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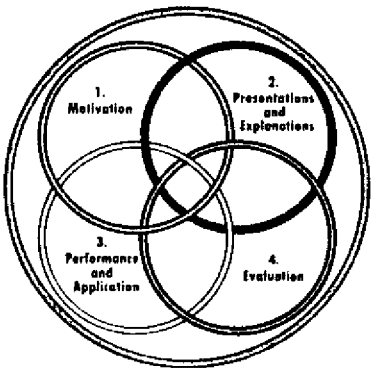
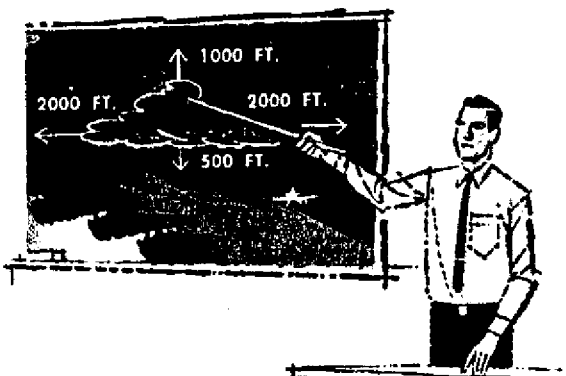
AC 143-1A

Ground Instructor Examination Guide

Basic-Advanced

superseded by AC 143-1B





Federal Aviation Agency

FEDERAL AVIATION AGENCY

FLIGHT STANDARDS SERVICE

Ground Instructor Examination Guide

Basic-Advanced

REVISED

1966

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CONTENTS

GROUND INSTRUCTOR EXAMINATION GUIDE
BASIC—ADVANCED

Introduction

This study guide was prepared by the Flight Standards Service of the Federal Aviation Agency to assist applicants who are preparing for the Basic or Advanced Ground Instructor Written Examination. It is not offered as a quick and easy way to gain the knowledge necessary for passing the written examination. Knowledge and understanding are seldom gained quickly or easily. This is particularly true in the diversified field of aviation ground instruction. There can be no substitute for diligent study to attain basic knowledge, unremitting effort to develop competence, and continuous review to remain current in the many areas where technological change is the rule rather than the exception.

The purpose of this guide is to provide guidance for the serious student by outlining the scope of knowledge required. Thus, the student is better able to intelligently direct his study plan.

Nature of the Examination

Much of the information and knowledge required of the instructor in aviation ground subjects is essentially the same today as it was many years ago, yet there has been a gradual and definite change in some areas. Technological advancements and refinements in today's aircraft, plus the increased use made of their capabilities by the general flying public, have outmoded the practice of testing for memory alone. Of course, basic knowledge is still necessary but it must be related to the operationally realistic situation. An aircraft's primary commercial use is to provide safe, speedy, and efficient transportation and all civilian training, flight or ground, is directed toward this end. For this reason, knowledge must be related to skill, and skill is inextricably interwoven with knowledge. Therefore, written examinations today require the ability to use basic knowledge in practical situations as well as in answering questions based on theoretical problems.

For this reason, this examination guide will deal with questions that test for knowledge alone as well as questions that test for the ability to apply and use this knowledge in a realistic environment. Some of the questions will deal with specific subjects (navigation, radio navigation, meteorology, Federal Aviation Regulations, aircraft and powerplants) and test for basic knowledge and grasp of theory in regard to fundamentals of instructing. Other questions will require the ability to combine and synthesize knowledge in two or more of the specific subject areas.

The FAA Written Examinations your students will take are of similar format and nature with regard to requiring competence at practical application of theory and knowledge. Knowing this should enable you to organize course material and direct classroom efforts so that your students will be well prepared for their examinations.

Type of Examination Questions

The examination questions are of the objective, multiple-choice type as illustrated by questions in the sample examination. Each question can be answered on a special answer sheet with a pencil mark. To preclude the possibility of an applicant's receiving a failing grade because of a mistake in grading, all tests scored below passing are rechecked by trained personnel.

Taking the Examination

The equipment that the applicant will need for taking the examination includes a pro-

tractor or plotter and a computer. It is also desirable to have a pair of dividers. The applicant is allowed the following number of hours to complete the Ground Instructor Examination:

A. Basic ..... 4 hours
B. Advanced ..... 5 hours
C. Fundamentals of Instructing. 2 hours
(It is not necessary to take this on the same day as the Basic or Advanced Examinations.)

While it may be possible to complete in less time, it would be unwise to plan on this. If it becomes necessary to hurry in order to finish the exam, it will only increase the probability of mistakes.

Always bear in mind the following facts when you are taking the examination:

1. The questions are not trick questions. Each statement means exactly what it says. Do not look for hidden meanings. The statement does not concern exceptions to the rule; it refers to the general rule.

2. Always read the statement or question first—before you look at the answers listed below it. Be sure you read the entire question carefully. Avoid "skimming" and hasty assumptions. This can lead to a completely erroneous approach to the problem or failure to consider vital words.

3. Only *one* of the alternate answers given is completely correct. Other answers may be correct as far as they go, but are not complete or are answers based on erroneous assumptions, misconceptions, or incorrect procedures and interpretations. *Understand* the question or statement. *Then work out your* answer before choosing from the list of alternate answers the response which you consider to be the best.

4. Do not spend too much time on a question which you cannot solve or on one where you have considerable doubt as to the correct answer. By so doing you deprive yourself of the opportunity to mark all those questions which you can promptly solve or answer. You may always go back to the questions you skipped after you are through with all those which you can readily answer. Many times you could have answered 5 or 10 questions during the time you work with one that is difficult. The procedure which will enable you to make maximum use of time available can well mean the difference between a passing and failing score.

5. In working problems which require computations or use of the plotter and computer, select the answer which is closest to the result you get. Due to slight differences in individual computers and many small errors you may make in measuring distances, true courses, etc., it is possible that you will not get an exact agreement every time. However, sufficient spread is provided between right and wrong answers so that the selection of the answer closest to your solution will be the right choice, *providing* you have used correct technique and reasonable care in making your computations.

NOTE: When the test is constructed, the correct answers are "double-checked" by several types of computers. Any of the several types of computers which are commonly used throughout the country should prove satisfactory.

RECOMMENDED STUDY MATERIALS

Aeronautical Charts

World Aeronautical Charts. (25 cents each)

Sectional Aeronautical Charts. (30 cents each)

Enroute Low Altitude Radio Navigation Charts. (25 cents each). This particular chart is not used on either the Basic or Advanced Examination, but instructor applicants and certificated instructors should be familiar with its format and use.

Flight Information

Airman's Information Manual. This publication presents, in three Parts, information necessary for the planning and conduct of flights in the U. S. airway system. Besides providing frequently updated airport and navaid data, the AIM includes instructional and procedural information, and is designed for use in the cockpit. Each Part is available on a separate annual subscription.

Part 1. *Basic Flight Manual and ATC Procedures.* ($2.00 domestic; $2.50 foreign — GPO) : combines the former Sections I and II and will be issued quarterly.

Part 2. *Airport Directory.* ($2.00 domestic; $2.50 foreign — GPO) : a revised version of former Section IV, expanded to include the physical description of those airports formerly shown only in Section IV-A. Will be issued semiannually.

Part 3. *Operational Data and Notices to Airmen.* ($9.00 domestic; $11.25 foreign — GPO) : presents former Sections III, III-A and IV-A every 28 days, supplemented by Section III-A (*Notices to Airmen*) every 14 days, midway of the 28-day cycle.

Handbooks and Technical Manuals

Private Pilot's Handbook of Aeronautical Knowledge. 1966. AC 61-23 ($2.75—GPO.) This handbook contains essential, authoritative information used in training and guiding private pilots. All subject areas in which an applicant may be tested are covered in the handbook. It tells how to use the Airman's Information Manual and the data in FAA approved airplane flight manuals, as well as basic instruments for airplane attitude control.

Personal Aircraft Inspection Handbook. Revised 1964. AC 20–9. (50¢—GPO). This is a general guide for inspection of aircraft; Part I deals with the fundamentals of inspection, and Part II covers a typical inspection in detail. As reliable inspection comes only with experience, it is emphasized that the use of this handbook by the novice does not qualify him to make final determinations regarding the airworthiness of the aircraft. This Handbook supersedes TM–101 dated 1950.

Flight Instructor's Handbook. 1964. AC 61–16. (60¢—GPO). This revised handbook is one of the primary sources of information and guidance for pilots preparing for the flight instructor written examination. It is basically a book which explains accepted theories and practices applicable to teaching and the learning process. Therefore, it will also prove most useful to those preparing for the Fundamentals of Instructing section of the Ground Instructor Written Examination.

Flight Training Handbook. AC 61-21. (70¢—GPO). This text deals with certain basic flight information such as load factor principles, weight and balance, and related aerodynamic aspects of flight, as well as principles of safe flight. The balance of the book provides information and direction in the introduction and performance of training maneuvers. Thus it serves primarily as a text for student pilots, for pilots improving their qualifications or preparing for additional ratings, and for flight instructors; however, it can also be useful to the ground instructor.

Navigation and Weather

Practical Air Navigation. 9th Edition, 1963. ($4.00). This is the revised commercial edition of CAA Bulletin No. 24. It provides a very comprehensive coverage of all subjects and areas dealing with navigation whether it be pilotage, dead reckoning, or radio and celestial navigation. Any student who understands the material avail-

able in this highly recommended text will have no serious trouble with the navigation problems on his examination. This text may be obtained from many book dealers or from the publisher, Weems System of Navigation, Inc., 229 Prince George Street, Annapolis, Maryland.

Aviation Weather. 1965. AC 00-6. ($2.25—GPO). This joint FAA/Weather Bureau publication supersedes and replaces "Pilot's Weather Handbook, TM-104," and provides an up-to-date and expanded text for pilots and flight operations personnel. It gives the pilot a practical understanding of those meteorological principles important to aviation and essential to his effective use of current weather and weather forecast information.

Weather Services for Pilots. 1962. (10 cents). This publication should do much to explain the weather services available through U. S. Weather Bureau stations and FAA Flight Service Stations. It explains in considerable detail weather reports and forecasts available and useful to pilots.

Federal Aviation Regulations

Part 1—Definitions and Abbreviations. (25 cents). This lists abbreviations and definitions to be used with the new Federal Aviation Regulations.

Part 61—Certification: Pilots and Flight Instructors. (50 cents). The applicant is responsible for the items in this Part which pertain to competency in all those areas which fall within the scope of knowledge required for his certification as a ground instructor.

Part 71—Designation of Federal Airways, Controlled Airspace and Reporting Points. (20 cents). The applicant will be directly concerned with this Part of the Federal Aviation Regulations dealing with airspace.

Part 91—General Operating and Flight Rules. (50 cents). It is imperative that the applicant be thoroughly familiar with the material contained in this Part, except those which pertain to Instrument Flight Rules.

Part 141—Pilot Schools. (25 cents). Although this Part of the Federal Aviation Regulations deals with pilot schools, it includes the regulations pertaining to ground schools with which the applicant should be familiar. General knowledge of various aspects of pilot school requirements will be of considerable value to the applicant.

Part 143—Ground Instructors. (15 cents). This short Part to the Regulations prescribes the requirements for issuing ground instructor certificates and associated ratings, and the general operating rules for the holders of those certificates and ratings.

Civil Aeronautics Board

Safety Investigation Regulations, Part 320. April 1, 1963. (5 cents). This publication deals with procedures required in dealing with accidents and lost or overdue aircraft in the United States, its territories, and possessions.

Training Aids

Commercial Pilot Examination Guide. 1966. (75 cents). This guide gives detailed information on the scope and depth of knowledge required of the commercial pilot applicant.

How to Obtain Study Materials

All study material, except charts and *Practical Air Navigation* may be obtained by remitting check or money order to:

Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Charts may be obtained at most local airports, or by remitting check or money order to:

Coast and Geodetic Survey
U. S. Department of Commerce
Washington, D. C. 20235

In many instances, the above materials may be obtained at airports or from book stores.

In addition, there are many other excellent commercially prepared textbooks, audio-visual training aids, and other instruction materials which may be helpful in preparation for the examination.

NOTE: The items listed were available or in preparation at the time this publication went to press.

STUDY OUTLINE FOR THE GROUND INSTRUCTOR WRITTEN EXAMINATION

The study outline which follows is the framework for basic aeronautical knowledge that the prospective ground instructor must know; *every question* on the FAA examination can be *directly* related to one or more of the topics contained in this outline. This subject matter is predicated on both theoretical questions in specific areas and on operationally realistic airman activity, and encompasses the knowledge requirements specified in Federal Aviation Regulations.

Section 1 — Fundamentals of Instructing

I. The Ground Instructor — Desirable Qualities.
   A. Good attitude toward teaching.
      1. Desire to do a competent job.
      2. Ability to develop and improve.
      3. Sincerity, enthusiasm, and patience.

II. The Pattern for Instruction—How to Guide the Learning Process.
   A. *Understand* the factors, conditions, and principles which guide the learning process.
      1. Establish clear objectives.
      2. Provide for student participation.
      3. Develop understanding and insight.
      4. Develop ability to think and reason through use of known facts.
      5. Use of motivation, presentation, trial performance and evaluation.

III. Planning—Vital to Teaching Success.
   A. Diagnose present student ability and ability desired upon completion of course.
   B. Arrange teaching sequence to "make sense".
      1. Proceed from the known to the unknown.
      2. Proceed from the easy to the difficult.
      3. Plan so student will see necessity and logic of each succeeding step.
      4. Use a lesson plan—know its advantages.

IV. Presentation—Procedure to Follow.
   A. Plan.
      1. Student-instructor relations — establish an atmosphere of cooperation.
      2. Direct and explain.
      3. Discuss.
         a. Get *all* students to participate.
         b. Keep discussion moving toward goal.
         c. Emphasize important points.
         d. Keep explanation short, clear, and to the point.
      4. Question technique—its use and importance.
      5. Use analogies as a link between known and unknown.
      6. Use instructional aids.

V. Performance, Practice, and Application.
   A. Steps to follow.
      1. Start with the easy and work toward the difficult.
      2. Make performance realistic.
      3. Guide student's efforts.
      4. Get each student to participate.
      5. Relate performance to previous explanations and directions.
      6. Provide adequate practice but guard against blind "trial and error".

7. Evaluate student progress.

VI. Motivation—Basic to All Learning.
- A. Reward—use and limitations.
- B. Immediate and long-range goals and their relative usefulness.
- C. Arousing interest.
  1. Use of student's background.
  2. Use of your own experience and background.
  3. Use of anecdotes and stories.
- D. Conditions detrimental to good motivation.
  1. Self-consciousness.
  2. Antagonism.
  3. Impatience.
  4. Worry.
  5. Physical discomfort.
  6. Boredom.

VII. Teaching Methods and Techniques.
- A. Telling—sometimes called the "lecture" method.
  1. Does not permit student participation.
  2. Can be combined with other methods to make it more effective.
- B. Discussions—techniques of.
  1. Develop cooperative spirit.
  2. Clarify problems.
  3. Encourage participation.
  4. Avoid dominating discussion.
  5. Summarize frequently.
- C. Demonstrations or showing.
  1. Must be combined with telling.
  2. Advantages.
     a. Makes explanations concrete.
     b. Aids student understanding.
     c. Saves learning time.
     d. Effective with large groups.
     e. Gives students over-all perspective.
     f. Appeals to several senses.
     g. Has dramatic appeal.
- D. Performing or Doing—Essential to the Learning Process.
  1. Techniques.
     a. Plan the performance.
     b. Prepare the student for performance.
     c. Guide the performance.
     d. Give individual attention.
     e. Evaluate the performance.
     f. Have the student evaluate the performance.
     g. Practice the performance.
     h. Supervised study—a form of performance.
        (1) Survey — student must get a picture of the problems.
        (2) Assign reading material.
        (3) Student must practice self-questioning.
        (4) Recite.
        (5) Review — necessary to develop and firmly fix learning and improve weakness revealed by recitations.
        (6) Critique — an analysis of performance.
- E. Test Administration Procedures — Preceding, During, and After Student Participation.
  1. Preceding.
     a. Be on time.
     b. Check tests for errors.
     c. Give clear instructions.
     d. Create relaxed atmosphere.
  2. During.
     a. Avoid distractions.
     b. Limit student discussions.
     c. Be alert to student need for permissible assistance.
  3. After.
     a. Review.
     b. Permit constructive student criticism—written and oral.
- F. Evaluation — The measure of Success of the Teaching Program.
  1. What to test.
     a. Understanding.
     b. Actual performance—ability to apply knowledge to realistic problems is the only positive assurance of mastery of subject.
  2. Characteristics of Good Evaluation Devices.
     a. Validity — does it measure what it is supposed to measure?

b. Reliability — are the results consistent?
c. Objectivity — limit personal judgments.
d. Differentiate — test must measure small but significant differences in achievement.
e. Comprehensive — provide adequate sampling.

3. Types of tests.
a. Multiple-choice.
b. Matching.
c. True-False.
d. Completion.
e. Essay.

G. Instructional Aids—Choose the Aid that Fits the Learning Situation.
1. Usual types of aids.
a. Films, strips, slides.
b. Training graphics — diagrams, charts, pictures, etc.
c. The blackboard.
d. Training devices—mockups, schematics, operational, sectionalized, and exploded.
e. Training literature.
f. Field trips.
2. Caution in the use of instructional aids.
a. Contribute little unless they develop student understanding.
b. Don't expect them to do your teaching.

VIII. Student-Instructor Relationship.
A. Establish receptive, cooperative working relationship.
1. Be natural, enthusiastic, and helpful.
2. Realize you are dealing with men, not machines.
3. Be a guide, not a driver.
4. Treat students as adults — do not talk down to them.
5. Be fair, firm, and friendly.

B. Additional suggestions for establishing atmosphere conducive to learning.
1. Show no partiality or favoritism.
2. Never try to bluff.
3. Never harshly criticize in front of others.
4. Acknowledge your own mistakes.
5. Act decisively.
6. Keep student headed toward his objective.
7. Be interested in your pupils as individuals.
8. Be courteous.
9. Recognize and reward excellence.
10. Encourage class participation.
11. Encourage initiative and self-reliance.

Section 2 — Aeronautical Knowledge

I. Preflight — Activities Relating to the Proposed Cross-Country Flight.

During the preflight portion of the examination you will be required to perform most of the following activitives which are directly related to the proposed cross-country flight:

A. Lay out the proposed route on the aeronautical chart provided with the examination.
1. Follow the instructions given in the examination and draw the course lines for the proposed route. Time can be saved in locating turning points, destination airports, and radio aids, by utilizing the geographic coordinates which are provided in the excerpts from the *Airman's Information Manual.*
2. Determine the true courses with a protractor and measure distances, *using the mileage scale at the bottom of the chart.* For accurate measurement, use the center of the airport symbols—not the edge.
3. Study the area along your proposed route and note the locations of the following:
a. *Prominent* checkpoints.
b. Radio aids to navigation (VOR, nondirectional radio beacons, and L/MF range stations). Be certain to

check this data against current information in the *Airman's Information Manual.*

c. High terrain (particular attention should be made to note the elevations—heights above sea level — of the higher ridges and peaks along the routes that traverse rough or mountainous country).

d. Obstructions (note the elevations of high obstructions enroute and in the vicinity of destination landing fields).

e. Control areas, control zones, and airport traffic areas.

f. Prohibited, restricted, caution, and warning areas.

B. Check the weather. Consult your local Weather Bureau Airport Station, or an FAA Flight Service Station for flight weather briefings. Be able to read and interpret the following data:

1. Surface weather map. (Identify fronts, air masses, and read station model data, using the key furnished in the examination.)
2. Area forecasts.
3. Terminal forecasts.
4. Winds-aloft forecasts.
5. SIGMETS (significant meteorological developments) and AIRMETS (formerly designated "Advisories for Light Aircraft", they include weather phenomena of less severity than that covered by SIGMETS).
6. Hourly Sequence Reports.

