TERRY T. LANKFORD

USING AERONAUTICAL CHARTS

- VFR AND IFR CHARTS
- ILLUSTRATES, DEFINES, EXPLAINS SYMBOLS AND THEIR IMPACT TO FLIGHT PLANNING
- COVERS ALL TYPES OF CHARTS
- FEATURES CURRENT AIRSPACE CLASSIFICATIONS

Using Aeronautical Charts

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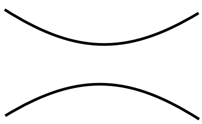
Contents

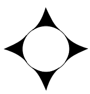
Before we take off

My goal, like that of the Federal Aviation Administration (FAA) and the aviation industry as a whole, is the safe and efficient use of our aircraft within the National Airspace System (NAS). Safety is, to a large extent, based on a pilot's training and experience. Unfortunately, the definition of "learning by experience" is "where the test comes before the lesson." This book is dedicated to one aspect of a pilot's training—the application of aeronautical charts and publications to our flying activity.

Before we begin we would like to challenge the reader with a series of true/false and multiple choice questions based on the interpretation and application of aeronautical charts and publications.

True/false

1. 

   The mountain pass symbol is always oriented with the direction of the pass.
2. An underlined frequency indicates the facility operates on a part-time basis.
3. The symbol 122.1R indicates the ATC facility has only receive capability on this frequency. Therefore, the pilot must transmit on 122.1 MHz and listen on another frequency—usually the associated navigational aid.
4. Controlled airspace establishes visual flight rules (VFR) minimums, and may mandate minimum pilot qualifications and aircraft equipment.
5. 

   This symbol indicates a visual checkpoint that is stored in the Global Positioning System (GPS) database.

6. VFR charts are often more complex than those used for instrument flight rules (IFR) navigation.
7. Pilots operating under IFR are required to accept charted visual flight procedures (CVFP) when assigned by Air Traffic Control.
8. All information concerning an instrument approach is contained in the published instrument approach procedure (IAP) chart.
9. Operating runway lights are required for night instrument approach operations.
10. Pilots can expect to receive all relevant information required by regulations, during a briefing from a flight service station (FSS) or direct user access terminal (DUAT).
11. The Aeronautical Information Manual (AIM) provides the pilot with mandatory procedures.

Multiple choice

1. Which statement best describes a swamp?
   a. An area of land and water, with abundant vegetation.
   b. A lake with trees growing out of it.
   c. A wooded tract of land that rises above an adjacent marsh.
2. A maximum elevation figure is defined as:
   a. The highest elevation in any group of related relief formations.
   b. The highest elevation, including terrain or other vertical obstacles, bounded by a grid on a chart.
   c. A point on the chart where elevation is noted, usually the highest point on a ridge or mountain range.
3. On average, how many changes occur with each sectional aeronautical chart revision?
   a. 95
   b. 125
   c. 280
4. Terminal area charts (TACs) are designed:
   a. For visual navigation of slow- to medium-speed aircraft.
   b. To allow a pilot to safely navigate in the vicinity of, and remain clear of, congested airspace.
   c. For visual navigation by moderate-speed aircraft and aircraft operating at higher altitudes.

5. Sectional charts are designed:
   a. For visual navigation of a low- to medium-speed aircraft.
   b. To allow a pilot to safely navigate in the vicinity of, and remain clear of, congested airspace.
   c. For visual navigation by moderate-speed aircraft.
6. Minimum climb rate on instrument charts is based on the aircraft's:
   a. True airspeed
   b. Indicated airspeed
   c. Ground speed
7. Which of the following minimum categories applies to most general aviation GPS equipped aircraft?
   a. LNAV/VNAV
   b. LNAV
   c. Circle to land
8. Which of the following are recent improvements to National Aeronautical Charting Organization (NACO) charts?
   a. Briefing strip
   b. Terrain
   c. Graphic missed approach
9. An often-overlooked element of instrument approach procedures are the:
   a. Missed approach procedures
   b. Circling minimums
   c. Notes
10. Pilots must be familiar with which of the following prior to beginning an instrument approach?
    a. The type and use of the equipment on board the aircraft.
    b. All aspects of the approach procedure.
    c. Aircraft approach configuration and missed approach procedure.
11. The official definition of night is:
    a. Sunset to sunrise.
    b. The time between the end of evening civil twilight and the beginning of morning civil twilight.
    c. One hour after sunset to one hour before sunrise.

