightly to the glass. Take your hand away from the cardboard. The cardboard stays in place against the glass. Tilt the glass or hold it sideways, and the cardboard still remains in place.



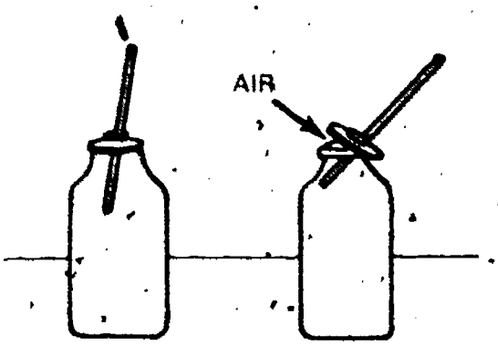
At *A* and *B* the upward and downward pressures balance, but at *C* the upward pressure of air is greater than the downward pressure of water and holds the cardboard in place.

2. Equipment: soda straw or glass tube

Put your finger over the top of a soda straw filled with water. Lift or tilt it. The water will not run out because your finger cuts off the air pressure on top, but air still presses up against the water at the bottom of the straw. Take your finger away, and the water runs out of the straw.

3. Equipment: bottle or jar with a tight cap
soda straw
modeling clay

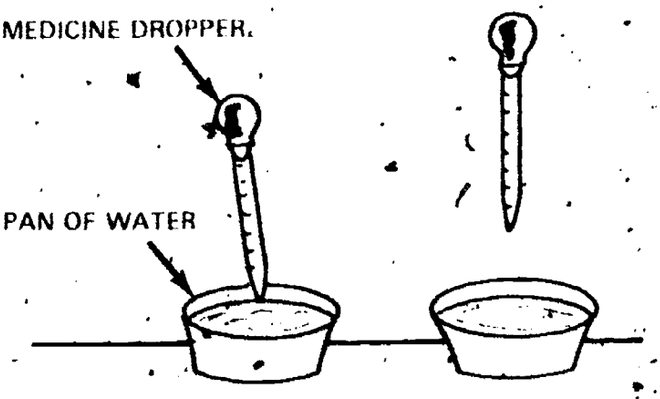
Fill the jar up to the cap with water. Punch a hole in the cap and insert the soda straw. Seal tightly around the straw with clay. Put the cap on tightly so that no air can get into the bottle. Now try to suck the water out of the bottle. No matter how hard you suck, the water will not flow through the straw. Release the cap on the bottle just enough to let in some air, and try to suck the water through the straw. Now, as you suck through the straw, the air pressure is lowered inside the straw. Air pressing on the surface of the water in the bottle pushes it up through the straw as you suck through it.



An elephant has a built-in straw, and he puts air pressure to work every time he takes a drink. He puts his trunk in water and breathes in to draw the air out of his trunk. As he does this, the water fills his trunk.

4. Equipment: large medicine dropper or any kind of a tube with a suction bulb

Put the dropper or tube in a pan of water and squeeze the attached bulb, forcing the air out of the tube. Release the bulb. Water now rushes into the tube. Lift the tube out of the water. The water does not run out. Air pushes on the water in the tube and holds it there.

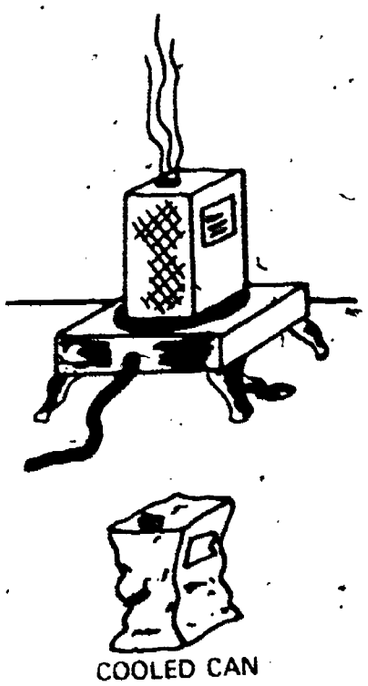


5. Equipment: 2 large, flat, rubber sink-stoppers

Air pressure tug-of-war: After wetting their surfaces, press the two sink-stoppers together so that no air is between them. Ask a friend to pull on one while you pull the other. You can't pull them apart. But just let the air get in between the pads or plungers, and presto!—they separate.

6. Equipment: tin can with a screw-on metal cap, such as a maple syrup can
hotplate or burner

Make sure the can is clean. Pour about an inch of hot water into the can. Put it on the burner and heat it until you see the steam coming out of the opening. Wait another few seconds and *turn off the heat.* Screw the cap on tightly and wait for it to cool. The can suddenly begins to cave in.



COOLED CAN

When it was heated, water turned into steam, driving out most of the air. Now as the can cools, the steam turns back into water, leaving neither air nor steam inside the can. A partial vacuum has been created. Consequently, the pressure of air outside the can, being greater than that inside the can, crushes the can.

VI. **Air makes up our atmosphere.**

A. *The Atmosphere*

Our atmosphere consists of 78% nitrogen, 20.9% oxygen, and 1.1% carbon dioxide and other gases. These gases are very important to the body physiologically. Because of constant mixing by the winds and other weather factors, the percentages of each gas in the atmosphere are normally constant to 70,000 feet. Utilize Diagram 1-1, *Percent of Gases in the Atmosphere*, to assist in explaining the content of our atmosphere.

B. *Nitrogen and Oxygen*

(1) Nitrogen is responsible for the major portion of the total atmospheric weight and, in turn, pressure. Nitrogen is dissolved in and is carried by the blood. Nitrogen does not appear to enter into any chemical combination as it is carried throughout the body. Each time we breathe, the same amount of nitrogen is exhaled as is inhaled.

(2) Oxygen is a colorless, odorless, tasteless gas that is absolutely essential to life. Each time we breathe, we breathe in oxygen that is taken into the lungs and absorbed into the bloodstream to be carried to all parts of the body. It is used to "burn" or oxidize food materials and produce energy transformations in the body.

C. *Air is heavy*

Air is heavy. It weighs 14.7 pounds per square inch at the earth's surface at sea level. Technically speaking, that is the pressure created by a column of air one inch square and about 100 miles high (the approximate thickness of the layer of free air or atmosphere covering the earth). A person normally does not notice this pressure because it presses upon him equally from all directions. Diagram 1-2, *Weight of Atmosphere*, and Diagram 1-3, *Pressure Varies with Altitude*, may be used to aid in teaching this about our atmosphere.

The weight of the atmosphere does not remain the same from top to bottom. Some people like to talk of the atmosphere as an ocean in which the diver finds that the pressure gets greater the deeper he goes. Others picture the air as a haystack because hay packs down at the bottom of the stack and is fairly loose at the top. In the same manner, air always remains the same in composition, but it is denser at the bottom because of all the weight on top.

D. *The atmosphere is divided into layers or regions.*

(1) Using Diagram 1-4, *The Atmosphere*, as an overhead transparency, discuss the following features of the atmosphere.

The atmosphere is made up of two main regions, the homosphere and the heterosphere. The homosphere extends from the Earth's surface up to an altitude of about 60 miles. The prefix *homo-* means same; thus, the homosphere is that region in which the gaseous composition and mixing are relatively constant (i.e., 78% nitrogen and 21% oxygen.)

The heterosphere (*hetero-* is a prefix meaning different) begins at the 60-mile altitude. Within this region, the molecules and atoms of the atmospheric gases tend not to mix, and they take on a vertical arrangement. At this altitude, they are spaced much farther apart, and gravity influences them according to mass. Thus, molecular nitrogen (N_2) and Oxygen (O_2), which are the heaviest, will be found in greater abundance in the lower portion of the heterosphere. Continuing upward, the lighter atomic oxygen (O), helium (He), and hydrogen (H) predominate. The exosphere, the upper subdivision of the heterosphere, is considered to extend into "space."

(2) The atmosphere may also be divided into regions based on differentiations of temperature.

This is the more common classification used in reference to altitude. The lowest layer of this *thermal structure* is the troposphere (trope-turning) which extends from the surface to a maximum of 10 miles.

Temperature within the troposphere decreases at a fairly constant rate as altitude increases. This decrease in temperature—called lapse rate—averages approximately 2°C (3.5°F) per 1,000 feet increase in altitude.

IT IS WITHIN THE TROPOSPHERE THAT MOST OF OUR "WEATHER" OCCURS.

At the top of the troposphere is the tropopause—the point where the lapse rate ceases and the point at which the temperature has dropped to −60°C (−76°F). We should think of the tropopause as a dividing line, rather than a layer or region. In any event, this is the "point" where the temperature stops decreasing with altitude, and where the base of the stratosphere begins.

The stratosphere is identified as the atmospheric region where the temperature either remains constant or increases slightly with increase in altitude. For convenience of explanation, we will say that the stratosphere begins at 10 miles and extends to about 19 miles. From the base to the top of the stratosphere, the temperature *rises* from −60°C (−76°F) to −40°C (−40°F).

At 19 miles "up," the warming trend stabilizes, and there is another dividing line called the stratopause. Here is where the next region begins—the mesosphere. From the stabilized −40°C stratopause, the mesosphere shows first a marked increase in temperature to +10°C (+50°F), then a decrease until at about 50 miles altitude the temperature has dropped to as low as −90°C (−130°F). This point is called the mesopause.

From about 50 miles outward to about 250 miles, there is the region called the thermosphere. Here the temperature increases again. But how much increase there is depends on solar activity. This amounts to a variation from +750°C (+1,380°F) to +1,250°C (+2,280°F). Thinking in conventional terms, we are in space, or the exosphere, at this point. Therefore, temperature is a relative sort of thing. It depends on one's proximity to the sun and whether or not the "thermometer" is in direct sunlight or is shaded from the sun. (Spacecraft on the way to the moon rotate slowly to prevent overheating on the "sun" side.)

Use Diagram 1-5, *The Atmosphere Showing Temperature Variations*, as an overhead transparency while you discuss this topic.

Diagram 1-1
Percentage of Gases in the Atmosphere

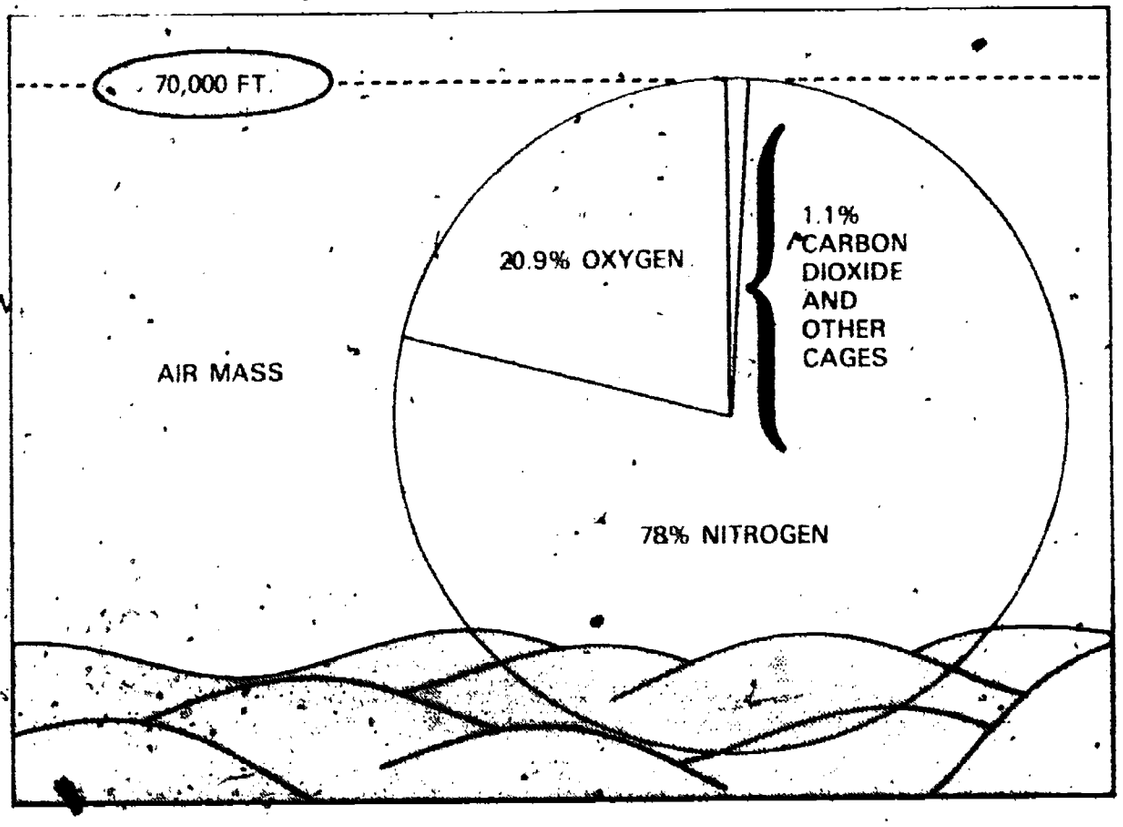


Diagram 1,2
Weight of the Atmosphere

THE PRESSURE OF THE ATMOSPHERE AT SEA LEVEL, IS THE RESULT OF THE WEIGHT OF THE ENTIRE COLUMN OF ATMOSPHERE ABOVE.