C. Review the important data in the flight planning publication — *the Airman's Information Manual.* Be familiar with and able to use the information pertaining to:

1. Communication frequencies: control towers, approach control, primary traffic control, ground control, departure control, Flight Service Stations.
2. Navigation aid frequencies: VOR Stations, nondirectional radio beacons, L/MF Range Stations, VHF/DF, Radar.
3. NOTAMS (Notices to Airmen).
4. Special Notices: list of Military Climb Corridors and Oil Burner Routes, good operating practices, and other helpful information.
5. Airport data: location, runway information, availability of fuel and service, availability of UNICOM and weather reporting facilities, etc., lighting.
6. Review pertinent information on:
   a. Enroute Cruising Altitudes.
   b. Airport Traffic Control procedures.
   c. Light Gun Signals.
   d. Radio-telephone phraseology and techniques.
   e. Complete list of VOR receiver checkpoints.
   f. Enroute communications.
   g. U. S. Aircraft Emergency procedures, search and rescue procedures, emergency SCATER rules (Security Control of Air Traffic and Electro-Magnetic Radiations).
   h. U. S. Weather Bureau telephone numbers.
   i. FAA Flight Standards District Office telephone numbers.
   j. Aircraft accident reporting.

D. Check your aircraft equipment and records, and your personal qualifications to see that regulations have been met.

1. Check to see that your aircraft—
   a. Has the required documents aboard.
   b. Has had the necessary in-

spections within the required time.

c. Is properly equipped for flight (including operations at night and operations in and out of airports on which United States Government-operated control towers are located).

2. Check your pilot qualifications to ascertain that—
   a. You have the proper pilot and medical certificates.
   b. You have complied with recency of experience requirements for carrying passengers (day and night).

E. Select your cruising altitudes, taking into consideration—
   1. Regulations with regard to the hemispherical rule (semi-circular rule).
   2. Enroute terrain and obstruction elevations.
   3. VFR cloud separation requirements.
   4. Winds aloft.
   5. Restricted areas such as Military Climb Corridors. (For additional information concerning ing prohibited, restricted, caution, and warning areas, see reverse side of your chart.)

F. Review your *Airplane Flight Manual* and *Owner's Handbook.*
   1. Understand the difference between normal and utility category.
   2. Consult the weight and balance data and determine that the aircraft is properly loaded. Know how to compute empty weight, useful load, gross weight, and moments.
   3. Check on the grade and quantity of fuel and oil required.
   4. Review flight load factor limitations and airspeed limitations.
   5. Check your performance charts as required for—
      a. Takeoff data (*Airplane Flight Manual* or *Owner's Handbook* charts or Denalt Performance Computer.
      b. Climb data.
      c. Landing distance data.
      d. Cruise performance data (cruise power settings, approximate true airspeeds, fuel consumption rate).
      e. Airspeed calibration table.
      f. Stall speed vs. angle of bank table.

G. Compute navigation data for the flight based on selected cruising altitudes, cruise performance data from the *Airplane Flight Manual* or *Owner's Handbook,* and the appropriate winds aloft.
   1. Convert the forecast winds aloft which are given in knots to miles per hour (also convert, when required, temperatures given in Centigrade to Fahrenheit or vice versa). Interpolate for winds (and temperatures) at intermediate altitudes.
   2. Compute true headings and convert to magnetic headings by applying the appropriate magnetic variation corrections. Convert magnetic headings to compass headings by applying correction for deviation.
   3. Compute estimated groundspeeds and estimated times enroute.
   4. Compute estimated fuel required for flight based on estimated times enroute and the aircraft cruise performance charts.
   5. Compute normal range and maximum range based on Cruise Performance Charts. Compute range with reserve allowance.
   6. Make a thorough visual inspection. During this inspection, drain a generous amount of fuel from your fuel supply (fuel strainer and wing tank sump

drains), and inspect for evidence of water contamination. If ice, snow, or frost is on the aircraft, remove completely.

H. Follow the recommended procedures in filing your VFR flight plan. Understand how to use Flight Following Service.

NOTE: Except for knowledge and interpretation of instruments in relation to *attitude control* of the airplane, the Basic and Advanced Ground Instructor Written Examinations will deal only with flight under VFR conditions.

II. Preflight—Basic Aeronautical Knowledge Indirectly Related to the Proposed Cross-Country Flight.

During the preflight portion of the examination, you will be questioned on additional aeronautical subjects. Some of these subjects may not directly relate to the proposed cross-country flight, but they are germane to the various airman certificates and ratings. These subject areas include:

A. Weather. As a ground instructor, you should demonstrate a broad understanding of weather. You should be familiar with—

1. Basic concepts of the earth's atmosphere and the composition of air.
2. Types of clouds and associated weather phenomena.
3. General circulation patterns (winds).
4. Air masses.
5. Low and high pressure centers.
6. Frontal weather (weather conditions generally associated with cold fronts, warm fronts, occluded fronts, etc.).
7. Thunderstorms.
8. Ice and turbulence.
9. Fog and other visibility obscurations.
10. Meteorological terminology (definitions).

B. Navigation. You should understand the following:

1. The earth and its coordinates of latitude and longitude.
2. Chart projections used for air navigation (with emphasis on the properties of the Lambert Conformal Conic Projection).
3. Map reading.
4. Dead reckoning.
   a. Wind triangle (vector) problems.
      (1) Determine true course and groundspeed.
      (2) Determine true heading and groundspeed.
      (3) Determine wind direction and velocity.
      (4) Determine true heading and true airspeed.
      (5) *Off-course corrections.*
   b. True course to compass heading.
   c. Compass heading to true course. (Application of wind, variation, and deviation corrections.)
   d. Speed—time—distance problems.
   e. Knots—m.p.h. conversions.
   f. Nautical — statute conversions for both speed and distance.
   g. Rates of climb and descent computations.
   h. Airspeed and altitude corrections.
   i. Centigrade—Fahrenheit conversions.
   j. Estimated time of arrival (ETA), estimated time enroute (ETE), and arrival scheduling.
   k. Cruise control.
   l. Use of flight log (preflight and in-flight).
5. Radio navigation as it pertains to VFR flight. (See item E.)
6. Navigation terminology (definitions).
7. The vital relationship between weather phenomena and problems of navigation.

C. Aerodynamics and Principles of

Flight. You should demonstrate a knowledge of— .

1. Forces acting on an aircraft.
2. Principles of basic maneuvers.
3. Aircraft performance and factors affecting performance (with emphasis on the effect of density altitude on aircraft performance).
4. Static and dynamic stability (longitudinal and lateral).
5. V_y and V_x speeds.
6. Terminology and definitions.

D. Airframe and Powerplant. You should have a working knowledge of—

1. Aircraft structures.
2. Airframe components and control surfaces.
3. Fuel and fuel systems.
4. Oil and oil systems.
5. Electrical system fundamentals.
6. Reciprocating engine principles and components.
7. Carburetion and fuel injection.
8. Ignition.
9. Propellers.
10. Engine instruments.
11. Engine controls (throttle, propeller, mixture, carburetor heat, cowl flaps, etc.).
12. Relationship between r.p.m. and manifold pressure.
13. Brake mean effective pressure (BMEP), and its significance.

E. Radio Equipment. You should understand the basic characteristics, operations, frequency ranges, advantages, and limitations of—

1. VHF Communications Equipment. Understand the "line of sight" range of transmissions. Understand that an operative transmitter and receiver are all that are required to use VHF Direction Finding Service and radar assistance from ground stations. (In some instances, assistance may be available even when all radios are out if proper procedures are followed.)
2. VOR Equipment.
   a. Understand principle of VOR operation. Be able to recognize a usable signal.
   b. Know the components of your VOR receiver and the importance of proper tuning.
   c. Understand that a radial is a line of magnetic bearing extending *from* a VOR.
   d. Understand how to utilize receiver checkpoints to establish receiver accuracy.
   e. Be able to work a VOR orientation. Understand how to determine your approximate position relative to the station by interpreting the setting of the omni-bearing selector, the position of the LEFT-RIGHT needle, and the indication of the TO-FROM indicator. Understand the importance of correct "sensing".
   f. Know and understand the procedures for VOR off-course navigation and for solving time and distance problems.

*3. L/MF Range and ADF.
   a. By referring to your chart, be able to determine the magnetic direction of the four legs of low frequency ranges and the relative position of the "A" and "N" quadrants.
   b. Know how range legs are numbered, why average quadrant bisectors are used, and how they are obtained.
   c. Know the types of markers used with the L/MF range and their functions.
   d. Understand nondirectional beacons—their use, classification and range.

* Applicable primarily to Ground Instructor-Advanced Examination.

e. Understand how to interpret bearing information when using your ADF for tracking inbound and outbound and for track interception.
(1) Relative Bearings.
(2) Magnetic Bearings.
(3) True Bearings.

F. Flight Instruments. You should understand the basic principles of operation and characteristics of all flight instruments.

1. Understand the basic similarity between visual and instrument flying with regard to control of aircraft attitude.
2. Be able to interpret the pitch-and-bank attitude of your aircraft by reference to the flight instruments.
3. Understand the bowl-type magnetic compass.
   a. Know the method of making turns by referring to the magnetic compass to determine the lead point at which to begin rolling out.
   b. Understand the following errors of the bowl magnetic compass:
      (1) Deviation.
      (2) Oscillation error.
      (3) Magnetic dip error. Dip error is responsible for:
         (*a*) *Northerly turn error* which is most pronounced on northerly and southerly headings; and
         (*b*) *Acceleration error* which is most pronounced on easterly and westerly headings.
4. Thoroughly understand the altimeter (sensitive altimeter adjustable for changes in barometric pressure).
   a. Know the effect of nonstandard temperature and pressure on the indications of the altimeter.
   b. Understand how to apply altimeter settings to the altimeter setting window of the altimeter.
   c. Be able to interpret the indications of the altimeter.
   d. Know how to determine pressure altitude.
5. The Airspeed Indicator. Know the eight airspeed ranges and limitations that are reflected by the standard marking system on the face of the airspeed indicator (white, green, and yellow arcs, and the red line).
   a. Flap operating range.
   b. Normal operating range.
   c. Caution range.
   d. Power-off stalling speed with the wing flaps and the landing gear in the landing position (V_{so}).
   e. Power-off stalling speed "clean"——wing flaps up and landing gear retracted (V_{s1}), if equipped with a retractable landing gear.
   f. Maximum flap extended speed (V_{fe}).
   g. Maximum structural cruising speed (V_{no}).
   h. Never-exceed speed (V_{ne}). (See fig. 27 in appendix.)

III. Prestarting Inspections.

A. Exterior Visual Inspection. Understand the importance of—

1. The use of a checklist in establishing good habit patterns.
2. Allowing sufficient time for a thorough and complete walk-around inspection as recommended by the aircraft manufacturer.
3. The emphasis placed on checking for, and adequate drainage of, possible fuel contamination.
4. Checking the pitot tube and static pressure orifice.
5. Ice, snow, and frost removal from the aircraft.

IV. Starting, Taxiing, and Engine Runup.
A. Understand the need for—
1. Following a checklist based on manufacturer's recommendations.
2. Familiarity with emergency procedures with regard to engine or induction system fires.
3. Ground control or tower contacts where applicable for taxi clearance.
4. Careful observance of the oil pressure/temperature, and magneto checks; and where applicable, check on fuel pressure, cylinder head temperature, r.p.m., manifold pressure, flaps, trim, and full control travel in the proper direction.
5. Courtesy in control of propeller blast in taxiing and runup where proximity of other aircraft, buildings, and personnel are involved.

V. Takeoff.
A. Use your checklist.
B. Contact tower for takeoff clearance but check traffic carefully yourself. You are still responsible for the safety of your operation.
C. Activate any VFR flight plan by reporting time off to appropriate facility.
D. Be certain you clearly understand tower instructions.
E. Follow tower instructions without deviation except when cleared to do so, or in an emergency.
F. Check density altitude/performance.
G. Use takeoff performance charts. (See fig. 12 in the appendix.)

VI. In-Flight.
A. Climb to your selected altitude and complete your level-off procedures. Take necessary precautions to ensure accuracy when making readings from the bowl magnetic compass. Reset the gyro-driven heading indicator to the magnetic compass frequently.
B. Comply with FAR 91, *General Operating and Flight Rules*, at all times. Maintain a constant vigilance for other traffic.
C. Compute estimated true airspeeds and true altitudes. Be forever alert to density altitude, etc.
D. Determine time between checkpoints and compute groundspeed. Compute ETA over various checkpoints and destination. Keep log of time over various points.
E. Use good fuel management procedures. Keep close check on fuel consumption rate. Maintain proper fuel/air mixture setting appropriate to cruising altitude through proper use of mixture control.
F. If the winds-aloft forecast proves inaccurate, or if you drift off your flight-planned course, compute new headings and groundspeeds to destination from your present position.
G. Make periodic VFR position reports to Flight Service Stations. Give PIREPS (Pilot Reports) on unusual weather or erratic operation of radio navigation aids. Request weather information if necessary.
H. Be able to follow L/MF Range Legs and VOR radials.
I. Know how to tune in and identify a radio range or VOR station. Understand how to utilize an air navigation radio aid, i.e., VOR radial, L/MF range leg, and ADF bearing.
J. Have a working knowledge of the procedures for requesting radar vectors, D/F steers and associated enroute emergency navigation assistance.
K. Monitor appropriate stations for 15 minutes after the hour (area) and 45 minutes after the hour (airway) weather broadcasts. Maintain a continuous listening watch for possible in-flight weather safety advisories (SIGMET or AIRMET).
L. When operating in the vicinity of a large aircraft, be on the alert for wing-tip vortices (wakes of ex-

treme turbulence behind aircraft). Take recommended action if you inadvertently encounter wing-tip vortices.

M. Avoid bad weather. Do not get trapped above an overcast. When necessary, use the 180° turn, but this device is reliable only when you have not waited too long to make the decision to turn.

N. Avoid turbulent air if possible. If you encounter severe turbulence, slow the aircraft to at least the recommended maneuvering speed.

O. Keep a continuous watch of all engine instruments. Be able to recognize symptoms of carburetor icing. Remember that, on aircraft equipped with constant speed propellers, the initial loss of power will be reflected by decreased manifold pressure, not by loss of r.p.m. due to action of propeller governor.

P. When making in-flight power adjustments, sequence your throttle and propeller controls in the correct order. Remember BMEP tolerances.

Q. Be prepared for in-flight emergencies—equipment failure, loss of orientation, or unexpected weather. Have alternate plans of action.

R. If you cross a Military Climb Corridor, be sure to fly at an altitude appropriate to the segment crossed.

S. If you take off or land at an airport located within an airport traffic area, *follow* applicable Regulations.

T. Know the official sunset time for the area over which you are flying. Turn your navigational lights on at the required time. Be familiar with airport lighting, runway lighting, and taxiway lighting.

U. Prior to starting your letdown, check to see that fuel selector is on the appropriate tank, and mixture control is in proper position. Take necessary precautions to avoid possible carburetor icing during prolonged letdowns at reduced power settings.

V. When approaching your destination, contact the tower for landing instructions. Be able to interpret instructions. (For example, if you are instructed to land on "RUNWAY 22 RIGHT TRAFFIC", you should understand you are to land on a runway with magnetic direction of 220°, using a right-hand traffic pattern.)

W. Use standard practice when entering traffic. Watch for light gun signals from the tower, in the air, or on the ground if your radio receiver becomes inoperative. Maintain a constant vigilance for other traffic. Be alert for segmented marker system or flashing amber light as indications of non-standard traffic.

X. Run a complete prelanding check, *using your checklist.*

Y. Understand the purpose and use of the Visual Approach Slope Indicator (VASI).

Z. After landing, switch to the appropriate ground control frequency if applicable (*after* turning off the active runway), and exercise extreme caution while taxiing back to ramp.

VII. Post-Flight Activities.

A. Turn off all switches and secure the controls.

B. Close your flight plan with the appropriate facility if you have not done so.

C. Refuel the aircraft in order to reduce condensation in the tanks and possible water contamination of the fuel.

D. If applicable, arrange for hangar space or tie-downs.

E. Understand procedures for notification and reporting of aircraft accidents and overdue aircraft as specified in CAB Safety Investigation Regulation Part 320.

F. Record your flight time. (Not mandatory except to verify recent experience or to substantiate claim to experience necessary for grade of certificate or rating sought.)

THE SAMPLE EXAMINATION

The following test items are included for one purpose—to familiarize you with the type of questions you may expect to find on FAA examinations. Keep in mind that these few sample items do not include all of the topics on which you will be tested in the FAA examination. For this reason you should concentrate on the section entitled "Study Outline for the Ground Instructor Written Examination." A KNOWLEDGE OF ALL THE TOPICS MENTIONED IN THIS OUTLINE—NOT JUST THE MASTERY OF THE SAMPLE TEST ITEMS — SHOULD BE USED AS THE CRITERION FOR DETERMINING THAT YOU ARE PROPERLY PREPARED TO TAKE THE FAA WRITTEN EXAMINATION.

The appendix of this booklet contains the supplementary materials which will be required from time to time during the sample examination. These materials include weather information, aircraft description and performance data, the flight planning data (excerpted information from the *Airman's Information Manual*, diagrams, charts, and illustrations.

This examination is divided into two sections. The first section tests for basic knowledge in *Fundamentals of Instructing*. It is necessary that an applicant for a Ground Instructor certificate pass a written examination dealing with the conditions, techniques, and principles which control the learning process. This examination is separate from, and in addition to, the written examination on subjects which pertain to the rating he seeks (Basic, Advanced or Instrument). The applicant may, if he chooses to do so, take this written examination on the same day that he takes the examination on the subjects covered by the rating sought. However, he may take it on another date before taking the written examination on subjects pertaining to the rating sought. Regardless of his choice as to when he takes this examination, *both* sections must be passed by an applicant. It is *not* necessary, however, to take the examination on *Fundamentals of Instructing* for each additional rating sought. For example, if an applicant for the Basic Ground Instructor rating passes both the section on *Fundamentals of Instructing* and the section pertaining to Navigation, Meteorology, Federal Aviation Regulations, Aircraft and Engines, it is not necessary for him to again pass the section on *Fundamentals of Instructing* to obtain either the Advanced Ground Instructor rating or the Instrument Ground Instructor rating. He only needs to pass an examination on the subject matter pertaining to the rating he seeks.

The second section of the sample examination is based on an operational realistic cross-country flight where general knowledge must be applied to practical situations. Answers and explanations to the questions which follow may be found on page 25 through page 30.

SAMPLE EXAMINATION

Section 1 — Fundamentals of Instructing

1. Test reliability refers to the
   1——characteristic of a test which indicates consistent results for a test over a period of time.
   2——measure of temporary variations influenced by chance errors.
   3——accuracy with which an examination identifies the superior students.
   4——exactness with which a test measures what it is supposed to measure.
2. If an instructor wishes to do an effective job of teaching, the most important requirement is that he master
   1——only teaching methods.
   2——only his subject matter.
   3——both teaching methods and subject matter.
   4——a good speaking voice, posture, and public speaking ability.
3. One of the most significant sources of information for an instructor with regard to the need to develop new and better ways of improving his teaching effectiveness lies in
   1——noting whether a comparison between his methods and those used by successful teachers is favorable or unfavorable.
   2——the observations and suggestions made by supervisors and other instructors.
   3——the observation and evaluation of the difficulties which his students are having.
   4——listening to student's suggestions.
4. Good instruction techniques involve many important elements. Select the answer which includes only those items important to good instruction.
   A. Evaluate the student and recognize his difficulties as an individual.
   B. Instruct each class in exactly the same manner so as to assure a constant level of student proficiency.
   C. Set specific goals.
   D. Avoid setting standards of performance lest failure to meet them prevents progress.
   E. Acquaint the student with his progress only if he seems concerned about the matter.
   F. Keep student informed of his progress.
   G. Allow the student to participate in the class session and demonstrate his ability, but anticipate mistakes, and if possible correct them before they occur.
   H. Use a teaching sequence that "makes sense" from the learner's point of view.
   I. Improve motivation through use of negative incentives.
   J. Use oral questions in the classroom to evaluate progress and level of learning.
   K. Use a lesson plan even if it is inadequate.
   L. Emphasize the lecture method of instruction.
   M. Limit classroom practice as much as possible since it consumes too much time.

