DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 36

Commonly Misunderstood Areas of Aeronautical Knowledge (Series 1)

The areas of aeronautical knowledge brought out in this Exam-O-Gram are those with which 50% or more of applicants are experiencing difficulty on the Private Pilot Written Test. A little knowledge is a dangerous thing. Erroneous solutions of problems or improper analyses of operational situations are usually the result of the use of partial information or misinformation, whether it be in flying activities or on written tests. In this Exam-O-Gram a generalized question is posed, followed by a brief introductory discussion. This is done to identify the problem areas. ANSWERS ARE PURPOSELY WITHHELD TO ENCOURAGE THOROUGH STUDY. Complete explanations for full understanding may be found in the references given.

AVIATION WEATHER REPORTS

1. How can the pilot determine the trend of the ceiling from Aviation Weather (Sequence) Reports?

Example:

0700	0800	0900
12Ø SCT 2ØØ BKN 4Ø	E5Ø BKN 12Ø OVC 4Ø	3Ø SCT E5Ø OVC 3Ø

Keep in mind the conditions that constitute a ceiling, and the contractions used to represent these conditions. Scattered clouds, thin clouds, or partial obscurations are not considered a ceiling. The progressive values denoting the ceiling only, will show the trend of the ceiling. (Ref: Pilot's Handbook of Aeronautical Knowledge and VFR Exam-O-Gram No. 20.)

TERMINAL FORECASTS

2. How can the pilot determine the predicted weather for a given station and period in Terminal Forecasts?

All expected cloud bases, with the ceiling specifically identified, are given in height above the surface of the station. When visibilities above a certain value or surface winds below a certain value are expected, they are not included. Any predicted changes during the forecast period are shown immediately following the indicated time of the change. When advisable for safety and efficiency of operation, AMENDED forecasts are issued and are so designated in the heading. (Ref: Pilot's Handbook of Aeronautical Knowledge, VFR Exam-O-Gram No. 26.)

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TEMPERATURE AND HUMIDITY

3. Do high temperature and high humidity adversely affect aircraft performance?

   The density of the air in which an aircraft is operated has a significant effect on its operation and performance. The combination of atmospheric pressure, temperature, and humidity influences the air density, and contrary to prevailing opinion, moist air is less dense than dry air. (Ref: Pilot's Handbook of Aeronautical Knowledge; VFR Exam-O-Gram No. 17.)

CARBURETOR ICE

4. What indications verify the presence and removal of carburetor ice?

   The indications, of course, will depend on the type of equipment installed in the aircraft; i.e., manifold pressure gauge, constant-speed propeller, or fixed-pitch propeller. (Ref: Pilot's Handbook of Aeronautical Knowledge.)

ALTIMETER ERROR

5. What effect does pressure and temperature have on altimeter indications?

   Altimeters are calibrated on the basis of both a standard pressure and a standard temperature at sea level with a standard lapse rate (reduction) as altitude is increased. If either of these factors are significantly different than standard for the altitude, an erroneous altitude will be indicated. (Ref: Pilot's Handbook of Aeronautical Knowledge.)

RADIO FREQUENCIES

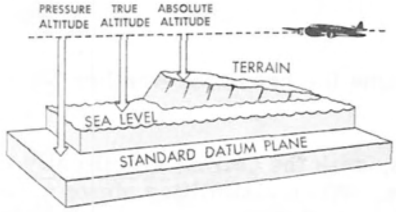
6. What frequencies can be used to communicate with particular radio facilities?

   Although the primary frequency on which a facility transmits can often be learned from the aeronautical chart, a complete and current listing of the available frequencies is found in the Airman's Information Manual. Some frequencies are used for both transmitting and receiving, while others, as designated, are for transmitting only or receiving only. (Ref: Pilot's Handbook of Aeronautical Knowledge; VFR Exam-O-Gram No. 50.)

PRESSURE ALTITUDE

7. How can the pilot in the aircraft determine the pressure altitude?

   Erroneously, pressure altitude is often thought to be the actual height above sea level obtained by placing the "altimeter setting" in the pressure dial of an altimeter. However, in reality, it is an altitude which, due to existing pressure, is equivalent to an elevation measured above a standard pressure level or datum plane, and is obtained by applying this standard pressure to the altimeter. Ref: Pilot's Handbook of Aeronautical Knowledge.



Types of altitude.

GROUNDSPEED AND HEADING

8. What must be considered when computing groundspeed and heading?

When solving problems involving speed and direction, the elements which relate to each other must be expressed in like terms. That is, speed factors must use the same unit of measurement, and direction components must be based on a common geographical point. Remember that in Winds Aloft Forecasts, wind speed is given in knots, while the aircraft's airspeed is normally given in miles per hour; wind direction is measured from True North, while courses may be True or Magnetic directions. (Ref: Pilot's Handbook of Aeronautical Knowledge; VFR Exam-O-Gram Nos. 17 and 26.)

AIRCRAFT INSPECTIONS

9. How can the pilot determine when an aircraft is due for an inspection?

The frequency and type of inspections required to be performed on an aircraft by Regulations is dependent on the type of operation in which the aircraft is engaged. Determination of when the next inspection is due should be made by reference to the completion record of the previous inspection entered in the aircraft's maintenance records and not by the Airworthiness Certificate as is frequently believed. (Ref: Federal Aviation Regulations 91.169 through 91.173; VFR Exam-O-Gram No. 26.)

ACCIDENT REPORTING

10. What are the requirements for the notification and reporting of aircraft accidents?

Although the FAA investigates certain aircraft accidents and incidents, the National Transportation Safety Board Regulations govern the procedures involved in the notification, reporting, and investigation of these occurrences. All pilots are required to be familiar with and comply with the part of NTSB Regulations pertinent to safety investigation. (Ref: National Transportation Safety Board regulation, Part 830; Airman's Information Manual, Part I.)

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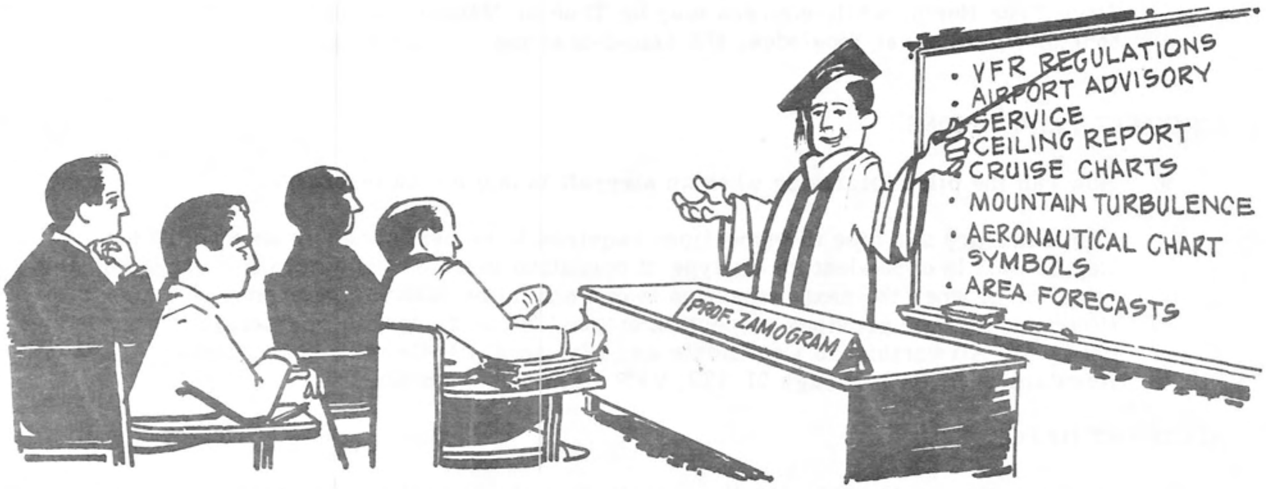
Exam-O-Grams available free of charge in limited quantities from this office.

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 37

Commonly Misunderstood Areas of Aeronautical Knowledge

(Series 2)



This is the second in a series of Exam-O-Grams dealing with areas of aeronautical knowledge in which 50% or more of the applicants are experiencing difficulty on the Private Pilot Written Test. A little knowledge is a dangerous thing. Erroneous solutions of problems or improper analyses of operational situations are usually the result of the use of partial information or misinformation, whether it be in flying activities or on written tests. In this Exam-O-Gram a generalized question is posed, followed by a brief introductory discussion. This is done to identify the problem areas. ANSWERS ARE PURPOSELY WITHHELD TO ENCOURAGE THOROUGH STUDY. Complete explanations for full understanding may be found in the references given.

SPECIAL VFR WEATHER MINIMUMS IN A CONTROL ZONE

1. Will Regulations permit VFR operations in a control zone when the ceiling is less than 1, 000 feet or visibility is less than 3 miles?

   The exact weather minimums required by Regulations for VFR operations in a control zone will vary, depending on the actions taken by the pilot. Basic VFR weather minimums apply unless the pilot obtains a special VFR clearance. (Ref: Federal Aviation Regulations 91. 107 and VFR Exam-O-Gram No. 26.)

AIRPORT ADVISORY SERVICE (Non-Radar)

2. What airports have Airport Advisory Service?

   This service is available (at the option of the pilot) from the Flight Service Station at various airports under certain prescribed conditions. Ref: Pilot's Handbook of Aeronautical Knowledge, Chapter 24.

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REPORTED CLOUD HEIGHTS VERSUS THEIR INDICATED ALTITUDE

3. What is the relationship between Cloud/Ceiling Reports and Altimeter Indications?

Except in those instances where it is specifically noted otherwise, all cloud and ceiling heights in aviation weather reports and forecasts are given in feet above the ground. The altimeter, however, is normally adjusted to measure altitude above sea level (MSL). This seems to be a confusing situation to many pilots. The problem is roughly comparable to the situation where air and ground speeds are computed in miles per hour, but wind speeds are given in knots. Just remember that you must reduce the information to a common denominator. That is, the point of reference must be common to both measurements. (Ref: Pilot's Handbook of Aeronautical Knowledge, Chapter 11, and VFR Exam-O-Gram Nos. 17, 20, and 21.)

CRUISE PERFORMANCE CHARTS

4. How are Cruise Performance Charts used?

The manufacturer of today's light airplane provides cruise charts or graphs pertaining to the rate of fuel consumption, true airspeed, range, endurance, etc. at different altitudes and power settings. These charts may be relatively simple or quite sophisticated, but in either case, it is important to remember that the performance data is based upon specific conditions of mixture, temperature, pressure, gross weight, wind, etc. Any deviation from the specific information upon which the chart computations were based will affect the accuracy of some or all of the results. For example, most Cruise Performance Charts are based on zero wind and standard atmospheric conditions, yet, during actual operations, these conditions seldom prevail. It should be noted that wind has a very significant effect on the distance an aircraft can fly but no effect on its rate of fuel consumption or the total time it can remain aloft. (Ref: Pilot's Handbook of Aeronautical Knowledge, Chapter 23, and VFR Exam-O-Gram No. 33.)

MOUNTAIN TURBULENCE

5. Will strong winds in mountainous terrain present any special flying hazards?

Although clouds and weather of any significance should be of particular concern to pilots when operating in mountainous areas, hazardous conditions may be encountered in cloudless skies or when excellent VFR conditions prevail in these areas. (Ref: Pilot's Handbook of Aeronautical Knowledge, Chapter 7. For more complete coverage of this, refer to Advisory Circular 00-17, Turbulence in Clear Air.)

AERONAUTICAL CHART SYMBOLS

6. What is the meaning of the chart symbols pertaining to radio facilities which appear on Visual Navigation Aeronautical Charts?

The symbols pertaining to radio facilities are explained on the charts. Careful comparison and study of these symbols and their explanatory legend should make it relatively easy to determine the exact nature of the radio aids available at any location. CAUTION: Chart information may be out of date and should always be checked against the information in the Airman's Information Manual and teletype NOTAMS at the Flight Service Stations. (Ref: Pilot's Handbook of Aeronautical Knowledge, Chapter 13, and VFR Exam-O-Gram No. 50.)

AREA FORECASTS

7. How can a pilot use Area Forecasts in preflight planning?

Area Forecasts deal with weather on a regional basis and are intended primarily as Enroute Forecasts. A pilot can obtain a broad picture of the weather conditions he is likely to encounter during the time period specified by:

A. Studying the forecast with regard to clouds, weather, icing, freezing level(s), turbulence, and weather outlook.
B. Carefully locating the specific geographical area as described in the forecast to which the items in (A) apply.
C. Establishing the times during which (A) will apply to (B).
D. Correlating (A), (B), and (C) with the planned route of flight as well as estimated departure, enroute, and arrival times.

(Ref: Pilot's Handbook of Aeronautical Knowledge,
VFR Exam-O-Gram No. 26.)

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FEDERAL AVIATION ADMINISTRATION

VFR PILOT EXAM-O-GRAM* NO. 38

MIXTURE CONTROL--FUEL/AIR RATIO

It is generally conceded by most leading aircraft engine manufacturers that correct use of the mixture control in flight for adjusting the fuel/air ratio (F/A) is one of the most important items in the operation of aircraft engines. This Exam-O-Gram explains some of the related factors which should be considered when leaning the fuel/air mixture. It is hoped that this brief discussion will serve as a stimulus for pilots to study and search for more information on this subject--in aircraft power plant manuals--and especially the engine manual pertinent to the aircraft they are operating. Certain General Aviation Written Examinations contain test items which are concerned with the results of improper use of mixture control.

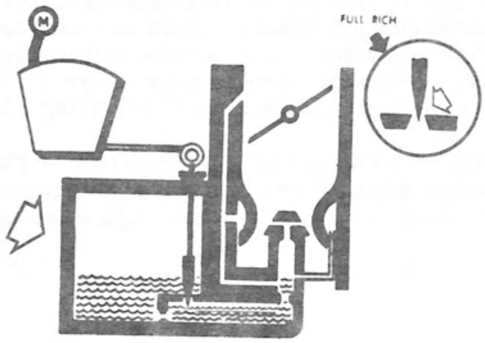
The mixture control knob in an aircraft cockpit is usually RED--an indication that it should be used with "caution." Proper leaning of the mixture provides smoother engine operation, more power for a given power setting, best range and endurance; on the other hand, misuse of the mixture control can soon ruin an aircraft engine.

WHAT DOES FUEL/AIR (F/A) RATIO MEAN? It is the ratio between the weight of the fuel and the weight of the air that goes into the cylinders. In general, gasoline engines require approximately 15 pounds of air in order to completely burn 1 pound of gasoline. However, a theoretically perfect mixture ratio is not essential or desired in all cases. Certain conditions may require the use of mixture either richer or leaner than this average ratio. Usually, the useful mixture ratios are between 1 to 11 and 1 to 16. Fuel and air proportions are expressed on the basis of weight rather than volume. Fuel/air ratios may be given as a direct ratio, such as 1 to 12, but in more common usage, they are designated as decimal fractions such as 0.083. For example: $1 \div 12 = 0.083:1$ (0.083 lb. of fuel to 1 lb. of air).

WHAT IS THE FUNCTION OF THE CARBURETOR? It measures the correct quantity of fuel to be supplied to the engine, ATOMIZING and MIXING the fuel with air in the correct proportion (F/A ratio) before the mixture enters the cylinders. This proportioning must be done correctly regardless of the speed, load, and altitude at which the engine is operating. Gasoline cannot ignite or burn when in the liquid state, it first must be vaporized and mixed with the correct amount of air before it can be ignited and combustion takes place. When compared to other gasoline engines, aircraft engines operate at a greater altitude range and therefore are equipped with manual and/or automatic mixture controls.

HOW ARE CARBURETORS NORMALLY CALIBRATED? They are calibrated for sea-level operation, which means that the correct mixture of fuel and air will be obtained at sea level with the mixture control in the "full rich" position. As we climb to higher altitudes, the air density decreases--that is, a cubic foot of air will not weigh as much as it would at a lower altitude. Therefore, the weight of air entering the carburetor will decrease, although the volume remains the same. The amount of fuel entering the carburetor depends on the volume of air and not the weight of air. As the altitude increases, the amount of fuel entering the carburetor will remain approximately the same for any given throttle setting. Since the same amount (weight) of fuel is entering the carburetor, but a lesser amount (weight) of air, the fuel-air mixture becomes richer as altitude increases.