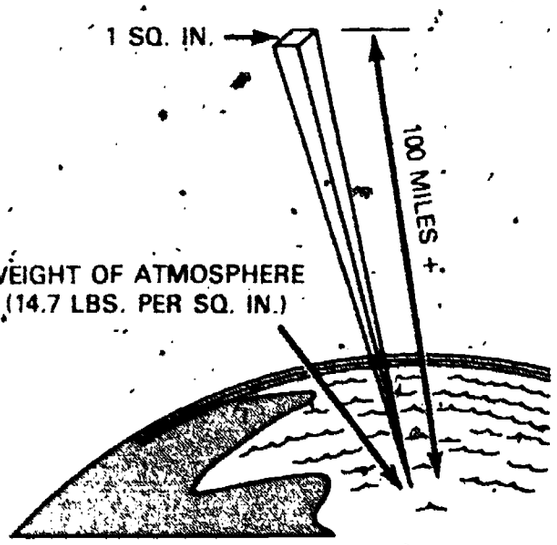


Diagram 1-3

Pressure Varies with Altitude

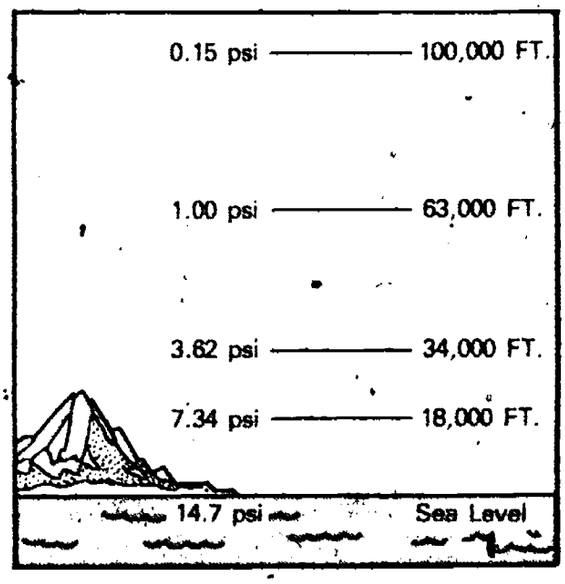


Diagram 1-4
The Atmosphere

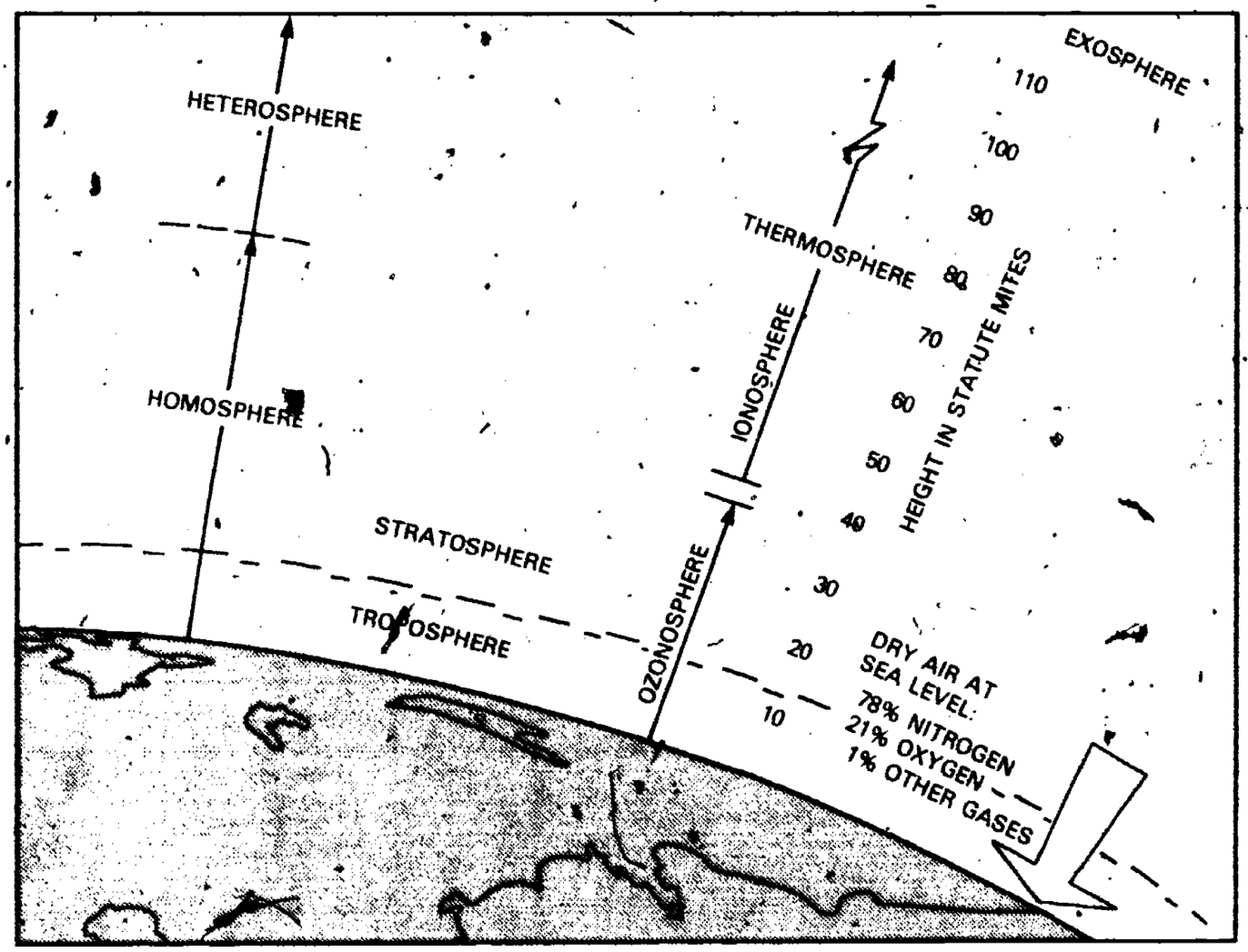
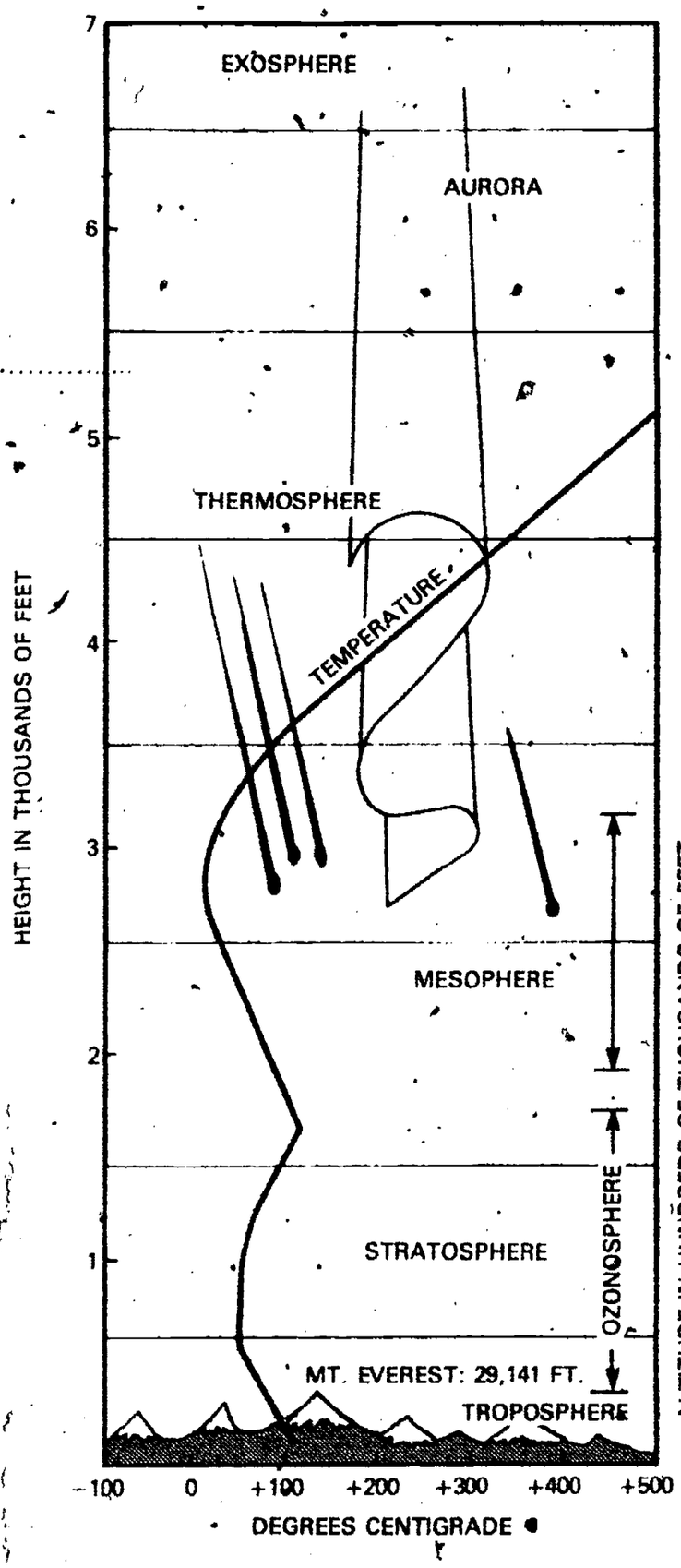
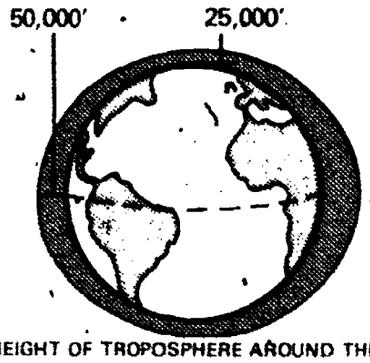


Diagram 1-5
The Atmosphere Showing Temperature Variations

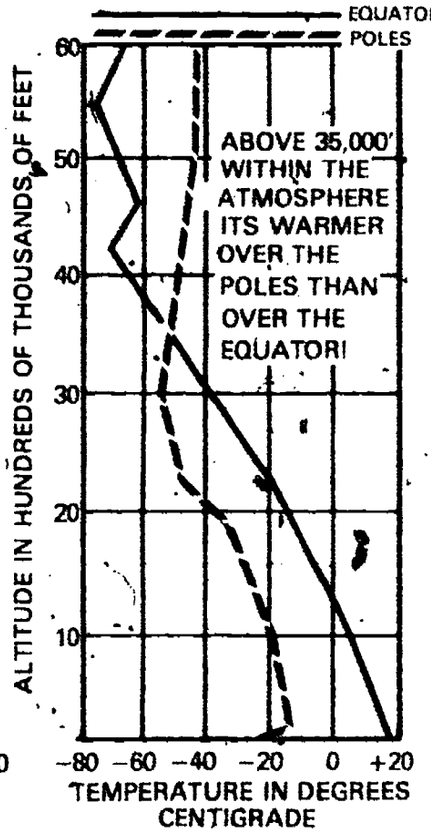


THE ATMOSPHERE SHOWING TEMPERATURE VARIATIONS

WHEN MAN LEAVES THE TWO-DIMENSIONAL SURFACE OF THE EARTH, HE ENTERS A THREE-DIMENSIONAL ENVIRONMENT WHOSE MULTIPLE CHARACTERISTICS ARE FAST-CHANGING AND FOREIGN TO HIM.



HEIGHT OF TROPOSPHERE AROUND THE EARTH



LESSON 2

FLIGHT

Conceptual Scheme

Air is a fluid that under certain conditions supports flight.

Objectives

Upon completion of this lesson, the student should be able to:

1. demonstrate Bernoulli's principle by diagramming or constructing a model;
2. define an airfoil as a structure designed to obtain lift;
3. demonstrate the application of Newton's third law on an airfoil by diagramming or constructing a model; and
4. demonstrate knowledge of induced lift and dynamic lift by diagramming the forces involved to produce total lift.

TO THE TEACHER

This lesson concerns the theory of flight and certain physical properties of flowing air that contribute to flight. Once an aircraft leaves the ground, it is supported in the air by aerodynamic forces. It is the examination of these forces acting upon an airplane and the application of the principles upon which these forces are based that this lesson is all about.

TECHNIQUES AND STRATEGIES

I. Air as a Fluid

Air is a fluid because it can flow. Fluids are defined in the dictionary as any substance that can flow or has the capability of flowing.

A good example of flowing air might be the cold air flowing out of the bottom of the refrigerator when the door is kept open.

II. Bernoulli's Principle and Induced Lift

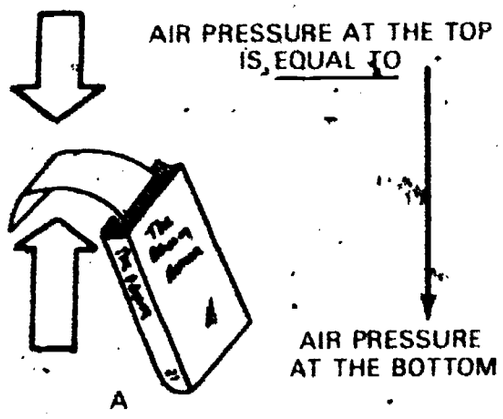
One of the most significant physical laws that led to the creation of an airfoil is the Bernoulli Principle. Many years ago, Daniel Bernoulli (1700-1782) developed a theory concerning the behavior of fluids, and his theory has been accepted as a partial explanation of how air pressure and velocity interact on an airfoil to help provide the lift necessary for flight. His theory was that the total energy of a fluid in motion is constant at all points in its path of steady flow. This means that if at any point in the flow path the velocity of the fluid increases, then the pressure of the fluid must decrease at that point proportionately. You can prove this theory very simply by taking a small strip of lightweight paper, placing the end of it against your lower lip while supporting it in a horizontal position, and gently blowing along the paper's upper surface. The extended end of the paper will rise. What has happened is that you have increased the velocity of the air pressing on the upper surface of the paper and, simultaneously, lowered the pressure on the upper surface. You have not disturbed the pressure or velocity of the air under the paper. The result is that the pressure under the paper is greater than the pressure on top, thereby providing a lifting action. The resulting lift is called induced lift.

Use Diagram 2-1, *Induced Lift*, to explain Bernoulli's Principle.

III. Use the following activities to show how the creation of an airfoil demonstrates Bernoulli's Principle and creates lift.

1. Equipment: strip of notebook paper or newspaper, about 2 inches wide and 10 inches long
   book
   paper clips

Make an *airfoil* (wing) by placing one end of the strip of paper between the pages of the book so that the other hangs over the top of the book as shown in Diagram A. Move the book swiftly through the air, or blow across the top of the strip of paper. It flutters upward.

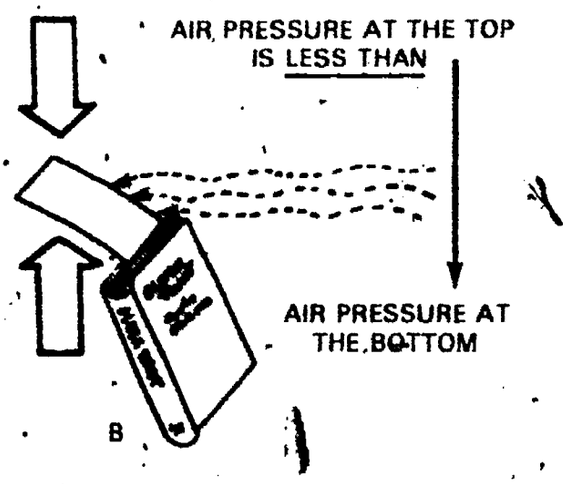


Hold the book in the breeze of an electric fan so the air blows over the top of the paper.

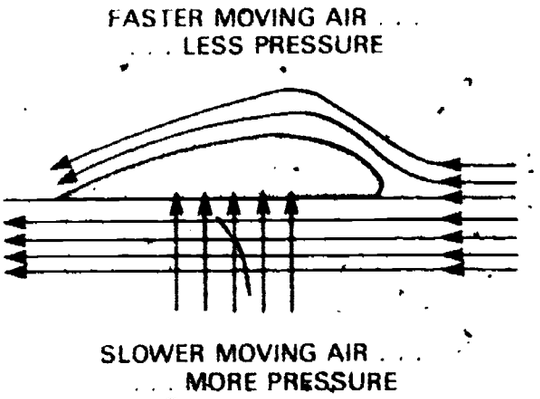
Take the strip of paper out of the book. Grasp one end of the paper and set it against your chin, just below your mouth. Hold it in place with your thumb and blow over the top of the strip. The paper rises. Try the same thing after you have fastened a paper clip on the end of the strip. See how many paper clips you can lift in this way.

Hold the strip of paper in your hands and run around the room.

It doesn't matter whether you move the air over the strip of paper by blowing or whether you move the paper rapidly through the air—either way it rises.



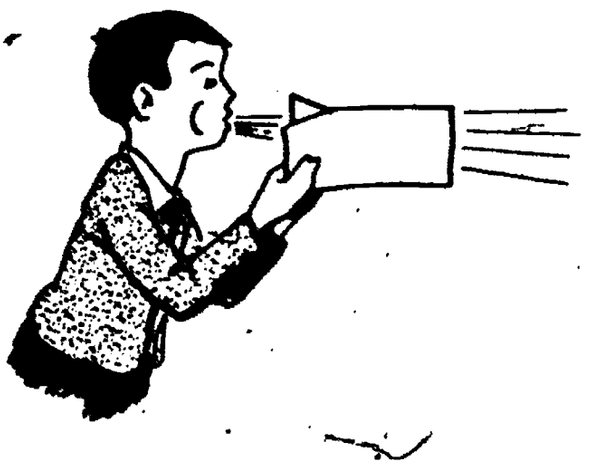
Bernoulli's Principle states that an increase in the velocity of any fluid is always accompanied by a decrease in pressure. Air is a fluid. If you can cause the air to move rapidly on one side of a surface, the pressure on that side of the surface is less than that on its other side.



Bernoulli's Principle works with an airplane wing. In motion, air hits the leading edge (front edge) of the wing. Some of the air moves under the wing, and some of it goes over the top. The air moving over the top of the curved wing must travel farther to reach the back of the wing; consequently, it must travel faster than the air moving under the wing, to reach the trailing edge (back edge) at the same time. Therefore, the air pressure on top of the wing is less than that on the bottom of the wing.

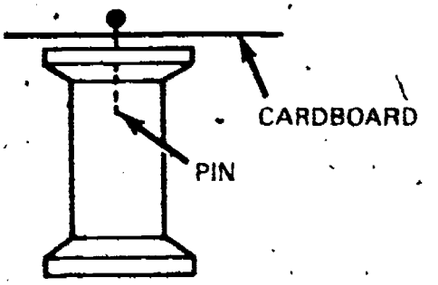
2. Equipment: 2 sheets of notebook paper

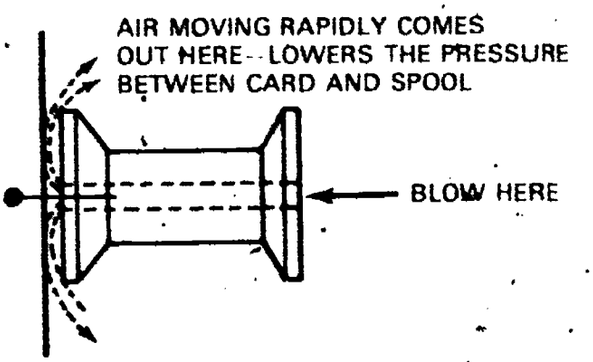
Hold two sheets of notebook paper about four inches apart. Blow between them. Instead of flying apart, they come together. The air moving rapidly between the two pieces of paper has less pressure than the air pressing on the outer sides of the paper.



3. Equipment: pin
spool
cardboard, 3" × 3", lightweight but firm

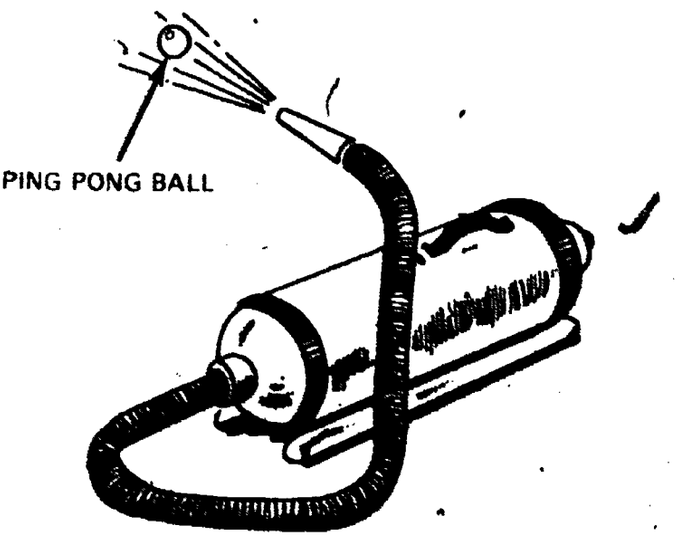
Place the pin through the center of the cardboard. Place the spool over the pin so that the pin goes into the hole in the spool. Hold the card against the spool and blow firmly through the spool. Release your hand. The card does not fall.





4. Equipment: ping-pong ball
tank-type vacuum cleaner

Connect the hose to the blower rather than to the suction end of the vacuum cleaner. Turn the switch on. Hold the hose vertically so the stream of



air goes straight up. Release the ping-pong ball into the stream of air about a foot from the nozzle. Slowly tip the nose so that the air shoots at an angle. The ball will stay suspended in the airstream.

The force of gravity upon the ball tends to make it drop out of the airstream. However, the fast-moving airstream lessens the air pressure on the portion of the ball remaining in the airstream, overcoming the force of gravity, with the result that the ball remains suspended.