   1——A, C, F, H, J, K.
   2——B, D, E, G, I, L, M.
   3——A, D, E, H, L.
   4——C, F, G, H, K.
5. True comprehension and understanding of a subject is the very essence of any learning. The best way to determine if a student really understands a subject is to
   1——accept a high grade average as evidence of such understanding.

2——give examinations which require high levels of retention in order to make a good grade.
3——ascertain that the student can actually apply his knowledge to all the problems covered in the classroom program.
4——test the student's ability to apply his knowledge toward solving new and difficult situations.

Section 2 — Aeronautical Knowledge

This part of the examination is based on a flight from Gallup, New Mexico, to Holbrook, Arizona, to Flagstaff, Arizona, and to Williams, Arizona.

Although this is a hypothetical cross-country, the weather data is authentic. The airplane you are assumed to be flying is a late model, 4-place, single-engine airplane. It is equipped with retractable, tricycle landing gear and a constant speed propeller. It is typical of several models currently being produced by various manufacturers. This airplane is designated as DAEDALIAN DART 2468–W. It is to be flown in accordance with FAA-approved Airplane Flight Manuals and placards that appear in the airplane.

PROPOSED CROSS-COUNTRY FLIGHT DATA

You are a professional pilot employed by an engineering corporation whose home office is in Gallup, New Mexico. You are scheduled for a flight originating in Gallup, New Mexico, and terminating in Williams, Arizona, with intermediate stops at Holbrook, Arizona, and Flagstaff, Arizona.

You will carry three corporation executives who are conducting a business survey. You have established your tentative route on WAC Chart 405 as follows:

LEG I

McKinley County Airport, Gallup, New Mexico, to Holbrook Municipal Airport, Holbrook, Arizona, via direct route.

LEG II

Holbrook Municipal Airport, Holbrook, Arizona, to Flagstaff Municipal Airport, Flagstaff, Arizona, via direct route to Winslow, Arizona, VORTAC; thence direct route to Flagstaff Airport.

LEG III

Flagstaff Municipal Airport, Flagstaff, Arizona, to Williams Municipal Airport, Williams, Arizona via direct route.

Except for Gallup, New Mexico, the places named can be located by reference to the excerpt from the *Airman's Information Manual,* figure 18 in the appendix.

Your preflight activities include:

1. Any necessary review of the *Airplane Flight Manual, Operation Placards,* and *Owner's Handbook,* with particular emphasis on operating speeds, power and mixture settings, weight and balance considerations, and emergency procedures.
2. A study of pertinent information in the *Airman's Information Manual.*
3. A review of your map with emphasis on the relationship between your route and airway structure, terrain and obstruction elevations, and all airport facilities available enroute in event of emergency.
4. A review of radio checkpoints and facilities.
5. Thorough check of all available weather information.
6. Filing a flight plan.
7. Preflight check of the airplane.

1. Federal Aviation Regulations require careful preflight planning
   1——only on flights that are conducted off-airways.
   2——on all cross-country flights.
   3——only on flights for hire.
   4——only on flights which carry passengers.

2. According to the 0700 Hourly Sequence Report (see fig. 5 in the appendix),
   1——PHX reports a ceiling of 12,000 feet.
   2——PRC reports a pressure of 906.4 millibars.
   3——TUS reports an altimeter setting of 39.83 inches.
   4——GNT reports calm surface winds.

3. The 0800 Hourly Sequence Report at Phoenix, Arizona, (see fig. 5) indicates that
   1——the ceiling is 10,000 feet.
   2——the ceiling is 1,200 feet.

3——the ceiling is 12,000 feet.
4——there is no reported ceiling at Phoenix.

4. You plan to depart at 0830 MST and a study of all the Hourly Sequence Reports in figure 5 permits you to conclude that
1——you have no weather problem with regard to the flight.
2——you can anticipate frontal activity between *0700* MST and *0800* MST.
3——ceilings will decrease along the route.
4——you are unable to ascertain what the weather is likely to do in the next few hours.

5. A study of *all* the weather information *available* to you before you start the flight (see figs. 3, 4, and 5 of the appendix) will allow you to deduce that
1——it is not possible to estimate what the weather is likely to do in the next few hours.
2——turbulence and surface winds are likely to be your principal enroute weather problems.
3——scattered thunderstorms will probably occur along your route before *1200* MST.
4——it would be best to fly as low as terrain and obstruction clearance will permit because of more favorable winds.

6. Your World Aeronautical Chart 405 is based on the Lambert Conformal Conic Projection, a chart projection which is much used for aeronautical charts because
1——scale errors are small, so for all practical purposes, scale may be considered constant over a single sheet.
2——it affords a simple and satisfactory solution for all problems of navigation, both rhumb line and great circle.
3——its directions conform very closely to directions on the earth.
4——all of the above are true.

NOTE: See figure 22 in the appendix for a diagram of this projection.

7. Pressure altitude and indicated altitude are approximately the same at 5,000 feet *above the ground* over Tucson, Arizona. Indicated airspeed is 170 m.p.h. If you use the TUS FD (Winds-Aloft Forecast) given in figure 4 of the appendix, you determine that
1——TAS is approximately 197 m.p.h.
2——TAS is approximately 183 m.p.h.
3——TAS is approximately 190 m.p.h.
4——there is not enough information available to find true airspeed.

NOTE: Assume CAS (Calibrated Airspeed) to be identical to IAS.

8. The statements listed below concerning the 1:00 a.m. EST surface weather map (see fig. 6 of appendix) may or may not be correct.
A. Tropical maritime air is south and east of the front while polar maritime air lies northwest of the front.
B. The front which extends eastward from Salt Lake City is an occluded front.
C. The front which extends eastward from Salt Lake City is a stationary front.
D. The isobar of lowest pressure that can be identified is the 1004.0-millibar line.
E. The isobaric pattern is such that the surface winds over the area pictured should be moderately strong (25 to 30 knots).
F. The surface wind at Winslow, Arizona, is from the north.
G. The surface temperature is 67° F. and dewpoint is 29° F. at Winslow, Arizona.

In selecting all the correct statements from the preceding, you would include items
1——A, B, E, and G.
2——A, C, D, and G.
3——C, D, and G.
4——B, E, and F.

9. Your weight .....165 lbs.
Front seat passenger weight ..150 lbs.
Rear seat passenger weight ..365 lbs.
Fuel .....Full
Oil .....Full
Baggage .....150 lbs.

Using the above information, together with data from the Aircraft Description in figure

8, you are able to determine through use of the Loading Graph and Center of Gravity Envelope Graph (fig. 10 of the appendix) that

1——your gross weight and balance requirements are both within limits.
2——your weight is in excess of maximum gross limit and until it is within limits it would be a waste of time to attempt to evaluate the center of gravity condition.
3——both weight and balance conditions are outside of established limits.
4——it is not possible to determine if the weight and balance conditions are within limit on the basis of information supplied.

10. If you were to drain 21 gallons of fuel from your tanks, you will

1——be within all placarded limitations.
2——still exceed placarded baggage limitations.
3——still exceed gross weight and balance limitations.
4——still be unable to figure your weight and balance problems because there is not enough information.

Your flight is comparatively short with two intermediate stops, so you decide to drain 21 gallons of gas and readjust your load in order to provide for better aircraft performance as well as allow for other important considerations.

11. You plan to remain VFR at all times, and to avoid turbulence as much as possible, you plan to fly more than 3,000 feet above the ground enroute. Your enroute altitude

1——would be indeterminable until you compute the magnetic heading.
2——should be odd thousand plus 500 feet from Gallup, New Mexico, to Holbrook, Arizona.
3——should be odd thousand plus 500 feet.
4——should be even thousand plus 500 feet.

12. Concerning Airport Traffic Area Rules as required by Federal Aviation Regulations, which of the following statements apply?

A. An Airport Traffic Area is defined as the space included within a 5-statute-mile horizontal radius of the geographical center of an airport and extending up to (but not including) 2,000 feet above the surface of the airport at which an operative traffic control tower is located.
B. Aircraft, when operating to or from an airport having a tower operated by the United States, shall normally maintain two-way radio communication with that tower while in the Airport Traffic Area.
C. Pilots operating under VFR conditions with aircraft having adequate radio equipment may, at their discretion, obtain Airport Advisory Service from those Flight Service Stations that are located on airports without control towers.
D. The basic VFR minimums when operating in an Airport Advisory Service Area are 5 miles visibility and 1,500-foot ceiling.
E. Unless he receives subsequent instructions to the contrary, a pilot who has been authorized by the tower to taxi "TO" a designated runway may cross any runways that intersect or cross his taxi route.

1——A, B, C, E.
2——A, B, C, D, E.
3——B, C, E.
4——A, B, C, E.

13. Refer to the *Airman's Information Manual* data in figures 14, 15, 16, 17, 18, and 19 of the appendix, and determine which of the following statements are ACCURATE.

A. The Holbrook Municipal Airport, Holbrook, Arizona, has only one runway.
B. The longest runway at Holbrook Municipal Airport is between 4,070 and 5,069 feet in length.
C. A Flight Service Station is located on the Tucson Municipal Airport, Tucson, Arizona.
D. Neither the Holbrook nor the Flagstaff Airport has UNICOM facilities.
E. Both the Holbrook and the Flagstaff Airports have the proper fuel for your airplane.

F. At Prescott, Arizona, Runway 3–21 is closed for takeoff and landing until further notice.

1——A, B, D, E.
2——C, E.
3——B, E.
4——B, D, F.

14. Of the airports where you intend to land along your route of flight, only the Winslow Municipal Airport, Winslow, Arizona, is within a control zone. If you were to land here, your basic VFR minimums would

1——be the same as for the other airports where you intend to land.
2——require 5 miles visibility and a ceiling of 1,500 feet.
3——require 3 miles visibility and a ceiling of 1,200 feet.
4——require 3 miles visibility and a ceiling of at least 1,000 feet.

LEG 1

15. If you were to select 10,500 feet MSL as your cruising altitude on the first leg of your flight, and at that indicated altitude found your pressure altitude to be 10,000 feet, your approximate compass heading and true airspeed should be

1——230° and 180 m.p.h.
2——229° and 173 m.p.h.
3——251° and 173 m.p.h.
4——251° and 179 m.p.h.

NOTE: Use an indicated airspeed of 150 m.p.h., outside air temperature of 10° C and the Winslow Winds Aloft Forecast (fig. 4). You need not interpolate the winds. (See fig. 9 for compass correction card.)

16. Assuming a gross weight of 2,900 lbs., together with a surface temperature of 73° F. and an estimated surface wind of 13 knots, your approximate takeoff distance to clear a 50-foot obstacle at Gallup, New Mexico, is

1——1,955 feet.
2——1,638 feet.
3——1,817 feet.
4——1,390 feet.

NOTE: Refer to the performance charts (fig. 12 of the appendix).

17. After your takeoff from Gallup, New Mexico, at 0830 MST, you notice as you climb out on course that you are passing through 8,800 feet. Which of the altimeter illustrations in figure 23 of the appendix indicates this altitude?

1——A.
2——B.
3——C.
4——D.

18. Assume that you have 33 gallons of usable fuel remaining after you reach 10,500 feet. Approximately how long can you fly with a power setting of 2200 r.p.m. and 19 inches of manifold pressure if you retain a 30-minute fuel reserve?

1——2 hours and 52 minutes.
2——5 hours and 6 minutes.
3——3 hours and 21 minutes.
4——None of the above are correct.

NOTE: Refer to the 10,000-ft. Cruise Performance Chart in the appendix, figure 13.

*19. While enroute to Holbrook, Arizona, you use ADF to tune in and properly identify the Winslow, Arizona, low frequency navigation aid. The proper setting for the function switch when warming up and tuning the ADF is

1——loop position.
2——antenna position.
3——compass position.
4——aural null position.

NOTE: See figure 24 for a picture of an ADF (radio compass).

*20. You are able to read the coded identifier for the Winslow L/MF facility satisfactorily, but repeated trials prove that there are neither "A" nor "N" quadrant signals, nor on-course signals. After a careful check of your equipment, the chart, and the Airport/Facility Directory of the *Airman's Information Manual* (figure 17 of the appendix), you decide

1——the L/MF ground facility is not functioning properly.
2——you have lost your sensing antenna.
3——your function switch was on the aural null position.
4——the Winslow L/MF navigation aid is no longer an L/MF radio range station.

LEG II

21. If you select 10,500 feet as your cruising altitude on the flight from Holbrook, Arizona, to Flagstaff, Arizona, and use an estimated indicated airspeed of 170 m.p.h., an outside air temperature of +15° C. and the Winslow Winds Aloft Forecast (fig. 4 in the appendix), you compute your estimated average groundspeed for this leg to be approximately

1——187 m.p.h.
2——175 m.p.h.
3——150 m.p.h.
4——None of the above.

NOTE: You need not interpolate winds. Assume pressure altitude and indicated altitude to be the same.

22. Assume that on this leg of the flight, conditions are favorable for carburetor icing. To properly cope with this condition, you should know that

A. in your airplane, the first evidence of carburetor icing would be a decrease in r.p.m., followed by engine roughness.
B. the first indication of carburetor icing is engine roughness, followed by loss of engine r.p.m.
C. in your airplane the first evidence of carburetor icing would most likely be a decrease in manifold pressure.
D. it is best to use carburetor heat as a preventive measure rather than as a measure to cure the icing condition.
E. it is best to wait until there is some evidence of carburetor icing before application of carburetor heat since application of heat when no ice is present will result in a lean mixture and possible detonation.

In selecting correct statements from the above list, you would include items

1——A and D.
2——B and E.
3——C and E.
4——C and D.

23. As you approach the Winslow, Arizona, VORTAC, you note that your course will cause you to cross the path of a four-engine jet. This crossing will be approximately 3 miles behind and slightly below the jet. If you are familiar with hazards involving turbulence in the wake of large aircraft, you would select which of the following as correct statements?

A. The main source of the disturbance or turbulence is the "jet wash" or "prop wash".
B. The main source of the disturbance or turbulence is the vortex created by the wing tips.
C. Large, heavy, slow flying aircraft produce the most violent turbulence or vortices.
D. The violent, compact, tornado-like air masses associated with this phenomena can cause loss of aircraft control or even structural failure.
E. Under the circumstances described, you are too far from the jet to be affected by this invisible hazard.
F. If you encounter this hazard in cruising flight, you should decrease speed as fast as possible, avoid "fighting the controls", and if possible change altitude.
G. If taking off or landing behind large aircraft, fly up-wind of their track, KEEP PLENTY OF DISTANCE, and request delay from the tower on takeoffs and landings if in doubt about wake turbulence or spacing.
H. Helicopters can create conditions of vortex turbulence similar to that produced by fixed-wing aircraft and you should stay above their flight path.

1——B, C, D, F, G, and H.
2——A, D, E, F, and G.
3——A, C, D, E, and G.
4——B, E, F, and H.

24. If, for some reason, you were to lose your visual references while taking evasive action with regard to the jet, and a check of your instruments showed the readings pictured in figure 25 in the appendix, which of the following statements are true? You are in a

A. coordinated, descending turn to the right, and should first reduce power and bank to return to level flight.

B. coordinated, descending turn to the right, and should first add power and increase back pressure to return to level flight.
C. skidding, climbing turn to the left.
D. nose-high attitude.
E. nose-low attitude.
F. 20° bank, approximately.
G. standard rate turn.
1——A, D, F, and G.
2——B, E, F, and G.
3——A, E, F, and G.
4——C and D only.

NOTE: Assume a 2-minute turn needle on the turn-and-bank indicator.

25. Assume that you now find yourself in a coordinated level turn with a 40° bank. Your present gross weight, when in straight and level flight, is 2,800 pounds. Referring to the illustrations in figure 26 in the appendix, which of the following statements are correct?

A. In the situation depicted in illustration A, your approximate effective gross weight is 3,360 pounds.
B. Your rate of turn is the same for situation A, B, and C, but the radius of turn increases as the speed increases.
C. The radius of turn remains constant for situations A, B, and C, but the rate of turn will increase as the speed increases.
D. The radius of turn is less, but the rate of turn is greater in situation A than in either B or C.
E. The load factor increases as the speed increases.
1——B and C.
2——A, C, and D.
3——A, B, and D.
4——A and D.

26. Soon after leveling off on-course, you encounter moderate turbulence and quickly you check your airspeed indicator which appears in figure 27 of the appendix. If you wished to remain at or below maximum structural cruising speed, you could not exceed

1——252 m.p.h.
2——10 m.p.h. less than red line speed.
3——210 m.p.h.
4——None of the above are correct.

*27. In the vicinity of Winslow, Arizona, you decide to combine ADF navigation and pilotage. You tune in and identify the Winslow low frequency radio aid to navigation. You next place the ADF function switch on COMP. After the ADF needle holds a steady indication, you check your magnetic heading and the ADF readings. Their indications are shown in figure 28 in the appendix. This means you have a

1——magnetic bearing of 45° to the station and that you are southwest of the station.
2——relative bearing of 45°, but your bearing to the station cannot be determined with the information supplied.
3——magnetic bearing of 315° to the station, and that you are southeast of the station.
4——magnetic bearing of 45° to the station and that you are southeast of the station.

NOTE: Assume a nonrotatable azimuth dial on the ADF.

28. You are ready to land on Runway 21 at Flagstaff, Arizona, Municipal Airport, after a total flying time of 1 hour and 5 minutes since leaving Gallup, New Mexico. Fuel consumption has been at the rate of 10 gallons per hour. Surface wind is 20 knots from 210°, and surface temperature is 75° F. You will use 40° of flaps for the landing. Referring to the landing table in figure 12 of the appendix, your landing distance for clearing a 50-foot obstacle is approximately

1——834 feet if the temperature were standard at your altitude.
2——973 feet regardless of the temperature.
3——1,390 feet.
4——645 feet.

NOTE: Interpolate weight to the closest 500 pounds, altitude to the closest 500 feet, and wind to the closest 6 m.p.h. Assume takeoff gross weight was 2,900 pounds.

LEG III

29. It is 1700 MST before your clients are ready to take off for Williams, Arizona. A check of the *latest* area forecast, terminal forecast, and in-flight weather advisories in

figures 3, 4, and 5 of the appendix indicates that there should be

1——only scattered clouds at 8,000 feet above the ground, and turbulence should remain about the same as the evening progresses.

2——increasing turbulence and decreasing clouds as the evening progresses.

3——no ceilings below 10,000 feet MSL, and turbulence should gradually decrease.

4——scattered clouds at 8,000 feet, broken clouds 12,000 — 15,000 above ground, and gradually decreasing turbulence.

30. After departing Flagstaff, Arizona, you wish to "dog-leg" your direct route so as to stay away from the Restricted Area (R–2302), 7 miles west of Flagstaff, and yet stay close to the highway and railroad to Williams. You tune in and identify the Winslow VORTAC with the omni bearing selector set on 270°. If you did not know your position and used *only* your omni, which reads as illustrated in figure 29 in the appendix, you would know that you are

1——on the 90° radial and flying toward the station.