WHAT DOES THE MIXTURE CONTROL DO? It compensates for the decreased air density by metering the amount of fuel that passes through the main jet in the carburetor. In the less dense air at higher altitudes, a leaner mixture reduces fuel consumption and provides smoother engine operation. The mixture control is used to reduce the amount of fuel flow and maintain the proper F/A ratio--this is also true of engines with fuel injection.



Needle Type Mixture Control System

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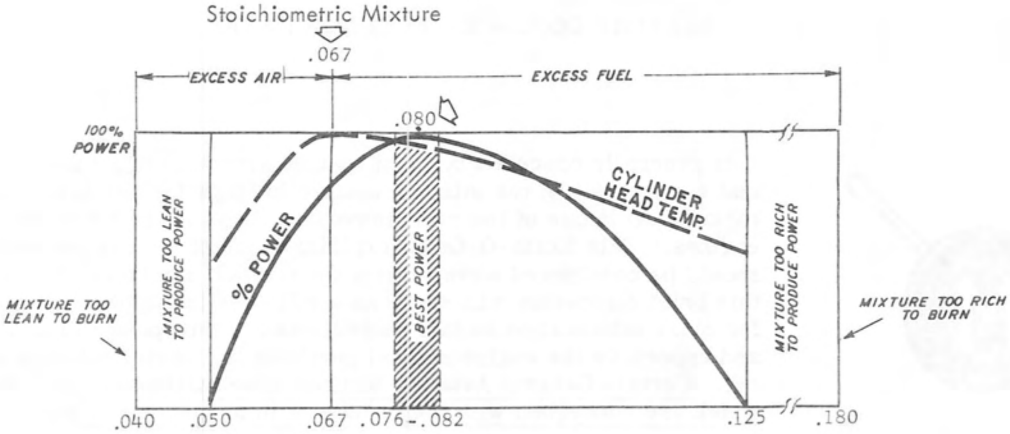
AT WHAT F/A RATIO DO THE HIGHEST CYLINDER TEMPERATURES OCCUR? The greatest heat occurs at a fuel to air ratio of 1 to 15, or .067, and this is known as stoichiometric mixture (pronounced like stoy-key-o-metric), which is the chemically correct mixture where all the air and all the fuel is burned. Even though an F/A ratio of .067 is considered a chemically correct mixture for combustion, it produces peak temperatures and this is generally the mixture which will cause all gasoline engines to run the hottest (see Illustration below).



Fuel-Air Ratios vs Power & Temperature

The mixture of .067 is a theoretical point that can be demonstrated only on a single cylinder engine in a laboratory. In engines with more than one cylinder, the variations in fuel distribution between the cylinders makes it difficult to evaluate the F/A ratio in each cylinder. This matter of distributing equal amounts of fuel and air to the various cylinders is one of the greatest problems facing the aircraft engine manufacturers--or the designer of any gasoline engine for that matter. Because of the unequal Fuel/Air ratio in the various cylinders, the pilot who practices using extremely lean mixture settings without reference to proper instrumentation can experience a situation where all cylinders on his engine are operating at normal temperatures--except for one hot cylinder, where the exhaust valve and seat are red hot.

WHAT IS THE "BEST POWER" MIXTURE? The .080 fuel/air ratio is known as the "Best Power" mixture and it is that ratio at which the most power can be obtained for any given throttle setting. "Best Power" mixture is the fuel/air ratio where we can get a given power with the lowest manifold pressure or throttle setting. (See Illustration above.)

WHAT DOES EXCESS AIR AND EXCESS FUEL MEAN IN THE ILLUSTRATION? The illustration shows "Excess Air" on the left side of the .067 mixture, which means there is more air in the cylinders than is needed for normal combustion, and this excess of air absorbs heat and helps to cool the engine. On the right side of .067 mixture, we have "Excess Fuel" which means that there is more fuel in the cylinders than is needed for normal combustion, and this "Excess Fuel" also absorbs heat and provides additional cooling. Large supercharged engines can operate in the "Excess Air" lean mixture side of the .067 mixture, whereas the carburetor equipped, unsupercharged small aircraft engine should never be leaned to this extent. For example: If the manual mixture control of a supercharged engine is moved toward the lean position, cylinder head temperatures will be greatest when the F/A ratio is .067 and as the mixture is leaned still further, cylinder head temperatures will return to cooler normal values. When cylinder head temperatures climb too high while leaning carburetor equipped, unsupercharged engines, the mixture must be richened in order to return to cooler head temperatures.

WHAT IS MEANT BY UNEVEN MIXTURE DISTRIBUTION? In a carburetor equipped engine, the intake manifolds and induction pipes are used to distribute the fuel and air charge to the various cylinders. Those cylinders which are the farthest from the carburetor often receive a slightly leaner mixture than those cylinders close to the carburetor. When the mixture control is used to lean the mixture, the cylinders which are already receiving a leaner mixture will be the first ones to run hot or misfire.

DOES FUEL INJECTION PROVIDE BETTER FUEL DISTRIBUTION? Yes, the fuel is injected into the intake manifold and it is mixed with air just before entering the cylinders. Theoretically, all of the cylinders of a fuel injection engine are receiving an equal amount of fuel.

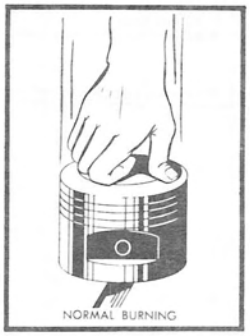
NOTE: Fuel injection engines are equipped with Fuel Flow Gauges to indicate the F/A mixture being supplied to the engine. Some of these instruments also show the percentage of power being used. Proper mixture control and better economy in the operation of a fuel injection engine can be achieved best through the use of an Exhaust Gas Temperature Indicator, a Cylinder Head Temperature Gauge and an Oil Temperature Gauge. The two latter instruments have slow response times but the trend of these basic heat references are very meaningful.

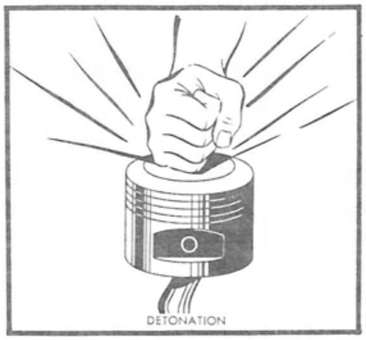
WHAT ARE THE RESULTS OF HAVING THE MIXTURE TOO LEAN? When the mixture is too lean there is too little fuel for the amount of air--in terms of weight. Rough engine operation, sudden "cutting out" or "back firing," detonation, overheating, or an appreciable loss of engine power may occur. Lean mixtures must be avoided when an engine is operating near its maximum output.

AT WHAT ALTITUDE IS LEANING THE MIXTURE NORMALLY EFFECTIVE? Leaning is normally effective above 5,000 feet; however, some aircraft engines may be leaned below 5,000 feet. Always follow the manufacturer's recommendations on leaning the fuel mixture for the particular airplane. By leaning the mixture at too low an altitude or leaning the mixture excessively, you could damage the engine at a high power setting. For example: Suppose that a pilot had been cruising at 8,000 feet with a lean mixture and forgot to move the mixture to full rich before entering the traffic pattern of a low elevation airport. The pilot may experience a rough engine or the engine might "cut out" or even worse if he were to exceed approximately 70% power in the pattern or on a go-around he would be in serious trouble with detonation and engine overheating. In general, lean mixtures must be employed with caution when operating aircraft engines at high power settings.

WHY IS 5,000 FEET CONSIDERED A SAFE ALTITUDE FOR LEANING? Certain aircraft engine manuals state that their engines should not be leaned below 5,000 feet. At 5,000 feet the unsupercharged engine is capable of developing only about 75% of its rated power, and at less than 75% power it is much harder to get into trouble using improper leaning techniques, since the cylinders and other engine parts are operating at lower temperatures.

WHAT IS DETONATION? Detonation is the spontaneous explosion of the unburned charge (in the cylinders) after normal ignition. If the temperature and pressure of the unburned portion of the fuel-air charge reach critical values, combustion will begin spontaneously. The result is a sudden and violent explosion of the charge (detonation) rather than the relatively slow burning of normal combustion.


NORMAL BURNING


DETONATION

Continued operation when detonation is present can result in dished piston heads, collapsed valve heads, broken rings, or eroded portions of valves, pistons, or cylinder heads, and may terminate in sudden and complete engine failure.

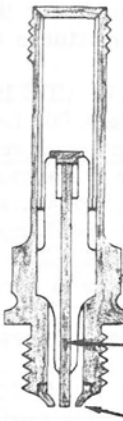
Since it is very important to avoid detonation, it is well to consider the principal factors which contribute to this condition. The anti-knock value of the fuel (octane rating-performance no.), cylinder head temperature, incoming mixture temperature, fuel-air ratio, and intake manifold pressure are the most important factors of greatest significance for the pilot.

Usually detonation cannot be recognized from the cockpit through sound or engine roughness; therefore, protection from its possible occurrence must be provided by the design of the engine and adherence to the engine operating limitations.

WHAT IS PRE-IGNITION? Pre-ignition is the uncontrolled firing of the fuel-air charge in advance of normal spark ignition. It is caused by the presence within the combustion chamber of an area which is incandescent (red hot, glowing, luminous, with intense heat) and serves as an ignitor in advance of normal ignition. Pre-ignition may result from a glowing spark plug electrode, exhaust valve, or perhaps a carbon or lead particle heated to incandescence. As with detonation, such operating factors as high intake air temperatures, lean mixtures, high manifold pressures, and improper cooling are likely to set the stage for pre-ignition. Pre-ignition may start detonation, and paradoxically, detonation may start pre-ignition because of the high temperatures involved. Moreover, pre-ignition can be fully as destructive as detonation.

HOW IS ADDITIONAL FUEL PROVIDED FOR COOLING THE ENGINE ON TAKEOFF? At full power on takeoff with the mixture "full rich" you are assured of the best combination of power and cooling. The enrichment of the fuel-air mixture at high-power output is accomplished in actual carburetor design by the incorporation of auxiliary fuel-metering devices. Such devices are variously known as economizers, high speed jets, enrichment jets, power compensators, etc. Regardless of the name applied, all such units serve the same general purpose--that is, when full power is used on takeoff, the enrichment jets or valves cut in and provide additional fuel. This additional fuel helps to cool the engine during maximum power operation.

WHAT ARE THE RESULTS OF USING AN EXCESSIVELY RICH MIXTURE AT HIGH ALTITUDES? Whenever an unsupercharged engine is operated at a high altitude with an excessively rich mixture, the power will be reduced from that which is available at that altitude with proper mixture. Excessive fuel is not required for combustion chamber cooling at high altitudes. The fouling of spark plugs is one of the greatest "bad effects" of operating with an excessively rich mixture. Spark plugs are designed to operate within certain heat ranges in order to function properly and operate without fouling. The excessively rich mixture will cause a below normal temperature of the spark plug center electrode, which, in turn, results in the formation of carbon and lead deposits. These deposits are electrically conductive and when they reach a sufficient depth, the electric current will flow through the deposit rather than "jumping-the-gap" in the spark plug to ignite the fuel air charge. This is what is known as a "fouled" or "shorted out" plug, since the current flows across the deposits on the ceramic insulator and is grounded instead of jumping the gap. Therefore, it is essential to maintain a fuel-air ratio which will provide sufficient heat in the combustion chamber to vaporize any deposits which may form on the ceramic center of the spark plug.



Radio Shielded Spark Plug

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FOLLOW THE MANUFACTURER'S RECOMMENDATIONS ON LEANING THE MIXTURE.

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 40

VISUAL APPROACH SLOPE INDICATOR (VASI)

Within the National Airspace System, there are many airports equipped with the standard Visual Approach Slope Indicators, and some are equipped with Abbreviated Visual Approach Slopes. The abbreviated systems contain fewer light units which may be installed on one side of the runway only. It is apparent that misconceptions and a lack of knowledge concerning this aid exist among the general aviation public. To assist those who are not familiar with VASI, particularly those taking FAA written tests, this Exam-O-Gram briefly explains the system, and answers questions commonly asked regarding the purpose, availability, and use of the device.

SYSTEM DESCRIPTION. The Visual Approach Slope Indicator (VASI) is a ground device which uses lights to define a predetermined visual glide path during the approach to a runway. As soon as the VASI lights are visible on final approach--day or night--a pilot receives the same information by visual reference that the glide slope unit of the Instrument Landing System (ILS) provides electronically. Once the principles and color code of the lighting system are understood, flying the VASI is as simple as looking out through the windshield and establishing and maintaining the proper rate of descent to stay on the glide slope.

This facility emits a visual light path within the final approach zone, at a fixed plane inclined from a minimum of $2\frac{1}{2}°$ to a maximum of 4° from horizontal, which gives the pilot visual descent guidance during an approach to landing. The beam width is 15 degrees on each side of the extended runway centerline, but actual runway alignment is not provided by VASI. Course guidance to assure runway alignment should be obtained by reference to the runway lights, the runway itself, or by other approach aids.

Standard installation of the system requires twelve light-source boxes arranged in two split bars of light that straddle the runway. A set of 3 light units (boxes) is placed on each side of the runway approximately 600 feet from the threshold, and a second set of 3 is placed on each side at approximately the 1,300-foot point from the threshold. Formerly, these light unit arrays were known as the "downwind" and "upwind" light bars, respectively. Currently, however, the downwind bar is called the "near bar" and the upwind bar is known as the "far bar." The visual approach slope reference point is located midway between the far and near bars.

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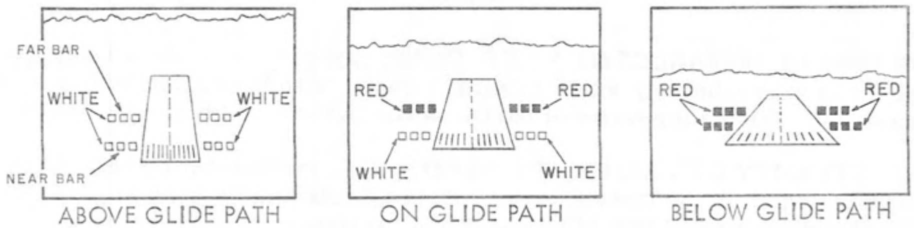

ABOVE GLIDE PATH — ON GLIDE PATH — BELOW GLIDE PATH

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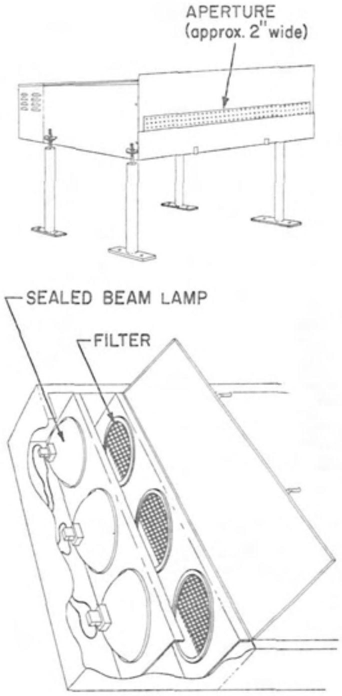

VASI LIGHT UNIT

LIGHT UNITS. Each light unit consists of a metal box 4.5 feet square and about 1 foot thick, housing three high intensity sealed beam lamps. Immediately in front of the lamps is a color filter assembly, the upper two-thirds of which is red and the lower portion is clear. Across the front of the box at the focal point of the lamps is a 2-inch aperture that extends across the width of the box. The "lens" effect, thus achieved, causes the light to appear white when viewed from a high angle, red when viewed from a low angle, and pink when viewed from the horizontal center of the aperture. The light intensity of each light unit is approximately 40,000 candlepower in the white light zone.

PRINCIPLE. The basic principle of VASI is that of color differential between red and white. The VASI provides obstruction clearance in the final approach area only. It is especially effective during approaches over water or featureless terrain where other sources of visual reference are lacking or misleading.