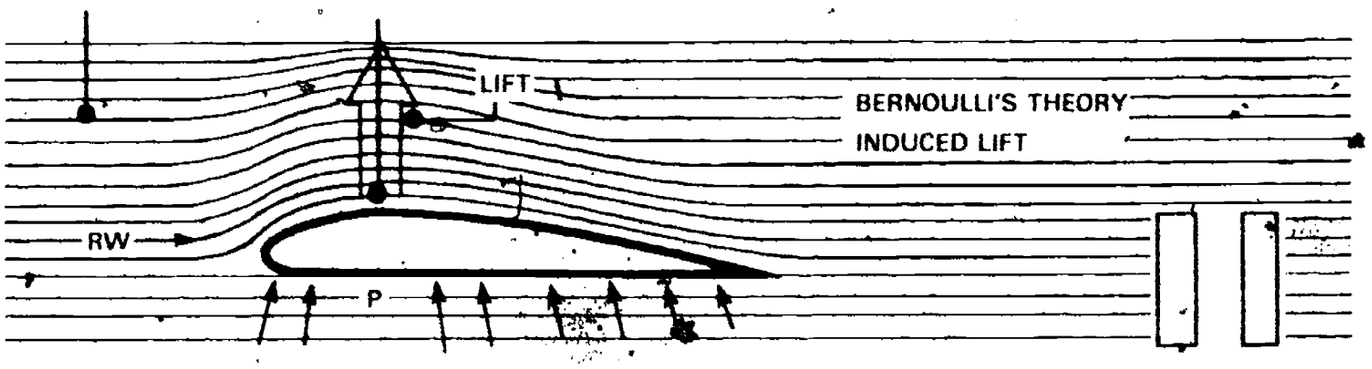
IV. Newton's Action/Reaction Theory and Dynamic Lift

Newton's third law of motion states that for every action there is an equal and opposite reaction. When a wing is slanted so that the leading edge is higher than the trailing edge, the relative wind strikes the underside of the wing (action) and the wing is given a lifting action (reaction), with the amount of lift depending, among other things, on the speed and the angle of attack, the angle being the amount the leading edge is higher than the trailing edge, in relation to the relative wing. This very simple action-reaction principle actually provides from 15% to 30% of an aircraft's lift (dynamic lift), and the remainder of the lift (induced lift) is provided by the less obvious pressure differential based on Bernoulli's Principle.

Use Diagram 2-2, *Dynamic Lift on a Kite*, to help explain the principle of dynamic lift using Newton's third law of motion. Use Diagram 2-3, *Dynamic Lift*, to show dynamic lift on an airfoil (wing).

V. Diagram 2-4, *Dynamic Lift Plus Induced Lift Produces Total Lift*, combines induced lift (Bernoulli's Principle) and dynamic lift (as a result of application of Newton's third law of motion). Use this as an overhead to demonstrate total lift.

Diagram 2-1
Induced Lift



P - P' = 14.7 12.5 = 2.2#/IN.²
= PRESSURE DIFFERENTIAL

Diagram 2-2

Dynamic Lift on a Kite

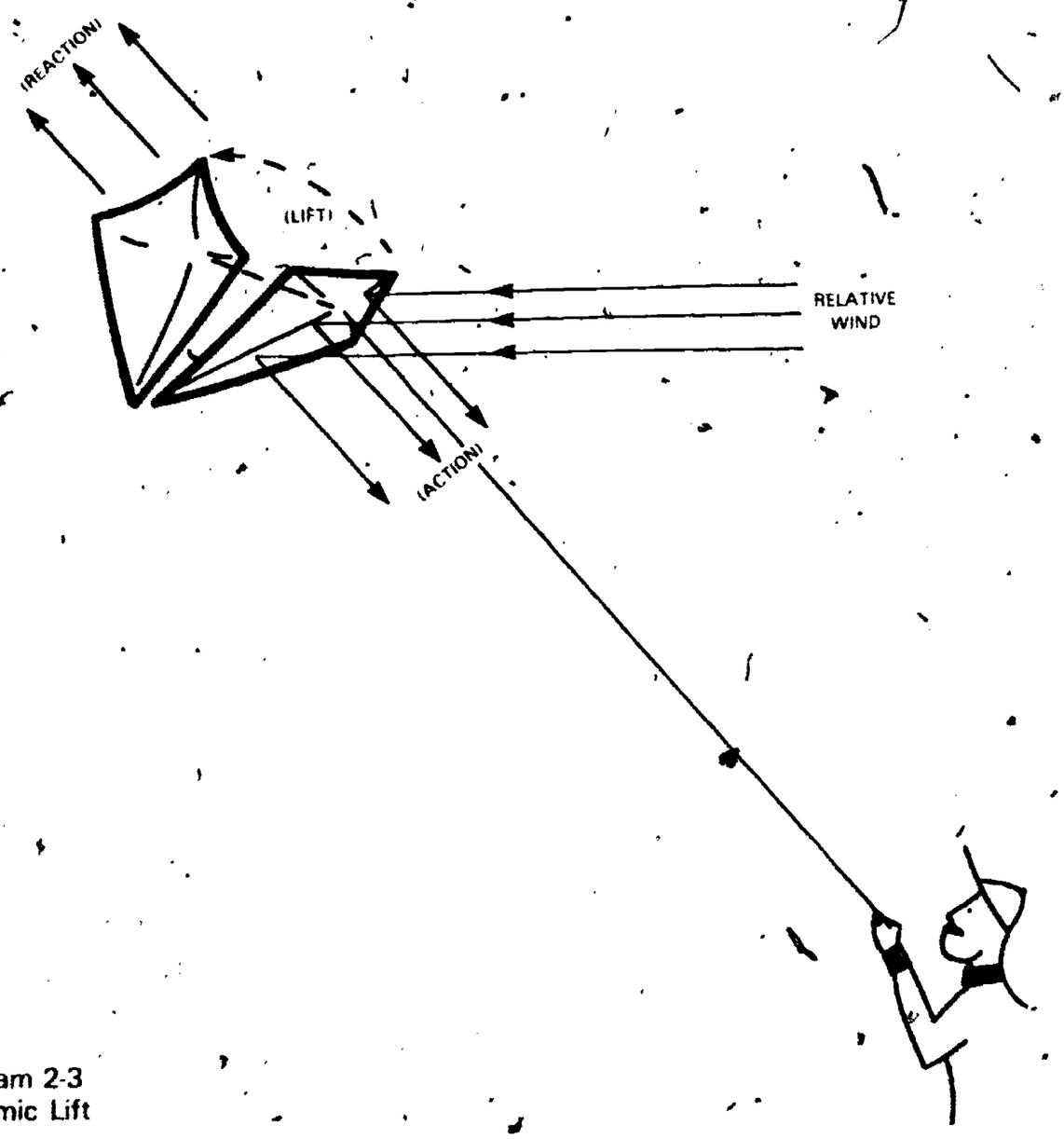
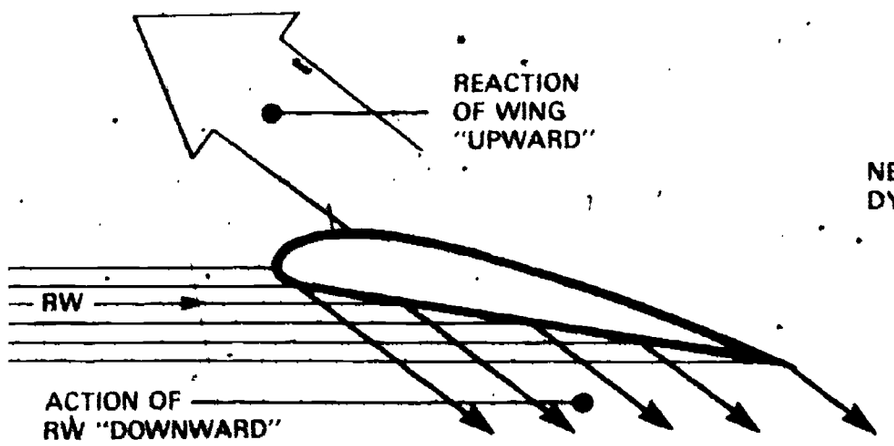
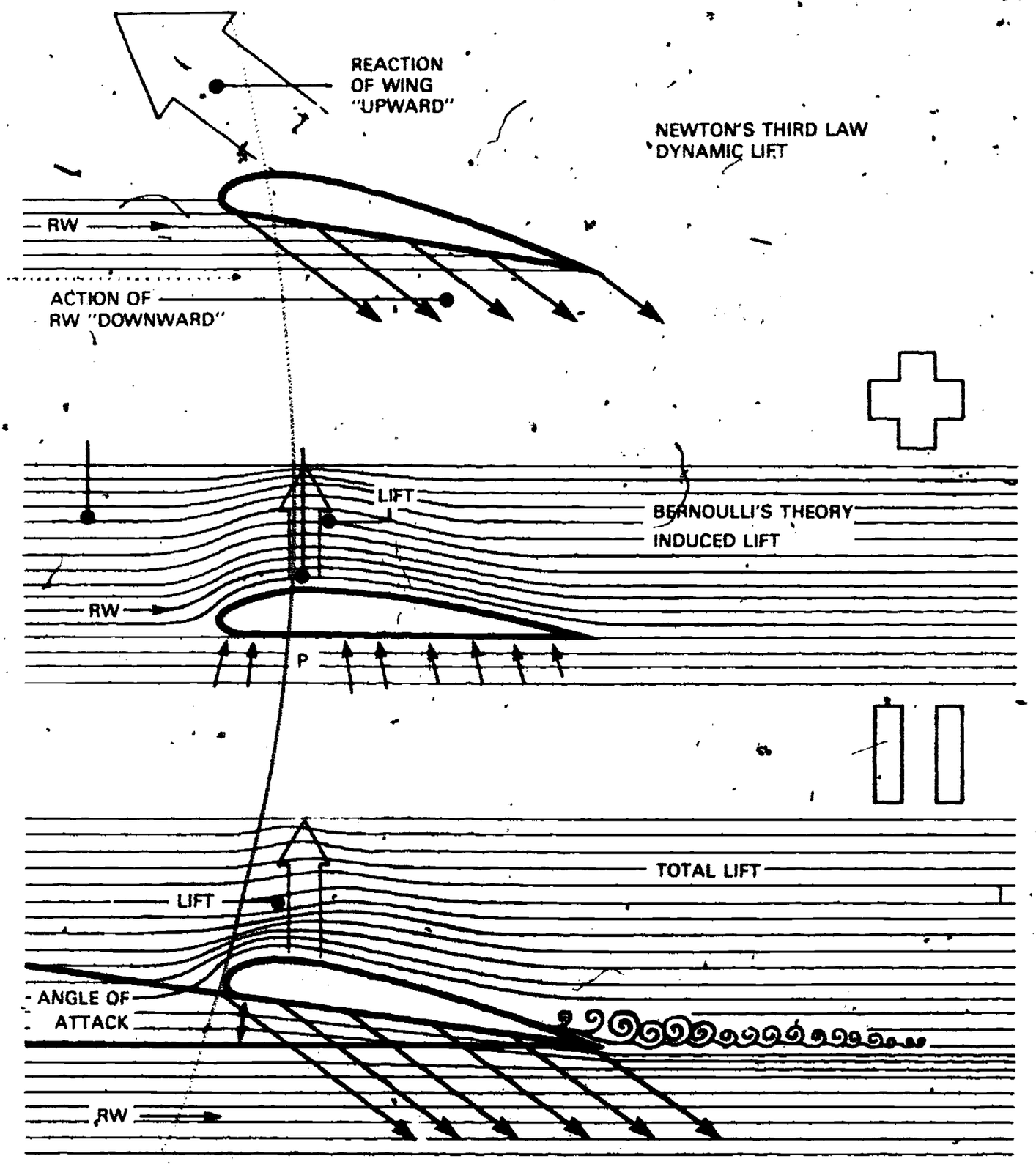


Diagram 2-3
Dynamic Lift



NEWTON'S THIRD LAW
DYNAMIC LIFT

Diagram 2-4
Dynamic Lift + Induced Lift = Total Lift



LESSON 3

WHY AIR TRAFFIC CONTROL

Conceptual Scheme

In order to insure safety in the air, there must be some order or rules to minimize aircraft accidents.

Objectives

Upon completion of this lesson, the student should be able to:

1. define what constitutes any aircraft;
2. name and describe four kinds of aircraft;
3. define air traffic in terms of approximate numbers of commercial, military, and general aviation aircraft;
4. define the terms *commercial aircraft, military aircraft,* and *general aviation aircraft*; and
5. demonstrate an understanding of the National Airspace system.

TO THE TEACHER

This lesson concerns itself with the growing volume of air traffic. Aircraft are vehicles that constitute air traffic, much like the variety of vehicles that make up highway traffic. Just as we have cars, trucks, motorcycles, and buses, so does the air traffic consist of many kinds of aircraft such as airplanes of many sizes, including reciprocal engine planes with propellers, planes with jet engines, and the many types of turboprop planes; planes that are high wing planes, low wing planes, and biplanes; planes that are used commercially to carry passengers and freight; planes used in agriculture to dust crops and spray fields; and the thousands of private planes used for pleasure. Air traffic also includes hot air balloons, blimps, gliders, and many different types of experimental aircraft.

Without specific rules to regulate highway traffic, many more accidents would occur on our highways than presently do. If all drivers made up their own rules, chaos and catastrophe would be rampant. The same would be true for air traffic. Rules must be formulated to insure safety.

Thus, this lesson will help to make students aware of the great variety of aircraft that utilize the airspace over our nation and bring them to the realization that unless air traffic is controlled, tragedies would result.

TECHNIQUES AND STRATEGIES

I. What constitutes an aircraft?

When is an aircraft an aircraft? An aircraft is any contrivance now known or hereafter invented, used, or designed for navigation of or flight in the air. In the broadest sense, an aircraft is any device that flies.

The FAA has developed detailed guidelines which assist in differentiating between the vast array of aircraft. One method of classification is based on the manner in which an aircraft sustains itself while airborne. Using this definition, aircraft may be divided into the following four categories. Use Diagram 3-1, *Varieties of Aircraft*, to illustrate these categories:

1. Lighter-than-air
2. Gliders
3. Rotorcraft
4. Airplanes

Before listing the above categories, you might have the class explore the various categories and see if they can establish the four groups of aircraft.

II. Lighter-than-air

Historically, balloons were the first aircraft to carry man into the atmosphere and enabled him to break the bonds that held him to earth. The balloon still survives primarily for sport and the highly inflammable hydrogen, previously used for lifting power, has now been replaced with noninflammable helium or by heated air. Use Diagram 3-2, *Hot Air Balloon*, for illustration.

The blimp is also another variety of lighter-than-air. It generally has a rigid keel running along the bottom of a gas-filled envelope. Usually a cabin or control car is attached to the keel and twin engines are usually attached to either side of the cabin or control car. Use Diagram 3-3, *Blimp*, as an overhead transparency or a handout.[1]

Another variety of lighter-than-air craft is the dirigible or Zeppelin. These giant aircraft differed from the blimp in that they had lightweight aluminum frames. Diagram 3-4, *Dirigible*, can be used as an overhead transparency or handout.

III. Gliders

The sailplane is probably the most popular glider today. This type of aircraft has excellent aerodynamic characteristics. This aircraft allows the pilot to apply his knowledge of air currents and his skill in controlling the sailplane to achieve great altitudes and long-duration flights. Diagram 3-5, *Sailplane*, can be shown as a modern glider.

You might introduce a discussion of hang gliders at this time: Are hang gliders considered aircraft by our definition? Are they involved in air traffic safety? How can we find out? Students might want to investigate through FAA some air safety controls on hang gliders. Some student may want to investigate the aerodynamics of hang gliding, others may do some historical research on hang gliding.

IV. Rotorcraft

Rotorcraft can be divided into two groups. *Gyroplanes* attain their thrust with a pusher-type propeller and attain lift with a free-wheeling rotor. *Helicopters* attain their lift with a powered rotor. The helicopter has evolved into an extremely versatile aircraft because of its ability to fly slowly, hover, and climb or descend vertically. Diagram 3-6, *Rotorcraft*, can be utilized to show both the gyroplane and the helicopter. Students may want to investigate the fact that gyroplanes have enjoyed great popularity among home builders of aircraft. Several inexpensive kits have been marketed and have been written up in *Popular Science* and *Popular Mechanics* magazines.

V. Airplanes

Airplanes are the most important type of aircraft in terms of numbers, economics, sociological impact, and national defense. Airplanes can be classified on the basis of their intended use, number of engines, type of landing gear, and the location and configuration of their wings. Diagram 3-7, *Airplanes*, shows the four major divisions of airplanes:

1. single engine, land
2. multi engine, land
3. single engine, sea
4. multi engine, sea

VI. Aviation Today

All aircraft flying today can fit into any one of the three main categories of aircraft designated by use. The three categories are: General Aviation, Commercial Aviation or Air Transport Industry, and Military Aircraft.

Today there are approximately 225,000 *general aviation* planes in operation throughout the United States. Diagram 3–8, *FAA General Aviation Forecast of Aircraft*, may be used to demonstrate the large numbers of general aircraft in recent years. General aviation is a category that includes all civilian flying except that performed by the air transport industry. It includes a wide range of aircraft uses that can be grouped into five categories:

A. *Personal flying*—aircraft used for personal purposes not associated with a business or profession and not for hire

B. *Business flying*—aircraft that are owned or leased by a company or individual to transport persons or property required by business

C. *Commercial flying*—scheduled and non-scheduled taxi service and aerial application (agriculture)

D. *Instructional flying*—flight training

E. *Other flying*—research and development, demonstration, sports, parachuting and ferrying flights, highway patrol, pipeline patrol, aerial photography, emergency and rescue operations

Besides general aviation aircraft, there is also the *Air Transport Industry or Commercial Airlines*, with approximately 2,500 aircraft used for passenger service and freight service. Diagram 3-9, *Air Transport Industry*, shows the growth and development of commercial aviation in terms of passenger and freight growth.

The third aviation category is *Military Aviation*, which includes all aircraft used for military or defense purposes.