2——on the 270° radial and flying away from the station.

3——unable to determine at the moment where you are going, but you are on the 270° radial.

4——unable to determine *anything* about where you are, or where you are going.

31. Assume that in taxiing to the flight line at the Williams Municipal Airport, Williams, Arizona, your nosewheel collapses causing damage in excess of $300.00. If you were unsure about accident reporting procedures, you could find the necessary information in

1——Part 61, Federal Aviation Regulations.

2——Part 67, Federal Aviation Regulations.

3——Part 1, Federal Aviation Regulations.

4——Civil Aeronautics Board, Safety Investigation Regulations Part 320.

32. Usually the first measure appropriate for control of detonation on takeoff in an aircraft with constant speed propellers is the

1——reduction of manifold pressure.

2——reduction of r.p.m.

3——adjustment of mixture to a leaner setting.

4——application of carburetor heat.

* Indicates questions that are applicable primarily to the Ground Instructor—Advanced Examination.

ANSWERS AND EXPLANATIONS

Section 1 — Fundamentals of Instructing

1. (1) Alternate #2 is incorrect because it refers only to one of the factors which affect reliability, not the complete evaluation of reliability. Alternate #3 has nothing to do with reliability of a test. Alternate #4 is the definition for validity.

2. (3) Alternates #1 and #2 are not complete. Alternate #4, while useful, is not as essential to success in teaching as item #3.

3. (3) All of the other responses are means of effecting improvement, not clues to determining the need for improvement.

4. (1) The statements made in this question cover a broad range of items; however, the correct response may be found in *Flight Instructor's Handbook*, AC 61–16. Response #2 is incorrect because every item included in it is incorrect. Response #3 is incorrect because items D, E, and L are incorrect. Response #4 is incorrect because it includes item G.

5. (4) All the alternate responses will test for rote memory on ability to deal with familiar problems which, in themselves, will not effectively prove that the student *understands* what he knows.

Section 2 — Aeronautical Knowledge

1. (2) FAR 91.5, *Preflight Action*, states: "Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include, for a flight under IFR or a flight not in the vicinity of an airport, available weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which he has been advised by ATC."

2. (4) The 0700 Sequence Report for GNT shows the letter "C" in the space denoting surface wind which designates a calm wind condition.

3. (4) The reported layer of *thin* broken clouds at 12,000 feet does not constitute a ceiling. (Reference *Aviation Weather* AC 00–6, and Part 1 of the Federal Aviation Regulations.)

4. (4) The study of hourly sequence reports *only* will not furnish sufficient information to make a route forecast of your own. (Reference *Aviation Weather* AC 00-6.)

5. (2) The terminal forecasts call for surface winds in this area to be 20 to 30 knots. The in-flight advisory calls for light to moderate turbulence below 14,000 feet until at least 1900M. Area forecasts covering the period between 0600 MST and 1800 MST call for light to moderate turbulence with locally severe turbulence in some areas. The 1245Z Pilot Report Summary supports the Terminal and Area Forecasts and In-Flight Advisory.

6. (4) The first three statements are all true. (Reference p. 16–28, *Practical Air Navigation*, 9th edition.)

7. (1) Using a pressure altitude of 7,630 (5,000 feet plus ground elevation at TUS), and a forecast temperature of +20° C., (you must interpolate the temperature between 5,000 feet and 10,000 feet) your computer should indicate approximately 197 m.p.h. TAS opposite a CAS of 170 m.p.h. Normally the indicated airspeed should be corrected for instrument and installation errors to calibrated airspeed. This can be done through the use of an airspeed correction table as shown in figure 30. Remember, calibrated airspeed (CAS) is the same as true indicated airspeed (TIAS).

8. (2) The air mass to the south and east of the front is composed of tropical maritime air as represented by the symbol "MT" located in the Texas Panhandle. The air mass to the northwest of the front is composed of maritime polar air as represented by the symbol "MP" located in Northern California. (Reference *Aviation Weather* AC 00-6.) The portion of the front extending eastward from Salt Lake City is stationary as indicated by a combination of the warm front and cold front symbols and their placement (opposing) on the frontal line. (Reference *Aviation Weather* AC 00–6.)

Isobars are lines connecting points of equal pressure. The line curving into Nevada from Cedar, Utah, and back to the front at a point north of Salt Lake City, Utah, represents a pressure of 1004.0 millibars as indicated by the figure "1004." (Reference *Aviation Weather* AC 00–6.)

The figure "67" at the 10 o'clock position and the figure "29" at the 8 o'clock position on the Winslow station model represent a temperature of 67° F. and a dewpoint of 29° F. respectively. (See the specimen station model in fig. 6.)

9. (2) The empty weight, including unusable fuel, is 1839 lbs. (figs. 8 and 11). The empty weight moment is approximately 65,900 pound-inches (empty weight X empty C.G.).

LOADING PROBLEM

	Weight in Pounds	*Moment in Thousand Pound-Inches*
Airplane (empty)	1839	65.9
Pilot and Front Seat Passenger	315	11.5
Rear Seat Passengers ..	365	25.4
Fuel (55 gal. @ 6 lbs. per gal., fig. 9)	330	15.8
Oil (3 gal. @ 7.5 lbs. per gal., fig. 9)	22.5	—.4
Baggage	150	14.1
TOTAL	3021.5	132.3

In this particular instance it is not possible to state with absolute certainty that the airplane is not within safe balance limits even though it exceeds weight limits. The moment of 132.3 does lie within the extended lines on the chart which delineate the forward and rearward C.G. limits. In reality, the question becomes rather academic since you could not legally take off with a gross weight of 3021.5 pounds, regardless of the situation with regard to C.G. Your gross weight is 121.5 pounds in excess of the maximum allowable gross weight; therefore, you must reduce the load to 2900 pounds or less and recompute the center of gravity. (Reference figures 10 and 11, and *Flight Training Handbook*, AC 1–21.)

10. (2) The draining of 21 gallons (126 lbs.) of fuel would reduce the gross weight below the maximum allowable, but the baggage weight still would exceed maximum allowable weight of 125 pounds in the baggage compartment. (Reference fig. 8.)

11. (4) When an aircraft is operated in level cruising flight at 3,000 feet or more above the surface, the cruising altitudes . . . shall be observed:

(a) "Below 18,000 feet. At an altitude appropriate to the magnetic course being flown as follows:
(1) ". . ."
(2) "180° to 359° inclusive, at even thousands plus 500 (4,500; 6,500; etc.)." (Reference FAR 91.109.)

12. (1) Statements A, B, C, and E are correct. (Reference FAR 1, *Definitions*, for Statement A; FAR 91.87, *Operation at Airports with Operating Control Towers*, for Statements B and E.

13. (3) Statements B, C, and E are accurate and may be verified by referring to figures 14, 15, 16, and 17 in the appendix. A careful analysis of figures 14, 15, 16, 17, and 19 will reveal that statements A, D, and F are erroneous.

14. (4) Regulations pertaining to *basic* VFR minimums state that an aircraft shall not be flown within a control zone beneath the ceiling if the ceiling is less than 1,000 feet. Neither shall any person operate an aircraft in flight within a control zone when the flight visibility is less than 3 miles. When ground visibility is less than 3 miles no person shall take off or land an aircraft, or enter

the traffic pattern of an airport within a control zone. Study FAR 91.105.

15. (1) Given Indicated Airspeed
——150 m.p.h.
Given Pressure Altitude
——10,000 Feet
Given Outside Air Temperature
—— +10° C.
Computed True Airspeed
——180 m.p.h.
Plotted True Course
——243°
Figure 4—Wind
——230°/29 m.p.h. (25 knots)
Computed Wind Correction Angle
—— −2°
Computed True Heading
——241°
Chart Magnetic Variation
——14° E.
Computed Magnetic Heading
——227°
Figure 10 (intermediate) compass deviation
—— +3°
Computed Compass Heading
——230°

16. (2) The elevation of McKinley County Airport at Gallup, New Mexico, is 6,467 feet. Referring to the takeoff data chart in figure 12, you will note that interpolation between the 5,000-foot and 7,500-foot column will be necessary. Enter the chart at the 2900 lb. gross weight block and read across (right) on the 15 m.p.h. (13 knots) line to:

5,000 ft.—1,200′ to clear 50′ obstacle
7,500 ft.—1,580′ to clear 50′ obstacle
Difference—380′
Interpolate for 6,467 feet—59% of 380′ plus 1,200 feet (in actual practice 60% would probably be more desirable)
6,467 feet—1,424′ to clear 50′ obstacle (*with standard temperature*)
Interpolated standard temperature for 6,467 feet is +36° F. Current temperature of +73° F. will necessitate increasing the takeoff distance by 15% (current temperature is 37° higher than standard).

Final Computed Takeoff Distance at Gallup is *1,638* feet.

17. (2) The altitudes indicated by the four altimeters are as follows:

A. 880 feet.
B. 8,800 feet.
C. 18,800 feet.
D. 7,880 feet.

18. (1) Figure 13 in the appendix shows a fuel consumption of 9.8 gal./hr. at 10,000 feet with a power setting of 2200 r.p.m. and 19 inches of manifold pressure. Subtracting the 30-minute fuel reserve from the total of 33 gallons leaves 28.1 gallons of fuel (33 gallons—4.9 gallons). Burning 28.1 gallons of fuel at the rate of 9.8 gallons per hour would permit 2 hours 52 minutes of flying. Study the charts until you understand their use.

19. (2) When tuning a radio compass, the set should be allowed to warm up with the switch in the "Antenna" position.

20. (4) A careful check of the excerpt from the *Airman's Information Manual*, figure 17, shows that the Winslow low frequency facility is now classified as RBN H-SAB. From the information in figure 17, we find that this means it is a non-directional radio beacon providing automatic transcribed weather service (TWEB). The WAC Chart is not current in the information it provides with regard to this radio navigation aid. This illustrates one of the reasons why some of the information which appears on charts must be cross-checked against appropriate supplemental sources of information. *Use* the *Airman's Information Manual* in planning and conducting flights. Study chapter 4 of *Practical Air Navigation*. Note in particular the last paragraph on page 58.

21. (1) You must first correct indicated airspeed to true airspeed. An indicated airspeed of 170 m.p.h. at 10,500 feet and +15° C. results in a true airspeed of 207 m.p.h. To compute the average groundspeed you could either use an average true course and apply the wind to this or apply the wind to each segment of the leg and average the resulting groundspeeds. It should be noted that technically this procedure is not abso-

lutely accurate since it is 10 miles more from the INW to Flagstaff than from Holbrook Airport to INW VORTAC. However, the difference in groundspeeds over the two segments is negligible; therefore, the time difference would be slight. The INW winds aloft forecast shows the wind at 10,000 feet is from 230° true, at approximately 29 m.p.h. Whether you apply this wind to an average true course of 279° or to the exact true course for each segment and average the resulting groundspeeds, the answer is the same—187 m.p.h.

22. (4) In aircraft with constant speed propellers, loss of power is first reflected in the manifold pressure reading since the propeller governor will maintain the r.p.m. setting made with the propeller control. Engine roughness generally does not develop to a noticeable degree until icing has progressed beyond the point where it could have been recognized by loss of manifold pressure. It is far easier and safer to prevent the formation of carburetor ice than to remove it after it has formed. Study chapter 18 of *Private Pilot's Handbook of Aeronautical Knowledge.*

23. (1) This problem is covered in detail in Exam-O-Gram No. 3 and Advisory Circular 90–23, *Wake Turbulence* (information available at General Aviation District Offices or through the FAA, Washington, D. C. 20553). You should study both of these publications carefully.

24. (3) The quality of a turn (slipping, skidding, coordinated) is indicated by the position of the ball in the turn-and-bank indicator. If the ball is in the center between the two reference markers, the turn is coordinated. The aircraft is in a nose-low attitude since the attitude indicator (artificial horizon) shows the nose below the horizon and the other instruments show a descent. Even if the attitude indicator were malfunctioning, it is scarcely possible to be in other than a nose-low attitude in your airplane with the airspeed, vertical speed, and altimeter indicating as illustrated. The attitude indicator shows a 20° bank to the right (each of the small graduations on the scale at the top of the instrument is for 10°). The turn needle also indicates a turn to the right at a standard rate. Reduce power, decrease bank, and then apply back pressure as necessary to recover when the nose is low and the airspeed is increasing. This is much safer than adding back pressure first which might well increase the load factor beyond safe limits.

25. (4) The load factor for a 40° bank is determined by using the graph in figure 27. This graph gives a load factor of approximately 1.31 for a 40° bank. Multiplying 2800 by 1.31 results in an effective gross weight of 3,360 lbs. In order to maintain a given rate of turn, the angle of bank must be varied with the TAS. If, for example, you wish to hold a standard rate turn of 3° per second at a true airspeed of 100 m.p.h., your angle of bank will be 13.5°. The bank required to produce this same rate of turn at 200 m.p.h. TAS is nearly double the bank required at 100 m.p.h. It now becomes 25.6°; therefore, the rate of turn must decrease if the TAS increases while the bank remains constant. It then follows that any given bank at slow speed provides a higher rate of turn and results in a smaller radius of turn than the same degree of bank at higher speeds.

26. (3) Maximum structural speed (V_{no}) is the maximum speed for normal operation. It is located at the juncture point of the lower limit of the yellow arc (caution), and the upper limit of the green arc (normal operating range) on the face of the airspeed indicator. Study Exam-O-Gram No. 8 and FAR 23.1545.

27. (3) The magnetic bearing to the station is the magnetic heading ± the relative bearing. 270°, the magnetic heading, plus 45°, the relative bearing, is 315°, the magnetic bearing *to* the station. If the magnetic bearing to the station is 315°, then the magnetic bearing *from* the station is the reciprocal of this, or 135°. A magnetic bearing of 135° from the station places you southeast of the station. Because of meridian convergence and possible difference in variation values between the location of the station and the location of the aircraft, certain errors are inherent to the use of radio bearings. Therefore, the serious student should study carefully chapters 11 and 14 of *Prac-*

study carefully chapters 11 and 14 of *Practical Air Navigation* (9th Edition).

28. (1) Flying for 1 hour 5 minutes burning fuel at the rate of 10 gallons per hour would mean a gross weight reduction of approximately 65 pounds. Interpolating weight to the closest 500 pounds would mean using a weight of 2,900 pounds for the following computation:

(a) A 20-knot headwind equals 23 m.p.h.

(b) 24 m.p.h. means a 40% reduction in landing distance.

(c) Field elevation of Flagstaff is 7,012 feet; thus the closest 1,000-ft value is 7,000 feet.

(d) Interpolating on the chart, with a gross weight of 2,900 lbs. at 7,000 feet and standard temperature, the landing distance to clear a 50′ obstacle is *1,390* feet.

(e) A 40% reduction of 1,390 feet is 556 feet.

(f) Subtracting 556 feet from 1,390 feet equals 834 feet.

(g) This figure is valid only if the temperature is standard at 7,000 feet.

29. (3) The latest weather information in figures 3 and 4, pertaining to those items mentioned in the question are:

*FA 1845Z
*FT 2245Z
*FL 2320Z

Area forecasts report heights of cloud bases above mean sea level, not the ground, unless stated to the contrary. Cloud bases on terminal forecasts are reported in feet above the ground. A check of the terminal and area forecasts reveals that in both instances clouds are forecast to be above 10,000 feet MSL. The 2320Z AIRMET indicates that the moderately turbulent conditions existing below 14,000 feet in northern New Mexico and Arizona should decrease to light turbulence by 1900 MST. Study Chapter 17, *Aviation Weather*.

30. (3) With the information supplied, you cannot fix your location by use of omni alone, but under the circumstances given here you can only determine that you are on the 270° radial. At any given moment, omni alone tells you only where you are and *not* where you are going. Only by relating the course selector value and the TO-FROM indication to the magnetic compass reading can you determine whether you are actually going TO the station or FROM the station on the selected radial or simply crossing that radial. Even after you have determined which radial you are on you can determine your position or "fix" along this radial only by use of geographical landmarks, or an accurate groundspeed estimate, or by a cross-bearing from another station. For a more detailed explanation of omni (VOR) and its use, study chapter 2 of the 1965 edition of the *Private Pilot's Handbook of Aeronautical Knowledge*, chapter 13 of the 9th edition of *Practical Air Navigation*, and Exam-O-Grams 15 and 16.

31. (4) Figure 21 gives an explanation of how to report an accident and refers to the Regulation which pertains to this requirement.

32. (1) Horsepower is a function of both torque and r.p.m. That is, an engine can deliver the same brake horsepower (b.h.p.) at different combinations of crankshaft r.p.m. and crankshaft torque. The pilot, through adjustment of throttle and r.p.m., exercises control over these factors. One of the basic limitations placed on engine operation is the amount of pressure developed within a cylinder as controlled by combination of torque and r.p.m. values. An increase in these values will increase pressure and pressure will increase power. It will also increase the loads imposed on the engine, and if they are not controlled or kept within limits, it can ultimately result in engine failure. Power is therefore limited by the pressures developed within the cylinders. The most convenient way of estimating cylinder pressure is through the index of Brake Mean Effective Pressure (BMEP).

The limits of operation within which the accepted degree of reliability can be obtained are known as engine ratings. Takeoff power

* See figure 2 for meaning of code.

generally approaches the limits of these ratings for an engine. If detonation should occur on takeoff, the throttle should be retarded in order to reduce the cylinder pressure. A reduction of r.p.m. will cause an *increase* in BMEP, and only aggravate the condition. Adjustments of mixture may produce just the opposite of results desired if the cause of the detonation is improperly evaluated. Application of carburetor heat with full power setting will tend to cause or increase detonation.

WEATHER INFORMATION

ABQ—Albuquerque, New Mexico
FMN—Farmington, New Mexico
FLG—Flagstaff, Arizona
GNT—Grants, New Mexico
INW—Winslow, Arizona
PHX—Phoenix, Arizona
PRC—Prescott, Arizona
SAF—Santa Fe, New Mexico
TUS—Tucson, Arizona
ZUN—Zuni, New Mexico

FIGURE 1. *Station identifiers.*

1. FT1—12-hr. Terminal Forecasts
2. FT2—24-hr. Terminal Forecasts
3. FA —Area Forecasts
4. FD —Winds Aloft Forecasts
5. FL —In-Flight Advisory
   a. SIGMET—Weather significant to safety of all aircraft.
   b. AIRMET—Weather potentially hazardous to light, single, and multiengine aircraft.
6. UA —Pilot Report Summary
7. SA —Hourly Sequence Report
8. WW—Severe Weather Forecasts
9. AC —Severe Weather Outlooks

FIGURE 2. *Letter designators for reports and forecasts.*

WEATHER INFORMATION

Albuquerque Area Forecast

FA ABQ 111245Z
ø6M-18M FRI (0600 MST—1800 MST FRI)
NRN ARIZ NRN NEW MEX
CLDS AND WX. MOSTLY CLR WITH OCNL -◐ ABV 18ø MSL. SCTD CU DVLPG OVR MTNS BCMG 14ø-15ø◐ MSL DURG THE AFTN WITH A FEW HIGH LVL SHWRS OVR THE MTNS. SFC WNDS W OF CONTDVD LCLY UP TO 1825G BY 11øøM
ICG. LGT ICGIC. FRZG 135-145
LGT TO MDT TURBC. MDT TURBC TO 15ø DVLPG BY LATE MRNG WITH LCL SVR TURBC VCNTY HIER MTNS AND NEAR SHWRS
OTLK 18M FRI-06M SAT. NO RSTV WX

FA ABQ 111845Z
12M FRI-ØØM SAT (Noon Friday—Midnight Friday)
NRN ARIZ NRN NEW MEX
CLDS AND WX. ERN PLAINS OF NRN NEW MEX 11ø-12ø◐MSL CLRG AFT 22ØØM. NRN ARIZ AND RMNDR NRN NEW MEX 13ø◐MSL WITH ABV 15ø◐V⊕MSL BRFLY 12ø◐ MSL IN FEW SHWRS DURG EVE HRS. AFT 21M ABV 15ø◐V◐MSL
ICG. NONE. FRZG LVL 12ø-135 MSL
TURBC. MDT FOR LGT ACFT DCRG DURG EVE BCMG LGT AFT 2ØM
OTLK ØØM-12M SAT. CLR OR ABV 15ø◐ MSL DURG MRNG HRS. AFT 12M SCTD CU BASES 12ø MSL BRFLY BRKN OVR MTNS IN FEW SHWRS

FIGURE 3. *Albuquerque area forecasts.*

Albuquerque Terminal Forecasts

FT1 80 111045Z
04M-16M FRI (0400 MST—1600 MST)
INW O. 1200M 90◑ 2325
PRC O. 2012. 1000M 80◑+100◑ 2020
FLG O. 1000M 70◑+100◑ 2020
FMN O. 1200M 90◑ 2320
ABQ O. 1300M 100◑ OCNLY 2325
FT1 30 112245Z
16M FRI-04M SAT (1600 MST FRI—0400 MST SAT)
INW 80◑+100◑ OCNLY 2525G. 1900M +100◑
PRC 80◑C+120◍ 2320G30. 1900M C+150◍. 2200M +150-◍
FLG 80◑C+120◍ 2020G. 1900M C+120◍ 2325G. 2200M+100-◍
FMN C80◍ 2320 OCNLY 70◍ BRF RW—VCNTY 2000M C+100◍
ABQ 80◑+100◑ 2020 OCNLY C80◍ 2525G30. 1900M+100◑

NOTE: FMN (Farmington, New Mexico) is approximately 180 Statute Miles N. E. of Winslow, Arizona.