As you proceed through the book, keep these questions in mind. They will be answered and explained—you may be surprised.

Answers

True/false

1. F
2. F
3. T
4. T
5. T
6. T
7. F
8. F
9. T
10. F
11. F

Multiple Choice

1. b
2. b
3. c
4. b
5. a
6. c
7. b, c
8. a, b, c
9. c
10. a, b, c
11. b

Introduction

An essential part of flight preparation is the acquisition, interpretation, and application of aeronautical information. A primary source of these data are contained in aeronautical charts and their related publications.

Any map user seeks information; a pilot needs specific details on terrain, airspace, landing area, and navigational aids. The cartographer's task is to design a map with the least distortion for the intended purpose. The success of a map is dependent upon the cartographer's and user's knowledge and on their joint realization of the purpose and limitations of the map.

No matter how short or simple the flight, regulations place the responsibility for flight preparation on the pilot. To effectively use available resources during preflight planning, a pilot must understand what information is available, how it is distributed, and how it can be obtained and applied. During the flight, a pilot must constantly use charted information for navigation and communications.

Almost at the beginning of commercial aviation it became apparent that charts could not contain all of the vast and varied information necessary for a safe and efficient flight. Because of the expense of chart production, charts could not economically be updated at every change. To this end, aeronautical publications were developed. Publications primarily provide planning information, data to update charted information, or data that remain relatively unchanged.

In this text, technical concepts and terms are explained in nontechnical language, progressing beyond decoding and translating, to interpreting and applying information to actual flight situations. Discussions include applying chart information to visual flight rules (VFR) and instrument flight rules (IFR) operations, plus low-and high-level flights.

Chart limitations are discussed. There is an examination of chart information and publication usage while flight planning using direct user access terminals (DUATs). This is a sound foundation for the novice and a practical review for the experienced pilot; a thorough knowledge of aeronautical charts and their relationship to the air traffic control system is essential to a safe, efficient operation.

The strictly VFR pilot should not overlook the information in the chapters on instrument charts. The VFR pilot might want to utilize products designed for instrument flying. For example, some pilots supplement visual charts with enroute low-altitude charts for the enroute chart information (airway radials, minimum enroute altitudes, ATC frequencies). Instrument approach procedure charts feature all related communication and navigation frequencies with an airport sketch. A detailed diagram is available for larger airports, which can be very valuable to the VFR pilot. With the increased number of runway incursions, every pilot should obtain a copy of the airport sketch or airport diagram, especially when planning a flight into an unfamiliar or major airport.

The importance of chapters explaining aeronautical publications cannot be overstated. Publications are chart extensions, as important as the charts themselves. Supplemental publications provide information on how to use the air traffic control system, airspace, and procedures. Various commercial supplements are available that go beyond aeronautical data. Many provide commercial information about airport services, transportation, and lodging.

This book provides information that is required to pass written and practical examinations, prepare the dispatcher as well as the pilot—from student through airline transport employee, flying aircraft from recreational airplane to business jet—to operate safer and more efficiently within an increasingly complex environment.

Chapter 1 begins with the limitations of the cartographer. How do we transfer a globe onto a flat surface, then locate a specific point? The various chart projections, each with its own advantages and limitations, are discussed, along with limitations common to all charts; methods and criteria used by the cartographer are explained. The problems of scale, simplification, and classifications are considered. Another section discusses the problem of currency. In an ever-changing environment, how does a pilot obtain the latest information required for a safe and efficient flight? A pilot must be fully aware of the system used to update aeronautical information. This includes the information available from flight service stations (FSSs) and DUAT weather briefings, as well as the services available through commercial chart producers, and their limitations.