Diagram 3-1
Varieties of Aircraft

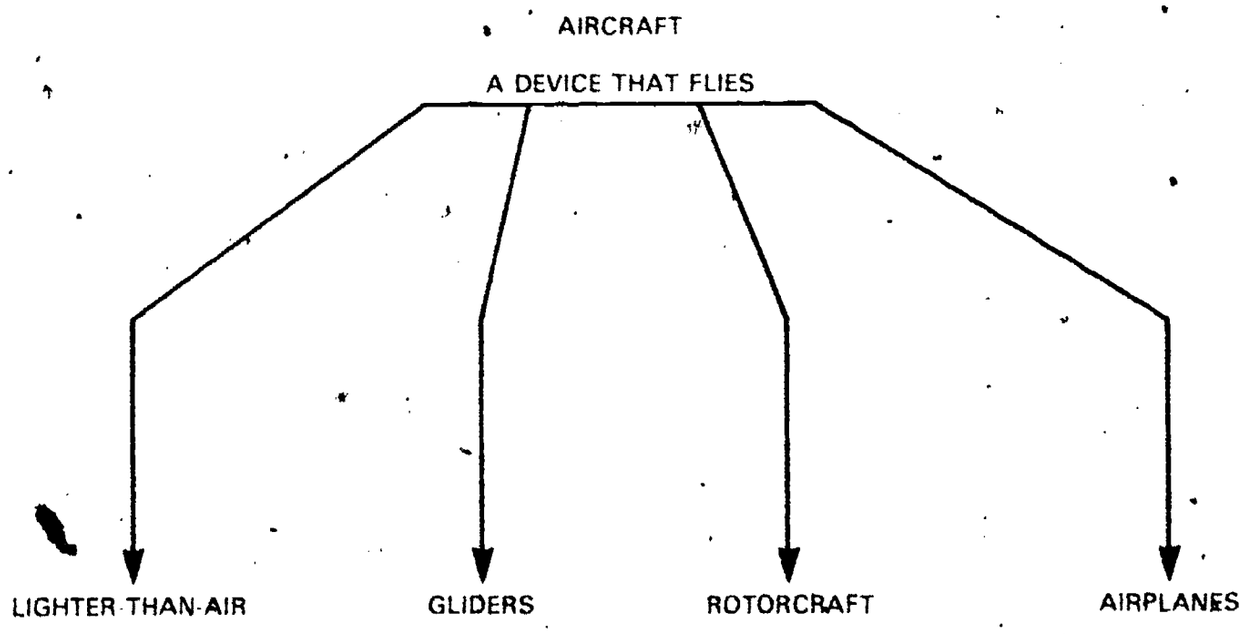


Diagram 3-2
Hot Air Balloon

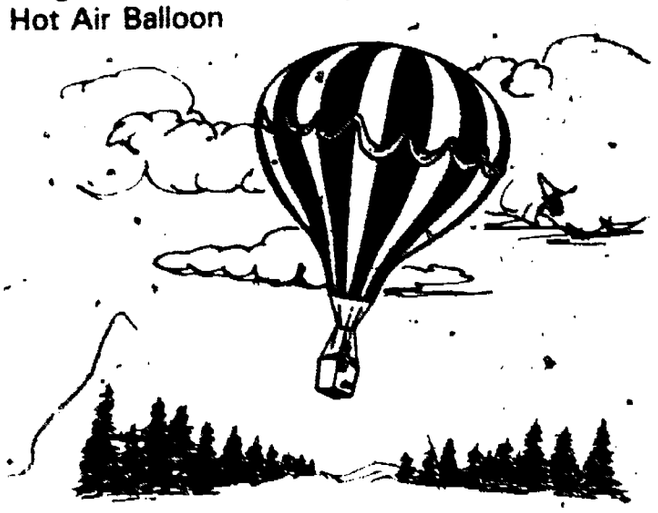


Diagram 3-3
Blimp

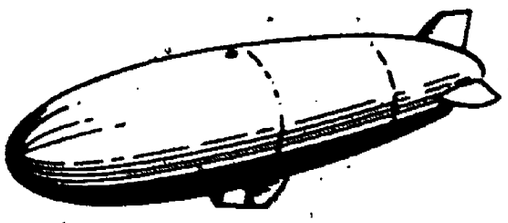


Diagram 3-4
Dirigible or Zepplin

Diagram 3-5
Sailplane

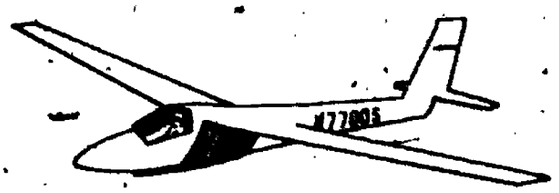
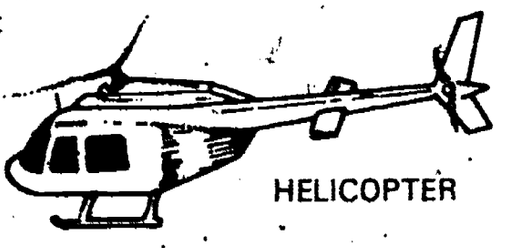


Diagram 3-6
Rotorcraft



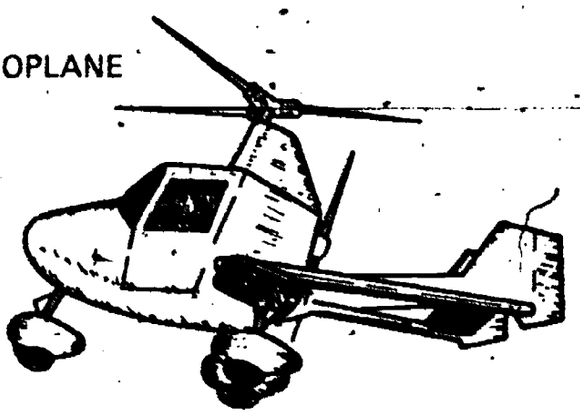
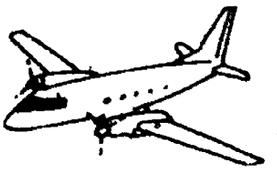
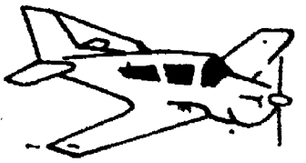


Diagram 3-7
Airplanes





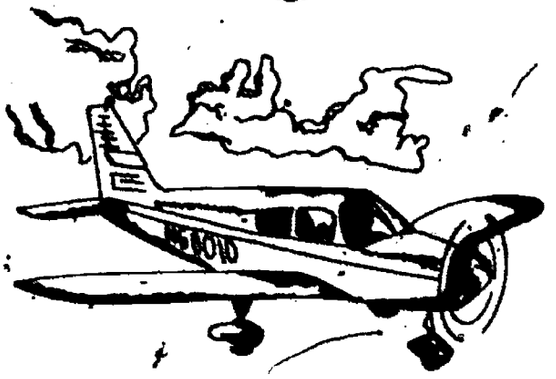


Diagram 3-8

FAA General Aviation Forecast of Aircraft

THE AIR AND SPACE AGE

AS OF JANUARY 1	TOTAL AIRCRAFT
1970	130.8
1971	131.7
1972	131.1
1973	146.0
1974	153.5
1975	161.0
1976	168.0
1977	178.0
1978	184.3
1979	198.8
1980*	208.0
1981*	218.7
1982*	228.5
1983*	237.1
1984*	246.8
1985*	254.5
1986*	263.2
1987*	271.4
1988*	280.8
1989*	289.4
1990*	298.1
1991*	306.8
1992*	315.5

Fig. 14-36. FAA General Aviation Forecast of Aircraft

*Forecast

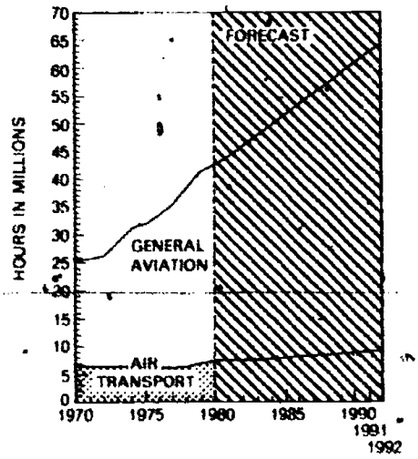
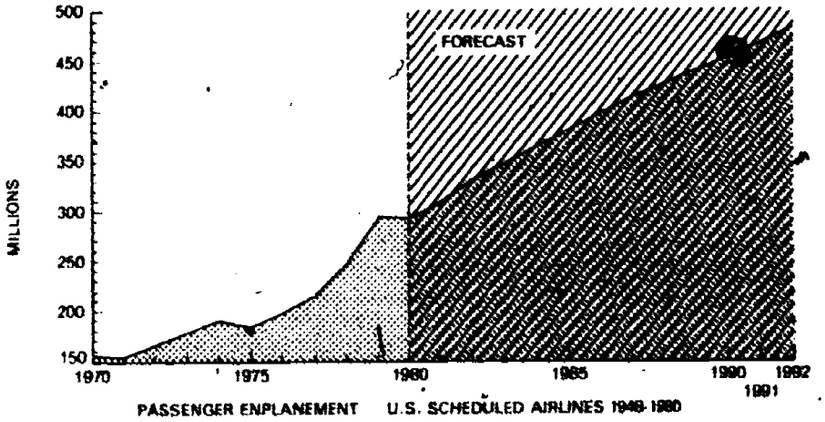


Fig. 14-37 Forecast of Hours Flown by General Aviation vs Air Transport Aircraft

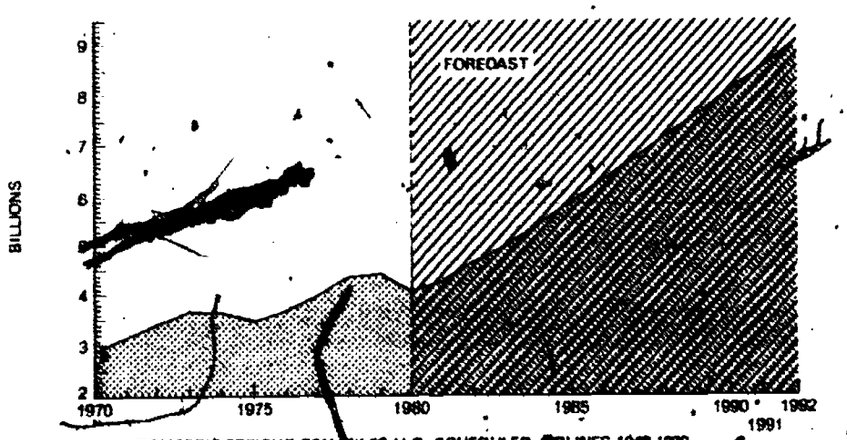
Diagram 3-9

Air Transport Flying or Commercial Airlines

THE AIR AND SPACE AGE



PASSENGER ENPLANEMENT U.S. SCHEDULED AIRLINES 1948-1980



DOMESTIC FREIGHT TON MILES U.S. SCHEDULED AIRLINES 1948-1980

LESSON 4

VFR

Conceptual Scheme

1. A great percentage of all flying in the United States utilizes *visual flight rules* (VFR).

2. Assuming weather conditions are above the applicable minimums, any licensed pilot may fly from any uncontrolled airport to any other uncontrolled airport without talking to Air Traffic Control (ATC).

Objectives

Upon completion of this lesson, the student should be able to:

1. identify the conditions necessary to obtain a pilot's license;
2. identify conditions necessary for VFR;
3. identify services available to VFR pilots; and
4. identify the VFR rules.

TO THE TEACHER

Just as all automobile drivers should have licenses, so should all aircraft pilots. Once a pilot obtains a license in the United States, and assuming weather conditions are above the applicable minimums, he or she may take off and fly hundreds of miles in any direction and land at any uncontrolled airport without ever being under ATC (Air Traffic Control).

When flying was very young, there were no rules and all flight was done "by the seat of the pants." All flights were visual, pilots followed certain familiar landmarks and features on the ground, and somehow managed to get where they wanted to go. Clouds and fog were avoided and night flying was done by only the [illegible] experienced pilots, using the lights of cities, towns, and villages. Some of the [illegible] adventurous navigated by the stars.

Visual flight has remained an important aspect of aviation and even today a large percentage of all flying is done visually. Even though many pilots fly visually, this lesson will discuss some services available to VFR pilots if they choose to use them.

It is important to note that even under the most ideal conditions pilots, when flying VFR, must abide by certain regulations and must be regulated in turn by air traffic control when entering or leaving any area of controlled aircraft.

TECHNIQUES AND STRATEGIES

I. Discuss the feasibility of the licensing of pilots.

1. Why should pilots be licensed?

2. What physical qualifications would you expect pilots to have?

3. What skills should pilots have?

4. Why should pilots have a basic understanding of aerodynamics, airplane systems, theory of flight, airport communications and air traffic control, weather, basic navigation, and Federal Aviation Regulations?

II. Use Diagram 4-1, *Pilot Certificate Qualifications,* for a discussion of general qualifications for application for pilot's license.

III. Discuss pilot ratings, using Diagram 4-2, *Pilot Ratings,* as an overhead transparency. The purpose of this discussion about pilot certificates and ratings is to show that in order for people to obtain the status of pilot of any kind of aircraft they must pass specific written tests and display competencies that are very carefully monitored by the Federal Aviation Administration (FAA).

IV. VFR or Visual Flight Rules are a set of rules that apply to pilots even though the pilot may fly visually without contacting any control facility. He/she must still follow certain rules designed primarily for the safety of all aircraft in any given airspace.

V. Airspace

Because of the various airspace users' operations and needs, certain restrictions must be placed on airspace areas. As the complexity and density of aircraft movements in specific airspace areas increases, more aircraft and pilot requirements are needed for operation in such airspace. Generally, all airspace over the continental United States can be divided into two kinds of airspace: Controlled and Uncontrolled airspace.

VI. Use Diagram 4-3, *A Schematic Representation of the Various Controlled and Uncontrolled Segments of the Airspace in the United States* for discussion. It is important for pilots to know whether they are in controlled or uncontrolled airspace so that they will know if they are subject to Air Traffic Control and also because different weather minimums (visibility, ceiling, and distance from clouds) apply in the various types of controlled and uncontrolled airspace. In this lesson our primary concern is with the aircraft operating under Visual Flight Rules in controlled and uncontrolled airspace.

VII. Uncontrolled Airspace

Uncontrolled airspace is defined as that portion of airspace within which FAA Air Traffic Control (ATC) does not have authority nor the responsibility to exercise any control over air traffic. Uncontrolled airspace is that portion of the airspace that has not been designated as continental control area, control area, control zone, terminal control area, or transition area. Use Diagram 4-3, *Controlled and Uncontrolled Airspace,* to familiarize students with uncontrolled airspace.

VIII. VFR Requirements in Uncontrolled Airspace

Diagram 4-4, *VFR Visibility and Distance from Clouds,* shows that there are some very important rules to follow while flying VFR. These rules are designed for the protection of all aircraft and personnel during flight.

IX. Unlike the land we travel on, the air is a three-dimensional medium. On land, everyone travels at the same relative altitude—ground level—and as a result we tend to bump into each other or have head-on crashes. To avoid this happening in the air, there are specific rules about what altitude to fly when you are going in a certain direction.

Diagram 4-5, *Altitudes and Flight Levels,* shows how this system works. Using the diagram, answer the following questions:

1. If you were flying VFR with a compass heading of 90°, what are some of your altitude options?

2. If you were flying IFR below 18,000 feet with a compass heading of 270°, at what altitudes could you fly?

Diagram 4–1

PILOT CERTIFICATE QUALIFICATIONS

Student Pilot	*Private Pilot*	*Commercial Pilot*	*Air Transport Pilot*
Eligibility Age 16 minimum Must read, speak, and understand English	*Eligibility* Age 17 minimum Must read, speak, and understand English	*Eligibility* Age 18 minimum Must read, speak, and understand English	*Eligibility* Age 23 minimum Must read, speak, and understand English No accent or speech impediment
Aeronautical knowledge, experience and skills Knowledge	*Aeronautical knowledge, experience and skills* Knowledge: Pass written exam in Federal Aviation Regulations, Cross-Country Flying, Meteorology, General Safety Practices	*Aeronautical knowledge, experience and skills* Knowledge: Pass written exam in Federal Aviation Regulations, Basic Aerodynamics, Airplane Operations, Principles of Safe Flight	*Aeronautical knowledge, experience and skills* Knowledge: Pass written exam in Federal Aviation Regulations, Air Navigation, Meteorology, Air Navigation Facilities, Radio Communication Procedures, Weight and Balance Principles
	Experience: 40 hours flying, including flight instruction and solo time	Experience: 250 hours flying	Experience: Must have a Commercial Pilot's Certificate and at least 1,500 hours flying
	Skill: Pass test on applicable procedures and maneuvers	Skill: Pass test on applicable procedures and maneuvers	Skill: Must pass a practice test
	Medical: Third class medical certificate	Medical: Second class medical certificate	Medical: First class medical certificate

Diagram 4-2

Pilot Ratings

In addition to each of the pilot certificates issued, each pilot certificate must be rating qualified in order to operate the following various aircraft:

Airplane	*Rotorcraft*	*Glider*	*Lighter-Than-Air*
Rating:	Rating:	Rating:	Rating:
Single engine, land	Helicopter	Glider or Sailplane	Airship
	Gyroplane	Sailplane	Free Balloon
Multi engine, land			
Single engine, sea			
Multi engine, sea			

A pilot may also become an *instrument rated* pilot if he has 200 hours flight time, including 40 hours of instrument time, and can pass a practice test in instrument flying.