Winds Aloft Forecasts (FD)

03M-15M (0300 MST—1500 MST)

LVL	3000	5000-FT	7000	10000FT	15000FT	20000FT
INW			2020	2325+12	2730+03	2740-10
PHX	1915	1920+24	2025	2030+13	2040+02	2140-10
TUS		2715+25	2720	2830+15	2940+05	3040-10

Albuquerque In-Flight Weather Advisories

FL ABQ 111345Z
0645M—1045M FRI
AIRMET ALPHA 1. NRN ARIZ AND W OF CONTDVD IN NWN NEW MEX LGT TO LCLY MDT TURBC BLO 80 MSL WITH STNG DOWNDRAFTS OVER LEE SLPS
FL ABQ 112320Z
1620M-1900M FRI
AIRMET ALPHA 2. NRN ARIZ NRN NEW MEX MDT TURBC BLO 140 MSL DCRG BCMG LGT BY 1900M

FIGURE 4. *Albuquerque forecasts and in-flight weather advisories.*

Albuquerque Pilot Report Summaries

ABQ UA 111245Z
GNT—40 W GNT MDT TURBC 105 BN35. FLG AREA LGT TURBC SFC TO 105 PA23. 50 E PRC LGT MDT TURBC 105 PA24. ZUN—INW MDT TURBC 9500 C 310
ABQ UA 111625Z
ZUN V-62 SAF MDT TURBC 120 C 182
INW—PRC MDT OCNLY SVR TURBC 105 PA22
ZUN-GNT MDT TURBC ICRG 9500 C 172

Hourly Sequence Weather Reports
07M

SA33 111400Z
PRC 14ø-⏀2ø+ø64/6ø/32/181ø/985
FLG 12ø-⏀15+ ø55/55/18/1812G18/993
INW 1øø⏀6ø ø45/55/26/181ø/998
ZUN 12ø⏀2ø+ ø7ø/55/3ø/2øø5/995
GNT 12ø-⏀35 ø65/55/31/øøøø/øø1
PHX 9ø⏀12ø-◍45 ø75/7ø/3ø/27ø4/HK ALQDS
TUS E15ø◍/◍5ø ø6ø/75/35/181ø/983

Hourly Sequence Reports
08M

SA33 111500Z
PRC 13ø⏀45 ø67/68/31/2718/991
FLG 12ø⏀2ø+ ø65/6ø/3ø/2ø15/993
INW 1øø⏀6ø+ ø47/65/31/1815/989
ZUN 1øø-◍25 ø65/6ø/33/231ø/999
GNT 12ø⏀/-⏀35 ø6ø/65/32/181øG15/øøø
PHX 1øø⏀12ø-◍35 ø82/75/33/27ø5/HK ALQDS
TUS E15ø◍U⊕7ø ø75/75/32/2315/985

FIGURE 5. *Albuquerque pilot report summaries and hourly sequence reports.*

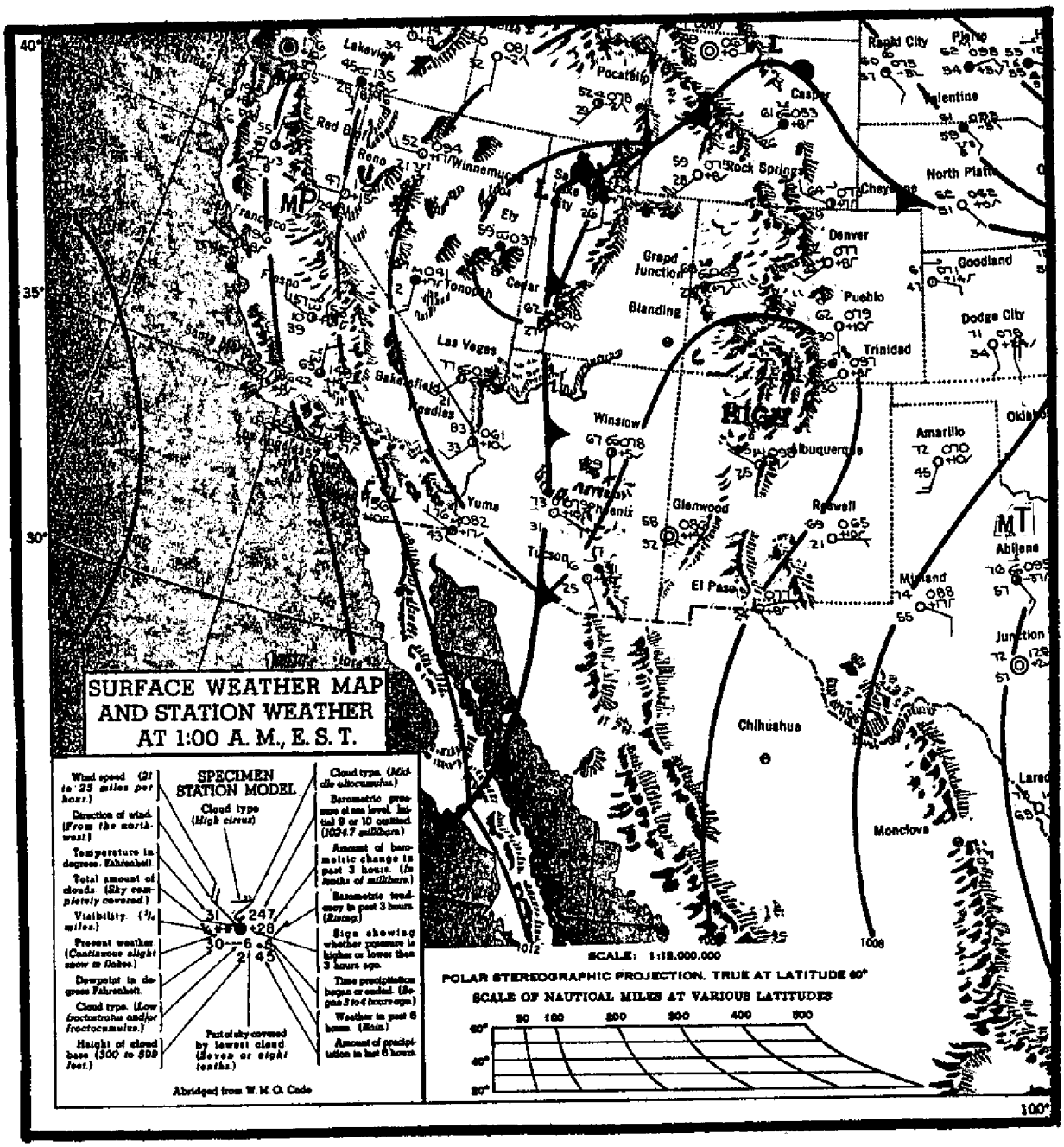


FIGURE 6. *Daily weather map excerpt—1:00 a.m. EST.*

Standard time zone	Letter designator	Meridian (degrees)	To convert to GMT, add (hours)--
Atlantic	. . . . .	60	4
Eastern	E	75	5
Central	C	90	6
Mountain	M	105	7
Pacific	P	120	8
Yukon	Y	135	9
Alaskan	A	150	10
Bering.	B	165	11

FIGURE 7. *Meridians of standard time zones and conversion to Greenwich (Z) time.*

AIRCRAFT DESCRIPTION
PLACARDS IN THE AIRPLANE

THIS AIRPLANE MUST BE OPERATED AS A NORMAL CATEGORY AIRPLANE. NO ACROBATIC MANEUVERS (INCLUDING SPINS) APPROVED

IDENTIFICATION: N 2468W.

MAXIMUM GEAR OPERATING SPEED: 135 mph, CAS.

MANEUVERING SPEED: 130 mph, CAS.

MAXIMUM ALLOWABLE WEIGHT IN BAGGAGE COMPARTMENT: 125 lbs.

The following information is excerpted from the AIRPLANE FLIGHT MANUAL.

ENGINE OPERATION LIMITATION:
Power and Speed 260 bhp at 2625 rpm.

FUEL SYSTEM: The engine is approved for 100/130 fuel only. Fuel is supplied from 2 tanks of 32.5 gallons total capacity each.

Separate electric gauges indicate the quantity in each tank. The gauges read empty when the level is down to 5 gallons since the last 5 gallons in each tank are unusable. The airplane is equipped with an electrically-driven auxiliary fuel pump for standby use in the event the engine-driven pump fails.

OIL: The engine uses a wet-sump, full-pressure oil system. The oil capacity is 12 quarts.

For temperature above 40° F use SAE 50; below 40° F use SAE 30.

PROPELLER: The propeller is a single-acting, hydraulic constant-speed type with two forged aluminum blades, controlled by an engine-driven governor.

HYDRAULIC SYSTEM: The landing gear and flaps are extended and retracted by hydraulic actuators, powered by an engine-driven hydraulic pump and a pressure accumulator.

ENGINE INSTRUMENT MARKINGS:

Oil Pressure Gauge	
Idling	10 psi (red line)
Normal Operating Range	80–60 psi (green arc)
Maximum Pressure	100 psi (red line)
Manifold Pressure Gauge	
Normal Operating Range	15–24 in. Hg (green arc)
Cylinder Head Temperature	
Normal Operating Range	300–460° F (green arc)
Do Not Exceed	460° F (red line)
Tachometer	
Normal Operating Range	2200–2450 rpm (green arc)
Maximum (Engine-rated speed)	2625 rpm (red line)
Fuel Quantity Indicators	
Less than one-quarter tank remaining	red arc to red line
Empty (includes 5 gallons each tank unusable)	E (red line)

EMPTY WEIGHT: 1839 lbs.

MAXIMUM GROSS WEIGHT: 2900 lbs.

FLIGHT LOAD FACTORS:

Flaps Up	+3.8, − 1.52
Flaps Down	+3.5

EMERGENCY PROCEDURES:

Emergency Gear Extension Procedure.

When the landing gear will not extend hydraulically, it may be extended manually as follows:

(1) Place the gear handle in the full down position.

(2) Pull the auxiliary pump handle out its full extension.

(3) Operate the auxiliary pump handle up and down until the green gear-down light comes on.

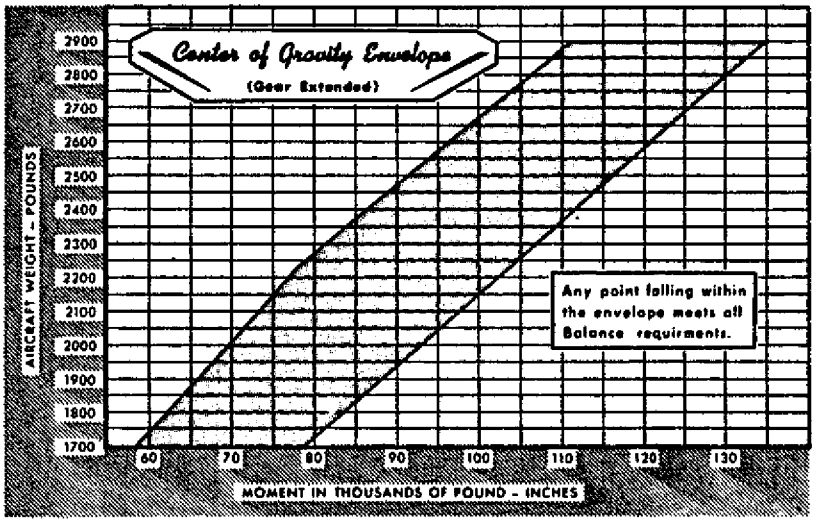
* * * * *

FIGURE 8. *Aircraft description, placards, and excerpts from* Airplane Flight Manual.

1. VHF transmitter ..... 118.1 mc to 126.8 mc.
2. VHF receiver with OMNI ..... 108.1 mc to 126.8 mc.
3. ADF receiver ..... 200 kc to 1750 kc.

COMPASS CORRECTION CARD											
FOR(MH) 0	30	60	90	120	150	180	210	240	270	300	330
STEER(CH) 0	28	56	88	120	151	183	216	240	268	296	328

FIGURE 9. *Radio equipment and compass correction card.*



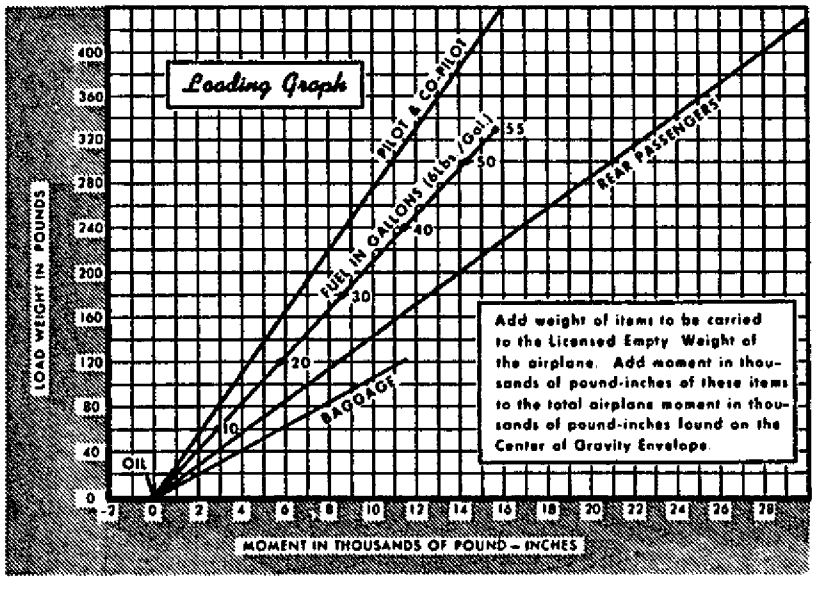


FIGURE 10. *Loading graph and center of gravity envelope.*

WEIGHT AND BALANCE

All airplanes are designed for certain limit loads and balance conditions. These limits for your aircraft are shown on the graphs for Figure 10.

An individual weight and balance report and equipment list is furnished with each airplane; these documents list the empty weight and empty weight center of gravity of the individual airplane as equipped when it left the factory. *Changes in equipment which affect the empty weight and empty weight center of gravity must be entered in the aircraft maintenance records in accordance with Federal Aviation Regulations.*

To determine that your gross weight and center of gravity for a given flight are within limits, use the following procedure:

(1) From the weight and balance report or the latest entry pertaining to weight and balance in the aircraft maintenance record.

(2) Determine the weights and moments of your disposable load items, using the loading graph.

(3) Add these items, as shown in the sample problem.

(4) Plot the totals on the center of gravity envelope graph.

EXAMPLE PROBLEM

Example for an airplane with a licensed empty weight of 1839 pounds and a moment of 65,873 pound-inches: (Empty weight of 1,839 lbs. multiplied by the number of inches the empty C. G. is from the datum—in this airplane 35.82 inches. The figure thus obtained is arbitrarily divided by 1,000, the moment in pound inches.)

	Weight Pounds	Moment (lb-in) 1000
Empty Weight (licensed)	1839.0	65.9
Oil (12 qts.)	22.5	−0.4
Pilot and Front Seat Passenger	340.0	12.2
Rear Seat Passengers	340.0	23.8
Full Fuel (55 gal.)	330.0	15.8
Baggage	28.5	2.7
TOTAL	2900.0	120.0

Locate this point (2900 – 120.0) on the center of gravity envelope graph. Since the point falls within the envelope the above loading meets all the balance requirements.

FIGURE 11. *Weight and balance instructions.*

LANDING DISTANCE TABLE

GROSS WEIGHT LBS.	APPROACH IAS MPH	AT SEA LEVEL & 59°F		AT 2500 FT & 50°F		AT 5000 FT & 41°F		AT 7500 FT & 32°F	
		GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE
2300	68	415	1015	445	1070	480	1130	520	1190
2600	72	470	1105	505	1165	545	1230	590	1300
2900	76	520	1190	560	1260	605	1330	655	1405

NOTE: REDUCE LANDING DISTANCES 10% FOR EACH 6 MPH HEADWIND. FLAPS 40° AND POWER OFF.

CLIMB DATA

GROSS WEIGHT LBS.	AT SEA LEVEL & 59°F			AT 5000 FT. & 41°F			AT 10000 FT. & 23°F			AT 15000 FT. & 5°F			AT 20000 FT. & -12°F		
	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED
2300	97	1770	2.0	94	1415	3.0	91	1065	4.0	88	715	5.1	85	370	6.3
2600	100	1510	2.0	98	1190	3.1	95	875	4.4	92	560	5.8	89	250	7.5
2900	104	1300	2.0	101	1010	3.3	98	720	4.8	96	430	6.7	94	140	9.2

NOTE: THROTTLE, 2625 RPM, MIXTURE AT RECOMMENDED LEANING SCHEDULE-FLAPS AND GEAR UP. FUEL USED INCLUDES WARM-UP AND TAKE-OFF ALLOWANCE.

TAKE-OFF DATA

TAKE-OFF DISTANCE WITH 20° FLAPS FROM HARD-SURFACED RUNWAY

GROSS WEIGHT LBS.	IAS AT 50 FT. MPH	HEAD WIND MPH	AT SEA LEVEL & 59°F		AT 2500 FT. & 50°F		AT 5000 FT. & 41°F		AT 7500 FT. & 32°F	
			GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE
2300	58	0	435	695	515	805	615	950	740	1145
		15	265	465	320	545	390	650	480	800
		30	135	270	170	330	215	400	270	505
2600	62	0	570	885	680	1040	815	1250	985	1550
		15	360	605	435	720	530	880	655	1105
		30	195	365	240	445	305	560	385	725
2900	65	0	740	1135	880	1355	1055	1655	1285	2155
		15	480	790	580	950	705	1200	875	1580
		30	270	500	335	615	425	795	540	1080

NOTE: INCREASE DISTANCES 10% FOR EACH 25°F ABOVE STANDARD TEMPERATURE FOR PARTICULAR ALTITUDE.