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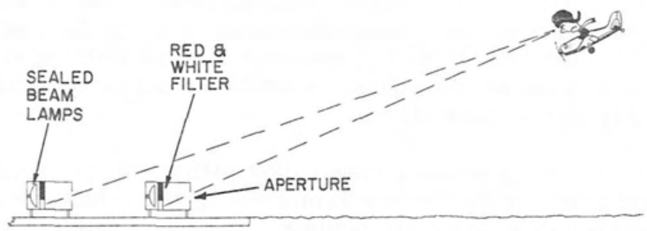
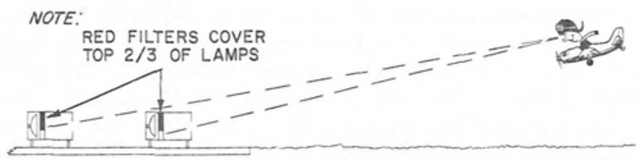
HOW ARE THE VASI APPROACH LIGHTS USED? For VFR conditions, proceed inbound maintaining normal traffic pattern altitude. When the near (downwind) bars transition from red through pink to white, commence descent. When on the proper approach path, the pilot is, in effect, overshooting the near bar light beam, and undershooting the far bar light beam. Thus, he sees the near bars as white and the far bars as red. When below the glidepath, both bars are red; when high, both bars are white.

Departure from the glidepath is indicated to the pilot by a transition in color of one of the light bars. If the departure is to the high side, the far bars will change from red through pink to white, leaving a completely white display. If the departure is to the low side, the near bar will change from white through pink to red, warning of a descent below the approach slope--by a completely red array of lights.



ABOVE GLIDE SLOPE (PILOT SEES WHITE/WHITE)

NOTE: Some deterioration of system guidance may occur as the pilot approaches the runway threshold due to the spread of light sources and narrowing of individual colors. However, the VASI will bring the pilot safely through a "gate" at the threshold where he may accomplish a normal flareout and landing. Since deterioration of system guidance occurs close in, the VASI is an approach aid rather than a landing aid.

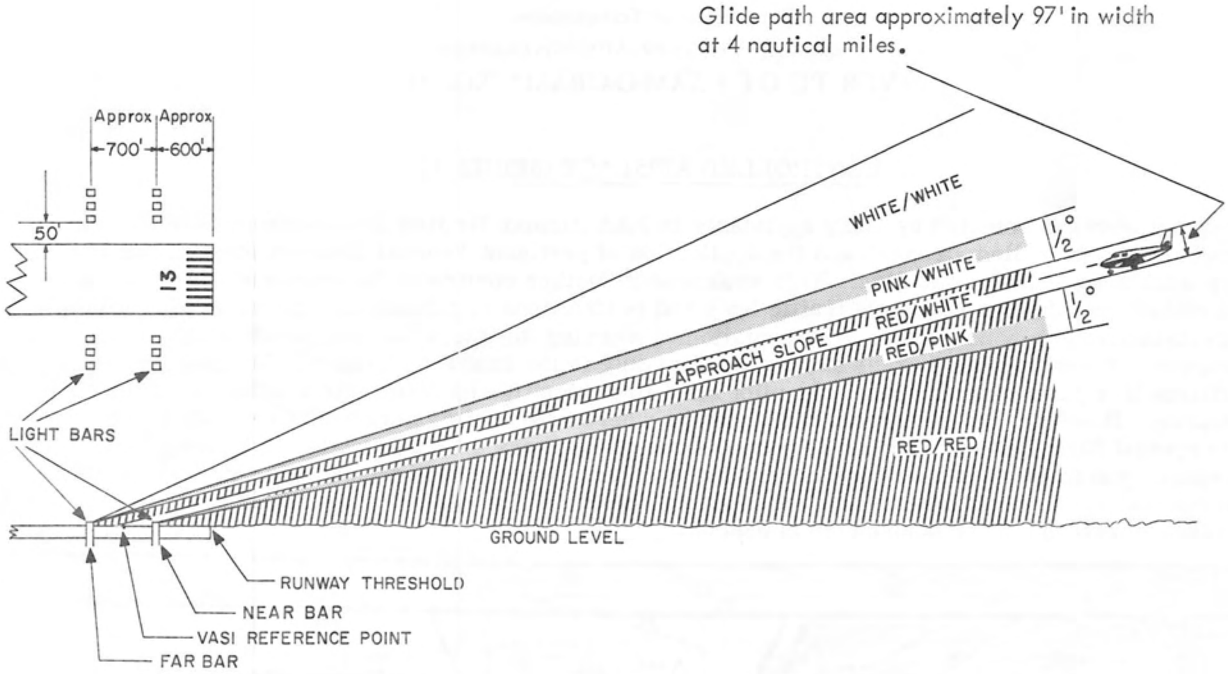


ON GLIDE SLOPE (PILOT SEES RED/WHITE)

●●●

WHAT ARE THE USABLE DISTANCES OF VASI? During daylight hours the VASI lights normally can be seen at distances of approximately 4 to 5 nautical miles. With bright sunlight or snow conditions the range is decreased. During the hours of darkness the lights may be seen at greater distances.

CAN THE LIGHT INTENSITY OF VASI BE ADJUSTED? Yes, the standard VASI system includes a light intensity control switch in the control tower. This remote control may be a two position "HIGH-LOW" switch or a three position "LOW-MEDIUM-HIGH" selector. If a pilot making a night VASI approach desired to have brightness of the lights turned down, he can request the controller in the tower to do so.



TYPICAL VASI COLOR INDICATION PROFILE

WHAT ARE SOME OF THE FACTORS THAT AFFECT A PILOT'S COLOR INTERPRETATION? Such factors as snow, dust, precipitation, and color of background terrain affect the pilot's color interpretation of the VASI. Atmospheric conditions may distort the color the pilot is actually seeing or preclude the determination of a <u>well-defined</u> glide path or transition area. However, there is no distortion in the Red/Red area. When all lights are solid red, the aircraft is definitely below the glide slope.

HOW DOES A PILOT DETERMINE IF AN AIRPORT IS EQUIPPED WITH VASI? By referring to the Airman's Information Manual (AIM) Airport/Facility Directory listing for that airport. Note in the excerpt to the right that VASI equipment is provided for Runways 17 and 35. There is no VASI information listed on WAC or Sectional Charts, however, it does appear on the Instrument Approach Procedure Charts.

§ **PONCA CITY MUNI (PNC)** FSS: PONCA CITY(PNC) ON FLD
36°43'41'' 97°06'00'' 2NW 1007' IFR
RWY 17/35: H6201. HI RWY LGTS. (S-50,D-72,DT-133)
RWY 17: REIL. VASI. RGT TFC **RWY 35:** POLE LINES. REIL. VASI
FUEL: 80, 100, JET A. **REPAIRS:** MAJOR A & E
ROTG BCN: DUSK-DAWN. **UNICOM:** 123.0
REMARKS: RWY LGTS OPER DUSK-DAWN. CERT FAR 139 CFR INDEX A. NORTH 1400' RWY 17/35 NON STD PLASTIC GROOVING ENTIRE WIDTH AND 25' EACH EDGE AT REMAINDER OF RWY (4800').
SDF RWY: 17
REMARKS: NON-FEDERAL SDF
PIONEER VORTAC 101° 3.1 NM TO ARPT
KILDAIRE NDB 171° 5.2 NM TO RWY 17

WHEN ARE THE VASI LIGHTS IN OPERATION? The VASI shall normally be operated, day or night, when the runway it serves is the landing runway--or--when requested by the pilot.

ARE THERE ANY REGULATIONS THAT DEAL WITH VASI? Yes, FAR 91.87 states in part: "(d) Minimum altitudes. When operating to an airport with an operating control tower, each pilot of --. . . (3) an airplane approaching to land on a runway served by a visual approach slope indicator, shall maintain an altitude at or above the glide slope until a lower altitude is necessary for a safe landing." (NOTE: Regulations permit normal bracketing maneuvers above or below the glide slope that are conducted for the purpose of remaining on the glide slope.)

● ● ●

VASI provides unquestionable obstruction clearance in the approach area which is very comforting during night landings at strange airports. It reduces the chance of overshooting or undershooting, and it aids in making a landing in the first portion of the runway. VASI is also an effective noise abatement procedure where large airplanes and turbine-powered airplanes are concerned.

★ ★ ★ ★ ★

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5/67

U.S. Department of Transportation

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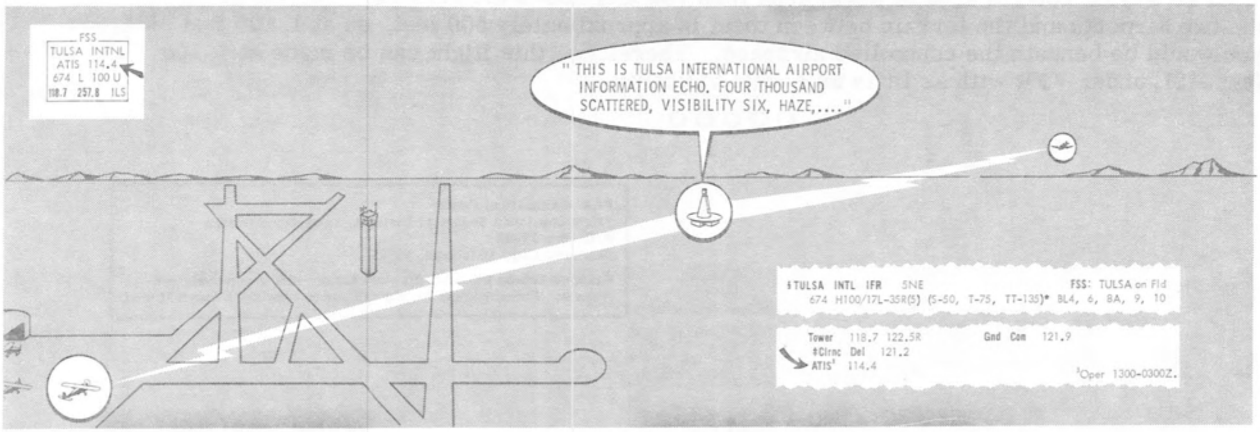
VFR PILOT EXAM-O-GRAM* NO. 43

ATIS (AUTOMATIC TERMINAL INFORMATION SERVICE)



The Federal Aviation Administration is constantly striving to improve its service to the public. This Exam-O-Gram describes Automatic Terminal Information Service (ATIS) which has improved Air Traffic Controller effectiveness and relieved radio frequency congestion in many terminal areas. Because ATIS contributes to safety, FAA written tests may include questions on this subject.

WHAT IS ATIS? The continuous broadcast of recorded non-control information in selected high-activity terminal areas. It relieves frequency congestion by automating the repetitive transmission of routine but essential information on frequencies other than those normally used for airport traffic control. This service is presently being provided at many FAA tower-controlled airports.

WHAT KIND OF INFORMATION IS PROVIDED BY ATIS? Sky condition, visibility, wind, altimeter setting, instrument approach, and runway/s in use are continuously broadcast for the designated airport. NOTAMS, Airman Advisories, or other information pertinent to the airport will be included as appropriate.

HOW ARE ATIS BROADCASTS RECEIVED? By tuning to the appropriate frequency published on the sectional charts or in the Airport/Facility Directory of the Airman's Information Manual as depicted above. This is a continuous broadcast on the voice feature of a TVOR/VOR/VORTAC located on or near the airport, or a discrete UHF/VHF frequency. ATIS broadcasts on VOR/VORTAC facilities may be interrupted by the FSS to reply to frequency limited aircraft if necessary.

WHEN SHOULD THE ATIS BROADCASTS BE UTILIZED? Prior to requesting taxi clearance by departing aircraft and prior to reporting to the tower by arriving aircraft.

IS ATIS DESIGNED PRIMARILY FOR THE IFR PILOT? No! The information broadcast is applicable to all departing and arriving aircraft, VFR as well as IFR.

DOES THE ATIS BROADCAST CONSTITUTE A CLEARANCE TO TAXI FOR TAKEOFF OR A CLEARANCE TO LAND? No! Since only routine information is contained in these broadcasts, ATC clearances to taxi, take off, or land must be issued separately to the individual aircraft by the appropriate controller on the appropriate frequency.

WHAT ARE THE ADVANTAGES OF ATIS OVER THE LONG-STANDING METHOD OF INDIVIDUAL INSTRUCTIONS? There are three distinct advantages: First, extensive utilization of ATIS by pilots will greatly reduce the congestion on tower and ground control frequencies, and the routine workload on the controllers. This will allow the controllers to devote more time to the specific control of arriving and departing aircraft; second, the ATIS broadcast contains more information than the normal tower or ground control instructions for taxi, takeoff, or landing (i. e., weather, NOTAMS, etc.); and third, the pilot can receive this information when cockpit duties are least pressing and listen to as many repeats as desired. (This should be a great boon to student pilots or pilots who operate infrequently at tower controlled airports.)

Rev. 4/77

* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

DISTRIBUTION: ZC-307

WHAT DOES A TYPICAL ATIS BROADCAST SOUND LIKE? Sample broadcast --". . THIS IS TULSA INTERNATIONAL AIRPORT INFORMATION ECHO. FOUR THOUSAND SCATTERED, VISIBILITY SIX, HAZE, WIND ONE FIVE ZERO DEGREES AT ONE THREE. TEMPERATURE EIGHT ONE, DEWPOINT SIX FOUR. ALTIMETER TWO NINER EIGHT NINER. I L S RUNWAY ONE SEVEN LEFT IN USE. LANDING AND DEPARTURE RUNWAYS ONE SEVEN LEFT AND ONE SEVEN RIGHT. NOTAM, RUNWAY ONE TWO, THREE ZERO CLOSED TO ALL OPERATIONS. INFORM TULSA APPROACH CONTROL, TOWER, OR GROUND CONTROL ON INITIAL CONTACT THAT YOU HAVE RECEIVED INFORMATION ECHO. ."

WHAT ARE THE SPECIFIC PROCEDURES FOR UTILIZING ATIS BROADCASTS? The broadcast should be monitored prior to requesting taxi clearance or prior to requesting landing clearance. Arriving aircraft should monitor the broadcast well in advance of entering the Airport Traffic Area. Each ATIS broadcast will carry an identifying phonetic alphabet code word (Alpha, Bravo, Charlie, etc.). This code word is important. After receiving the ATIS broadcast, the pilot, on initial contact with ground control, tower, or approach control, should state he has the information and repeat the specific code word. Example -- ". . TULSA GROUND CONTROL, THIS IS BEECHCRAFT SEVEN FOUR SIX FOUR CHARLIE. ON TERMINAL RAMP, READY TO TAXI. I HAVE INFORMATION ECHO. OVER. ."

HOW OFTEN ARE ATIS BROADCASTS CHANGED? They are normally updated hourly. However, they will be updated more frequently should a significant change occur in the information. Each time the message is updated, the next phonetic alphabet code word will be used.

WHAT HAPPENS WHEN PILOTS REQUEST CLEARANCE WITHOUT ACKNOWLEDGING RECEIPT OF THE ATIS BROADCAST OR ACKNOWLEDGE BY A CODE WORD WHICH IS NOT CURRENT? In either case the controller will issue the normal taxi or landing information.

ATIS IS A VALUABLE SERVICE. ALL PILOTS ARE ENCOURAGED TO USE IT EXTENSIVELY.

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VFR – No. 43

5-70

FAA Aeronautical Center
Flight Standards Technical Division, Operations Branch
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Department of Transportation

FEDERAL AVIATION ADMINISTRATION

VFR PILOT EXAM-O-GRAM NO. 45

AIRSPEEDS AND AIRSPEED INDICATOR MARKINGS (Series 2)

Most FAA written tests contain several test items involving airspeed. Analyses show that many applicants are not knowledgeable concerning airspeeds. The use of performance charts, computation of navigation problems, and filing of flight plans involves the use of True Airspeed. However, in various configurations and flight conditions, airplanes are also operated with reference to Calibrated Airspeed.

WHAT ARE THE DIFFERENT AIRSPEEDS? The four principle airspeeds are defined below.

Indicated Airspeed (IAS) is the uncorrected speed read from the airspeed dial. It is the measurement of the difference between impact pressure and atmospheric pressure in the pitot-static system.