Chapters 2 through 4 pertain to visual charts. A pilot has access to charts covering the world. These charts are of little value without the knowledge and understanding to apply their vast wealth of information. These chapters begin with the terminology and symbols used on visual charts, then go on to explore visual charts used in routine flying, and supplemental charts available for other parts of the world and those used for special purposes. Dozens of different charts have been developed for aviation. Each has its own criteria, purpose, and limitations; each is analyzed. The pilot can then apply the array of charts available, with respect to regulations, type of operation, and pilot ability, to efficiently operate within today's aviation system.

Visual chart terminology and symbols are discussed. Topographical features of terrain, hydrography (water and drainage features), culture (man-made objects), and obstruction are defined and chart symbology explained. Next, aeronautical terminology and symbols for airports, navigational aids (NAVAIDS), and airspace are considered. From this analysis, and a practical application of terminology and symbols, the reader should be able to define and explain all visual chart symbols, and apply their meaning to various flight situations.

A thorough analysis of standard visual charts includes visual planning and sectional charts, terminal area charts (TACs), and world aeronautical charts (WACs), which are used most often for VFR flying. A pilot should be able to choose the best product for the planned flight; inappropriate chart selection has often led to pilot disorientation, and, unfortunately, at times to fatal accidents.

Civil aeronautical charts for the United States, its territories, and possessions are produced by the National Aeronautical Charting Office (NACO), which is part of the Federal Aviation

Administration's (FAA) Office of Aviation Systems Standards (AVN). The National Imagery and Mapping Agency (NIMA) provides charts for the rest of the world. Both NACO and NIMA charts use similar symbology and format. NIMA products are of limited value in the United States because of the NACO chart series; however, some NIMA charts might be helpful for planning, or other specialized missions. Special NACO charts are also presented, such as the Grand Canyon VFR aeronautical chart, which provides guidance through canyon airspace affected by a special regulation. Charts and related material published by foreign countries and private publishers are explored. This should give the reader a sense of the products available, but sometimes overlooked.

Chapters 5 through 7 examine instrument procedure charts. Since the late 1960s, more and more pilots are obtaining an instrument rating. General aviation aircraft are approaching and exceeding commercial aircraft performance of the 1940s and 1950s. Each chart series is analyzed with respect to use, regulations, and limitations.

This book is not intended to make recommendations regarding chart publishers, merely to provide the reader with information for an educated choice. It is the pilot's responsibility to select the chart and information publisher that best suits his or her needs.

A number of points can be inferred from these chapters. The FAA and other government agencies have gone to great lengths to establish a safe airway system. But the pilot's safety, and that of the passengers and those on the ground, ultimately rests with a pilot's chart knowledge. The pilot must know what equipment is available and operational on the aircraft. Certain routes and procedures can be flown only with specific equipment, such as automatic direction finder (ADF), distance measurement equipment (DME), or the Global Positioning System (GPS). The pilot must then correctly interpret the chart, refusing any ATC clearance that cannot be complied with because of equipment limitations or deficiencies.

The instrument chart chapters contain interrelated material; therefore, the reader is occasionally asked to refer to a previous chapter, usually a specific figure number. I apologize for any inconvenience, but this seemed the best way to integrate the material.

The IFR-specific chapters begin with enroute instrument charts. This might seem like starting in the middle, with subsequent chapters on departure and arrival procedures, and approaches; however, because most terminology and symbols on enroute charts also apply to the other chart series it would seem to be a logical starting point. A solid understanding of enroute products is a foundation for examining specific charts used for departure, arrival, and approach.