FIGURE 12. *Takeoff, climb, and landing performance tables.*

CRUISE PERFORMANCE — 10000

NORMAL LEAN MIXTURE

Standard Atmosphere
Zero Wind

Gross Weight - 2900 Pounds
55 Gallons - No Reserve

10,000 FEET

RPM	MP	% BHP	Fuel Press.	MPH TAS	Gal/ Hour	Endurance Hours	Range Sta. Miles
2450	20	65	7.5	184	12.2	4.5	830
	19	60	6.8	179	11.4	4.8	860
	18	56	6.2	174	10.6	5.2	900
	17	52	5.6	169	9.9	5.6	940
2300	20	59	6.5	177	11.0	5.0	885
	19	55	6.0	172	10.4	5.3	910
	18	51	5.5	167	9.7	5.7	950
	17	47	5.1	162	9.1	6.0	975
2200	20	55	5.9	172	10.3	5.3	915
	19	51	5.5	168	9.8	5.6	940
	18	48	5.1	163	9.1	6.0	985
	17	44	4.8	157	8.6	6.4	1005
2100	20	50	5.3	165	9.5	5.8	955
	19	47	5.0	161	9.0	6.1	980
	18	43	4.7	156	8.5	6.5	1010
	17	40	4.4	151	8.0	6.9	1035
	16	37	4.2	145	7.6	7.2	1050
	15	34	4.0	138	7.1	7.8	1070
	14	30	3.8	129	6.6	8.3	1075

FIGURE 13. *Cruise performance chart.*

AIRPORT FACILITY DIRECTORY LEGEND

LOCATION

The airport location is given in nautical miles (to the nearest mile) and direction from center of referenced city.

ELEVATION

Elevation is given in feet above mean sea level and is based on highest usable portion of the landing area. When elevation is sea level, elevation will be indicated as "00". When elevation is below sea level, a minus sign (–) will precede the figure.

RUNWAYS

The runway surface, length, reciprocal headings, and weight bearing capacity are listed for the longest instrument runway or sealane, or the longest active landing portion of the runway or strip, given to the nearest hundred feet, using 70 feet as the division point, i.e., 1468 feet would be shown as "14"; 1474 feet would be shown as "15." Runway lengths prefixed by the letter "H" indicates that runways are hard surfaced (concrete; asphalt; bitumen, or macadam with a seal coat). If the runway length is not prefixed, the surface is sod, clay, etc. The total number of runways available is shown in parenthesis. (However, only hard surfaced runways are counted at airfields with both hard surfaced and sod runways.)

RUNWAY WEIGHT BEARING CAPACITY

Add 000 to figure following S, T, TT and MAX for gross weight capacity, e.g., (S–000).

S–Runway weight bearing capacity for aircraft with single-wheel type landing gear. (DC–3), etc.

T–Runway weight bearing capacity for aircraft with twin-wheel type landing gear. (DC–6), etc.

TT–Runway weight bearing capacity for aircraft with twin-tandem type landing gear. (707), etc.

Quadricycle and twin-tandem are considered virtually equal for runway weight bearing considerations, as are single-tandem and twin-wheel.

A blank space following the letter designation is used to indicate the runway weight bearing capacity to sustain aircraft with the same type landing gear, although definite figures are not available, e.g., (T–).

MAX–Maximum runway gross weight bearing capacity for all aircraft.

Omission of weight bearing capacity indicates information unknown. Footnote remarks are used to indicate a runway with a weight bearing greater than the longest runway.

SEAPLANE BASE FACILITIES

A number preceding the parenthetical designation, indicates the number (quantity) available.

Beaching gear, consisting of the quantity and type of beaching gear available.

The number (quantity) if available, of Mooring Buoys (MB) and Crash Boats (CB) available. MB & CB indicates details of quantity are not available.

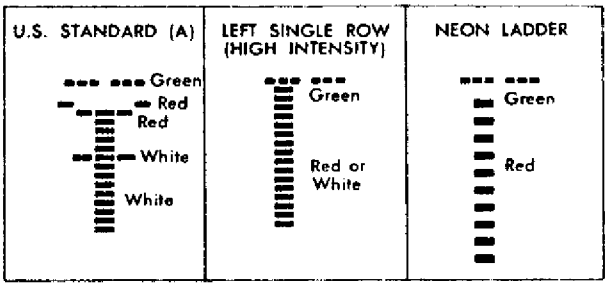
LIGHTING

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

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

L: Field Lighting (when code **L4–7** is indicated, lighting **4, 5, 6, 7** is available). An asterisk (*) preceding an element indicates that it operates on prior request only (by phone call, telegram or letter). Where the asterisk is not shown, the lights are in operation or available sunset to sunrise or be request (circling the field or radio call). **L** by itself indicates temporary lighting, such as flares, smudge pots, lanterns.

1–Strip lights or portable runway lights (electrical)
2–Boundry
3–Runway Floods
4–Low Intensity Runway
5–Medium Intensity Runway
6–Iligh Intensity Runway
7–Instrument Approach (neon)
8A, B, or C–High Intensity Instrument Approach



9–Sequence Flashing Lights (3,000' out unless otherwise stated)
10–Visual Approach Slope Indicator (VASI)
11–Runway end identification lights (threshold strobe) (REIL)
12–Short approach light systems (SALS)

FIGURE 14. *Airport Facility Directory Legend.*

AIRPORT FACILITY DIRECTORY

Lighting (Con't)

13–Runway alignment lights (RAIL)
14–Runway centerline
15–Touchdown zone

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

SERVICING

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

FUEL

F1 80 oct., at least.
F2 80/87 oct., or lower
F3 91/96 oct., or lower
F4 100/130 performance rating, or lower.
F5 115/145 performance rating, or lower.

TURBINE FUELS

TP–1 650 turbine fuels for civil jets.
JP–1 (Kerosene), JP–3, JP–4, JP–5.

DAYLIGHT SAVING TIME

An airport located in a geographic area which normally converts to daylight saving time will be so identified by use of a code.

The two most common time periods during which daylight time is in effect in the conterminous United States are April 25–September 26 and April 25–October 31, and these are indicated as DT 1 and DT 2 respectively. The code "DT" by itself indicates that daylight time is in effect but not on the common time periods of DT 1 or DT 2. In such cases the applicable time period is footnoted in the airport remarks section.

Reference to daylight time will remain in the Airport Directory continuously.

OTHER

AOE–Airport of Entry.
VASI–Visual Approach Slope Indicator, applicable runway provided.
RVV–Runway visibility, applicable runway provided
RVR–Runway Visual Range, applicable runway provided.
TPA–Traffic Pattern Altitude–This information is provided only at those airports without a 24–hour operating control tower or without an FSS providing Airport Advisory Service. Directions of turns are indicated only when turns of the pattern(s) are to the right (non-standard). TPA data are related to the runway listed under the tabulated airport information. Generally, only one altitude is listed; however, at some airports two altitudes have been established; one for conventional aircraft and one for high performance aircraft. They are shown in this manner, TPA 8/15–R (increments of 100 feet). The higher figure being the higher performance aircraft altitude.

FSS–The name of the controlling FSS is shown in all instances. When the FSS is located on the named airport, "on fld" is shown following the FSS name. When the FSS can be called through the local telephone exchange, (Foreign Exchange) at the cost of a local call, it is indicated by "(LC)" (local call) with the phone number immediately following the name of the FSS, i.e., "FSS: WICHITA (LC481-5867)." When at Intephone line exists between the field and the FSS, it is indicated by "(DL)" (direct line) immediately following the name of the FSS, i.e., "FSS: OTTO (DL)".

AIRPORT REMARKS

"FEE" indicates landing charges for private or nonrevenue producing aircraft. In addition, fees may be charged for planes that remain over a couple of hours and buy no services, or at major airline terminals for all aircraft.

"Rgt tfc 13–31" indicates right turns should be made on landings and takeoffs on runways 13 and 31.

Limited–intended for private use, but use by public is not prohibited.

Remarks data is confined to operational items affecting the status and usability of the airport, traffic patterns and departure procedures.

Obstructions.–Because of space limitations only the more dangerous obstructions are indicated. Natural obstructions, such as trees, clearly discernible for contact operations, are frequently omitted. On the other hand, all pole lines within at least 15:1 glide angle are indicated.

COMMUNICATIONS

Clearance is required prior to taxiing on a runway, taking off, or landing at a tower controlled airport.

When operating at an airport where the control tower is operated by the U.S. Government, two-way radio communication is required unless otherwise authorized by the tower. (When the tower is operated by someone other than the U.S. Government, two-way radio communication is required if the aircraft has the necessary equipment.)

Frequencies transmit and receive unless specified as: T–Transmit only, R–Receive only, X–On request. Primary frequencies are listed first in each frequency grouping, i.e., VHF, I.F. Emergency frequency 121.5 is available at all TOWER, APPROACH CONTROL and RADAR facilities, unless indicated otherwise by a crossout: ~~121.5~~

Radar available is listed under "RADAR SERVICES" Radar beacons are indicated by "(BCN)" after "RADAR SERVICES", when available.

VOICE CALL

The voice call for contact with the traffic control services listed at each airport is the airport name followed by the call of the particular service desired, i.e., "LAGUARDIA TOWER." In these instances, only the name of the service is listed. When the voice call of the facility is not the same as the airport name, the complete voice call is listed.

FIGURE 15. *Airport Facility Directory Legend.*

AIRPORT FACILITY DIRECTORY

SERVICES AVAILABLE

(See ATC Operations and Procedures, Section II)

TOWER

Clearance Delivery (CLRNC DEL).
Approach Control (APP CON) Radar and Non-Radar.
Departure Control (DEP CON) Radar and Non-Radar.
VFR Advisory Service (VFR ADV) Non-Radar.
Traffic Information Service (TFC INFO) Radar.
Surveillance Radar Approach (ASR).
Precision Radar Approach (PAR).
Ground Control (GND CON).
VHF Direction Finding (VHF/DF).

RADAR APPROACH PROCEDURE MINIMA

Weather minima for precision and surveillance radar approaches (PAR/ASR) specify only the lowest straight-in authorized for the approach.

FLIGHT SERVICE STATION (FSS)

Airport Advisory Service (AAS).
Flight Following Service.
Island, Mountain and Lake Reporting Service.

Standard Flight Service Station civil communications frequencies are: 123.6 126.7 122.2T 122.1R and emergency 121.5. These frequencies are normally available at all stations listed.

UNICOM

Private aeronautical station, operates same hours as the airport, transmits and receives on one of the following frequencies:

U-1-122.8 mc (at airports without a control tower).
U-2-123.0 mc (at airports with a control tower).

SAMPLE

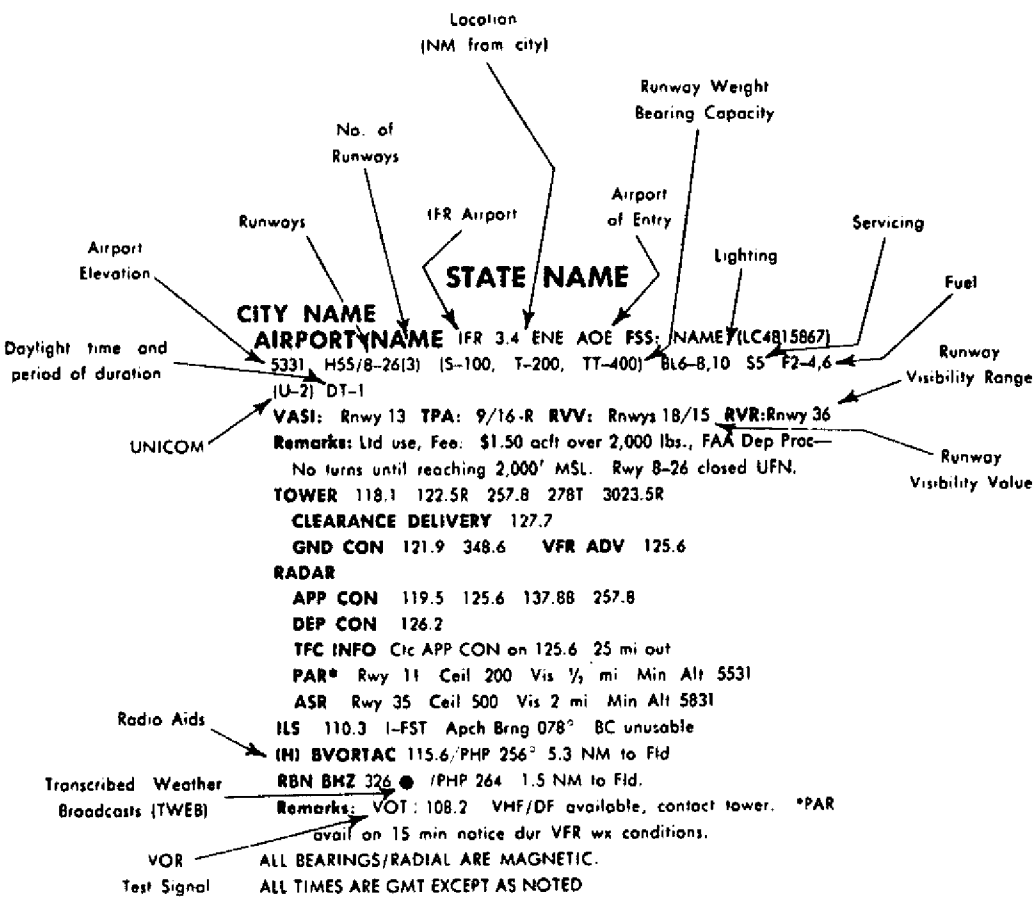


FIGURE 16. *Airport Facility Directory Legend.*

RADIO CLASS DESIGNATIONS

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

Class	Normally Anticipated Altitude Service	Normally Anticipated Interference Free Distance Service
H	Up to 45,000 MSL	149.75 smi (130 nmi)
	Above 45,000' MSL	115.2 smi (100 nmi)
L	Up to 18,000' MSL	46.06 smi (40 nmi)
T	Up to 12,000' MSL	28.79 smi (25 nmi)

H=High L=Low T=Terminal

NOTE: An H facility is capable of providing L and T service volume and an L facility additionally provides T service volume.

The term VOR is, operationally, a general term covering the VHF omnidirectional bearing type of facility without regard to the fact that the power, the frequency-protected service volume, the equipment configuration, and operational requirements *may vary between facilities* at different locations.

AB ..... Continuous automatic transcribed broadcast service.

B ..... Scheduled Broadcast Station (*broadcasts* weather at 15 and 45 minutes after the hour; Air Force Broadcasts, generally, 20 minutes).

DME ..... UHF standard (TACAN compatible) distance measuring equipment.

H ..... Non-directional radio beacon (homing), power 50 watts to less than 2,000 watts.

HH ..... Non-directional radio beacon (homing), power 2,000 watts or more.

H-SAB ..... Non-directional radio beacons providing automatic transcribed weather service.

ILS ..... Instrument Landing System (voice on *localizer channel*).

LMM ..... Compass locator station when installed at middle marker site.

LOM ..... Compass locator station when installed at outer marker site.

MA ..... Range (adcock, vertical raditors), power less than 50 watts.

MH ..... Non-directional radio beacon (homing) power less than 50 watts.

ML ..... Range (loop radiators), power less than 50 watts.

MRA ..... Range (adcock, vertical radiators), power 50 watts or more but less than 150 watts.

MRL ..... Range (loop radiators), power 50 watts or more, but less than 150 watts.

RA ..... Range (adcock, vertical radiators), power *150 watts or more.*

RL ..... Range (loop radiators), power 150 watts or more.

S ..... Simultaneous range, homing signal and/or voice.

SABH ..... Non-directional radio beacon having limited navigational use. Provides automatic weather broadcasts.

TACAN ..... UHF navigational facility—omnidirectional *course and distance information.*

VOR ..... VHF navigational facility—omnidirectional, course only.

VOR/DME ..... Collocated VOR navigational facility and UHF standard distance measuring equipment.

VORTAC ..... Collocated VOR and TACAN navigational facilities.

W ..... Without voice facilities on range frequency.

Z ..... VHF station location marker at a LF range station.

NOTES

1. All FAA MH facilities operate continuously unless otherwise cited.
2. All FAA ranges operate continuously. Those which *are not manned continuously* are cited in the remarks with hours of operation in parentheses, e.g., (0600–2400).
3. LMF and VHF ranges listed at the same location are *controlled by the same FSS.*
4. Military navigational facilities which are not part of the common system are not listed in this publication.

AIRPORT/FACILITY DIRECTORY

ARIZONA

BUCKEYE (L) BVOR 110.6/BXK **FSS:** PHOENIX
Remarks: To be BVORTAC Sept. 30.

CASA GRANDE (L) BVOR *114.8/CZG* **FSS:** PHOENIX

PHOENIX
SKY HARBOR MUNI *IFR* 3E **FSS:** PHOENIX on Fld
1122 H103/8R-26L(2) (S-170, T-300, TT-595) BL4,10 S5
F5 JP1 U2 **VASI:** Rnwy 8R
Phoenix Tower 118.7 122.5R 120.9
Clnc Del 120.4 **Phoenix Gnd Con** 121.9
Phoenix App Con 118.1 122.5R 115.6T
Phoenix (H) BVORTAC 115.6/PHX 256° 5.3NM to fld.
Phoenix RBn BHZ 326/PHX 264° 1.5NM to fld.
Remarks: VOT: 109.0

ARIZONA—*Continued*

TUCSON INTL *IFR* 6S AOE **FSS:** TUCSON on Fld
2630 H120/12L-30R(3) (S-100, T-200, TT-360) BL4 S5
F5, JP1, JP4 U2
Remarks: 5649' avbl lndg rnwy 3, 6000' avbl rnwy 21. Jet arresting gear rnwy 12L-30R.
Tower: 118.3 122.5R **Gnd Con** 121.9
Radar Services: (BCN)
App Con 118.5 134.1 126.2 125.9 125.1 122.5R
Dep Con 125.9 **Tfc Info** ctc App Con 25 mi out.
ASR Rnwy 12, 30 Ceil 400 Vsby 1 mi Min Alt 3030.
(H) BVORTAC 117.1/TUS 254° 6.1NM to fld.
RBn H-SABZ 338°/TUS 083° 10.6NM to fld.

WINSLOW (H) BVORTAC 112.6/INW **FSS:** PRESCOTT
RBn H-SAB 266°/INW

FIGURE 17. *Radio Class Designations and Airport/Facility Directory.*

AIRPORT DIRECTORY

*** ARIZONA ***

AGUILA
AGUILA FARMS 2 N
2204 44 (1) FSS: PHOENIX
Remarks: Unattended. *Livestock on strip.

BISBEE
BISBEE MUNI 5 SE
4780 39 (3) *L4 F2 FSS: DOUGLAS

DOUGLAS INTL See **DOUGLAS-BISBEE**

CASA GRANDE
CASA GRANDE MUNI 4 NW
1462 H38 (4) BL4 S3 F4 FSS: PHOENIX
Remarks: P-line S, E.

DEER VALLEY See **PHOENIX**

ELOY
CASA GRANDE IMPERIAL VALLEY CATTLE COMPANY OF ARIZONA 2 7 WSW
1525 52 (1)
Remarks: P-line E.

FLAGSTAFF
PULLIAM 4 S
7012 H70 (1) BL4 S5 F4 U-1 FSS: PRESCOTT

GILA BEND 2 SE
800 32 (2) L4 S3 F4 FSS: PHOENIX (LC 261-4295)

HOLBROOK MUNI 2 NE
5245 50 (2) BL4 S3 F4 FSS: ZUNI
Remarks: Rnwy 11-29 rolling.

KAYENTA 2 SE
5810 58 (1)
Remarks: 80 87 Fuel avbl emgcy. P-line SW end. Livestock and vehicles on rnwy.

LUKEVILLE Adj W
1416 22 (1)
Remarks: N, S apchs hazardous.