Diagram 4-3A
Controlled and Uncontrolled Airspace

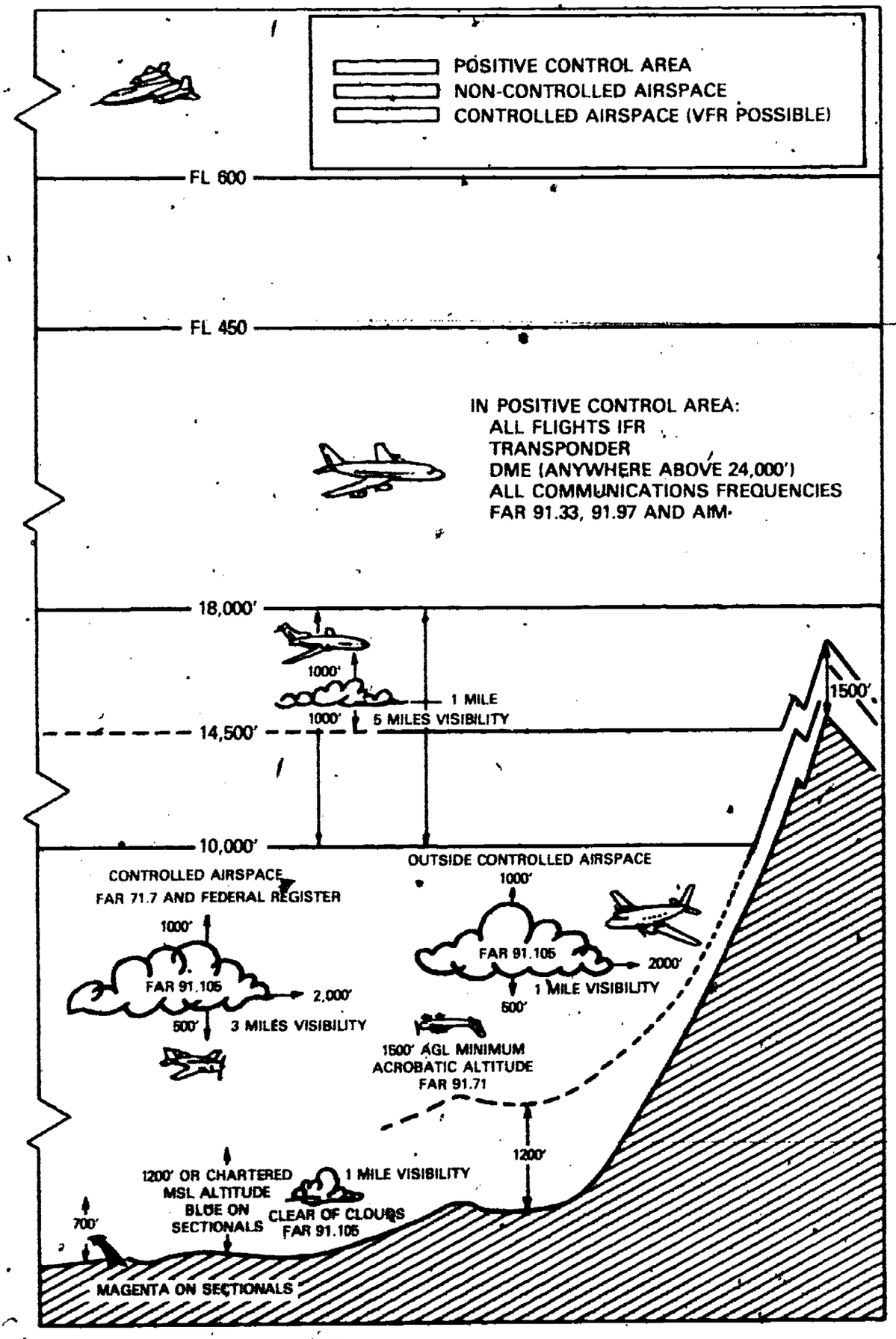


Diagram 4-3B
Controlled and Uncontrolled Airspace

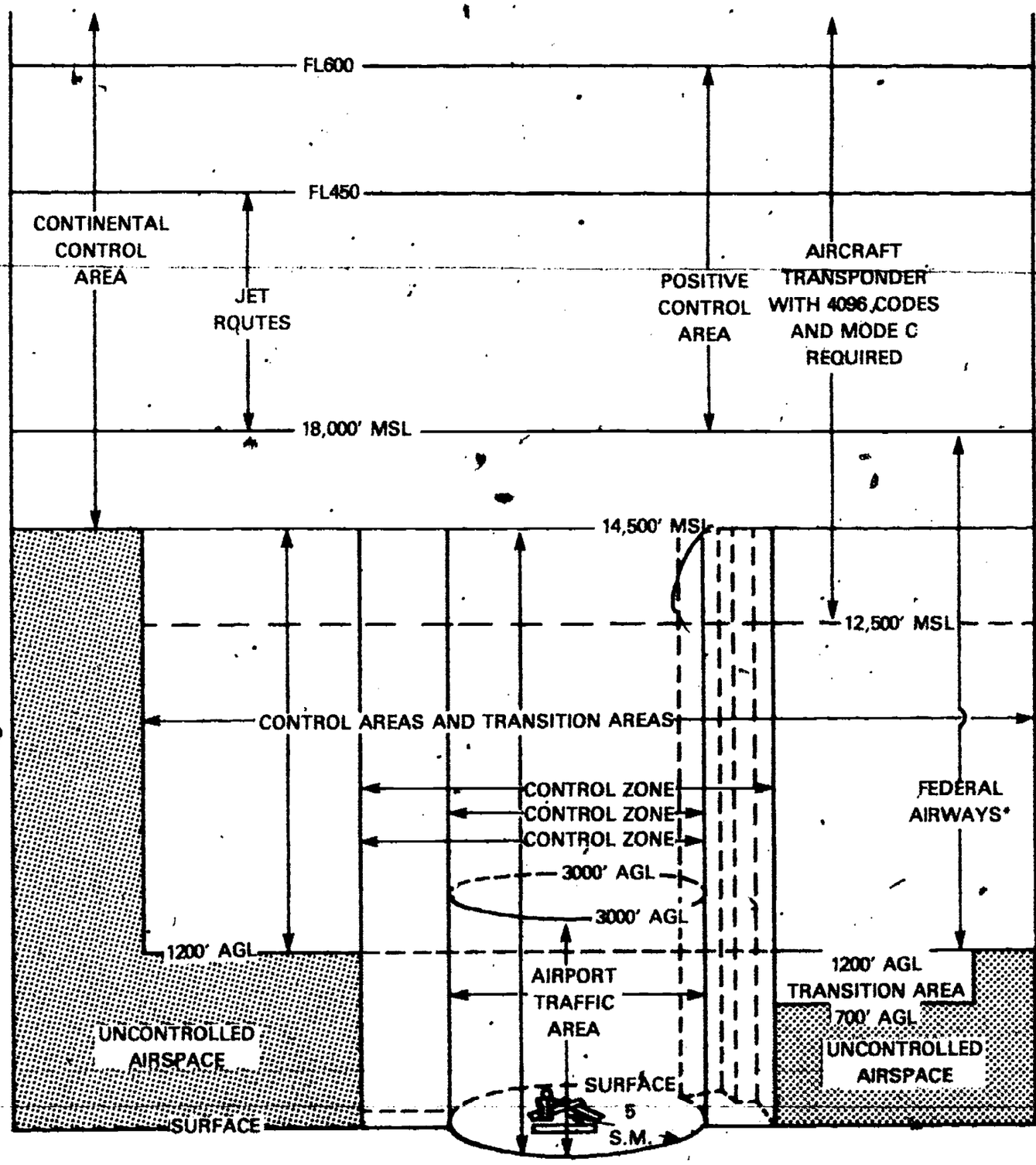
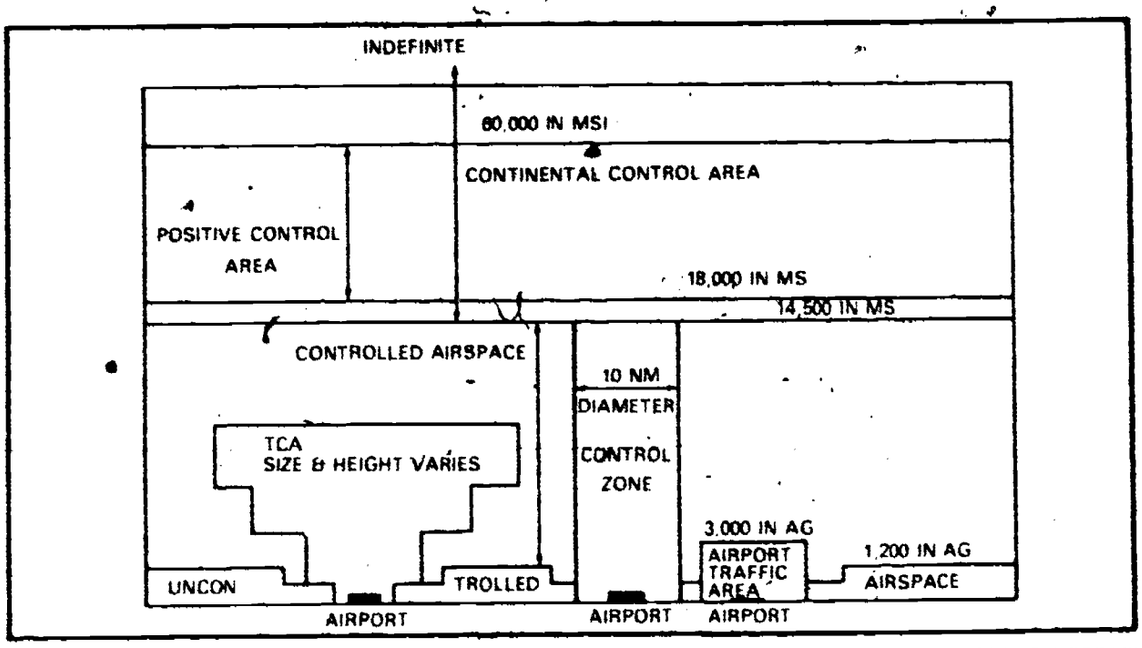


Diagram 4-3C
Controlled and Uncontrolled Airspace



A SCHEMATIC REPRESENTATION OF THE VARIOUS CONTROLLED AND UNCONTROLLED SEGMENTS OF THE AIRSPACE IN THE U S

Diagram 4-4
Minimum VFR Visibility and Distance From Clouds

ALTITUDE	UNCONTROLLED AIRSPACE		CONTROLLED AIRSPACE	
	DISTANCE PILOT MUST BE ABLE TO SEE	DISTANCE AIRCRAFT MUST STAY AWAY FROM CLOUDS	DISTANCE PILOT MUST BE ABLE TO SEE	DISTANCE AIRCRAFT MUST STAY AWAY FROM CLOUDS
1200' OR LESS ABOVE THE SURFACE 1200' ABOVE SURFACE	MUST BE ABLE TO SEE FOR 1 MILE	MUST STAY CLEAR OF ANY CLOUDS	MUST BE ABLE TO SEE FOR 3 MILES	MUST STAY AWAY 1000' ABOVE 2000' EITHER SIDE 500' BELOW
MORE THAN 1200' ABOVE SURFACE BUT LESS THAN 10,000' ABOVE SEA LEVEL 10,000' ABOVE SEA LEVEL 1200'	MUST BE ABLE TO SEE FOR 1 MILE	MUST STAY AWAY 1000' ABOVE 2000' EITHER SIDE 500' BELOW	MUST BE ABLE TO SEE FOR 3 MILES	MUST STAY AWAY 1000' ABOVE 2000' EITHER SIDE 500' BELOW
MORE THAN 1200' ABOVE SURFACE AND AT OR ABOVE 10,000' ABOVE SEA LEVEL 1200' ABOVE SURFACE 10,000' ABOVE SEA LEVEL	MUST BE ABLE TO SEE FOR 5 MILES	MUST STAY AWAY 1000' ABOVE 1 MILE EITHER SIDE 1000' BELOW	MUST BE ABLE TO SEE FOR 5 MILES	MUST STAY AWAY 1000' ABOVE 1 MILE EITHER SIDE 1000' BELOW

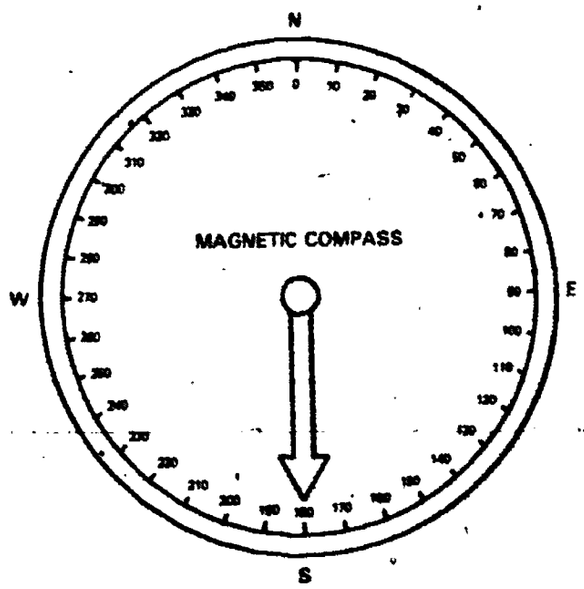
Diagram 4-5
Altitudes and Flight Levels

UNCONTROLLED AIRSPACE

84. ALTITUDES AND FLIGHT LEVELS

CONTROLLED AND UNCONTROLLED AIRSPACE VFR ALTITUDES AND FLIGHT LEVELS			
IF YOUR MAGNETIC COURSE (GROUND TRACK) IS	MORE THAN 3000' ABOVE THE SURFACE BUT BELOW 18,000' MSL FLY	ABOVE 18,000' MSL TO FL 290 (EXCEPT WITHIN POSITIVE CONTROL AREA, FAR 71.193) FLY	ABOVE FL 290 (EXCEPT WITHIN POSITIVE CONTROL AREA, FAR 71.193) FLY 4000' INTERVALS
0° TO 179°	ODD THOUSANDS, MSL, PLUS 500' (3500, 5500, 7500 ETC)	ODD FLIGHT LEVELS, PLUS 500' (FL 195, 215, 235 ETC)	BEGINNING AT FL 300 (FL 300, 340, 380, ETC)
180° TO 359°	EVEN THOUSANDS, MSL, PLUS 500' (4500, 6500, 8500, ETC)	EVEN FLIGHT LEVELS PLUS 500' (FL 185, FL 205, 225, ETC)	BEGINNING AT FL 320 (FL 320, 360, 400, ETC)

UNCONTROLLED AIRSPACE – IFR ALTITUDES AND FLIGHT LEVELS			
IF YOUR MAGNETIC COURSE (GROUND TRACK) IS	BELOW 18,000' MSL, FLY	AT OR ABOVE 18,000' MSL BUT BELOW FL 290, FLY	AT OR ABOVE FL 290, FLY 4000' INTERVALS
0° TO 179°	ODD THOUSANDS, MSL, (3000, 5000, 7000, ETC)	ODD FLIGHT LEVELS, FL 190, 210, 230, ETC)	BEGINNING AT FL 290, (FL 290, 330, 370, ETC)
180° TO 359°	EVEN THOUSANDS, MSL, (2000, 4000, 6000, ETC)	EVEN FLIGHT LEVELS (FL 180, 200, 220, ETC)	BEGINNING AT FL 310, (FL 310 350, 390, ETC)



LESSON 5

INSTRUMENT FLIGHT RULES (IFR)

Conceptual Scheme

Every IFR flight, regardless of the weather, is a mission done cooperatively by the pilot and Air Traffic Control. The pilot must operate the craft within the parameters and constraints established by Air Traffic Control and it is the responsibility of Air Traffic Control to provide separation between all flights under its jurisdiction.

Objectives

Upon completion of this lesson, the student should be able to:

1. identify the safety rules under which all IFR flights must conform;
2. demonstrate an understanding of the Air Traffic Control system, how it is structured;
3. describe the enroute control system and how it operates; and
4. name the three functions of the Air Traffic Control system as: surveillance, communications, and control.

TO THE TEACHER

IFR or Instrument Flight Rules are the key to basic air traffic safety for all commercial aviation flights and many general aviation flights. The Air Traffic Control system, administered by the Federal Aviation Administration, is an air traffic safety system set up nationwide, including Guam, Panama, and Puerto Rico. The system involves about 25,000 highly trained personnel, each with a mission designed to contribute to maximum air traffic safety. The system consists of 25 enroute traffic control centers, which will be described in the lesson, some 400 airport towers, and 300 flight service stations. Administration of these facilities requires tremendous cooperation and coordination—cooperation between the pilot and the controller and coordination between controllers and the pilots.

This lesson is designed to give the students some idea of the vast network known as the Air Traffic Control system in operation 24 hours a day throughout the United States.

TECHNIQUES AND STRATEGIES

I. There are three basics or universals that all flights have in common with one another. Discuss with the class what the phases of any flight might be and which phase might be most critical to the entire flight. The three phases of flight are: Takeoff and Climbout, Enroute, and Descent/Approach/Landing. Use Diagram 5-1, *Three Phases of Flight*, to review the three phases of any flight.

II. All IFR flights are continuously monitored by Air Traffic Control. Using the FAA booklet, *Air Traffic Control*, take the students through a typical commercial flight using Diagram 5-2, *Washington National Airport Area Map*.

"Taxi into position and hold." Hold the flight at this point and, using Diagram 5-3, *U.S. Map Showing FAA Air Route Traffic Control Center Boundaries*, show how the nation has been partitioned off into regions for the purpose of efficient and safe air traffic control. Have students find their region and decide which states are wholly or partially in their region.

Many regions are divided by natural boundaries, many by state or political boundaries. Again using a transparency of Diagram 5-3, decide which boundaries might be natural or political. Note that each region has an Air Route Traffic Control Center (ARTCC).

What is the name of the center for your region? The center is the "brains" of each Air Traffic Control region. Within each center are the automated computers that have entered into them a flight plan made out by the pilot and turned in at a center or flight service station or any military operations office. All centers are connected through the computer.