Calibrated Airspeed (CAS) is indicated airspeed corrected for instrument error and installation error in the pitot-static system. As the aircraft flight attitude or configuration is changed, the airflow in the vicinity of the static inlets may introduce impact pressure into the static source, which results in erroneous airspeed indications. The pitot section is subject to error at high angles of attack, since the impact pressure entering the system is reduced, when the pitot tube is not parallel to the relative wind. Note in the chart to the right the difference between indicated and calibrated airspeed in the lower speed ranges. Performance data in aircraft flight manuals is normally based on calibrated airspeed.

AIRSPEED CORRECTION TABLE

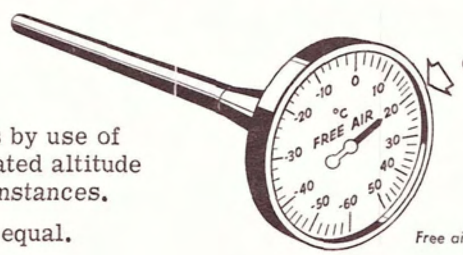
FLAPS	IAS	40	50	60	70	80	90	100	110	120	130	140
FLAPS UP	CAS	55	60	66	72	80	89	98	108	117	127	136
FLAPS DOWN	CAS	52	58	65	73	82	91	101	•	•	•	•

Equivalent Airspeed (EAS) is calibrated airspeed corrected for compressibility factor. This value is very significant to pilots of high speed aircraft, but relatively unimportant to pilots operating at speeds below 250 knots at altitudes below 10,000 feet.

True Airspeed (TAS) is calibrated airspeed (or equivalent airspeed if applicable) corrected for air density error. TAS is the actual speed of the aircraft through the air mass. Air density error is caused by nonstandard pressure and temperature for which the instrument does not automatically compensate. The standard airspeed indicator is calibrated to read correctly only at standard sea level conditions--that is, when the pressure is 29.92 inches Hg and the temperature is 15°C.

○○○○○

HOW IS TRUE AIRSPEED DETERMINED? To find TAS, it is necessary to--(a) work a computer solution, or - (b) have in the aircraft an airspeed indicator, similar to the one illustrated to the left, which incorporates that portion of a computer which is necessary for determining TAS in the cruising speed range. This represents the current trend in the design of flight instruments that reduce pilot workload. In either case, the prerequisites for determining TAS are pressure altitude*, CAS, and outside air temperature. Example: For a pressure altitude of 6,500 feet, a CAS** of 175 mph, and an outside air temperature (OAT) of +20°C., you would use the instrument to the left as follows: With the adjusting knob, set the pressure altitude (6,500 feet) opposite the OAT (+20°C.). The needle then shows a TAS of 202 mph while on the inner portion of the dial the needle is registering an IAS of 175 mph or 152 knots.



OAT +20° C

Free air temperature gage

*The most accurate method of solving for TAS is by use of pressure altitude. However, you can use indicated altitude without introducing too great an error in most instances.

**For this example the IAS and CAS are assumed equal.

NOTE: Free Air Temperature gages are subject to heat of compression (friction) errors. The higher the TAS the more the increase in indication above the actual temperature of the air.

DO SOME INSTRUMENTS AUTOMATICALLY REGISTER TRUE AIRSPEED? Yes, more advanced true airspeed indicators contain components which correct for pressure altitude, OAT, and compressability to automatically provide TAS without computations on the part of the pilot.

WHAT ADDITIONAL AIRSPEED INDICATOR MARKINGS ARE REQUIRED IN MULTI-ENGINE AIRPLANES? FAR Part 23, which deals with Airworthiness Standards for airplanes of 12, 500 lbs. or less, was amended November 11, 1965, to require the following airspeed markings in multi-engine airplanes: (a) a blue radial line to show the best rate of climb speed (V_y) with one-engine-inoperative. (b) a red radial line to show V_{mc} -the minimum control speed with one-engine-inoperative. Note in the illustration to the left, that these markings for key speeds in multi-engine airplanes are in addition to those normally required for other airplanes.

WHICH MULTI-ENGINE AIRPLANES ARE REQUIRED TO HAVE THESE MARKINGS? Only those airplanes which were type certificated under Part 23 on or after November 11, 1965, are required to have these markings. However, airplanes type certificated before that date may also be so marked at the option of the owner.

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VFR – No. 45

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NOTE: THE COLORED MARKINGS ON AIRSPEED INDICATORS ARE BASED ON CAS, NOT IAS.

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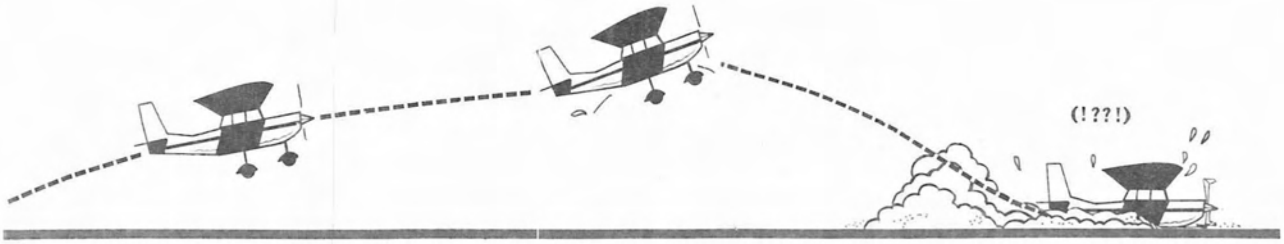
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 47

GROUND EFFECT



It is possible to fly an aircraft a few feet above the ground at an airspeed lower than that required to sustain level flight at an altitude only slightly higher. This is the result of a phenomenon called ground effect -- apparently better known than understood by many pilots. In terms as nontechnical as possible, we will here define and discuss the major problems associated with this rather complex subject.

WHAT IS GROUND EFFECT? It is not possible, nor would it serve our purpose, to attempt in the space available an indepth discussion of the precise aerodynamics of ground effect. Suffice it to say, that in simple terms, it is the result of interaction between wing airflow patterns and the surface of the earth. All airfoils such as wings, rotor blades, etc., produce tip vortices and exhibit distinct airstream downwash characteristics when developing lift. The vertical components of such tip vortices and downwash velocities are progressively reduced as the airfoil nears the surface, and at touchdown are almost completely canceled by surface interference. This alteration in airflow pattern decreases induced drag (the drag produced by lift). The closer the airfoil to the surface, the greater the reduction. Induced drag, at a height of approximately one-tenth of a wing span above the surface, may be 47% less than when the airplane is operating out of ground effect. It is this decrease in drag which explains basic airplane reactions when in ground effect.

HOW DOES A REDUCTION IN INDUCED DRAG AFFECT PERFORMANCE? To the pilot the reduction in drag means increased performance. That is, lift will increase with no increase in angle of attack, or the same lift can be obtained at a smaller angle of attack. This can be useful since it allows the pilot to either decrease angle of attack/power to maintain level flight, or as on most landings, to maintain wing lift while reducing power. A word of caution is in order, however. A full stall landing will require several more degrees of up elevator deflection than would a full stall when done free of ground effect. This is true because ground effect usually changes horizontal tail effectiveness in airplanes of conventional configuration.

UP TO WHAT ALTITUDE CAN GROUND EFFECT BE DETECTED? A pilot is unlikely to detect ground effect if his height above the surface exceeds the airplane's wing span. In fact, there is appreciable ground effect only if height is less than half the wing span. At this or lower altitudes, ground effect is quite pronounced.

WHAT MAJOR PROBLEMS CAN BE CAUSED BY GROUND EFFECT? Floating during landing is, in part, a result of ground effect. An airplane will continue to remain airborne just above the surface at a speed which would have produced an immediate stall had the airplane been a bit higher. Therefore, a pilot may run out of both runway and options if he carries excess speed in the approach, or does not allow for at least a small margin of float after the flare from a normal approach.

Rev. 1/74

Another and perhaps more serious problem, can develop during takeoff and climb out, especially when using a runway of marginal length. Deluded into believing that he has climb-out capability simply because he was able to get in the air, a pilot may raise the gear the instant he is airborne or initiate an immediate climb. For a few feet, all may go well but he may really have only marginal climb performance even in ground effect, and therefore, an acute need for added thrust as he begins to move out of ground effect. Moving out of ground effect, even if it only slightly increases the effectiveness of the elevators, the nose will usually tend to pitch up. At the resultant high angle of attack, the pilot finds he cannot climb, or even worse, may begin to sink. Desperately holding his nose-high attitude in a futile effort to gain altitude, he steadily mushes or stalls back to the runway or into obstructions if no excess power is available to correct the situation. Add high gross weight and density altitude and a bit of turbulence to this scene and an accident is even more likely.

Airspeed indicator unreliability in ground effect is another though less critical problem. Usually it will indicate slightly higher as you leave and slightly lower as you enter ground effect.

Just remember, ground effect is always there; it may prolong the glide or permit an aircraft to get airborne with insufficient power to sustain flight outside the area of ground effect. If this occurs the pilot must allow the airplane to accelerate while still in ground effect, before attempting to continue the climb. Panic attempts to force a climb can only make lift/climb problems worse.

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U.S. DEPARTMENT OF TRANSPORTATION
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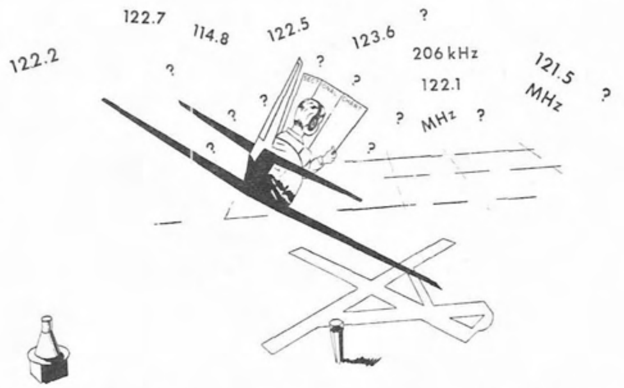
VFR PILOT EXAM-O-GRAM* NO. 50

INTERPRETING SECTIONAL CHARTS (SERIES 2)



This Exam-O-Gram discusses radio communications and how radio data appearing on back-to-back Sectional Aeronautical Charts can be used to assist the pilot in the expeditious and safe operation of his aircraft on the ground and in the air.

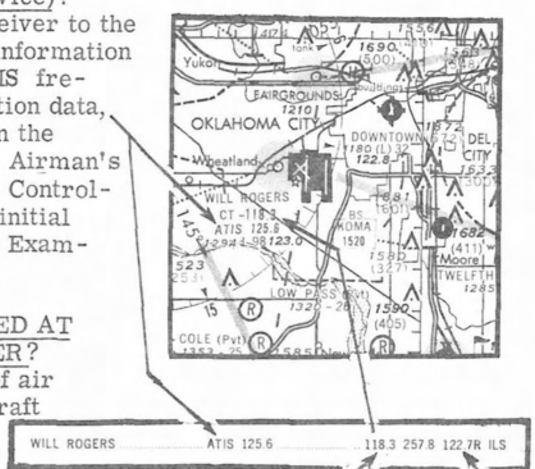
Lack of knowledge often causes pilots to avoid the use of appropriate radio communications. This is especially true of those pilots who are not knowledgeable in the use of aeronautical charts and other publications that list this data.

Pilots are encouraged to use all of the radio communication services available, even where it is not mandatory, to enhance safe flight. Pilots who do not use the benefits of radio communication actually create a hazard to themselves as well as other aircraft.

Radio communications will vary at different airports depending upon the type of flight and facilities available. Examples of airports used in this Exam-O-Gram exemplify the important aspects of radio communication during VFR flight using a variety of facilities.

HOW IS RADIO COMMUNICATION FIRST USED IN PREPARING FOR A LANDING AT AIRPORTS SERVED BY ATIS (Automatic Terminal Information Service)?

When 15 to 20 miles from these airports, tune your receiver to the ATIS frequency. You will hear repeated broadcasts of information that will help you plan your approach for a landing. ATIS frequencies are printed on the chart in the airport information data, and listed in the bottom margin of the chart, as shown in the illustration. These frequencies can also be found in the Airman's Information Manual (AIM), Airport/Facility Directory. Controllers expect pilots to obtain ATIS and advise, during the initial call, that they have received this information. Refer to Exam-O-Gram No. 43 for more details about ATIS.



WHAT ADDITIONAL COMMUNICATIONS ARE REQUIRED AT AIRPORTS THAT ARE SERVED BY A CONTROL TOWER?

The Control Tower (CT) must provide an orderly flow of air traffic in the vicinity of the airport, by sequencing aircraft in terms of safety and efficient utilization of airspace. Therefore, you are required to contact the control tower at least 5 miles from the airport. The primary transmitting and receiving (SIMPLEX) frequency is printed on the chart as shown, for example 118.3 MHz at Will Rogers Airport. If you can receive, but cannot transmit on a primary tower frequency, there are other transmitting frequencies available. Most towers have one of three additional frequencies (122.4, 122.5, or 122.7 MHz) available to receive pilots with limited transmitting capability. These frequencies are listed on the bottom margin of the chart as shown in the illustration, and followed by a letter R. (R means tower receive only.) They can also be found in the Airman's Information Manual.

* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

IS IT MANDATORY THAT YOU COMMUNICATE WITH APPROACH CONTROL PRIOR TO LANDING? No. Under a VFR flight it is not mandatory, but Radar Advisory Services are available to pilots on VFR flights at many of the busy airports. Although not mandatory, the service should be used because controllers can advise you of possible conflicting traffic and also give heading information that will direct you to the airport. If used, Approach Control should be contacted 15 or 20 miles out after receiving ATIS. If advisory services are available the appropriate radio communication frequencies can be found in the Airman's Information Manual, Part 3, Airport/Facility Directory under Radar Services.

WHAT FREQUENCY WOULD YOU EXPECT TO USE AFTER LANDING AND CLEARING THE RUNWAY? Normally the Control Tower will direct you to contact or monitor Ground Control on one of the frequencies assigned to Airport Ground Control. In the event the tower does not direct you to change frequencies, remain on the tower frequency. Ground Control frequencies are normally 121.6, 121.7, 121.8, and 121.9 MHz, one of which is assigned to each airport having this service. Ground Control provides information for surface traffic except on the active runway, and the appropriate frequencies can be found in the Airman's Information Manual, Airport/Facility Directory.

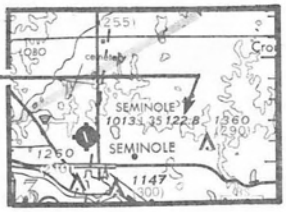
IN WHAT SEQUENCE WOULD YOU CONTACT THE FACILITIES IF YOU DEPART AN AIRPORT SERVED BY ATIS, GROUND CONTROL, AND A CONTROL TOWER? You would use the following order:

1. ATIS.
2. Ground Control.
3. Control Tower.

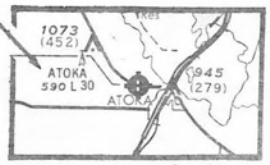
WHY ARE SOME AIRPORT SYMBOLS AND AIRPORT INFORMATION PRINTED ON THE CHART IN A BLUE COLOR WHILE OTHERS ARE COLORED MAGENTA (PURPLISH RED)?

Airports within the United States having Airport Traffic Areas (Control Towers) are shown in blue, all others in magenta. If a Control Tower is located at the airport, this fact can be noted in the airport information data by a CT with a frequency listed. The frequency 123.6 MHz has been designated for use at airports with Airport Advisory Service. Pilot requests for AAS on other station frequencies will be answered, but the FSS will then simultaneously transmit on the requested frequency and also 123.6 MHz. This will keep other traffic aware of the requester's position.

WHAT FREQUENCY IS USED WHEN OPERATING AN AIRCRAFT AT AIRPORTS SERVED ONLY BY AN AERONAUTICAL ADVISORY STATION (UNICOM)? The airport information, as shown in the illustration, indicates that only UNICOM is available for communication at this airport on the frequency of 122.8 MHz. The frequency assigned to Aeronautical Advisory Stations depends upon the type of facilities available at an airport. See the Airman's Information Manual, Part 1, and Exam-O-Gram No. 35 for full details on the use of UNICOM. Pilots are encouraged to use this service when operating at airports served only by UNICOM.