MARANA
MARANA ARPK 5 NW
1891 H68 (6) L4 S4 F5 U-1 FSS: TUCSON

NICKSVILLE Adj NE
4810 33 (1)
Remarks: Rnwy 4 apch restricted by acft in tie downs, P-line.

PHOENIX
DEER VALLEY 15 N
1650 H104 (1) (S30 T-45 TT 60) BL4 S5 F4 U-1
FSS: PHOENIX (DL)
Remarks: E 5200' clsd except special permission.

ARIZONA—*Continued*

QUARTZITE Adj SW
894 31 (1) FSS: BLYTHE
Remarks: Cactus apch rnwy 7.

ROLL
ANTELOPE RANCH 2 SW
250 27 (1) F3 FSS: YUMA
Remarks: P-line E & W. Occasionally clsd for irrigation.

SCOTTSDALE
THUNDERBIRD ACADEMY 8 N
1465 H48 (1) L4 S5 F4 FSS: PHOENIX (LC 261-4295)
Remarks: P-line W. Clsd Sat.

TUCSON
DOWNTOWN TUCSON 1 S
2490 43 (2) S5 F4 FSS: TUCSON (LC 294-1463)
Remarks: P-lines SE, W & NW. Use E side 16/34.

FREEWAY 4 NW
2290 45 (1) L4 S5 F4 U-1 FSS: TUCSON (LC 294-1463)

RYAN FLD 14 SW
2413 H40 (2) BL4 S5 F4 FSS: TUCSON (LC 294-1463)
Remarks: P-line SSE.

TUCSON INTL See Section IV-A

VALLE
ARIZONA STATE 2 E
6001 57 (3) FSS: PRESCOTT
Remarks: Use cntr of strips. P-line S.

WICKENBURG
FLYING E RANCH 3 SW
2417 29 (1) L5 F2 FSS: PHOENIX
Remarks: Only central 2250' is lgtd.

WICKENBURG MUNI 12 W
2360 36 (1) FSS: PHOENIX

WILLIAMS MUNI 4 N
6700 H40 (2) BL4 S5 F4 JP1 U-1 FSS: PRESCOTT
Remarks: Muddy when wet.

WINSLOW MUNI *IFR* 2 SW
4937 H75 (2) BL4, 12 S5 F5 FSS: PRESCOTT (DL)
Remarks: P-line ENE. Attended on call after 9:00 PM. Rnwy 22 threshold displaced 1237'.

YUMA
MARSH 1 E
130 33 (1) S5 F4 FSS: YUMA (LC 725-2601)
Remarks: Rgt tfc N. Ditch N end. Muddy when wet.

YUMA MCAS/INTL See Section IV-A

FIGURE 18. *Airport Directory.*

Section III–A—NOTICES TO AIRMEN

This section is issued every 14 days and is primarily designed to supplement Section III of the AIM. It contains appropriate notices from the daily NOTAM Summary, Airmen Advisories, new or revised Oil Burner Routes and other items considered essential to flight safety.

NOTE: Data preceded by a checkmark (✓) are considered permanent and will usually be cited only once. Such information should be noted on charts and records. Temporary information is continuously cited until the condition is no longer in effect.
NOTE: Data are arranged in alphabetical order by State (and within the State by City or locality).

NEW OR REVISED DATA: New or revised data are indicated by underlining the first line of the affected item. The new information is not necessarily limited to the underlined portion, which is used only to attract attention to the new insert.

ALABAMA

BAYOU LA BATRE, BAY VIEW ARPT: Paved 3000' drag strip 75'S and parallel to turf rnwy. P-line each side of drag strip and wire across strip 75' from E end. N/S turf rnwy under constr, covered with stumps not to be used for acft operns.

BRANTLEY MUNI ARPT: Clsd UFN.

MOBILE, BATES FLD: Rnwy 18–36 restricted to acft of GWT 12,500 lbs or less for tkoffs and lndgs except in emgcy.

SELMA, SELFIELD ARPT: Rnwy 18–36 clsd until aprxly July 1966. VFR acft ctc Craig Twr on 126.2 for tfc and lndg advisories.

ARIZONA

BOUSE ARPT: Clsd until aprxly Nov. 1965.

GRAND CANYON NATIONAL PARK ARPT: Clsd for constr.

MARICOPA: CAUTION—DO NOT MISTAKE FOR LANDING AREA. Space Surveillance Stn at lat *33°06'31"*, *long* 112°01'46" *aprxly* 4 mi N. 1200' W and parallel to hwy. Site is strip 300' x 1800' with paved portion lengthwise thru cntr 100' in width and studded with 6' steel posts. This permanent hazard lctd 22 nmi S Phoenix-Sky Harbor Arpt.

NOGALES INTL ARPT. Rnwy 3–21 clsd for resurfacing. Use parallel txwy for lndgs dalgt hrs.

PAYSON, BIRCH MESA ARPT: Clsd.

PRESCOTT MUNI ARPT: NW 1500' of rnwy 12–30 clsd UFN. 2903' avbl lndg and tkof both directions. Med intensity rnwy lgts serving rnwy 3–21 oper dusk-until aprxly 0315Z thereafter on request by radio to FSS or circling arpt.

WICKENBURG, REMUDA RANCH ARPT: Clsd.

ARKANSAS

CLARKSVILLE MUNI ARPT: First 125' both rnwy ends clsd for constr UFN.

EL DORADO, GOODWIN FLD: Rnwy 13–31 clsd days.

HOPE MUNI ARPT: Drag racing being conducted the 2nd and 4th Sunday of each month. Rnwy 10–28 will be clsd Sat and Sun on those weekends. Rnwy 16–34 open for tfc use caution.

MENA MUNI ARPT: Clsd until aprxly Oct 1, 1965.

TEXARKANA MUN ARPT: Daily demolition activity, lctd aprxly 18 mi W, Mon thru Fri from 1200 CST to 1330 CST and 1500 CST to 1615 CST. Shrapnel and shock waves up to 3000'.

CALIFORNIA

BAKER ARPT. Clsd for repairs UFN.

BAKERSFIELD, MEADOWS FLD: Voice feature on LMM will be decmsnd Oct 16, 1965.

BLUE CANYON ARPT: Clsd for indefinite period.

BORREGO SPRING, BORREGO VALLEY-SAN DIEGO COUNTY ARPT: Rotating bcn inop until aprxly Oct 1, 1965.

CONCORD, BUCHANAN FLD: Marked 2000' of txwy A has been designated as a tmpry parallel rnwy 1R–19L.

CORNING MUN ARPT: Clsd

DOS PALOS, EAGLE FLD: Clsd to all operns, til aprxly Oct 30, due major rnwy repairs.

FRAZIER PARK, LINCOLN SKY RANCH ARPT: Closed for unknown duration.

HANFORD MUNI ARPT: Rnwy under constr until aprxly Oct 4, for 400' extension on N end.

HAWTHORNE ARPT: REIL and txwy lgts will be inop 2300–0700 nightly UFN.

HYAMPON ARPT: Clsd UFN due flood.

LINCOLN MUN ARPT: Rnwy 6–24 clsd for repairs. Glider operns week-ends; ctc on unicom. Arpt restricted to acft with less than 20,000 lbs GWT.

MONTAGUE, SISKIYOU CO ARPT: Apch lgtg inop UFN.

NEEDLES–RIVERVIEW ARPT: Clsd to public UFN.

OAKLAND-METROPOLITAN OAKLAND INTL ARPT: Rnwy 9L–27R clsd until aprxly Nov 9 for reconstr.

OAKLAND-METROPOLITAN OAKLAND INTL ARPT TWR: ILS glide slope (rnwy 27R) will be shut down Oct 4 til aprxly Oct 13 for mod.

FIGURE 19. *Notices to Airmen (NOTAMS).*

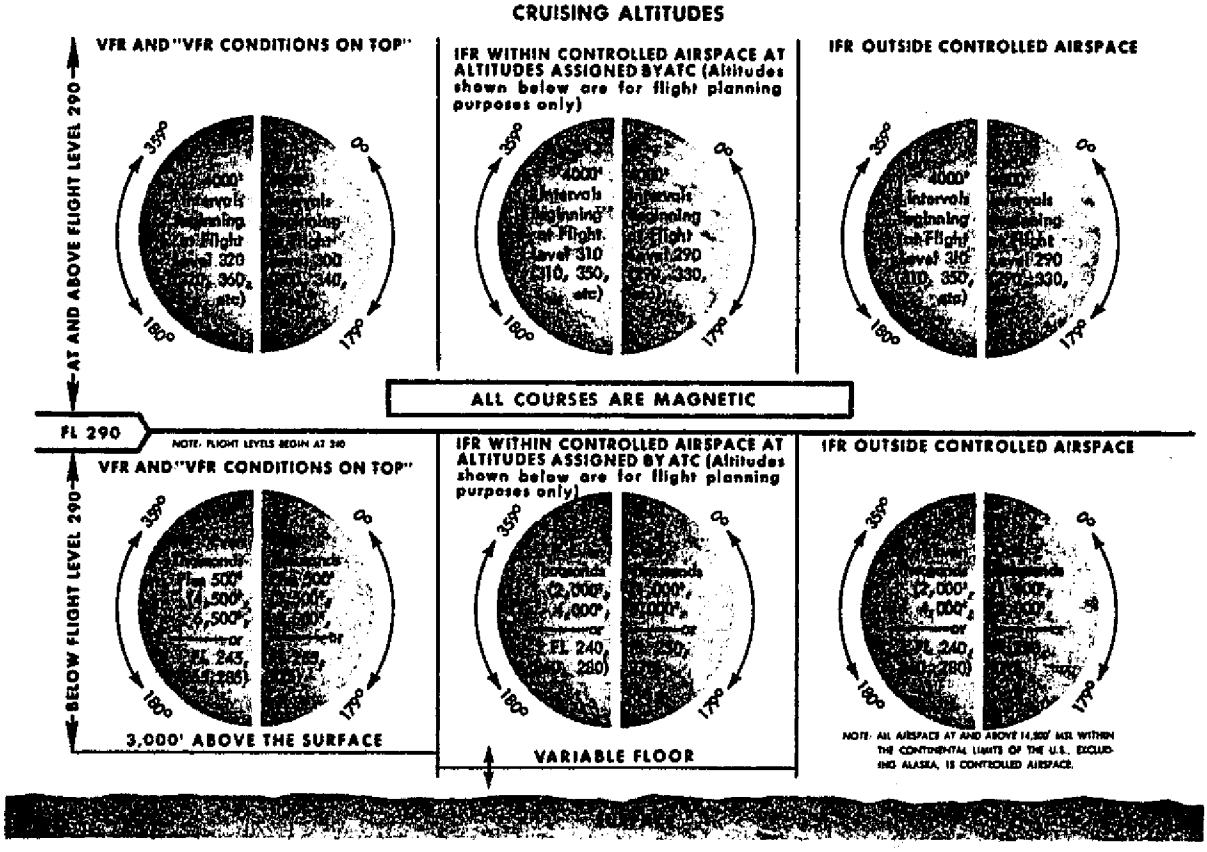


FIGURE 20. *Cruising altitudes.*

How to Report an Accident

Notification Requirements

The pilot, or operator, of an aircraft of U.S. registry *must immediately* notify the FAA of any aircraft accident which:

(a) Is known or believed to have been caused by structural failure of the aircraft, engine, or propeller.
(b) Involves midair collision of two or more aircraft.
(c) Results in serious injury to any person, or fatal injury to any person not an occupant of the aircraft.
(d) Involves fire in any of the components or systems on board the aircraft regardless of the extent of injury to the occupants or damage to the aircraft.

The pilot, or operator, shall notify the nearest FAA Flight Service Station, or General Aviation District Office informing them of:

1. Location.
2. Date.
3. Time of day.
4. Number of persons involved.
5. Injuries to each.
6. Aircraft registration number.
7. Aircraft make and model.
8. Names of crewmembers and operator.
9. The circumstances surrounding the accident.

Reporting Requirements

The pilot, or operator, of an aircraft of U.S. registry must, as soon as possible, after the accident, complete a written report to the FAA if the accident involved:

(a) Serious or fatal injury to a nonoccupant of the aircraft, or
(b) Estimated repair cost of $300 or more.

The written report must be submitted in triplicate on Form FAA-916 and mailed or delivered to the nearest FAA General Aviation District Office or Regional Office, or to the State aviation official or investigator, where applicable. (CAB Safety Investigation Regulations, Part 320, Subch. II.)

FIGURE 21. *How to report an accident.*

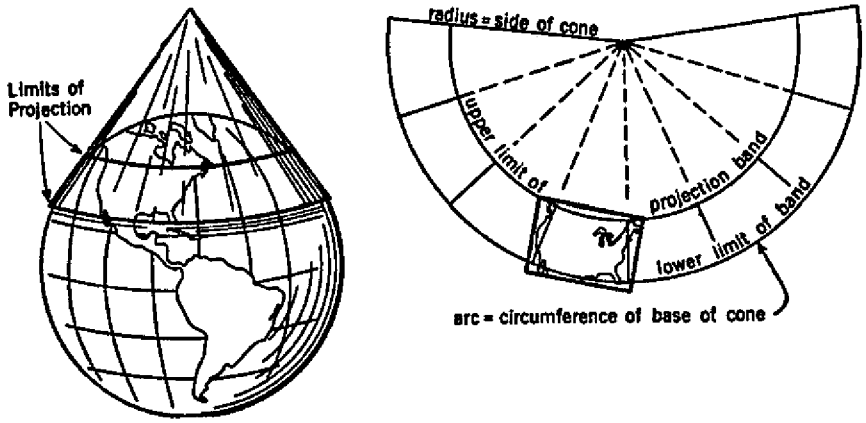
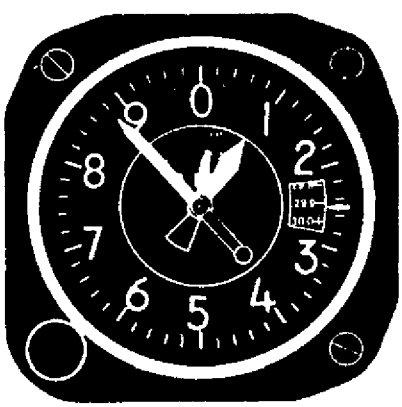
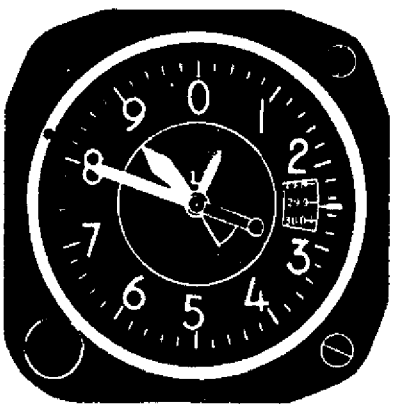


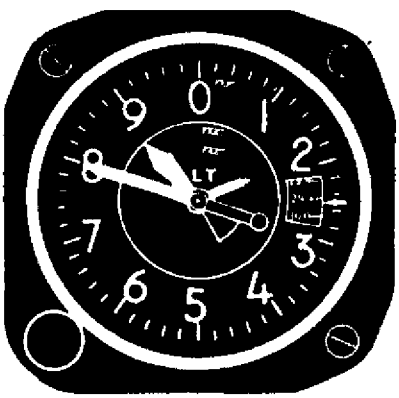
FIGURE 22. *The Lambert conformal chart projection.*