III. Since each center controls a vast amount of airspace—often as much as 100,000 square miles—it is divided into sectors. Use Diagram 5-4, *Your Local Region Divided Into Sections*, to illustrate this.

IV. There are 25 Air Route Traffic Control Centers (ARTCC) operated by the FAA throughout the United States. They control more than 30 million flights per year. These *enroute* centers control traffic from the time it leaves the immediate vicinity of an airport (usually 25 miles) until it reaches the vicinity of the airport of destination. Have the students simulate a flight from Miami to Boston and name the various centers that would be keeping track of their flight on radar.

(Answer: Miami Departure Control, Miami ARTCC, Jacksonville ARTCC, Washington ARTCC, New York ARTCC, Boston ARTCC, radar approach control at Boston Airport.

V. As you might have inferred by now, the whole Air Traffic Control system is based on one very important and vital development—radar. Using Diagram 5-5, *Radar*, show how the word radar originated and the basic principle of radar.

VI. At one time, radar alone was the vital instrument for detecting aircraft. Radar could tell you two things: (1) something was out there, and (2) what direction it was moving and approximately how fast.

The things that radar could not detect very accurately were the altitude of the aircraft and the identification of the aircraft. This had to be done by radio communication, a time-consuming conversation when perhaps seconds counted in avoiding accidents.

With the advent of more sophisticated technology, a tremendous improvement was made in radar detection of air traffic.

VII. Using Diagram 5-6, *Radar Identification—Then and Now*, show how the new system works.

In prior years, when an aircraft controller detected a blip or target on his radar screen, he had to identify that blip with a written tag that gave the aircraft identification number and altitude. Now when an aircraft is picked up on a radar screen, it can automatically give the controller information about itself. That information will show up right on the display screen and controllers can tell instantly what aircraft it is (Delta Flight 107, TWA Flight 206, etc.), at what altitude it is flying, and its apparent ground speed. The device that made all this possible is called a transponder.

The transponder is triggered by the radar waves and instantly sends back the information coded into it to the Air Route Traffic Control Center.

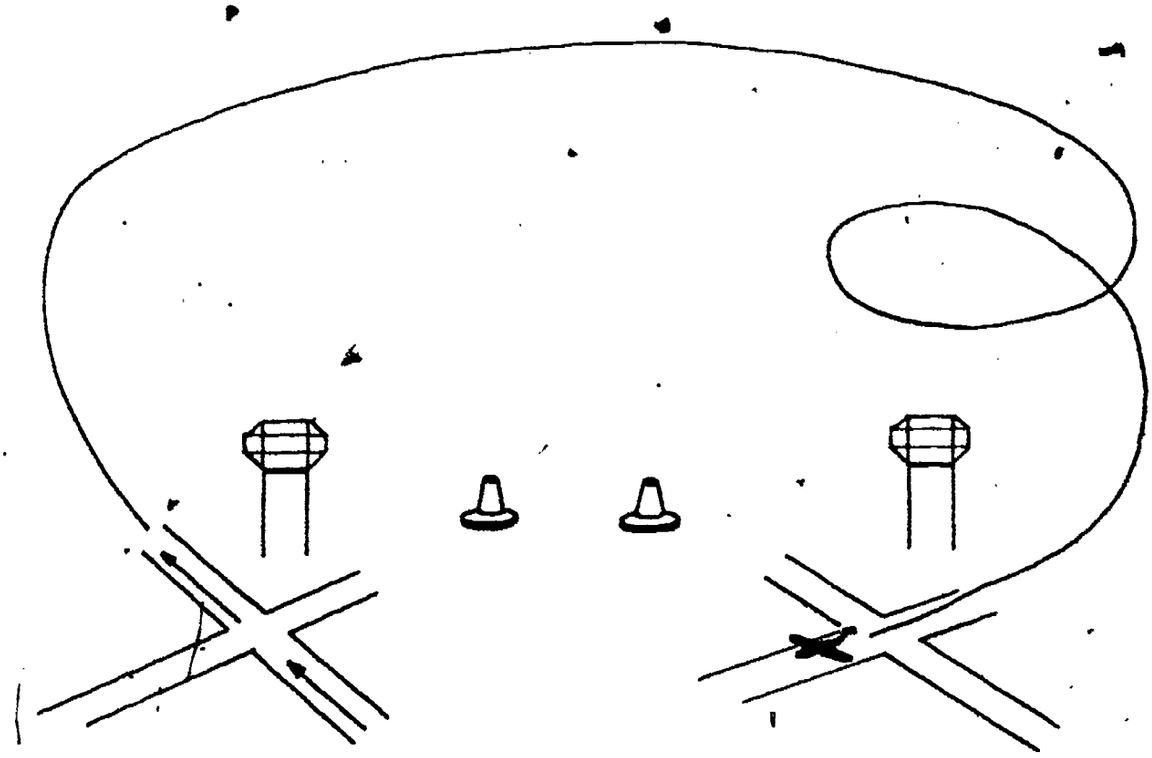
VIII. Diagram 5-7, *A Fuzz-Buster*, works on the same principle. When state patrol radar is beamed at your car, it triggers the fuzz-buster to signal to you that you are being detected by radar and tracked.

IX. We can now return to TransContinental Flight 483 holding on the north end of Runway 18.

"TransContinental 483, cleared for takeoff." Have the students continue to read the booklet to the completion of the flight. It might be interesting to have a Washington Center, Indianapolis Center, and a Chicago Center map showing jet routes and have the students follow the flight on the maps.

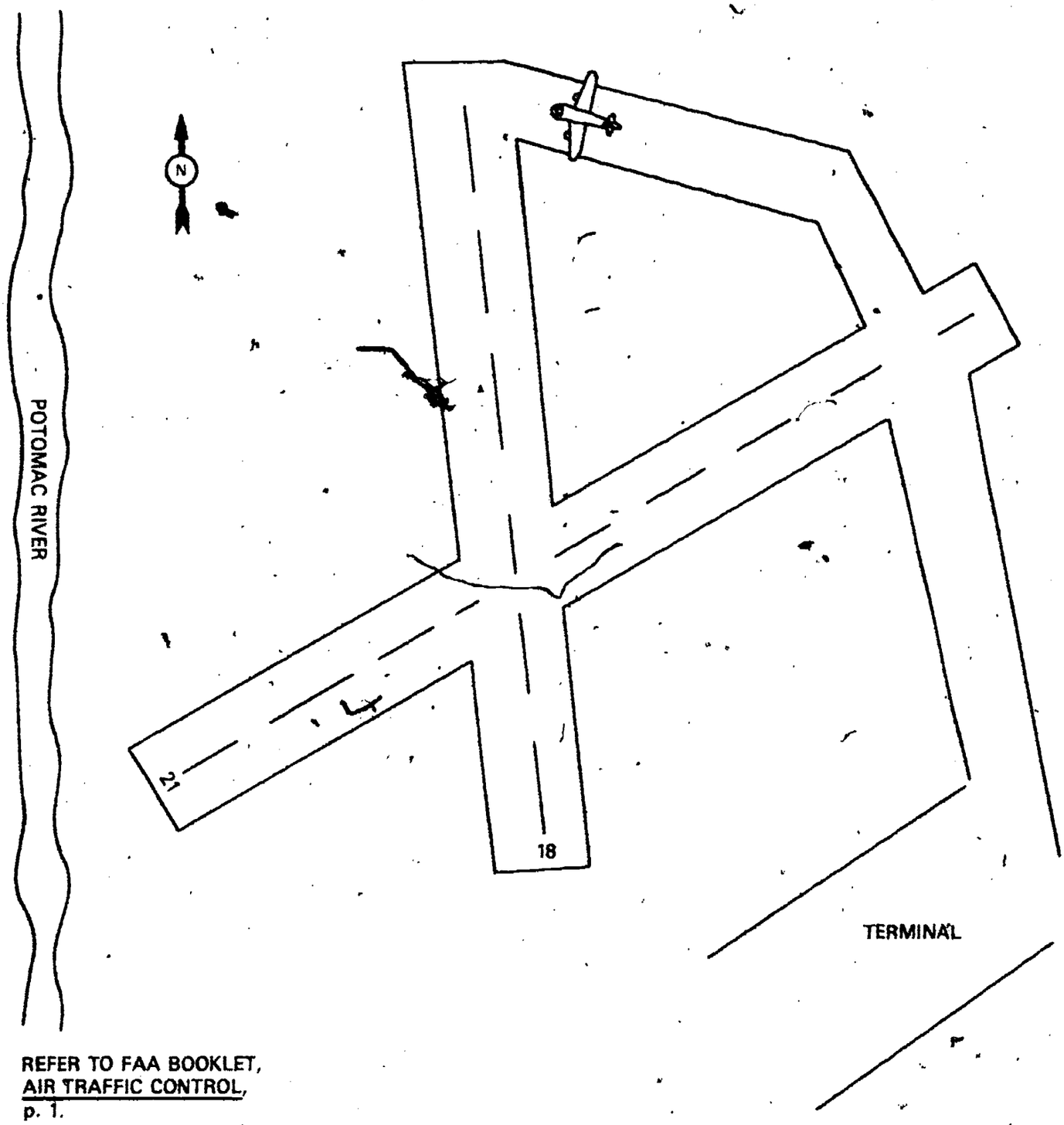
As the flight moves from one sector to another, the computer automatically prints a flight data strip for the next sector just before the flight enters that area of control. This same process takes place when one center is ready to hand off a flight to the next center or approach control facility. Computers talk directly to computers, and the controllers are spared a time-consuming chore.

Diagram 5-1
Three Phases of Flight



TAKEOFF AND CLIMBOUT ENROUTE DESCENT, APPROACH, AND LANDING

Diagram 5-2
Washington National Airport Area Map



REFER TO FAA BOOKLET,
AIR TRAFFIC CONTROL,
p. 1.

Diagram 5-3
FAA ARTCC Boundaries
1981 SYSTEM ARTCC AND FLIGHT ADVISORY AREA

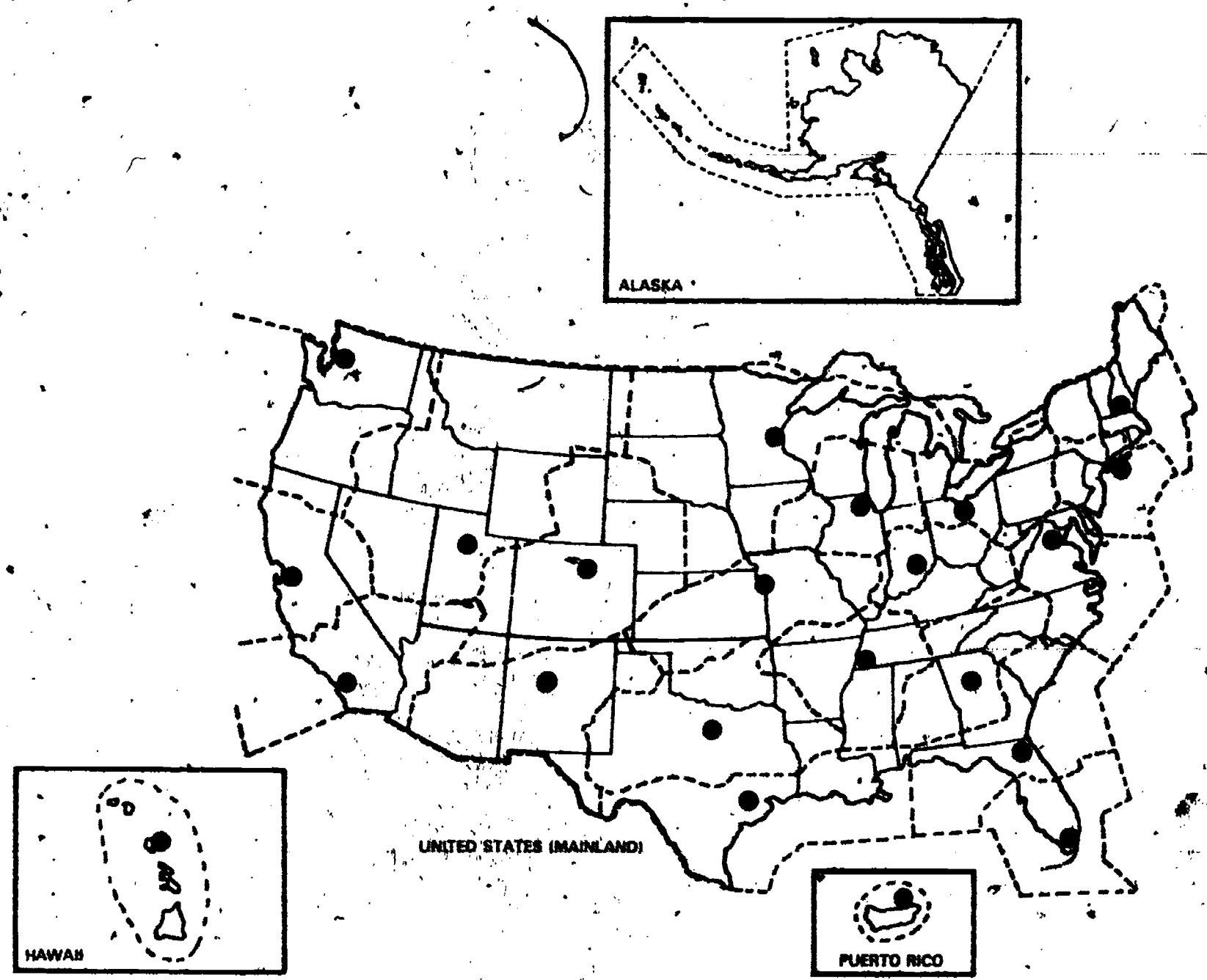


Diagram 5-4
Atlanta Center High Altitude Sector Chart FL 240-FL 330

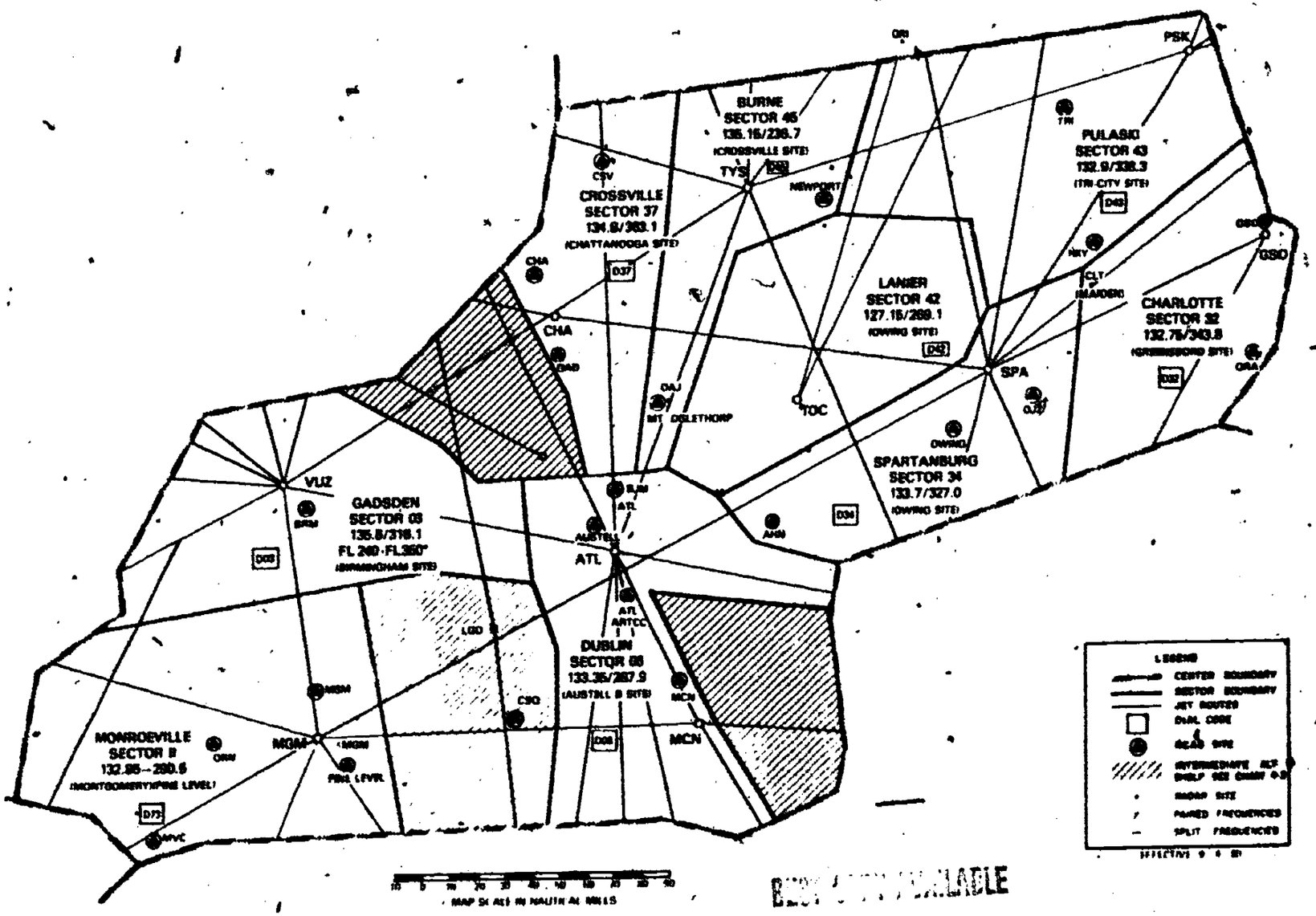
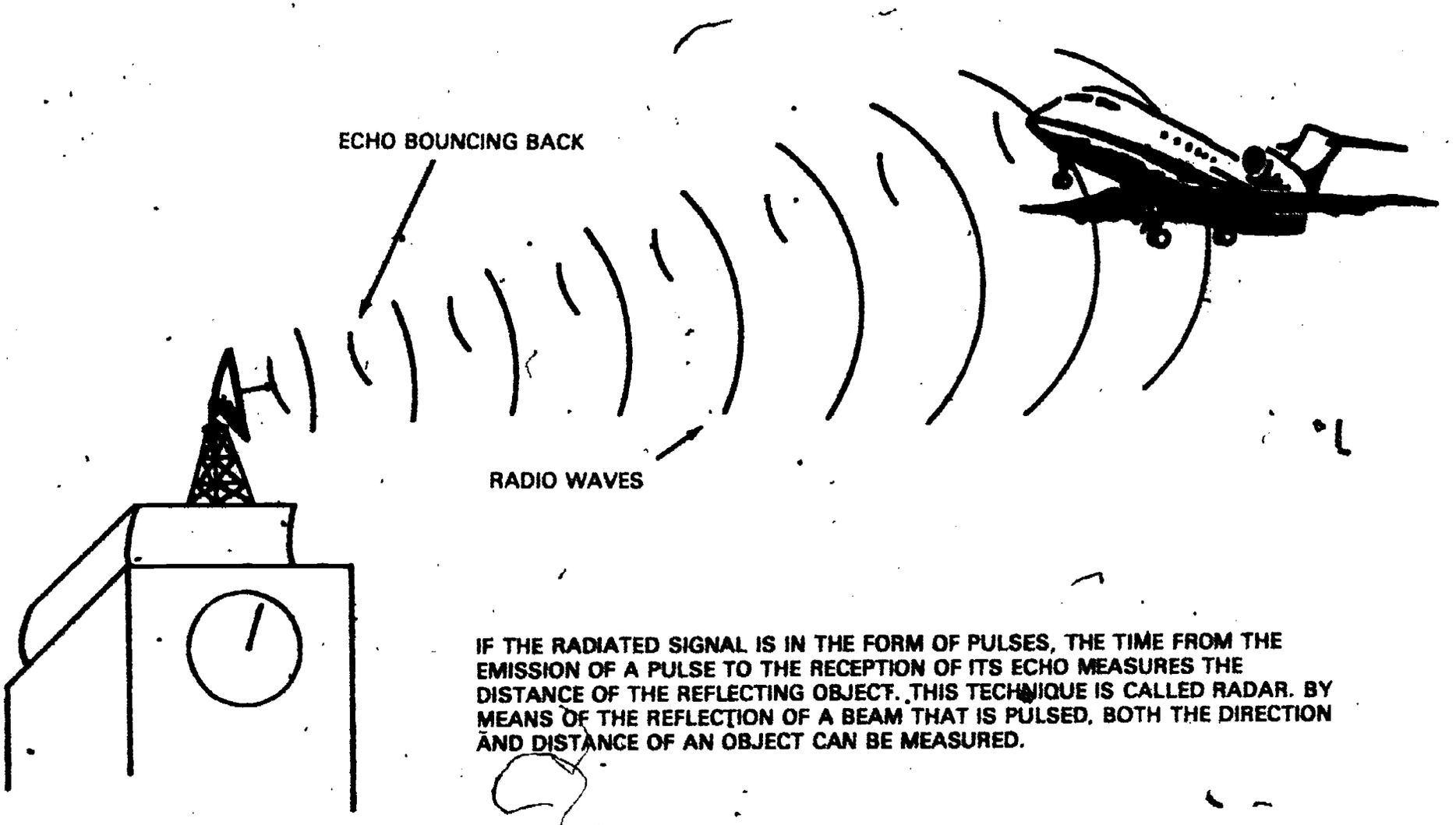