WHAT FREQUENCY WOULD YOU USE WHEN OPERATING AT AN AIRPORT THAT HAS NO FACILITIES FOR RADIO COMMUNICATIONS? As shown in the illustration, there is no facility for radio communication at this airport. At airports that have no communications facilities, you should transmit on 122.9 MHz, which is the frequency assigned to Aeronautical Multicom Service. DO NOT EXPECT A REPLY. About 15 miles from the airport, tune to 122.9 MHz and listen for other traffic transmission, at 5 miles transmit your position, altitude, and intentions. Follow-up an announcement of your position on downwind, base, and final approach. When departing this airport, tune to 122.9 MHz and listen before you taxi. Then broadcast your position on the airport and intention. Follow this up with an announcement before you taxi onto the runway for takeoff.



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U.S. DEPARTMENT OF TRANSPORTATION
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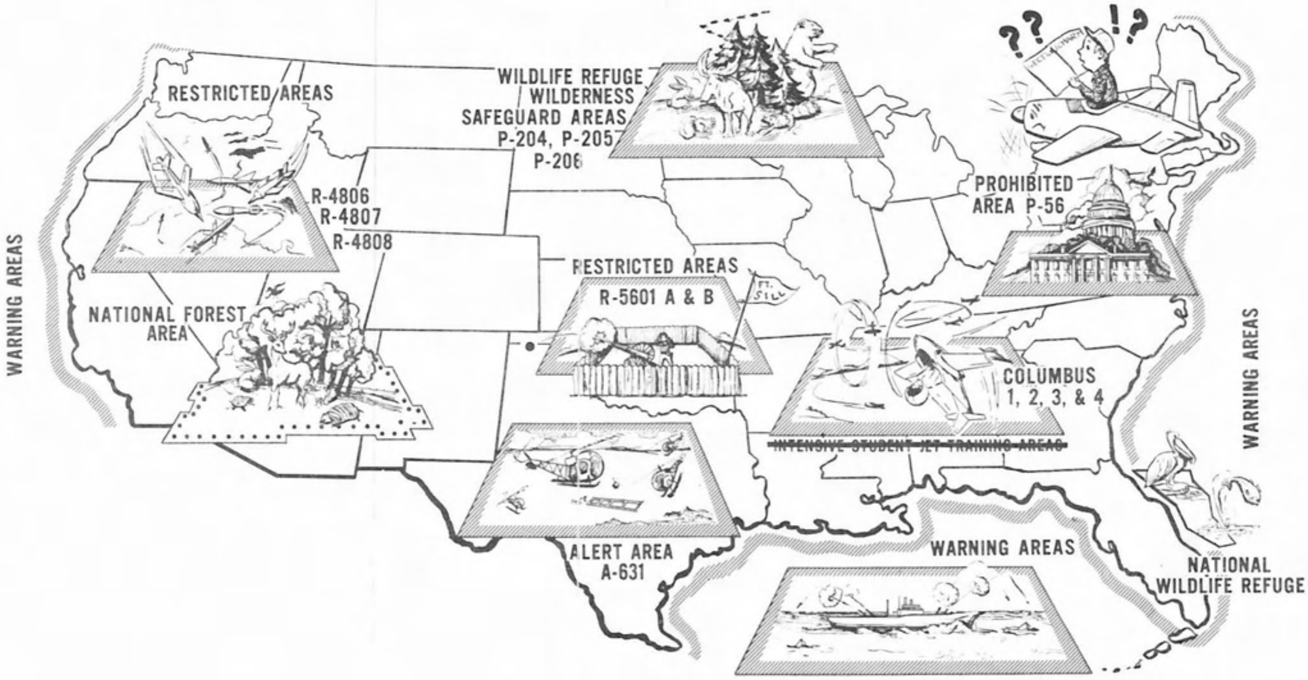
VFR PILOT EXAM-O-GRAM* NO. 51

INTERPRETING SECTIONAL CHARTS (SERIES 3)

SPECIAL USE AIRSPACE



This is the third in a series of Exam-O-Grams dealing with understanding and interpreting aeronautical symbols and legends of the new-type Sectional Charts. See VFR Exam-O-Grams Nos. 23 and 50.

FAR, Part 73.3, states in part: "Special Use Airspace consists of airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature, or wherein limitations are imposed upon aircraft operations that are not a part of those activities, or both." Special Use Airspace depicted on aeronautical charts are: Prohibited Areas, Restricted Areas, Warning Areas, Alert Areas, ~~and Intensive Student Jet Training Areas (ISJTA)~~. These areas are depicted on the charts in many shapes and sizes and their boundaries are outlined by crosshatching like this ———————→ ////// .

PROHIBITED, RESTRICTED, WARNING, AND ALERT AREAS
ON MIAMI SECTIONAL CHART

NO.	NAME	ALTITUDE	TIME	APPROPRIATE AUTHORITY
P-29	Key Biscayne, Florida	To FL 180	Continuous	Administrator, FAA, Washington, D.C.
R-2901A	Avon Park North, Fla.	To 6000	Sunrise to sunset	† FAA, Miami ARTC Center or area FSS. Comdr., MacDill AFB, Fla.
W-497	Patrick AFB, Fla	Unlimit…	…inuous	Comdr., AF Eastern Test Range, Patrick AFB, Fla.
A-291B	Miami, Fla.	[illegible]	Sunrise to sunset daily.	All Local Flying Schools & Flying Clubs Greater Miami Area.

EXCERPT

P - Prohibited R - Restricted W - Warning A - Alert † - Controlling Agency

Unless otherwise noted: Altitudes are MSL and in feet; time is local.

No person shall operate an aircraft within a Prohibited Area, or within a Restricted Area between the designated altitudes during the time of designation unless prior permission has been issued by the appropriate authority as listed above. The appropriate authority is defined as either the controlling agency (†) or the using agency.

Flight within Alert Areas is not restricted, but pilots are advised to exercise extreme caution.

In addition, supplemental information about Prohibited, Restricted, Warning, and Alert Areas is printed on the border of the charts like this.

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<u>WHAT IS A PROHIBITED AREA</u>? It is designated airspace within which the flight of aircraft is not allowed for security or other reasons associated with national welfare. An example of a Prohibited Area is the area that encompasses the White House and the Capitol buildings in Washington, D. C. It is designated P-56 and extends from the surface to flight level 180. AVOID THIS AREA! Three Prohibited Areas (designated P-204, P-205, and P-206) are located southeast of International Falls, Minnesota. These Prohibited Areas were established to safeguard the forest and wildlife in one of the few remaining wilderness areas in the United States. They extend from the surface to 4,000 feet. AVOID THESE AREAS!

PROHIBITED, RESTRICTED, WARNING, AND ALERT AREAS ON WASHINGTON SECTIONAL CHART

NO.	NAME	ALTITUDE	TIME	APPROPRIATE AUTHORITY
P-40	Thurmont, Md.	To & including 5000	Continuous	Admin., FAA Washington, D. C.
P-56	Washington, D. C.	To FL 180	Continuous	WARNING-AVOID THIS AREA Admin., FAA Washington, D.C.
P-73	Mount Vernon, Va.	1500	Continuous	Admin., FAA Washington, D. C.

No person shall operate an aircraft within a Prohibited Area, or within a Restricted Area between the designated altitudes during the time of designation unless prior permission has been issued by the appropriate authority as listed above. The appropriate authority is defined as either the controlling agency (†) or the using agency.

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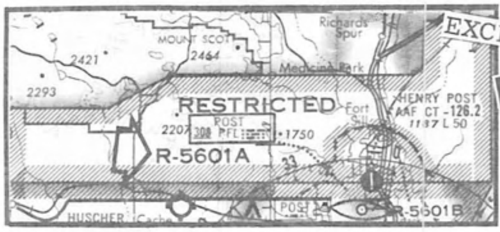
<u>WHAT IS A RESTRICTED AREA</u>? It is designated airspace within which flight, while NOT wholly prohibited, is subject to restrictions. A Restricted Area is designated when it is determined necessary to confine or segregate activities considered to be <u>hazardous</u> to nonparticipating aircraft. They denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Penetration of Restricted Areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. Permission must be received from the appropriate authority to operate an aircraft within a Restricted Area between the designated altitudes during the time specified.



PROHIBITED, RESTRICTED, WARNING, AND ALERT AREAS ON DALLAS-FT WORTH SECTIONAL CHART

NO.	NAME	ALTITUDE	TIME	APPROPRIATE AUTHORITY
R-5601A	Fort Sill, Okla.	To FL 230	Continuous	C. G. Fort Sill, Okla.
R-5601B	Fort Sill, Okla.	To FL 230	Continuous	† FAA, Fort Worth ARTC Center or area FSS. C. G. Fort Sill, Oklahoma

P - Prohibited R - Restricted W - Warning A - Alert † - Controlling Agency
Unless otherwise noted: Altitudes are MSL and in feet; time is local.

/ / / / / /

<u>WHAT IS A WARNING AREA</u>? It is airspace, within international airspace, established to contain hazardous operations conducted by U. S. military forces. The activities conducted within Warning Areas may be as hazardous to nonparticipating aircraft and its occupants as those contained within Restricted Areas. However, NO restriction to flight is imposed because flight within international airspace cannot legally be restricted. To alert nonparticipants to the existence of possible hazardous conditions, Warning Areas are depicted on aeronautical charts. Most Warning Areas lie within 3 statute miles of a coast line. When flying along an uneven coast line, shortcuts over water could result in unintentional flight into a Warning Area. <u>BE ALERT</u> and refer to the appropriate chart when flying along any coastline.

PROHIBITED, RESTRICTED, WARNING, AND ALERT AREAS ON NEW ORLEANS SECTIONAL CHART

NO.	NAME	ALTITUDE	TIME	APPROPRIATE AUTHORITY
W-92	New Orleans, La.	To FL 400	0800-2400	C.O., NAS, New Orleans, La.
W-151	Valparaiso, Fla.	Unlimited	Continuous	Comdr., Armament Development & Test Center, Eglin AFB, Florida.

NOTE: Due to the large size of Warning Areas, only part of W-92 is shown here.

* * * * * *

It is always the responsibility of the <u>PILOT</u> of any aircraft to do his best to avoid a collision when operating in VFR conditions, regardless of the type of operation being conducted, the area being used, or the type flight plan filed. Three Exam-O-Grams were written to help educate pilots in the ART OF COLLISION AVOIDANCE. It is certainly appropriate to mention them when writing about the rules governing Special Use Airspace. Review VFR Exam-O-Grams Nos. 22, 29, and 48.

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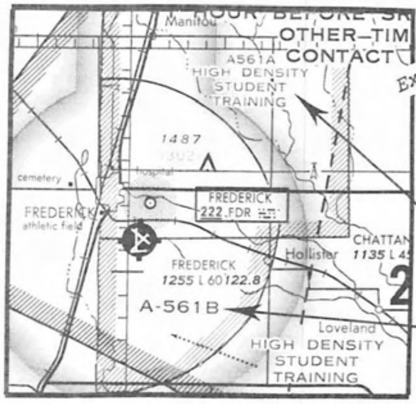
WHAT IS AN ALERT AREA? It is designated airspace which may contain a high volume of pilot training activities or an unusual type of aeronautical activity--neither of which is hazardous to aircraft. Alert Areas are depicted on aeronautical charts to alert pilots of nonparticipating aircraft of the activity within a specific area. All activity within an Alert Area shall be conducted in accordance with Federal Aviation Regulations, without waiver, and pilots of participating aircraft as well as pilots of aircraft transiting the area, shall be equally responsible for collision avoidance. The establishment of Alert Areas does not impose any flight restrictions or communication requirements on any pilots, although Flight Service Stations in the vicinity may broadcast information regarding the use being made of the area as circumstances dictate.



Excerpts

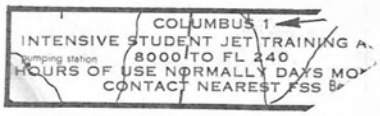
PROHIBITED, RESTRICTED, WARNING, AND ALERT AREAS
ON DALLAS-FT WORTH SECTIONAL CHART

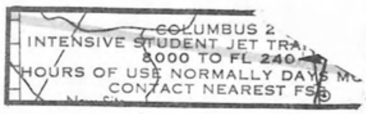
NO.	NAME	ALTITUDE	TIME	APPROPRIATE AUTHORITY
R-5601A	Fort Sill, Okla.	To 23,000	Continuous	C. G., Fort Sill, Okla.
R-5601B	Fort Sill, Okla.	To 23,000	Continuous	† FAA, Fort Worth ARTC Center or area FSS. C. G., Fort Sill, Oklahoma
R-5601D	Fort Sill, Okla.	To 16,500	Sunrise to sunset	† FAA, Fort Worth ARTC Center or area FSS. C. G., Fort Sill, Oklahoma
R-5601E	Fort Sill, Okla.	To 6000	Sunrise to sunset	† FAA, Fort Worth ARTC Center or area FSS. C.G., Fort Sill, Okla.
A-561A	Frederick, Okla.	3000 to & incl 4200	0700-2300 Mon-Fri	Comdr. Sheppard AFB, Texas
A-561B	Frederick, Okla.	To & incl 3200	0700-2300 Mon-Fri	Comdr. Sheppard AFB, Texas

Flight within Alert Areas is not restricted, but pilots are advised to exercise extreme caution.

●●●

WHAT IS AN INTENSIVE STUDENT JET TRAINING AREA (ISJTA)? It is desi- ... ce which contains intensive flight training activities of military student ... ns are imposed on IFR flights ONLY. All VFR flight- ... with Federal Aviation Regulat- ... pilots of aircraft transiting ... tion on these training areas m ... :ma- below show how the sectional ... rpts of Columbus AFB, Mississ- ... inity





Note the Special Notice concerning Intensive Student Jet Training Areas from the July 1976 issue of Airman's Information Manual.

MILITARY OPERATIONS AREAS (MOA)

ATC Assigned Airspace (ATCAA) has been estab-
lished for certain training activities when requested by
the military. These airspace areas will be established
as Military Operations Areas (MOA) and depicted on
sectional and low altitude enroute IFR charts. They
will be identified by the use of a nickname e.g. "Tarheel,
Moody 1" rather than by terms such as special opera-
tions areas or intercept training areas. The annotation
will include the altitudes to be used and may include
the specific types of activity to be conducted and times
of use. A review will be made of existing alert areas,
ISJTA's and they will be converted to MOA's.
Whenever an MOA is being used, nonparticipating IFR
traffic may be cleared through an MOA if IFR separa-
tion can be provided by ATC. Otherwise, ATC will re-
route or restrict nonparticipating IFR traffic.
Notices to Airman will be disseminated to alert VFR
traffic to the activity. In addition inflight/preflight
advisories will be issued. VFR pilots are urged to
exercise extreme caution if it is necessary to fly within
a military operations area when training activity is
being conducted. If there is any doubt as to the location
of military activity, inquire of the nearest Flight Service
Station.

Note: Due to the large s- ... blocks are shown abov- ... ation

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WHO CAN AUTHORIZE THE OPERATION OF AN AIRCRAFT IN SPECIAL USE AIRSPACE? An Appropriate Authority, defined as either the Using Agency or the Controlling Agency, may authorize transit through, or flight within, Special Use Airspace.

The Using Agency is the agency, organization, or military command whose activity within a Restricted Area necessitated the area being so designated, or that established the requirement for the Prohibited Area.

The Controlling Agency is the FAA facility that may authorize the transit through, or flight within, a Restricted Area in accordance with a joint-use letter issued under FAR Part 73.15.

Contact the Using Agency for Warning Area and Alert Area information.

~~Contact the nearest FSS for Intensive Student Jet Training Area information.~~

●●●●

ALTHOUGH NOT CLASSIFIED AS A SPECIAL USE AIRSPACE, THERE ARE OTHER AREAS THAT HAVE LIMITATIONS TO FLIGHT AS REGULATED BY THE SERVICE THAT ADMINISTERS THEM.

The excerpt to the right shows how National Wildlife Refuges are depicted on a sectional chart.