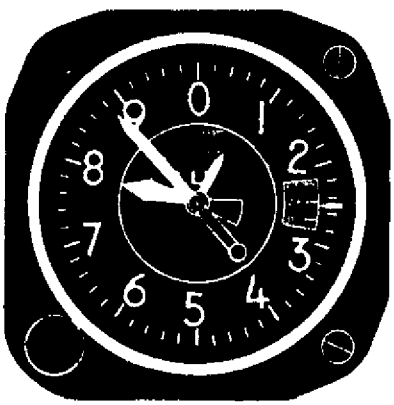
A



B



C



D

FIGURE 23. *Altimeter readings.*

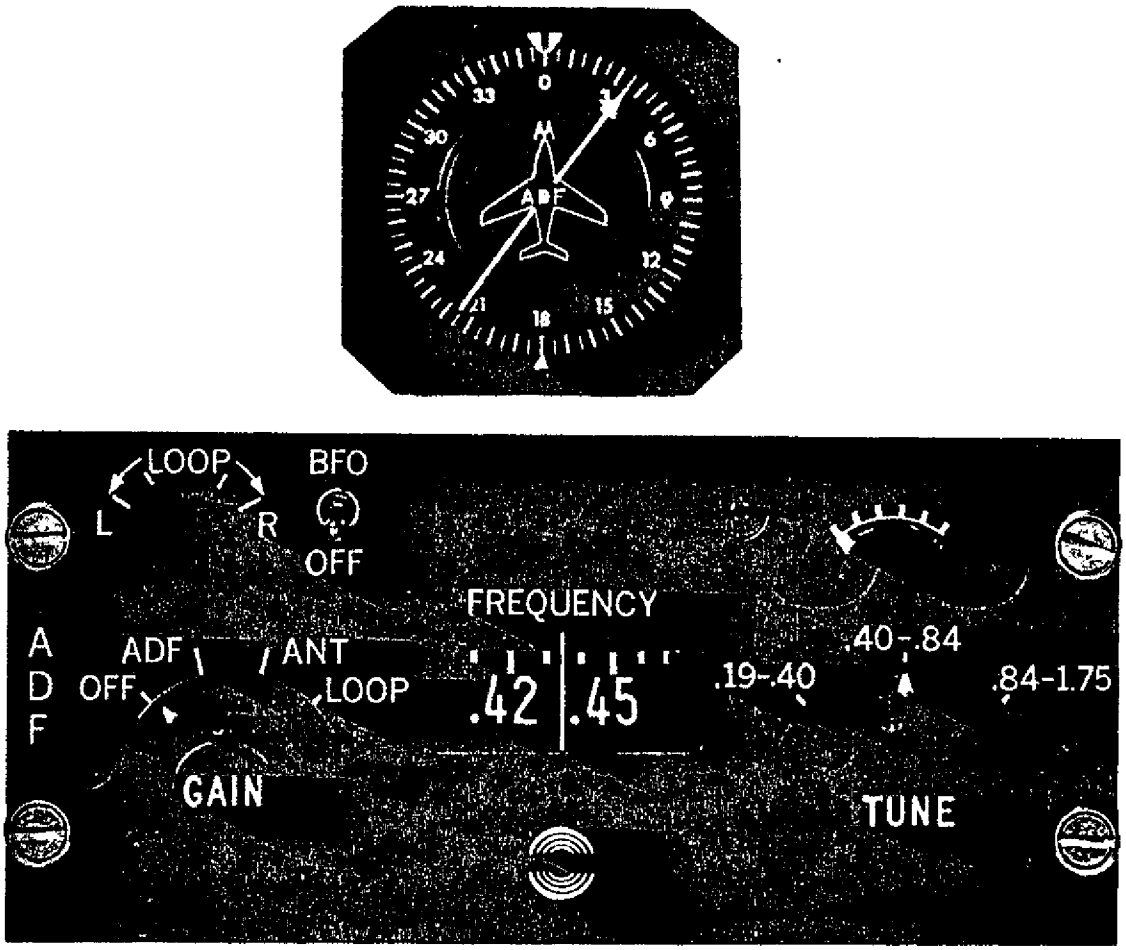


FIGURE 24. *Radio compass (ADF).*

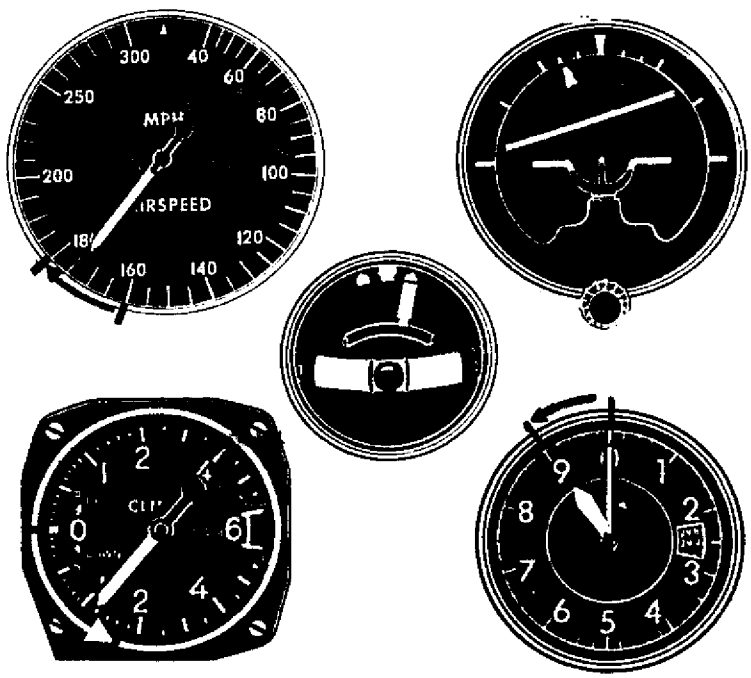


FIGURE 25. *Instrument grouping.*

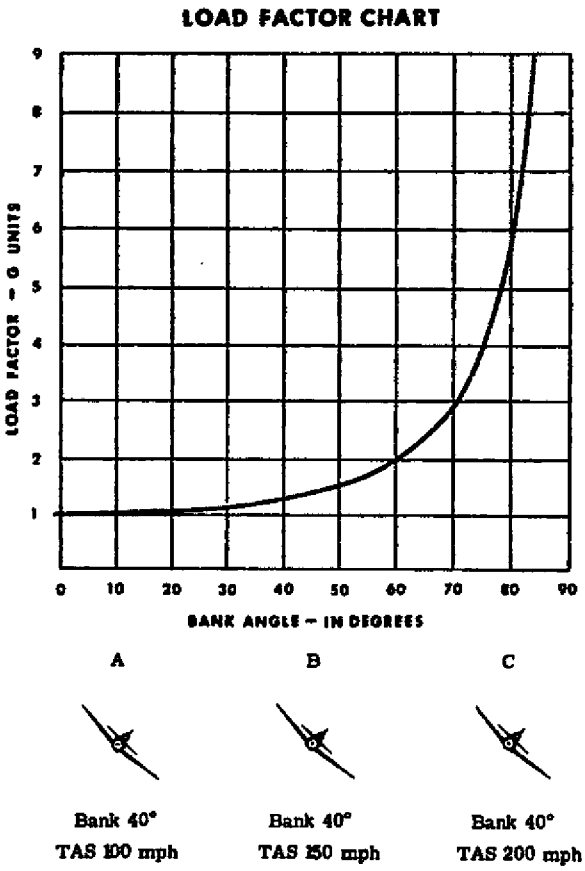


FIGURE 26. *Load factors, speeds and rates of turn.*

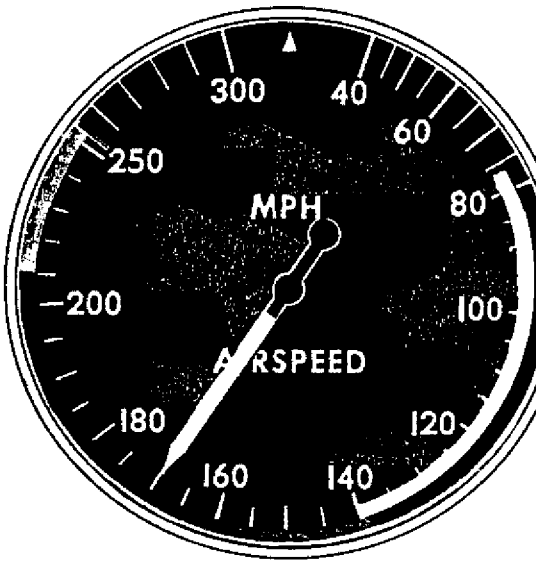


FIGURE 27. *Airspeed Indicator*

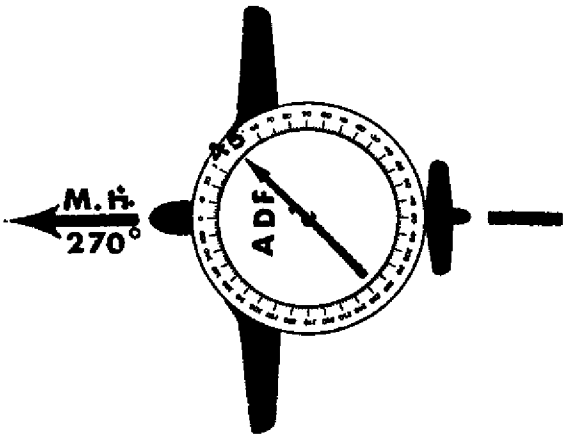


FIGURE 28. *ADF indications.*

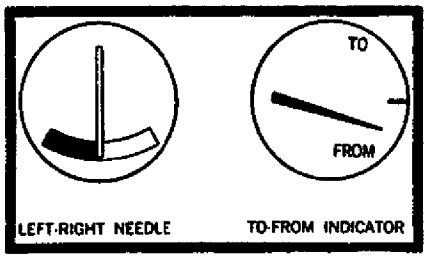


FIGURE 29. *VOR navigation receiver indications.*

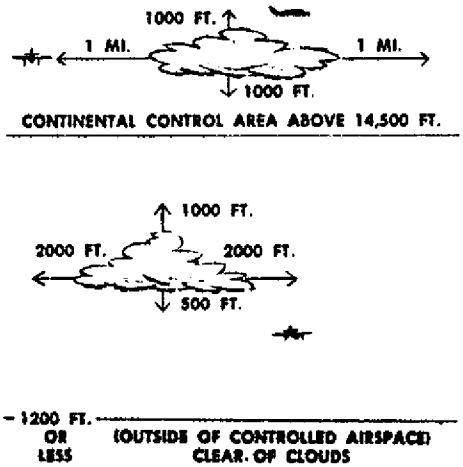


FIGURE 30. *Minimum VFR distance from clouds; airport traffic area.*

FEDERAL AVIATION AGENCY

FLIGHT PLAN

FORM APPROVED
BUDGET BUREAU NO. 04-R072.2

1. TYPE OF FLIGHT PLAN	2. AIRCRAFT IDENTIFICATION	3. AIRCRAFT TYPE	4. TRUE AIRSPEED	5. DEPARTURE TIME	
☑ VFR ☐ VFR ☐ IFR ☐ DVFR	N 2468 W	DAEDALIAN DART	180 KNOTS	PROPOSED (Z) 1530	ACTUAL (Z)

6. INITIAL CRUISING ALTITUDE	7. POINT OF DEPARTURE	8. ROUTE OF FLIGHT
10,500	GALLUP, NEW MEX.	DIRECT HOLBROOK, DIRECT WINSLOW VOR, DIRECT FLAGSTAFF, DIRECT WILLIAMS MUN.

9. DESTINATION (Name of airport and city)	10. ESTIMATED TIME EN ROUTE		11. FUEL ON BOARD		12. ALTERNATE AIRPORT(S)
	HOURS	MINUTES	HOURS	MINUTES	
WILLIAMS MUN. WILLIAMS, ARIZ.	2	20	3	20	

13. REMARKS

WILL GIVE TIME OFF TO ZUN FSS WHEN AIRBORNE; INTERMEDIATE STOPS AT HOLBROOK AND FLAGSTAFF WILL CANCEL WITH PRS FSS

14. PILOT'S NAME	15. PILOT'S ADDRESS OR AIRCRAFT HOME BASE	16. NO. OF PERSONS ABOARD
C. BREESE	McKINLEY COUNTY AIRPORT GALLUP, NEW MEX.	4

17. COLOR OF AIRCRAFT	18. FLIGHT WATCH
SILVER RED TRIM	

FAA Form 398 (7-64) USE PREVIOUS EDITION

CLOSE FLIGHT PLAN UPON ARRIVAL

GPO : 1964 OF—739-500 SEE REVERSE (7233)

FIGURE 31. *Example of VFR flight plan with flight following service requested.*

Color and type of signal	On the ground	In flight
Steady green	Cleared for takeoff	Cleared to land.
Flashing green	Cleared for taxi	Return for landing (to be followed by steady green at proper time).
Steady red	Stop	Give way to other aircraft and and continue circling.
Flashing red	Taxi clear of landing area (runway) in use.	Airport unsafe—do not land.
Flashing white	Return to starting point on airport.	
Alternating red and green.	General warning signal—exercise extreme caution.	

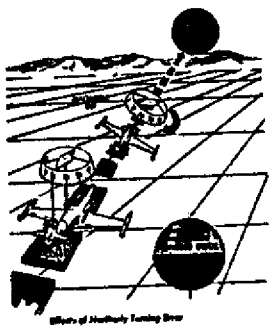
FIGURE 32. *Light gun signals used in airport traffic control.*

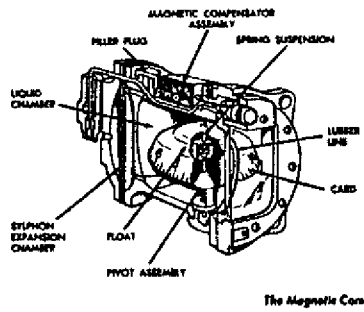
AIRSPEED CORRECTION TABLE

FLAPS 0°								
IAS - MPH	60	80	100	120	140	160	180	200
TIAS - MPH	66	80	97	117	137	158	178	198
FLAPS 20°								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	59	62	67	73	81	91	101	111
FLAPS 40°								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	58	62	66	73	82	92	102	112

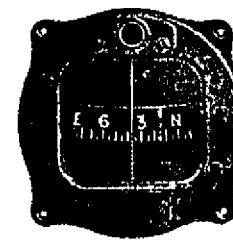
FIGURE 33. *Airspeed correction table.*

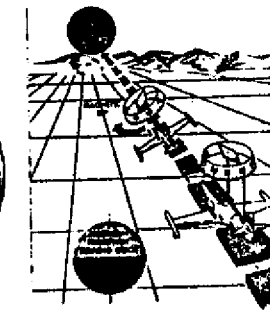
EXAM-O-GRAM NO. 12
THE MAGNETIC COMPASS





The Magnetic Compass





The magnetic compass, in terms of its errors, limitations, and in-flight characteristics, is one of those aeronautical subjects in which consistently large numbers of pilots fare poorly on FAA written examinations. There is evidence that this veteran instrument—it was one of the first to be installed in an aircraft—is one of the least understood instruments in the cockpit of today's modern general aviation aircraft. Many pilots seem to operate on the premise that it is easier to ignore this instrument's errors than it is to learn them. However, it should be remembered that (1) this is the only directional-seeking instrument in the cockpit of most general aviation aircraft, and (2) it is mechanically a simple, self-contained unit (independent of external suction or electrical power for its operation) that is likely to remain reliable at all times—reliable, that is, if the pilot understands its inherent errors.

WHAT ARE SOME OF THE COMPASS ERRORS THAT THE PILOT SHOULD UNDERSTAND?

The pilot should understand:

I. VARIATION—This is the angular difference between *true north* and *magnetic north* which is plotted on charts in *degrees east or west.* The pilot should understand perfectly *which to add and which to subtract* when converting from true headings or courses to magnetic headings or courses and vice versa. (Many pilots find such memory aids as "east is least and west is best" helpful in remembering that *east is subtracted* and *west is added* when going from *true* to *magnetic.*)

II. DEVIATION—This is the deflection of the compass needle from a position of magnetic north as a result of local magnetic disturbances in the aircraft. To reduce this deviation, the compass has a compensating device consisting of small adjustable magnets. The compass should be checked and compensated periodically. The errors remaining after "swinging" the compass should be recorded on a compass correction card which should be installed in the cockpit within the view of the pilot. (NOTE: Avoid placing metallic objects such as metal computers, flashlights, etc., on top of the instrument panel near the magnetic compass as this practice may induce large amounts of deviation and seriously affect the instrument's accuracy.)

In addition to these errors, the pilot should have a *working knowledge* of the following in-flight errors:

III. OSCILLATION ERROR — The erratic swinging of the compass card which may be the result of turbulence or rough pilot technique.

IV. MAGNETIC DIP—The tendency of the magnetic compass to point down as well as north in certain latitudes. This tendency is responsible for:

A. Northerly Turn Error—*This error is the most pronounced of the in-flight errors.* It is most apparent when turning to or from headings of north and south.

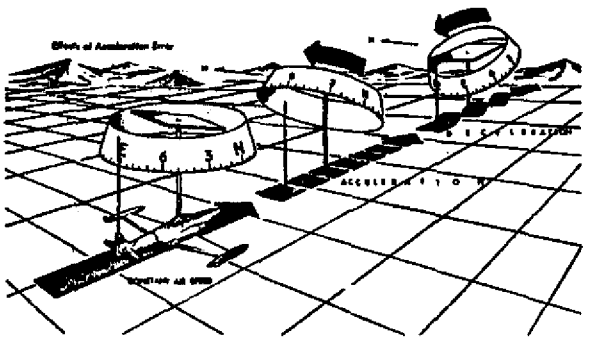
B. Acceleration Error—An error that can occur during airspeed changes. It is most apparent on headings of east and west.

As a quick refresher on this instrument's in-flight dip error, we invite you to accompany us on a simulated demonstration flight around the compass rose. Unless otherwise noted, we will limit our bank during turns to a gentle bank. Also, we will assume that we are in the northern hemisphere because the characteristics which we will observe would not be present at the magnetic equator, and would be reversed in the southern hemisphere.

DEMONSTRATION NO. 1 (Heading—North; Error—Northerly Turn Error)

As we start a turn in either direction from this heading, we notice that momentarily the compass *gives an indication of a turn opposite the direction of the actual turn.* (While the compass card is in a banked attitude, the vertical component of the earth's magnetic field causes the north-seeking end of the compass to dip to the low side of the turn, giving the pilot an erroneous turn indication.) If we continue the turn toward east or west, the compass card will begin to indicate a turn in the correct direction, *but will lag behind the actual turn*—at a diminishing rate—until we are within a few degrees east or west. One additional demonstration which we will cover before leaving north is the Slow Turn Error. If, while holding a compass indication of north, we sneak into a very gradual and shallow banked turn—say 3° or 4° of bank—it is possible to change the actual heading of the aircraft by 20° or more *while still maintaining an indication of north by the compass.*

DEMONSTRATION NO. 2 (Heading—East; Error—Acceleration Error)



The Northerly Turn Error that we previously experienced is not apparent on this heading (or on a west heading). However, let's see what happens when we accelerate and decelerate by changing the airspeed. With the wings level, we will *increase* the airspeed by increasing the power setting or by lowering the nose, or both. Result—although we are holding the nose of the aircraft straight ahead, our compass card erroneously indicates a turn toward *north.* On the other hand, if we decrease the airspeed by reducing the power setting or raising the nose of the aircraft, or both, the compass will give an erroneous indication of a turn toward *south.* (Because of the pendulous-type mounting, the end of the compass card, which the pilot sees, is tilted upward while accelerating and downward while decelerating during changes of airspeed. This momentary deflection of the compass card from the horizontal, results in an error that is most apparent on headings of east and west.)

DEMONSTRATION NO. 3 (Heading—South; Error—Northerly Turn Error)

Again we are presented with the Northerly Turn Error problem that we encountered in Demonstration No. 1. Although the same set of forces that caused the erroneous indication when we banked the aircraft while on a north heading will likewise be working against us on this heading, the compass indications will appear quite different. For example, as we roll into a turn in either direction, the compass gives us an indication of a turn in the *correct direction*

but at a *much faster rate than is actually being turned.* As we continue our turn toward west or east, the compass indications will continue to precede the actual turn—but at a diminishing rate—until we are within a few degrees of west or east. (It might be noted that the Acceleration Error is not apparent on this heading or on a north heading.)

DEMONSTRATION NO. 4 (Heading—West; Error—Acceleration Error)

On this heading we encounter the exact same errors that we have previously covered on a heading of east in Demonstration No. 2. If we *increase the airspeed,* we will get an erroneous indication of a *turn toward north.* If we *decrease the airspeed,* we will get an erroneous indication of a *turn toward south.* (A memory aid that might assist you in recalling this relationship between airspeed change and direction of the error is the word ANDS—Accelerate-North, Decelerate-South.)

WHAT ARE THE MAIN POINTS THAT SHOULD BE REMEMBERED CONCERNING THESE FOUR DEMONSTRATIONS?

The points we are trying to get across are these: (1) WHEN TAKING READINGS FROM THE MAGNETIC COMPASS WHILE ON A NORTHERLY OR SOUTHERLY HEADING (for establishing a course, setting the gyro-driven heading indicator, etc.), REMEMBER THAT IT IS ESSENTIAL TO HAVE THE WINGS PERFECTLY LEVEL FOR SEVERAL SECONDS PRIOR TO TAKING THE READING. (2) IF YOU ARE ON AN EASTERLY OR WESTERLY HEADING, IT IS IMPORTANT THAT THE AIRSPEED IS CONSTANT IN ORDER TO GET AN ACCURATE READING. (3) ON AN INTERMEDIATE HEADING, BOTH OF THE ABOVE CONDITIONS SHOULD BE MET. (Note: If your aircraft is equipped with a gyro-driven heading indicator, check it frequently with your magnetic compass.)

TURNS TO HEADINGS BY REFERENCE TO THE MAGNETIC COMPASS

For the pilot who would like a general set of rules for determining his lead point for making turns by reference to the Magnetic Compass, the following is submitted:

(NOTE: The angle of bank should not exceed 15° in order to minimize dip error.)

1. *When turning to a heading of north you must allow, in addition to your normal lead, a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a left turn to a heading of north in a locality where the latitude is 30°N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should start your rollout when the compass reads approximately 35°.
2. *When turning to a heading of south, you must turn past your normal lead point by a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a right turn to a heading of south in a locality where the latitude is 30°N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should turn past your normal lead point of 175° (180° — 5°) by 30°, and start your rollout when the compass reads approximately 205°.
3. *The error is negligible when turning to east or west; therefore, use the normal amount of lead when turning to an east or west heading.*
4. *For intermediate headings that lie between the cardinal headings, use an approximation based on the heading's proximity to north or south, the direction of the turn, and your knowledge of the compass's lead and lag characteristics in these areas.* In other words, use an "educated guesstimate".

We won't guarantee you that the above method will roll you out on the exact heading every time—at best, it is an approximate method. But it will get you reasonably close to your desired heading, and this beats having no method at all.

KNOW YOUR MAGNETIC COMPASS

How to Obtain EXAM-O-GRAMS

Many EXAM-O-GRAMS for Private, Commercial, and Instrument Pilots have been published, and as the need arises, more will be made available. Some EXAM-O-GRAMS are intended to provide specific, detailed information on those subjects that seem to cause applicants the most difficulty on examinations. Other EXAM-O-GRAMS deal with items of vital importance to the pilot, but available information may not adequately cover the subject for various reasons. All of the EXAM-O-GRAMS should prove most useful on any training program.

EXAM-O-GRAMS are distributed free to ground school operators, flight school operators, ground instructors, flight instructors, etc. Any individual in these classifications who wishes to be placed on the EXAM-O-GRAM mailing list should address his request to:

FAA Aeronautical Center
Flight Standards Technical Div., AC–700
Operations Branch, AC–740
P.O. Box 25082
Oklahoma City, Oklahoma 73125

NOTE: Normally, only single copies are distributed to each operator or instructor. Sufficient quantities are not available to supply all pilots and participants in ground school classes. However, they may be reproduced by recipients in any way desired.

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