Diagram 5-5
Radar

Ra(dio) D(etection) a(nd) R(anging)

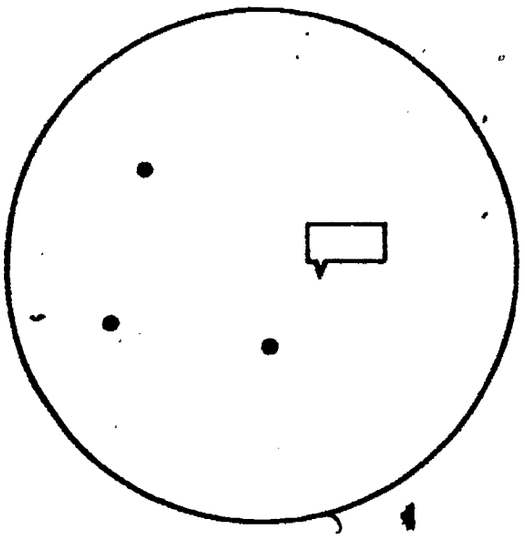
RADAR IS AN ELECTRONIC DEVICE THAT LOCATES OBJECTS BY BEAMING RADIO-FREQUENCY IMPULSES THAT ARE REFLECTED BACK FROM THE OBJECT, AND DETERMINES ITS DISTANCE BY A MEASUREMENT OF THE TIME ELAPSED BETWEEN TRANSMISSION AND RECEPTION OF THE IMPULSES.



IF THE RADIATED SIGNAL IS IN THE FORM OF PULSES, THE TIME FROM THE EMISSION OF A PULSE TO THE RECEPTION OF ITS ECHO MEASURES THE DISTANCE OF THE REFLECTING OBJECT. THIS TECHNIQUE IS CALLED RADAR. BY MEANS OF THE REFLECTION OF A BEAM THAT IS PULSED, BOTH THE DIRECTION AND DISTANCE OF AN OBJECT CAN BE MEASURED.

Diagram 5-6
Radar Identification Then and Now

IN THE PAST:



DISPLAY SCREEN WITH BLIPS AND CRUDE TAGS SHOWING IDENTIFICATION

NOW:

ELECTRONIC DISPLAY

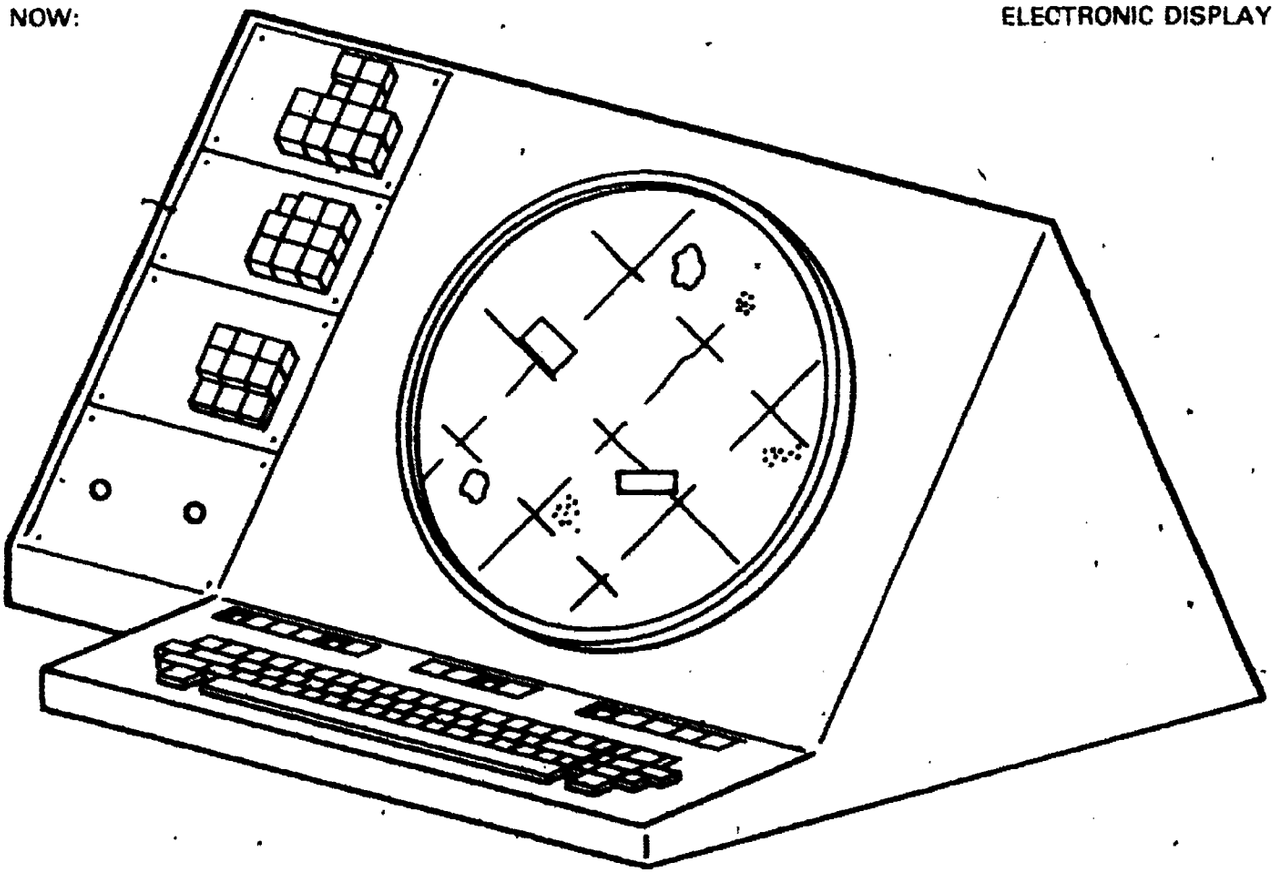
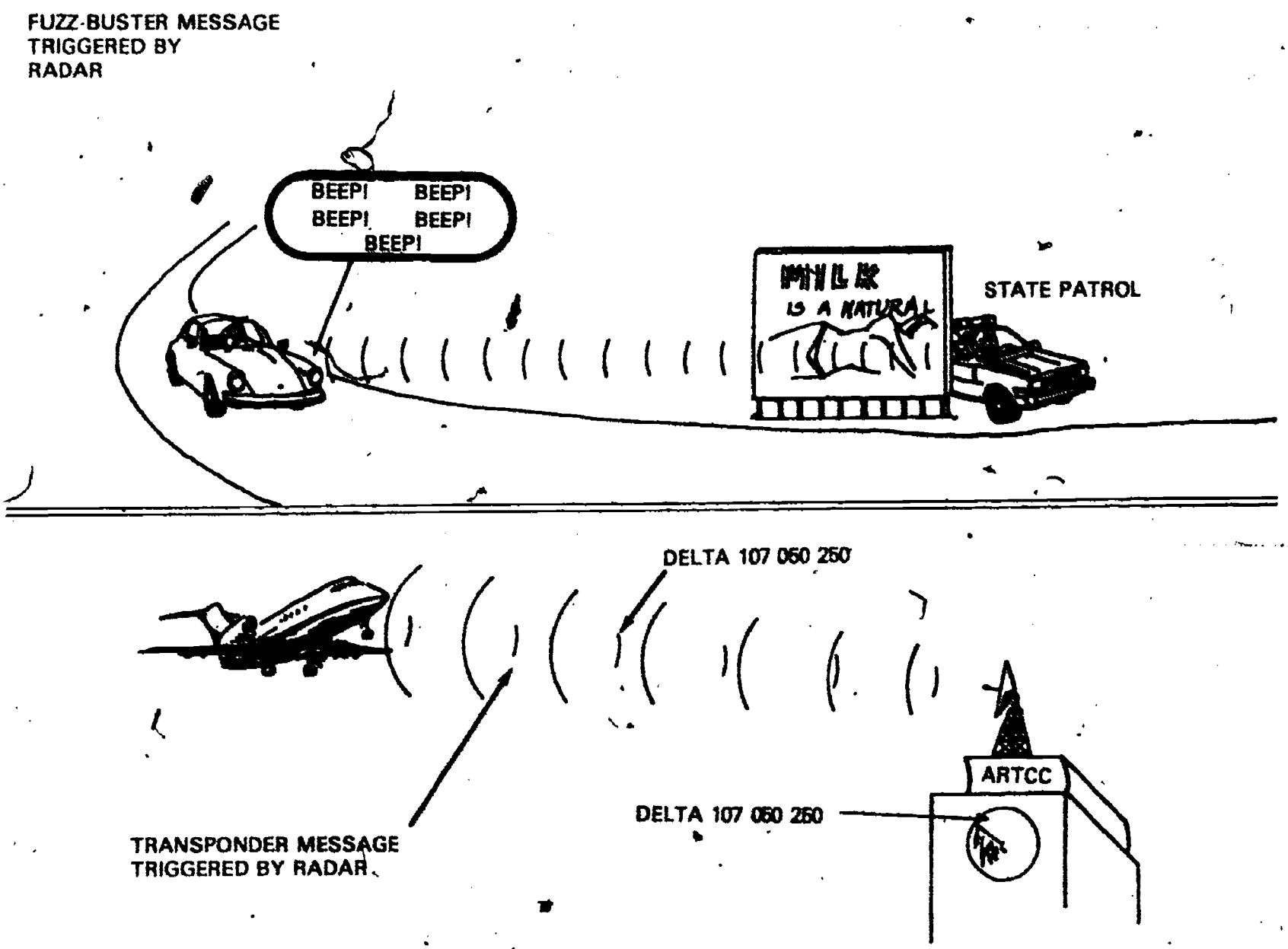


Diagram 5-7
Transponder Principle



LESSON 6

AIRPORT TERMINAL FACILITIES

Conceptual Scheme

Airport terminal facilities are vital in giving flight assistance to all VFR flights and IFR flights when necessary.

Objectives

Upon completion of this lesson, the student will be able to:

1. identify ATIS as an important service to pilots and a workload reducer for air traffic controllers;
2. name information that is given on most ATIS broadcasts;
3. identify the responsibilities of the control tower or local controller at any airport;
4. identify ground control in terms of function and responsibility;
5. name the functions and duties of Approach and Departure Control; and
6. describe what a flight service station is in terms of its functions and responsibilities.

TO THE TEACHER

Airport terminal facilities provided by the FAA are among the most important services any pilot can receive. The primary purpose of FAA facilities is to give information, advise air traffic, and provide traffic separation and weather information.

Each piece of information a pilot can gather about his/her specific flight helps to make that flight more safe and more fully insures the safety of others.

Airport terminal facilities can be divided into specific areas based on the function of each facility. Basically, the facilities at many airports are:

1. Automatic Terminal Information Service (ATIS)
2. Control tower or local controllers
3. Approach and Departure Control
4. Flight Service Station.

TECHNIQUES AND STRATEGIES

I. Automatic Terminal Information Service, or ATIS, is recorded information provided by the FAA at all major air terminals. The recording is designed to give the pilot both arriving and departing advance information on active runways, weather conditions, communication frequencies, and any NOTAMs (Notices to Airman) affecting the airport at a particular time.

All this information is recorded on a tape and transmitted continuously over specified commonly used frequency in any airport area.

Use Diagram 6-1, *ATIS Information*, to record the information on page 7 of FAA brochure "Air Traffic Control."

II. As airport conditions change, such as wind direction or velocity, altimeter setting (barometric pressure), or an active runway change, a new recording is made to reflect new conditions.

Have students make an ATIS tape for an airport layout that each group (3-4 people) designs or give each group Diagram 6-2, *Anytown Airport*, and have them make their own ATIS tape using the given airport. Remind the students that each time a tape is made it is coded with a phonetic letter of the alphabet (Example: Information Alpha or Information Quebec).

III. This might be a good time to introduce the International Phonetic Alphabet. Because of the thousands of miles that planes can travel in short time periods and the many international borders that can easily be crossed many times each day, a communications problem could result. Various countries of the world organized the International Civil Aviation Organization (ICAO) and adopted English as the international aviation communications language. This organization also adopted a phonetic alphabet to be used during radio transmissions.

Use Diagram 6-3, *International Phonetic Alphabet*, to show that words have been substituted for letters. This substitution is necessary because many letters of the English language sound alike. B, C, D, E, T, V, and Z could be confused with one another during radio transmission.

Using the phonetic alphabet, have students spell their first names aloud.

IV. Also a part of the air terminal facility is the control tower or local controller. After the pilot has listened to the ATIS and has completed the prelanding checklist, the radio transmitter and receiver are switched to the tower frequency.

The pilot identifies his plane, gives his approximate location, and tells the tower the approach is being made according to information "Alpha" (or whatever the current information phonetic code).

The controller will acknowledge and give any additional information the pilot needs to complete a safe landing. Towers usually are responsible for the control of all airborne traffic within a specific area of the airport, if the traffic is either landing or taking off.

If VFR conditions exist, the tower is in control of all VFR traffic within the airport traffic area. Usually this is within a five statute mile radius, including all the airspace up to but not including 3,000 feet above the airport.

IFR traffic during this time may be controlled by Departure Control and Approach Control in this same area. Use Diagram 6-4A, *Airport Controlled Area*, as an overhead transparency to show the controlled area around most airports.

V. You might want to go into more detail and use Diagram 6-4B, *Airport Controlled Areas*, to show controlled areas around major airports with much IFR and VFR traffic. The area is stacked similar to an upside-down wedding cake. This system allows the controller more flexibility during heavy traffic.

VI. If radio communication should break down, every control tower has a powerful light gun which can beam an intense, narrow light—either red, green, or white—at the plane the tower is trying to contact. The light gun is equipped with a gun sight similar to that on a rifle and, providing the pilot is looking in the direction of the control tower, the controller can send a limited amount of instructions. Use Diagram 6-5, *Light Gun Signals*, to show the variety of visual signals that can be sent. Have students bring in a flashlight and red or green plastic and communicate with the class. Groups might want to make up a set of light signals the teacher can use to communicate with the class.

VII. Once a pilot lands, he usually will switch to *Ground Control*. The FAA ground controller is also located in the tower and that controller is responsible for the separation of traffic moving on the *airport surface*. Diagram 6-6, *Ground Control Services* shows the many useful services ground control might provide.

VIII. Approach and Departure Control, although sometimes located at the airport tower facility, may be located separately, away from the tower. Approach and Departure Control utilize radar to keep traffic separated and this facility most commonly provides service to IFR traffic. VFR traffic could contact Approach and Departure Control and request Stage 1 Service (radar advisory service for VFR aircraft).