☆ ☆ ☆

In the margin of the sectional charts, information is listed concerning flight over National Park Service Areas, U.S. Fish and Wildlife Service Areas, and U.S. Forest Services Areas as shown below:

EXCERPT

REGULATIONS REGARDING FLIGHTS OVER CHARTED NATIONAL PARK SERVICE AREAS, U.S. FISH AND WILDLIFE SERVICE AREAS, AND U.S. FOREST SERVICE AREAS

The landing of aircraft is prohibited on lands or waters administered by the National Park Service, U.S. Fish and Wildlife Service or U.S. Forest Service without authorization from the respective agency. Exceptions include: 1) when forced to land due to an emergency beyond the control of the operator, 2) at officially designated landing sites, or 3) on approved official business of the Federal Government.

All aircraft are requested to maintain a minimum altitude of 2,000 feet above the terrain of the following: National Parks, Monuments, Seashores, Lakeshores, Recreation Areas and Scenic Riverways administered by the National Park Service; National Wildlife Refuges, Big Game Refuges, Game Ranges and Wildlife Ranges administered by the U.S. Fish and Wildlife Service; and Wilderness and Primitive areas administered by the U.S. Forest Service.

Federal regulations also prohibit airdrops by parachute or other means of persons, cargo or objects from aircraft on lands administered by the three agencies without authorization from the respective agency. Exceptions include: 1) emergencies involving the safety of human life or 2) threat of serious property loss.

. . . . _ _ _ Boundary of National Park Service areas, U.S. Fish and Wildlife Service areas and U.S. Forest Service Wilderness and Primitive areas.

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This Exam-O-Gram emphasizes the study and use of information printed on sectional charts. Study the borders and legend of your chart. Know what to look for, what to expect, and what is available to you along your route of flight.

Federal Aviation Administration
Flight Standards National Field Office, Examinations Branch
P.O. Box 25082
Oklahoma City, Oklahoma 73125

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DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM NO. 52

SKY COVER AND CEILING

A frequently misunderstood portion of the Aviation Weather Report is that part which contains SKY COVER and CEILING information. Do you thoroughly understand the following? TXK 3Ø SCT E5Ø BKN 1ØØ OVC...

The "E5Ø BKN" in the report indicates that the weather observer at TXK estimated the ceiling (broken clouds) to be 5,000 feet above the surface. Although an estimated ceiling is the least reliable of all ceiling reports, it is based on specific guides and is reasonably accurate and operationally useful. If you understand the methods used in making weather observations, you are likely to make better use of available weather reports.

HOW IS SKY COVER DETERMINED? The observer estimates the amount of the total sky that is covered by clouds or obscuring phenomena, and reports this amount of cover in tenths. Two examples of a sky condition which the weather observer would consider as scattered (one-tenth to five-tenths coverage) are shown in figures 1 and 2.

Fig.1

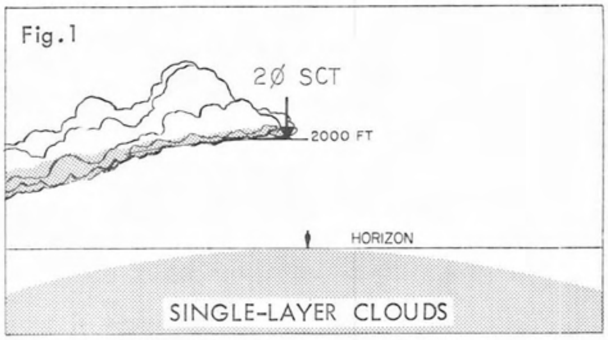
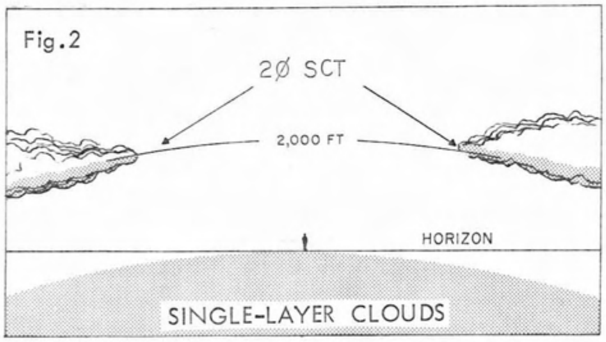


Fig.2



Scattered clouds tend to be of little concern to many pilots. However, the reported scattered clouds could change to either "overcast" or "clear" after the observation was made. Increasing cloud cover, headwinds, dwindling fuel supply, and deteriorating weather could cause problems for the non-instrument rated pilot planning (on the basis of the report) to descend between scattered clouds. Remember, the Aviation Weather Report contains local weather only, at observation time, and is not to be considered a forecast. Your observation in flight is far more timely than a report that must be processed through the communication system. Therefore, when clouds are increasing, you must determine when the time has come to make your descent to avoid getting stranded on top.

The summation principle is applied when two or more cloud layers are present (see figures 3 and 4).

Fig.3

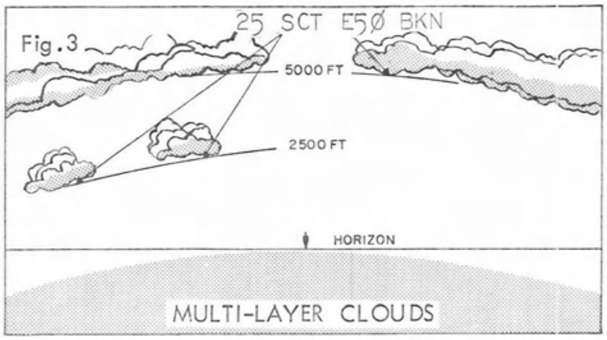
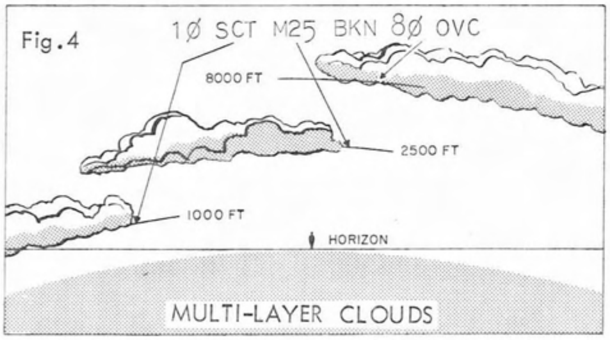


Fig.4



Cloud coverage of six- to nine-tenths of the sky is classified as broken---more than nine-tenths as overcast. However, a report of broken or overcast clouds at a specified height does not necessarily mean that the cloud layer at that altitude actually covers six- to nine-tenths or more than nine-tenths of the sky. The weather observer often does not know the actual extent of the higher cloud layers because his view is restricted by lower cloud layers. Therefore, he uses the summation principle in reporting the amount of sky covered by clouds. In this method, the observer adds the amount of sky covered by the lower clouds to the amount covered by clouds at higher levels. Thus, he reports the amount of sky covered by the combination of lower and higher clouds. A word of caution here--if the weather observer cannot see half or more of the sky above the base of a given cloud layer, most likely you cannot see half or more of the surface when flying above the base of that layer!

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HOW IS CLOUD HEIGHT DETERMINED? By using specific guides, the trained observer usually arrives at reasonably accurate estimates (E). The ceiling designator (E) ESTIMATED CEILING--means heights are determined from pilot reports, balloons, or other measurements not meeting criteria for measured ceiling. The ceiling designator (M) MEASURED CEILING--heights determined by ceilometer, ceiling light, cloud detection radar, or by unobscured portion of a landmark protruding into ceiling layer You should trust a report of "measured" ceiling more than one which is "estimated," although either in conjunction with visibility, determines whether VFR conditions exist.

The ceiling designator (W) is spoken as Indefinite Ceiling--vertical visibility into a surface based obstruction. Regardless of method of determination, vertical visibility is classified as an indefinite ceiling.

This Exam-O-Gram should be studied in conjunction with VFR Exam-O-Grams 20, 44, and 46. Together, they should help you understand that surface observations are spot reports; they may not provide the total enroute weather picture at flight time. You must also rely on forecasts and trends, radar weather reports, pilot reports, and your own timely observations in flight.

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FAA Aeronautical Center
Flight Standards Technical Division
Operations Branch
P. O. Box 25082
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3/72

VFR – No. 52
6/76

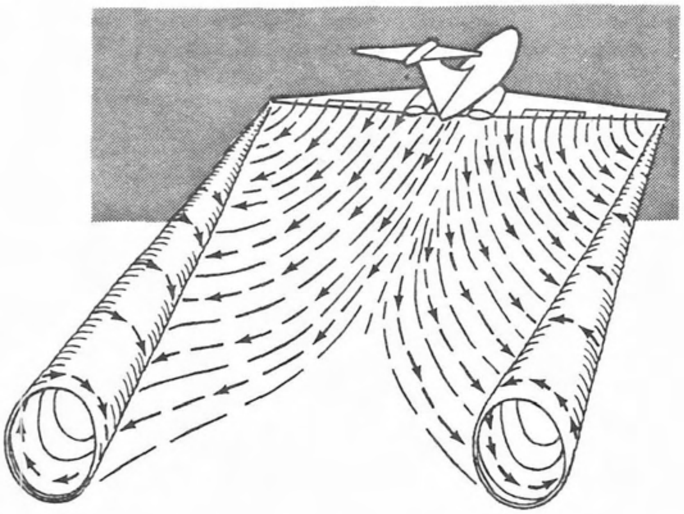
U.S. Department of Transportation
Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 53

DANGERS OF WINGTIP VORTICES

Investigations of several fatal and near-fatal accidents show the probable cause to be loss of control when encountering wingtip vortices created by large aircraft. Reports indicate that many pilots are unaware of the dangers associated with wake or vortex turbulence; therefore, applicants for pilot certificates are being tested on their knowledge of this subject.

WHAT ARE WINGTIP VORTICES? Wingtip vortices are compact, fast-spinning, violently turbulent air masses that trail behind an airplane, sometimes for miles. Unfortunately they are invisible, but if you could see them they would look like two tornadoes stretching back horizontally from each wingtip. Many pilots refer to this phenomenon as "prop wash" or "jet wash," but engineering studies have revealed that the main source of this disturbance is from the wingtips, not the props or engines. These vortex systems are generated by the flow of air from the high pressure region under the wing, and curl around the wingtip to the region of lower pressure on the upper surface forming the two rotating vortices.



WHY ARE THEY DANGEROUS? They are dangerous because loss of control of aircraft can occur when flying into the wingtip vortices of large aircraft. The velocity of the air circulating about the core of these vortex systems can be extremely high, particularly those generated by the larger airplanes, and these velocities can exceed the control power of most airplanes. A smaller airplane flying into one of these rotating air masses can experience dangerous upsets and excessive load factors causing structural damage to the airplane. Particular care should be taken to avoid the vortices during landing and taking off.

WHEN ARE THEY STRONGEST? There are many factors affecting the intensity of wingtip vortices, but it is a safe and practical generalization that the bigger the airplane the more violent and long-lived will be the vortex disturbance. Recent studies indicated that the strongest vortex systems trailing behind the very large airplanes will descend 400-500 feet per minute to approximately 1,000 feet below the airplane. The vortices retain their lateral separation and drift with the wind. The aircraft creating the vortices may be out of sight, and the turbulence generated might be still lingering in the area. The heavier and cleaner the airplane and the slower it is flying, the stronger the air circulation in the vortex cores.

WHAT ACTION CAN THE PILOT TAKE TO AVOID OR REDUCE THIS HAZARD?

a. Avoid passing behind any large aircraft. Alter course to avoid the area behind and below the generating aircraft.

b. Avoid, when possible, places and altitudes frequented by large aircraft. If possible, monitor approach control and control tower frequencies at airports where large aircraft operate. These radio transmissions may give you a clue to the locations and paths of large aircraft.

c. When it is necessary to operate behind a large aircraft, remain <u>above</u> the flight path of that aircraft. Vortices settle downward toward the surface and are also affected by the wind and move with the air mass.

d. When taking off or landing behind large aircraft, be on the alert for turbulence and allow adequate spacing. Visualize the location of the vortex trail and avoid those areas.

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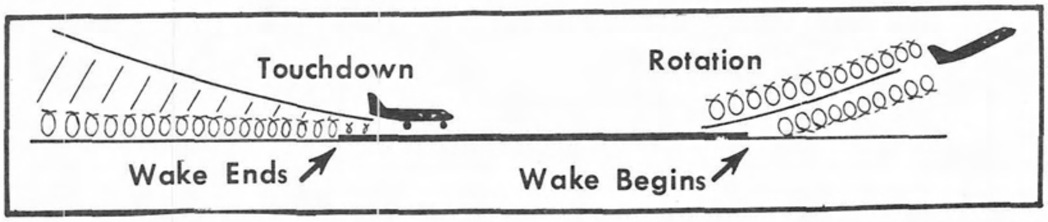
e. The best way of avoiding wingtip vortices is to know where they are most likely to be encountered and act accordingly. Since vortices are not produced until lift is produced, they will not be generated by an aircraft taking off until the aircraft rotates for lift-off. Vortices cease to be generated by a landing aircraft when its wings cease to produce lift -- when it has actually landed. Plan your takeoff and landing accordingly.



RECOMMENDED READING FOR ALL PILOTS. Your attention is invited to the Wake Turbulence Section of the Airman's Information Manual, which thoroughly explains this subject. It is also described in FAA Advisory Circular AC 90-23D (which may be obtained free of charge from: Publications Section, TAD 404.1, Department of Transportation, Washington, D.C. 20590).

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Flight Standards National Field Office, Examinations Branch
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VFR – No. 53
1/77

U.S. DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 54

EMERGENCY LOCATOR TRANSMITTERS (ELTs)

This Exam-O-Gram is issued to help fill the need of those studying for FAA airman written tests and of certificated pilots for additional information concerning the Emergency Locator Transmitter (ELT).

What is an Emergency Locator Transmitter or ELT?

It is a small, self-contained radio transmitter which is activated automatically by the impact force of a crash. It may also be activated manually by an "On-Off" switch. It transmits a distinctive variable tone on the emergency frequencies 121.5 and 243.0 megahertz. The range of an activated ELT varies from 75 to 150 miles, depending on environment. Its useful life varies from 3 to 8 days, depending on battery condition.

Is there a law requiring an ELT in all airplanes?

Yes. Public Law 91-596 was passed by Congress in 1970. As a consequence, FAR 91.52 now requires that an approved ELT must be installed in most U.S. registered airplanes by July 1, 1974. (Date extended from 12/30/73.) There are certain exceptions to this law; they are: (1) Turbojet airplanes, (2) Agricultural airplanes while dispensing chemicals, (3) Scheduled airline operations not over water or uninhabited areas, (4) Training airplanes operated within 50 miles of point of origin of flight, and (5) Aircraft equipped to carry not more than one person.

What is the purpose of an ELT?

It is designed to transmit an immediate electronic distress signal which can be used by other pilots and search and rescue organizations to locate a downed airplane. The pilot should always determine the ELT's location in the airplane; how to activate it manually; and, if it is portable, how to remove it from the airplane.

How can it be determined if an ELT is approved?

In order to carry out the provision of the law, a Technical Standard Order (TSO C91) has been issued by the FAA which covers the design and operational characteristics of approved locators. A label on the ELT indicates whether the unit meets these standards.

How often must battery be changed?

Battery replacement is required at 50 percent of the normal shelf life as defined by the manufacturer, or after one cumulative hour of use. Under the preventative maintenance provision of FAR 43, this battery replacement may be made by a certificated pilot. For expected reliability and life expectancy only those batteries recommended by the manufacturer should be used. Purchased batteries should be stamped with the date of the 50 percent battery life. The new expiration date for the replacement (or recharged) battery must be legibly marked on the outside of the transmitter. Failure to replace batteries at the specified dates may not only limit the operating time but may cause some damaging corrosion within the unit.

How can premature battery deterioration be minimized?

Premature battery deterioration can be minimized by preventing exposure to high temperature such as might be experienced in an aircraft parked on a ramp, or to extremely low temperatures. Anything that a pilot can do in time of emergency to obtain a battery temperature of approximately 70° will result in improved performance and longer operation of the ELT.

How can the pilot check ELT operation?

Operational testing can be done by tuning the VHF receiver to 121.5 MHz and actuating the unit. Tests should be limited to three audio sweeps and conducted during the first five minutes after any hour. If the testing must be done at any other time, it should be coordinated with the closest FAA Control Tower or Flight Service Station. (See Advisory Circular 20-81 for additional information.)

* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

How can the pilot tell if the locator is on?