IX. Throughout the United States, there are approximately 340 *Flight Service Stations* maintained by the FAA. Use Diagram 6-7, *Flight Service Stations*, as a transparency to show the total effect of these stations. Use Diagram 6-8, *Services Provided by Flight Service Stations*, to show the kinds of information pilots can benefit from as provided by these stations.

X. What are Flight Service Stations?

The automobile driver as he drives along has many things to assist him/her on his/her way. The driver has road signs, service stations, roadside parks, and information centers. The driver uses these services as needed and in times of emergency he/she can pull off the highway and reconsider the situation.

The pilot cannot pull off to the side of the road, but what he can do before, during, and after his flight is be in contact with a Flight Service Station.

Before flight, pilots can gather complete weather information, not only about their own local area but about weather along intended routes. There is also information about geologic peculiarities of the surrounding terrain and weather peculiarities of that particular sector. Controllers at flight service stations might suggest flight routes, altitudes, indications of turbulence, icing, or any other information important to the safety of a flight.

VFR pilots, after gathering all information, may want to file a flight plan with the service station. The pilot's plan will include much information about the flight and the aircraft. Diagram 6-9, *VFR Flight Plan*, shows information that is on a plan.

As a plane takes off, the FSS will "open" or activate the flight plan and notify the destination airport of the pilot's estimated time of arrival. It is the pilot's responsibility to "close" his flight plan within a half-hour after his arrival. If the flight plan is not "closed," the Flight Service Station will initiate a search for that plane and pilot—first by phone to airports along the way and eventually by a full-fledged search and rescue effort.

Flight Service Stations are truly a service to pilots.

Diagram 6-1

ATIS Recorded Information

Name of Airport _____

Coded Period (Phonetic Name) _____

_____ (City) Area Weather

Ceiling: _____

Visibility: _____

Wind: _____

Altimeter Setting: _____

Diagram 6-2

Anytown Airport*

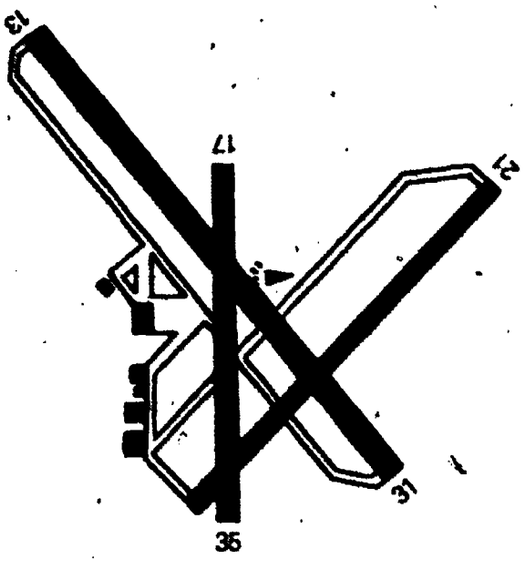


*DIAGRAM FROM AVIATION FUNDAMENTALS (SANDERSON).

Diagram 6-3
International Phonetic Alphabet

(ICAO) INTERNATIONAL PHONETIC ALPHABET

A	·—	ALFA	(*AL*-FAH)	N	—·	NOVEMBER	(NO-*VEM*-BER)
B	—···	BRAVO	(*BRAH*-VOH)	O	———	OSCAR	(*OSS*-CAH)
C	—·—·	CHARLIE	(*CHAR*-LEE)	P	·——·	PAPA	(PAH-*PAH*)
D	—··	DELTA	(*DELL*-TAH)	Q	——·—	QUEBEC	(KEH-*BECK*)
E	·	ECHO	(*ECK*-OH)	R	·—·	ROMEO	(*ROW*-ME-OH)
F	··—·	FOXTROT	(*FOKS*-TROT)	S	···	SIERRA	(SEE-*AIR*RAH)
G	——·	GOLF	(GOLF)	T	—	TANGO	(*TANG*-GO)
H	····	HOTEL	(HOH-*TELL*)	U	··—	UNIFORM	(*YOU*-NEE-FORM)
I	··	INDIA	(*IN*-DEE-AH	V	···—	VICTOR	(*VIK*-TAH)
J	·———	JULIETT	(*JEW*-LEE-*ETT*)	W	·——	WHISKEY	(*WISS*-KEY)
K	—·—	KILO	(*KEY*-LOH)	X	—··—	X RAY	(*ECKS*-RAY)
L	·—··	LIMA	(*LEE*-MAH)	Y	—·——	YANKEE	(*YANG*-KEY)
M	——	MIKE	(MIKE)	Z	——··	ZULU	(*ZOO*-LOO)

Diagram 6-4A

Airport Controlled Areas

(Common to Most Airports)

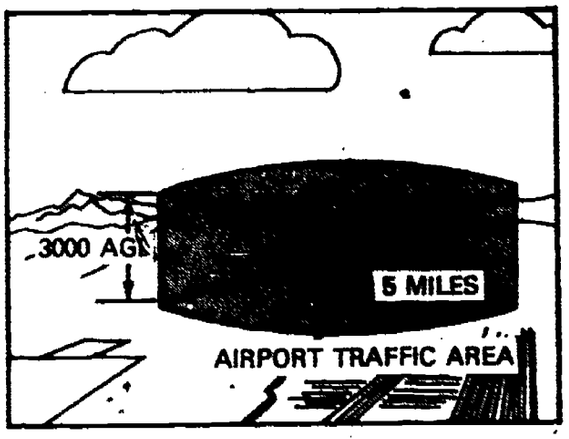
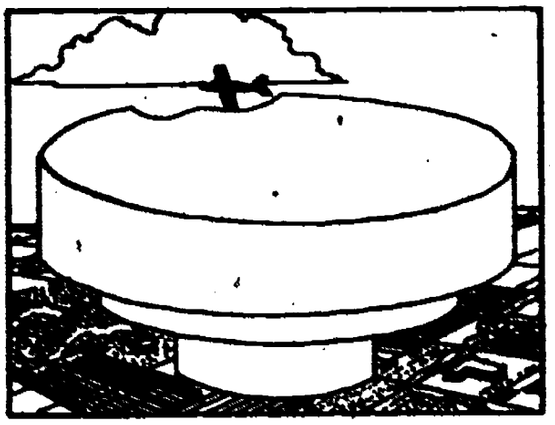


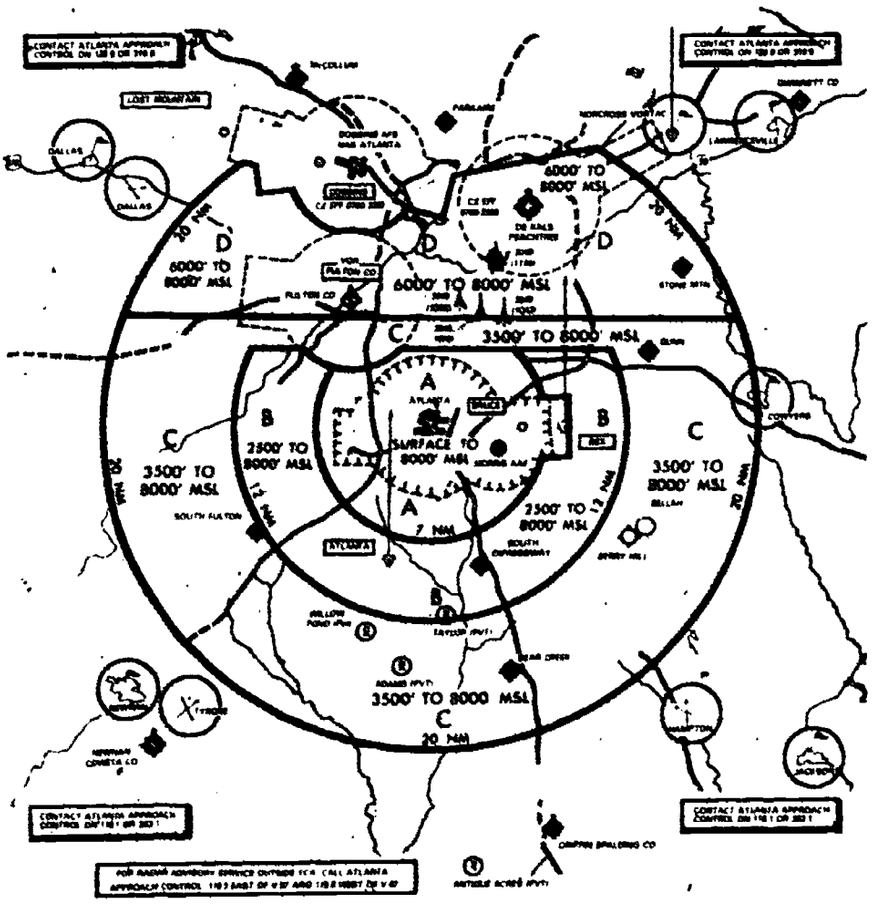
Diagram 6-4B

Airport Controlled Areas



TERMINAL CONTROL AREA

DESIGNED TO SEPARATE ALL ARRIVING TRAFFIC AT LARGE AIRPORTS (BOTH VFR AND IFR)



ATLANTA TCA PLANVIEW

Diagram 6-5

Light Gun Signals

Color and Type of Signal	*On the Ground*	*In Flight*
Steady Green	Clear for takeoff	Cleared to land
Flashing Green	Cleared to taxi	Return for landing (to be followed by steady green at proper time)
Steady Red	Stop	Give way to other aircraft and continue circling
Flashing Red	Taxi clear of landing area (runway in use)	Airport unsafe—do not land
Flashing White	Return to starting point on airport	(No Assigned Meaning)
Alternating Red and Green	General warning signal	Exercise extreme caution

Diagram 6-6

Ground Control Services

1. Provide the pilot with exact taxi instructions to the runway where he/she will take off.
2. Point out all hazards that might exist along the route across the airport.
3. Supply transient pilots with information about airport facilities:
   a. Where to tie down
   b. Maintenance Service
   c. Ramp Service
   d. Give locations of many other places at the airport

Diagram 6-7

FLIGHT SERVICE STATIONS

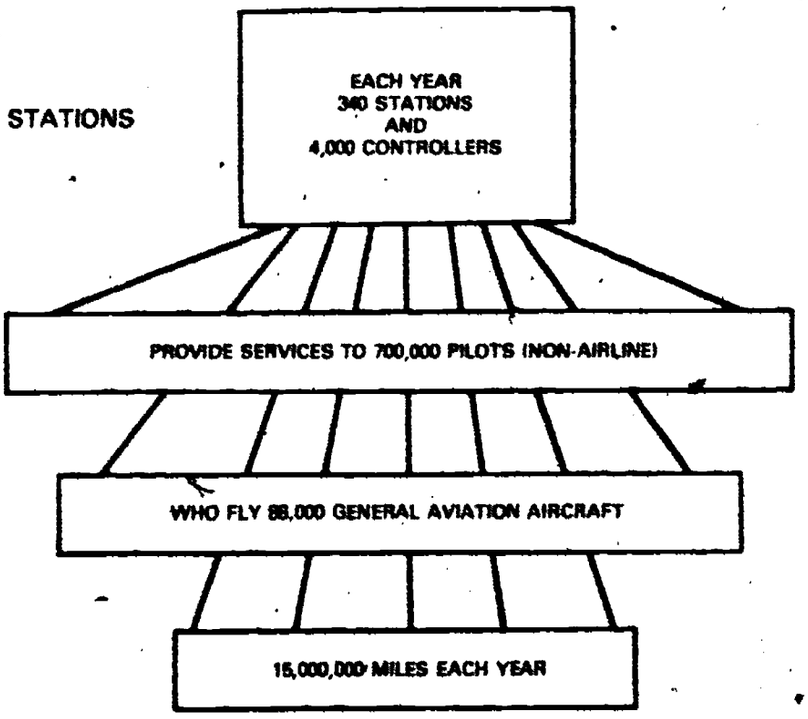


Diagram 6-8

Services Provided by Flight Service Stations

Information on the station's particular area, including:

1. terrain
2. weather peculiarities
3. preflight weather
4. inflight weather
5. suggested routes
6. altitudes
7. indications of turbulence
8. icing
9. airports

FSS initiates search and rescue when needed.

Diagram 6-9

Form Approved OMB No 2120-0026

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION **FLIGHT PLAN**	(FAA USE ONLY) ☐ PILOT BRIEFING ☐ VNR ☐ STOPOVER	TIME STARTED	SPECIALIST INITIALS

1 TYPE	2 AIRCRAFT IDENTIFICATION	3 AIRCRAFT TYPE/ SPECIAL EQUIPMENT	4 TRUE AIRSPEED	5 DEPARTURE POINT	6 DEPARTURE TIME		7 CRUISING ALTITUDE
					PROPOSED (Z)	ACTUAL (Z)	
VFR			KTS				
IFR							
DVFR							

8 ROUTE OF FLIGHT

9 DESTINATION (Name of airport and city)	10 EST. TIME ENROUTE		11 REMARKS
	HOURS	MINUTES	

12 FUEL ON BOARD		13 ALTERNATE AIRPORT(S)	14 PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE	15 NUMBER ABOARD
HOURS	MINUTES		17 DESTINATION CONTACT/TELEPHONE (OPTIONAL)	

16 COLOR OF AIRCRAFT	CIVIL AIRCRAFT PILOTS: FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed $1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans.

FAA Form 7233-1 (8-82) CLOSE VFR FLIGHT PLAN WITH _____ FSS ON ARRIVAL

b. Explanation of Flight Plan Items.

Block 1. Check the type flight plan. Check both the VFR and IFR blocks if composite VFR/IFR.

Block 2. Enter your complete aircraft identification including the prefix "N" if applicable.

Block 3. Enter the designator for the aircraft or, if unknown, the aircraft manufacturer's name (e.g., Cessna); followed by a slant (/) and the transponder or DME equipment code letter (e.g., C-182/U).

Block 4. Enter your computed true airspeed (TAS).

NOTE:—If IFR and the average TAS changes plus or minus 5 percent or 10 knots, whichever is greater, advise ATC.

Block 5. Enter the departure airport identifier code (or the name if identifier is unknown).

NOTE.—Use of identifier codes will expedite the processing of your flight plan.

Block 6. Enter the proposed departure time in Greenwich Mean Time (GMT) (Z). If airborne, specify the actual or proposed departure time as appropriate.

Block 7. If VFR, enter the appropriate VFR altitude (to assist the briefer in providing weather and wind information) and, if IFR, enter the requested enroute altitude or flight level.

NOTE.—Enter only the initial requested altitude in this block. When more than one IFR altitude or flight level is desired along the route of flight, it is best to make a subsequent request direct to the controller.

Block 8. Define the route of flight by using navaid identifier codes (or names if the code is unknown), airways, jet routes, and waypoints (for RNAV).

NOTE.—Use navaids or waypoints to define direct routes and radials/bearings to define other unpublished routes.

Block 9. Enter the destination airport identifier code (or name if identifier is unknown).

NOTE.—Include the city name (or even the state name) if needed for clarity.

Block 11. Enter only those remarks pertinent to ATC or to the clarification of other flight plan information. Items of a personnel nature are not accepted. Do not assume that remarks will be automatically transmitted to every controller. Specific ATC or Enroute requests should be made directly to the appropriate controller.

Block 12. Specify the fuel on board computed from the departure point.

Block 13. Specify an alternate airport if desired or required, but do not include routing to the alternate airport.

Block 14. Enter your complete name, address, and telephone number. Enter sufficient information to identify home base, airport, or operator.

NOTE.—This information would be essential in the event of search and rescue operation.

Block 15. Enter the total number of persons on board including crew.

Block 16. Enter the predominant colors. Last Block. For VFR flight plans, record the FSS name for closing the flight plan. If the flight plan is closed with a different FSS or facility, state the recorded FSS name that would normally have closed your flight plan.

NOTE.—Close IFR flight plans with tower, approach control, or ARTCC's, or if unable, with FSS. When landing at an airport with a functioning control tower, IFR flight plans are automatically cancelled.

c. The information transmitted to the destination FSS for VFR Flight Plans will consist only of flight plans blocks 2, 3, 9, and 10. Estimated time enroute (ETE) will be converted to the correct estimated time of arrival (ETA) for VFR flight plans.

d. The information transmitted to the ARTCC for IFR Flight Plans will consist of only flight plan blocks 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11.

e. A description of the International Flight Plan Form is contained in the International Flight Information Manual.

BIBLIOGRAPHY

Pamphlets:

1. "Air Traffic Control," Department of Transportation, Federal Aviation Administration, Washington, D.C. 20591. Free.
2. "Federal Aviation Administration," Department of Transportation, Federal Aviation Administration, Washington, D.C. 20591. Free.

Aviation Career Series:

3. "Pilots and Flight Engineers"
4. "Aviation Maintenance"
5. "Airport Careers"
6. "Airline Careers"
7. "Government Careers"

Aviation Career Series booklets available from:

Superintendent of Documents
Retail Distribution Division
Consigned Branch
8610 Cherry Lane
Laurel, MD 20707

Films:

An "FAA Film Catalog" is available from Department of Transportation, Federal Aviation Administration, Washington, D.C. 20591.

The following films are particularly applicable to the unit "Safety in the Air."

"Basic Radio Procedures for Pilots." 30 minutes. #1116.

"It May Even Save Your Life." 15 minutes. #11208.

"Flight #52." 14½ minutes. #11127.

Please request films at least one month in advance of the date to be shown. Be sure to specify title and film number, complete address where film is to be shipped, first choice of show dates, and an alternate date in case your first choice is not available. Order from:

FAA Film Service
c/o Modern Talking Pictures Service
5000 Park Street North
St. Petersburg, Florida 33709