The signal, because of the close proximity of the locator, will probably saturate the communications receiver regardless of the frequency it is on. However, accidental triggering of the ELT should be checked during the pre-takeoff check and before engine shut down by turning the VHF receiver to 121.5 or 243.0 MHz and listening for the ELT signal.

What should be done if an ELT is activated accidentally or by an unauthorized person?

If audio sweeps are heard and it is determined that they are coming from the airplane, turn off the ELT immediately. The pilot in command of an ELT-equipped plane is responsible for accidental inflight signalling by an ELT. If the plane is parked, the owner is liable. The Communications Act of 1934 prescribes fines and imprisonment for "the willful transmission of unauthorized signals on emergency frequencies." If you experience malfunctioning of the ELT, report the incident to the FAA through the "Malfunction Defects" program to provide a factual basis for corrective action. Contact any FAA District Office for the proper forms to report the malfunction.

What should you do if you hear an ELT signal?

The FAA suggests that you notify the nearest FAA ground facility stating your position when the ELT signal was first heard and when it was last heard. You need do nothing more unless requested by the ground facility. However, if you have actually discovered the site of a crash, and circumstances permit, you have the option of advising that you will circle the crash site to guide rescue teams.

FAA Aeronautical Center
Flight Standards Technical Division, Operations Branch
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Oklahoma City, Oklahoma 73125 5/74

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

VFR PILOT EXAM-O-GRAM* NO. 57

FLIGHT IN THE REGION OF REVERSED COMMAND IN RELATION TO TAKEOFFS AND LANDINGS

REGION OF REVERSED COMMAND
- or -
BACK SIDE OF THE POWER CURVE

The aeronautical knowledge requirements, set forth in Federal Aviation Regulations for pilot certification, place emphasis on basic aerodynamics and principles of flight. Consequently, FAA written tests contain test items relating to these subject areas.

This Exam-O-Gram deals with a rather complex and often misunderstood subject as it relates principally to propeller driven airplanes. Modern aerodynamics manuals refer to this as the "Region of Reversed Command," and devote one or more chapters to explaining its meaning. It is the intent of this Exam-O-Gram, to explain in layman's language and through the use of simple illustrations, flight in the regions of normal and reversed command, without the use of mathematical formulas, symbols, or equations. These few pages, though perhaps an oversimplification of a complicated subject, should serve as a stimulus for further study.

The following brief definitions of terms used in the text are presented to refresh the reader's memory:

PARASITE DRAG -- the drag not directly associated with lift (form and skin friction) and which predominates in the region of high-speed flight. NOTE: An increase in the parasite area of an airplane may be brought about by the deflections of flaps or extension of the landing gear.

INDUCED DRAG -- the drag caused by lift.

TOTAL DRAG -- the sum of the parasite and induced drags.

EQUILIBRIUM -- a state of balance or equality between opposing forces. An airplane is in a state of equilibrium when the sum of all forces and the sum of all moments acting on it are equal to zero.

BRAKE HORSEPOWER -- the power output of the reciprocating engine is determined by attaching a brake or load device to the output shaft. Hence, the term brake horsepower (BHP) is used to denote engine power.

POWER REQUIRED -- the aerodynamic properties of the airplane generally determine the power requirements at various conditions of flight, while the powerplant capabilities generally determine the power available at various conditions of flight. When the airplane is in steady level flight the condition of equilibrium must prevail. An unaccelerated condition of flight is achieved when lift equals weight, and the powerplant is set for a thrust equal to the airplane drag.

POWER REQUIRED CURVE -- the power required to achieve equilibrium in constant-altitude flight at various airspeeds. The power required curve illustrates the fact that at low airspeeds near the stall or minimum control speed, the power setting required for steady level flight is quite high.

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WHAT DOES "FLIGHT IN THE REGION OF NORMAL COMMAND" MEAN? Flight in the region of normal command means that while holding a constant altitude, a higher airspeed requires a higher power setting and a lower airspeed requires a lower power setting. The majority of all airplane flying (climb, cruise, and maneuvers) is conducted in the region of normal command.

WHAT DOES "FLIGHT IN THE REGION OF REVERSED COMMAND" MEAN? Flight in the region of reversed command means that a higher airspeed requires a lower power setting and a lower airspeed requires a higher power setting to hold altitude. It does not imply that a decrease in power will result in higher airspeed, or that an increase in power will produce lower airspeed. The region of reversed command is encountered in the low speed phases of flight. Flight speeds below the speed for maximum endurance (lowest point on the power curve) require higher power settings with a decrease in airspeed. Since the need to increase the required power setting with decreased speed is contrary to the normal command of flight, the regime of flight speeds between the speed for minimum required power setting and the stall speed (or minimum control speed) is termed the region of reversed command. In the region of reversed command, a decrease in airspeed must be accompanied by an increased power setting in order to maintain steady flight. Simply stated — it takes a lot of power to fly at very slow airspeeds.

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Rev. 8/77

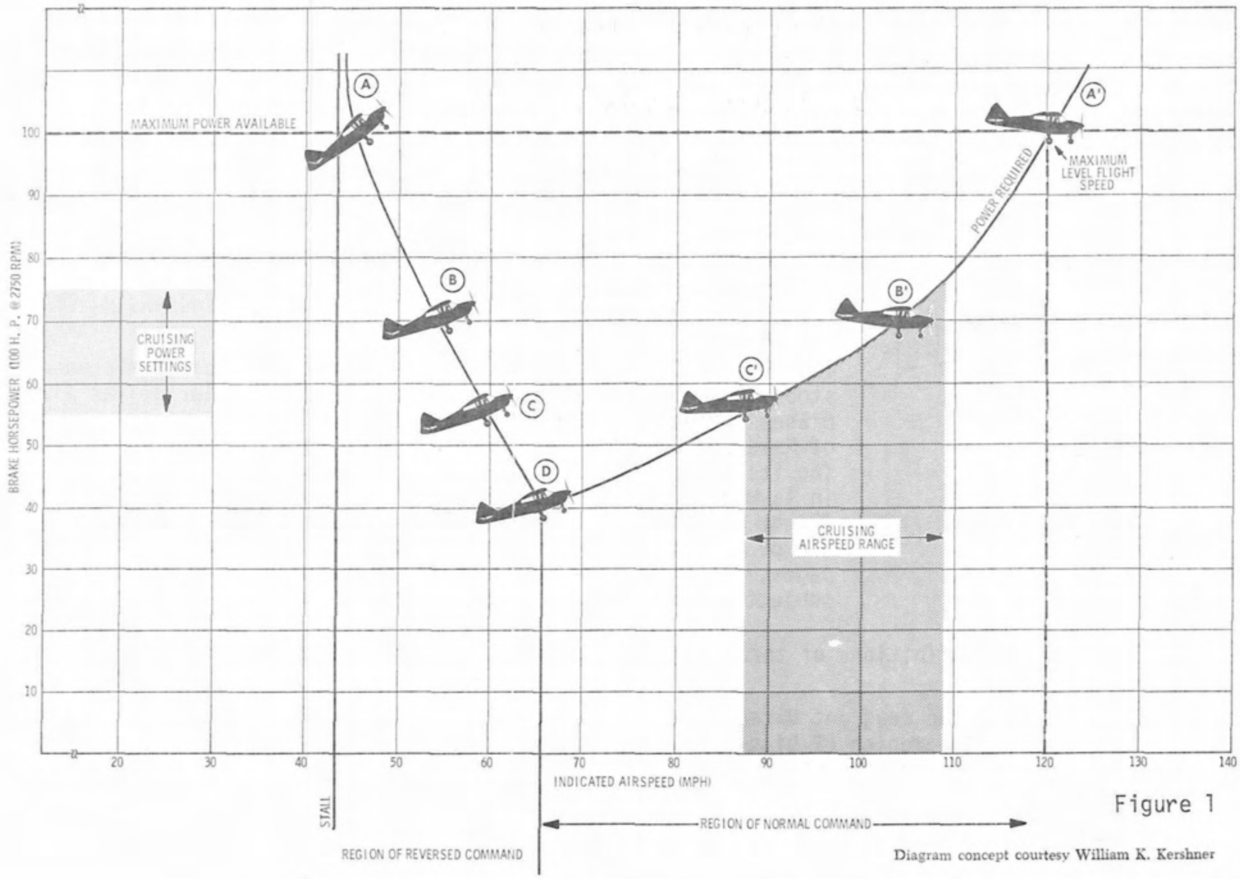

Figure 1

Diagram concept courtesy William K. Kershner

A LIGHT AIRPLANE IN A CLEAN CONFIGURATION AT SEA LEVEL

In order to chart the performance of a light airplane in the available space on the diagram above, it was necessary to somewhat distort the lower portion of the power required curve. This diagram illustrates that high power settings are required to fly fast or very slow. For example:

Airplane Position A — requires full power to hold altitude at 45 MPH. At position A' the airplane is flying with full power to attain maximum level flight speed. Any attempt to increase the airspeed at position A' will result in a loss of altitude.

Position B — requires 70 HP to maintain altitude at 55 MPH. Using the same power setting (70 HP) at position B' the airplane will maintain steady level flight while holding altitude and maintaining 104 MPH.

Position C — 55 HP is required to maintain altitude at approximately 58 MPH. With the same power setting the airplane will attain a speed of 87 MPH at position C'. At position C', if the angle of attack is increased the airplane will climb and fly slower -or- if the angle of attack is reduced the airplane will lose altitude and fly faster than 87 MPH. NOTE: Increasing or decreasing the angle of attack at positions A' and B' would produce similar results.

Position D — the aircraft is maintaining altitude at the lowest power (40 HP) and airspeed combination. Increasing the angle of attack at this point will not produce a climb — but a loss of altitude. Also, any reduction in the angle of attack will result in a loss of altitude.

WHAT DOES THE SPEED OF AIRPLANE D ON THE POWER REQUIRED CURVE REPRESENT? The Best Endurance Speed.— It is the lowest point on the curve. Since this is the lowest brake horsepower which will sustain level flight, it also will be the lowest fuel flow — hence, best endurance.

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Figure 2

The illustration to the left shows the "maximum power available" as a curved line. Lower power settings such as cruise power would also appear in a similar curve. The bottom of the power required curve is more realistic in this illustration than the one shown above.

WHY IS THE POWER AVAILABLE A CURVED LINE? If the engine produces full power at the rated RPM in level flight, at other airspeeds lower than maximum the engine does not turn up its rated RPM, but gradually loses RPM, even though full throttle is being used. This can be demonstrated in a fixed-pitch propeller equipped airplane by raising the nose above cruising level flight attitude and noting a decrease in RPM. (cont'd)

Power at high altitudes — the power produced by the unsupercharged aircraft engine also decreases with altitude, because weight of the charge of air and the oxygen content necessary for combustion decreases. Even if it is possible to prolong sea-level power to some greater altitude by supercharging, or some other method of power boosting, the power will inevitably decline when the boosting method reaches an altitude at which it can no longer maintain a set power.

The propeller suffers a gradual loss of efficiency for a given rated engine horsepower at both ends of the speed range, and therefore a gradual loss of thrust. For this reason, the Maximum Power Available Curve is just that, a curve — not a straight line.

NOTE: See Figure 2 on page 2. If the power available is greater than the power required, the difference is "excess horsepower" which can be used for climb. Where the power available and power required curves cross, there is no excess power, and therefore no ability to climb at that airspeed.

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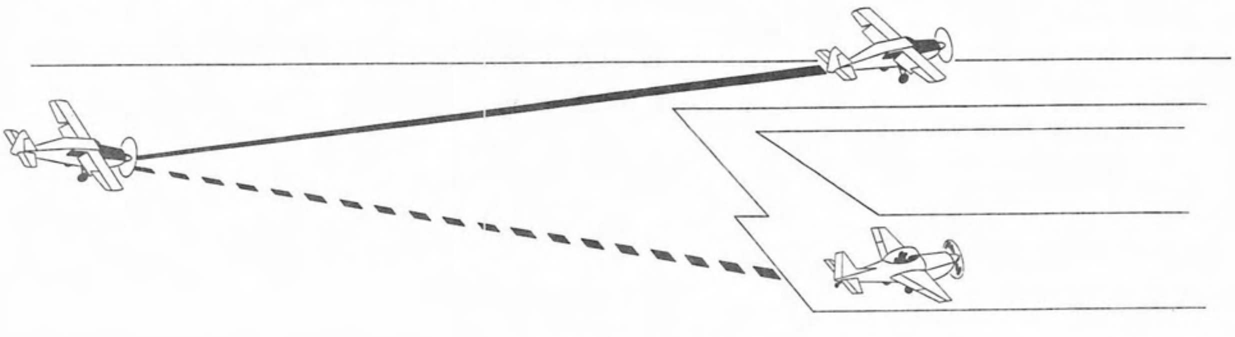
WHEN WOULD AN AIRPLANE BE OPERATING IN THE REGION OF REVERSED COMMAND? An airplane performing a low airspeed, high-pitch attitude power approach for a short field landing is an example of operating in this flight regime. Imagine what might happen if the pilot closed the throttle to idle position during this approach. Then by using a lot of power to correct this mistake it might be possible for the pilot to reduce or stop the resulting rapid rate of descent, but without further use of power the airplane would probably stall or be incapable of flaring for the landing. Merely lowering the nose of the airplane to regain flying speed in this situation, without the use of power, would result in a rapid sink rate and a great loss of altitude.

Airplane pilots must give particular attention to precise control of airspeed when operating in the low flight speeds of the region of reversed command. Now consider the use of wing flaps on airplane performance at low flight speeds with emphasis on climb performance. Some airplanes that have the capability of maintaining altitude in level flight with full flaps are incapable of climbing with full flaps extended. Drag is so great in this configuration that when the nose of the airplane is raised to establish a climb, there is a rapid decay in airspeed. Since the majority of pilot caused airplane accidents occur during takeoffs and landings, the remainder of this Exam-O-Gram is devoted to these phases of flight.

HOW DOES THE USE OF FULL FLAPS AFFECT STALL SPEED? An airplane in a clean configuration will stall at a higher airspeed than it will with the flaps fully extended. This means that if the flaps are rapidly or prematurely retracted, while the airplane is being flown with insufficient airspeed, lift may not be great enough to support the airplane in the clean configuration, and it will sink or stall. On a go-around with full power a safe airspeed must be maintained as the flaps are slowly retracted — in small increments.

SHOULD WING FLAPS BE USED FOR TAKEOFF? Certain Airplane Owner's Manuals do recommend the use of partial wing flaps (10°-20°) to reduce the ground run on short or soft field takeoffs. The use of full flaps on takeoff, however, is not recommended because of the great amount of drag they produce. A go-around with full flaps extended is a situation similar to the full flap takeoff.



A GO-AROUND WITH FULL FLAPS

Figure 3

In the illustration above, suppose the pilot of the airplane on the landing approach applies full throttle for a go-around because another airplane is on the runway, but due to a burned-out flap motor fuse, is unable to retract the fully extended flaps. Assume also that he is operating his airplane at near maximum certificated gross weight, or at an airport having a high elevation or high density altitude. Any one or a combination of these situations plus the tremendous drag of the flaps will require considerable pilot skill if the airplane is to gain enough altitude to circle the airport and land. Any misuse of the controls, such as overcontrolling or banking too steeply while operating in the "Region of Reversed Command," may cause the airplane to stall.

With a margin of only a few MPH between climbing, holding altitude, and descending, the airplane may cease its slow rate of climb and start descending or even stall, while the occupants are distracted in their attempt to identify or correct the cause of the malfunction. (cont'd)

Actual failure of the electric flap motor would require operating in this high drag configuration until the airplane lands.

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Most Airplane Owner's Manuals of present-day trainers state that full flaps are not recommended at any time for takeoff. In recent years an average of ten serious accidents have occurred each year as a result of pilots attempting to take off with full flaps extended.

Accident Report Summaries all recite much the same story as the excerpts which follow: "A solo student performing touch-and-go landings in an airplane attempted a takeoff with full flaps. He lost control of the airplane, closed the throttle, and the airplane flipped over on its back. He stated that his instructor had never demonstrated how the aircraft would react or respond when full flaps were used for takeoff. A low time student in a new and strange situation set the stage for this accident."

"A 200 hour private pilot with a passenger attempted to take off with full flaps. The airplane climbed to 150 feet, stalled and rotated one-half turn to the left and struck the ground nosedown in a near vertical attitude at impact."

"A commercial pilot with a passenger attempted to take off with full flaps. The airplane, which was 15 pounds over gross weight, staggered into the air to a height of about 30 feet. Power was reduced and the airplane descended at a steep angle with no flare for touchdown. The nosewheel collapsed on impact."

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<u>The slow rate of climb or inability to climb to traffic pattern altitude with full flaps presents the greatest problem!</u> Good pilot technique is necessary to obtain a slow rate of climb under ideal conditions. Climb performance is even more critical at high altitudes, higher weights, or high temperatures.

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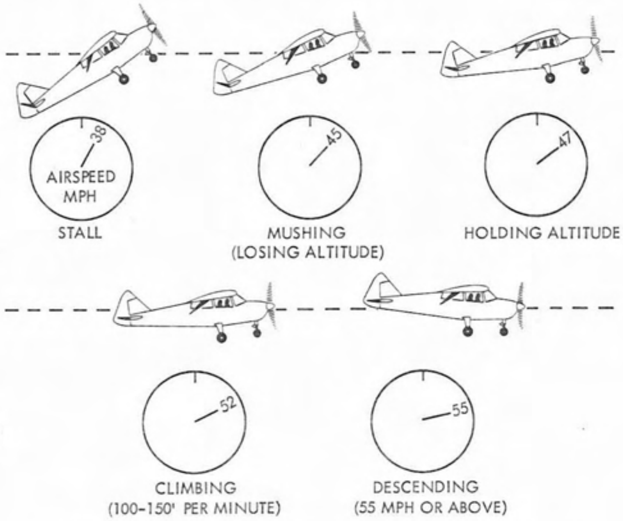

NOTE: Indicated airspeeds may be unreliable near the stall or in steep pitch attitudes. The airplanes and indicated airspeeds shown in this illustration are fictitious.

ATTEMPTING TO CLIMB (FULL THROTTLE) WITH FULL FLAPS EXTENDED

Operation in the region of reversed command does not imply that great control difficulty and dangerous conditions exist. For many aircraft, normal approach speeds are well within the region of reversed command. However, flight in the region of reversed command does amplify any errors of basic flying technique. Hence, proper flying technique and precise control of airplane are most necessary in the region of reversed command.

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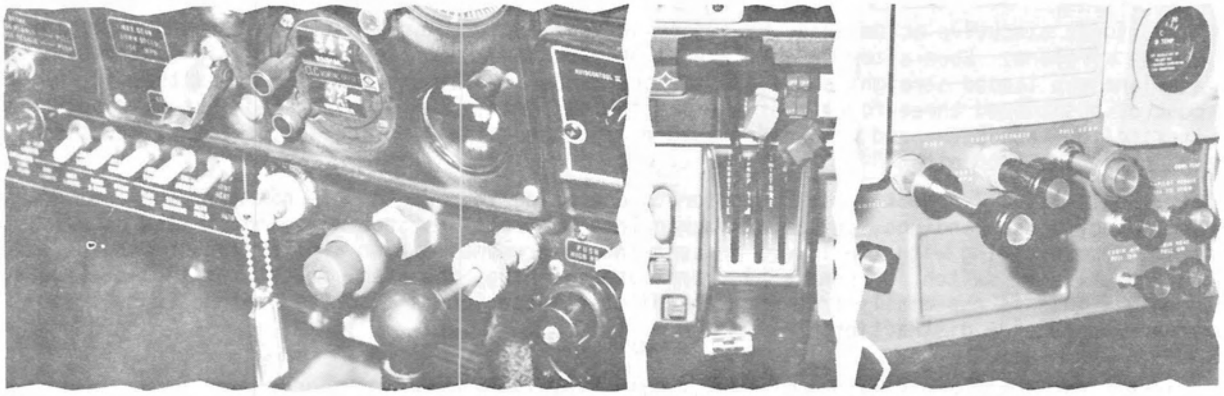
U.S. DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
VFR PILOT EXAM-O-GRAM NO. 58

PILOT INDUCED ACCIDENTS



PILOTS SOMETIMES PULL THE WRONG HANDLE OR FLIP THE WRONG SWITCH

The purpose of this Exam-O-Gram is to show how a lack of knowledge, inadequate preflight preparation, carelessness, confusion, and distractions have contributed to accidents. A study of many General Aviation Accident reports indicates that an alarming number of experienced pilots, as well as inexperienced pilots were involved in accidents that resulted from "inadequate preflight preparation and/or planning."

FAA written tests contain questions directly related to many of the conditions and factors that have caused accidents. All of the following are subject matter areas of aeronautical knowledge covered in written tests:

Preflight planning; use of the carburetor heat/mixture/throttle/propeller controls; pilot privileges/limitations; aircraft cruise performance charts; aircraft loading; fuel consumption; the effect of strong headwinds on aircraft range; etc.

Lack of knowledge in these subjects, combined with inadequate preflight preparation and careless flying habits, virtually assures that pilot error will be a significant factor in a high percentage of aircraft accidents. Also, some persons become involved in accidents by attempting to fly an airplane when: (1) there are pressing problems unrelated to flying on their minds; (2) they are not sufficiently alert; (3) their proficiency is marginal; or (4) they are not thoroughly familiar with or "at home" in the airplane being flown.

Experienced pilots as well as student pilots can benefit from the review of accident reports. We should all learn from the mistakes of others, yet it seems many persons must make the same costly mistakes themselves before they really learn. Reading the case reports which follow should make it clear that accidents are often related to a lack of knowledge, in addition to one or more of the factors mentioned above.

IMPROPER USE OF POWERPLANT CONTROLS

HOW HAS A LACK OF KNOWLEDGE OF USING THE MIXTURE CONTROL APPARENTLY CONTRIBUTED TO AIRCRAFT ACCIDENTS? Although pilots are familiar with stopping the engine after a flight by placing the mixture control in idle cutoff, some persons apparently are not familiar with how an engine responds in flight as this control is being moved toward the idle cutoff position. This is true when operating with high-power settings, and also during glides with the throttle closed as the propeller continues to windmill with the mixture in idle cutoff.

Reports for a 3-year period showed that an average of 16 accidents occurred each year as a result of pilots unintentionally pulling a wrong handle--the mixture control instead of the intended control. There were 38 "mismanagement of mixture control" accidents reported for a period of 2 1/2 years for just one popular make airplane. These pilot-induced emergencies were caused by pilots unintentionally creating complete power failures through improper use of the mixture control. Accident reports recite much the same story as the excerpts which follow:

★ "A student pilot on a solo cross-country flight was cruising at 6,500 feet, and being unfamiliar with the mixture control, made no attempt to lean out the mixture. When the engine started to run rough the student assumed the problem to be carburetor ice. After applying what he thought was carburetor heat--the engine sputtered and quit. After an emergency landing was made, the accident investigating team found the mixture control in the full lean (idle cutoff) position."

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★ "When the aircraft was removed from the river, the mixture control was in the "idle cutoff" position. The pilot stated that he closed the throttle and thought he applied full carburetor heat. When the engine seemed to be idling too slowly the throttle was advanced but the engine did not respond. The pilot assumed a fuel tank was empty and hurriedly switched tanks, and since this didn't solve the problem, an emergency landing was attempted on the river bank."

★ "A business executive accompanied by two passengers departed on a business trip in a single-engine airplane. Soon after takeoff the pilot experienced complete power failure, and the airplane was landed straight ahead outside the airport. Investigation revealed the mixture control positioned three-fourths of the way to full lean. The pilot stated that he was monitoring the tachometer and manifold pressure gauge and didn't notice which control he used to change the prop pitch."

Pilots should visually check a control prior to operating it, but this is not always practiced. During takeoffs and landings many pilots manipulate controls by touch while monitoring other traffic, communicating with the tower, or scanning instruments. When a pilot is not mindful of which knob, lever, switch, or handle his hands are touching, the stage is set for a pilot-induced emergency. This is especially true when the pilot's attention is diverted by some unusual circumstance or outside distraction.

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HOW HAVE FLIGHT INSTRUCTORS BEEN INVOLVED IN MISUSE OF THE MIXTURE CONTROL ACCIDENTS?

There were seven accidents of this type involving one popular make single-engine trainer, in a 1 1/2 year period. The following are "Brief Descriptions" of several of the accidents:

★ 1. "Instructor pulled mixture control for simulated emergency and engine would not restart."

★ 2. "Flight instructor moved mixture control to idle cutoff position to simulate engine failure. Could not get engine restarted. Battery was dead and alternator was inoperative."

★ 3. "Flight instructor pulled mixture control to idle cutoff to simulate engine failure at 800 feet. Engine did not respond when control was placed in RICH."

There were five similar accidents involving flight instructors in 1975. Two of these concerned light twin-engine aircraft - one on final approach and the other on takeoff at 20 feet AGL.

NOTE: The FAA inspector training policy for simulating partial or complete power malfunctions in single-engine aircraft is by smooth use of the throttle ONLY. The objective of simulated power malfunctions is not to shock the students but to train them in proper procedures and control of the aircraft.

WHAT MAY HAPPEN WHEN PILOTS ATTEMPT TO FLY AIRPLANES WITH WHICH THEY ARE NOT FAMILIAR?

★ "Shortly after lift-off the student pilot experienced a reduction in power and pulled a handle to apply carburetor heat. The airplane continued to lose power and was landed outside the airport boundary.

The Student Pilot Certificate had been endorsed for operating a similar earlier model (carburetor equipped) airplane of the same make that was being flown. The student had never flown an airplane equipped with fuel injection, a fuel boost pump, or a controllable pitch propeller, though the airplane involved in the accident was so equipped. Investigation revealed that the fuel boost pump was in the LOW operating position whereas the checklist specified that it be turned OFF during takeoff. The cabin heat control was in the full ON position and the student guessed that was the handle he pulled!"

Select One - Carefully.

WHAT ARE SOME OF THE MORE COMMON PILOT-INDUCED ACCIDENTS THAT HAVE RESULTED FROM USING THE WRONG HANDLE OR SWITCH?

Retracting the gear instead of the flaps after landing; retracting the gear while attempting to lock the parking brakes; turning off the ignition toggle switches while attempting to turn on the landing lights; etc.

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INADEQUATE PREFLIGHT PREPARATION AND/OR PLANNING

WHAT ARE THE HAZARDS OF NOT COMPLETING CERTAIN COCKPIT DUTIES?

Pilots who start one flight operation or procedure, and proceed to another operation before completing the first, may become involved in an accident simply because the first task was never completed. The following examples are typical:

Example 1.- A pilot of a multiengine airplane decides to check the operation of the crossfeed while taxiing from the ramp prior to takeoff. After placing the selector in the crossfeed position the pilot is distracted by a question from a passenger, another aircraft taxiing close by, or radio communications. The pilot intended to switch the fuel selectors back to the main fuel tanks after determining that the crossfeed was operating properly, but failed to do so because of the distractions.

Example 2.- Airplane "A" is on the downwind leg of the traffic pattern when airplane "B" squeezes in the pattern ahead of "A." The pilot of airplane "A" had started to perform the prelanding cockpit check when this distraction occurred. In a situation like this, unfortunately, some persons react with anger which sets the stage for a gear-up landing or a more serious accident.

INADEQUATE PREFLIGHT?

★ ATP Pilot -- Ran off the runway.
Remarks -- Movement of copilot's right rudder pedal obstructed by a whiskey bottle.

★ Private Pilot -- Collided with parked aircraft.
Remarks -- Did not remove right wing tiedown, started to taxi, tried to cut mixture control, but opened throttle.

HOW MIGHT AN INCOMPLETE PRETAKEOFF CHECK RESULT IN FUEL STARVATION?

Here is the way it happened to one pilot.

★ "An experienced private pilot flying his own airplane departed an airport with full fuel tanks. After a stopover of several hours at a nearby airport, the pilot hurriedly taxied to a runway for takeoff.

Airplane lost power at an altitude of approximately 50 feet on takeoff and settled back to surface. With only 437 feet of runway remaining, pilot was unable to stop, but chain link fence at field boundary turned the trick. Pilot was unable to recall position of fuel selector before takeoff, but noted that it was in OFF position after the accident. He stated that he had never turned fuel to the OFF position at the end of a flight."

This is an example of why a pilot should carefully check an airplane before each flight and not assume that it will remain just the same as it was on a previous flight. Many airports have people hanging around who enjoy climbing in airplanes, moving the controls, and flipping switches.

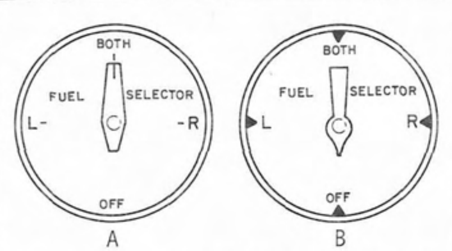
WHY DO MANY "FUEL STARVATION" ACCIDENTS OCCUR EVEN THOUGH THERE IS AMPLE FUEL ABOARD?

A common cause of engine failure is mismanagement of the fuel system. This happens frequently when the engine is fed fuel from one tank at a time.

Each year an alarming number of accidents result from pilots running a fuel tank dry. In their haste and anxiety to make an emergency landing, pilots are often back on the ground before realizing no attempt was made to switch to a tank containing fuel. In a recent year there were 59 accidents of this type.

The following accident excerpt illustrates the hazards of performing certain maneuvers while operating on one tank that contains a low level quantity of fuel.

★ "On a spiral descent from 7,500 feet engine quit and airplane landed in a field and hit a fence. Pilot had started flight with fuel only in left wing tank. The spiral down with left wing low caused the little remaining fuel to move away from tank opening to fuel line, which resulted in engine stoppage."



Being Familiar with Fuel Selector Valve "A" Could Lead to Trouble When Operating an Airplane Equipped with One Like "B"

FUEL STARVATION (Continued)

The pilot in command must always be alert and aware of the actions of other occupants of the airplane, as this fuel starvation accident reveals:

★ "The engine quit during climb out after takeoff and the pilot discovered the fuel had been turned off. His wife decided there was too much air blowing on her feet and used the fuel selector handle to turn off the cabin air vents. It worked! In less than a minute there was no air blowing on her feet."

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DOES FUEL EXHAUSTION HAVE THE SAME MEANING AS FUEL STARVATION?

No; fuel exhaustion means all the usable fuel aboard the aircraft has been consumed. Accidents such as these are of great concern in General Aviation, because they usually result from inadequate preflight preparation or planning and pilots not being familiar with the operating limitations of their equipment. There were 75 accidents attributed to fuel exhaustion in 1975. In recent years, some pilots operating in mountainous areas of western states have encountered fuel exhaustion before reaching their destination. Fuel exhaustion accidents resulted after they had been flying with 40-50 knot headwinds or had drifted off course in strong crosswinds. Some were operating at high altitudes without leaning the mixture, while others failed to refer to the Aircraft Cruise Performance charts and other data. For this reason, FAA written tests contain test items related to these subject areas.

BRIEF DESCRIPTION OF A TYPICAL FUEL EXHAUSTION ACCIDENT

★ "Engine quit because of fuel exhaustion 3 miles short of destination with forced landing in unsuitable terrain. Contributing factors were: (1) Improper flight planning, (2) relying on fuel gauges rather than manufacturer's fuel consumption figures, (3) overflying several suitable airports where additional fuel could have been obtained, (4) adverse weather conditions and strong headwinds."

IS THE PRACTICE OF RUNNING A FUEL TANK DRY BEFORE SWITCHING TANKS CONSIDERED A SAFE PROCEDURE?

No; some aircraft engine manufacturers recommend never running a fuel tank dry as a routine procedure. When the fuel selector remains on an empty tank which has run dry, the engine-driven fuel pump draws air into the fuel system and causes vapor lock. This is also true when an electric fuel boost pump is operated with the fuel selector on an empty tank. Fuel injection equipped engines, in particular, are vulnerable to vapor lock when the fuel selector is positioned on an empty tank.

BE ALERT, KNOW YOUR LIMITATIONS AND THE LIMITATIONS OF YOUR EQUIPMENT. LEARN FROM THE MISTAKES OF OTHERS AND AVOID SIMILAR ACCIDENTS.

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