Departure procedures (DP) and standard terminal arrival route (STAR) charts are discussed. Once the domain of air carrier, corporate, and military pilots, and contained in separate publications, DPs and STARs are an integral part of today's IFR system, and published along with their associated instrument approach procedures. A pilot's acceptance of a DP or STAR is an agreement to comply with the requirements of the procedure. In addition to terminology and symbols, procedural requirements are explored. For example, what is the pilot expected to do when radio communications are lost during a radar vector DP or STAR?

Instrument approach procedure (IAP) charts are dissected. Each item of information is decoded, defined, and explained. A half-dozen different instrument approach procedures, including RNAV and GPS approaches, are analyzed with respect to information available, pilot procedures and requirements, and lost communications. A thorough understanding of approach procedures should provide the pilot with the knowledge to apply any approach to a flight situation.

The final chapters discuss and analyze publications that support aeronautical charts. Recall that aviation complexities forced selected information off the chart and into supplemental publications. Aeronautical publications that support NACO VFR and IFR charts are discussed. These publications, which are direct extensions of charts, provide the detailed information beyond the scope of charts, and serve as interim documents to update charts between publication cycles or during periods of temporary, but extended, outages. Details on how to obtain NACO aeronautical charts and related publications are provided.

Additional supplement information available to the pilot is discussed. These documents should not be overlooked. They include Department of Defense (NIMA) flight information publications, Canadian supplements, additional documents available through NACO, and those produced by private vendors.

Appendix A contains a decode list of Notice to Airmen (NOTAM) and chart contractions. Appendix B provides a list of agencies that produce and distribute aeronautical charts and publications. Included are addresses, telephone numbers, Internet sites, and e-mail addresses for supplement product providers, many of which offer free catalogs.

The following chapters, hopefully told with a little humor and practical examples of application, explain how to use, translate, interpret, and apply aeronautical charts. Incidents and anecdotes are not intended to disparage or malign any individual, group, or organization; the sole purpose is illustration.

Navigation principles and techniques are not within the scope of this book; therefore, they are not included. The reader should remember that, especially in aviation, the only thing that doesn't change is change itself. Everything possible has been done to ensure that the information in this text is current and accurate at the time of writing.

1

Projections and limitations

The map or chart is a unique means of storing and communicating topographic and other information. It allows the user to reduce the world to a size within the normal range of vision. It is the most effective means of relating the relative location, size, direction, and distance of locations and objects on the earth.

For our purposes we will define *map* as a graphic representation of the physical features—natural, artificial, or both—of the earth's surface, by means of signs and symbols, at an established scale, on a specified projection, and with a means of orientation. A chart is a special-purpose map designed for navigation; specifically an aeronautical chart is a chart designed to meet the requirements of aerial navigation.

Ptolemy, a second century A.D. Egyptian mathematician, astronomer, and geographer, developed principles for map making, including divisions and coordinates. Ptolemy's reference system used lines parallel with and at equal intervals from the equator to the poles, and lines north and south at right angles to the parallels, equally spaced along the equator: latitude and longitude. Ptolemy acknowledged his work was based on Hipparchus (second century B.C.) who was the first geographer to use parallels of latitude and meridians of longitude. Interestingly, Columbus, more than 1000 years later, based his reasoning that if you sailed west you would reach the east on Ptolemy's assumption that the world was round.

In the sixteenth century, Gerardus Mercator began working on the problem of transferring a sphere, the earth, onto a flat map. He reintroduced latitude and longitude, which had only been sporadically used. His maps allowed the navigator to draw a straight line between locations and determine a constant course. In 1569, he introduced his first map of the world using the Mercator projection.

By the eighteenth century, the German mathematician, astronomer, and physicist Johann Heinrich Lambert improved the cone projection derived from Ptolemy to conform with two standard parallels. He developed a half-dozen projections, one of which was Lambert conformal conic; however, it was more than a century before cartographers fully appreciated the value of these projections, and not until World War I was it adopted by the allies for military maps.

Fact

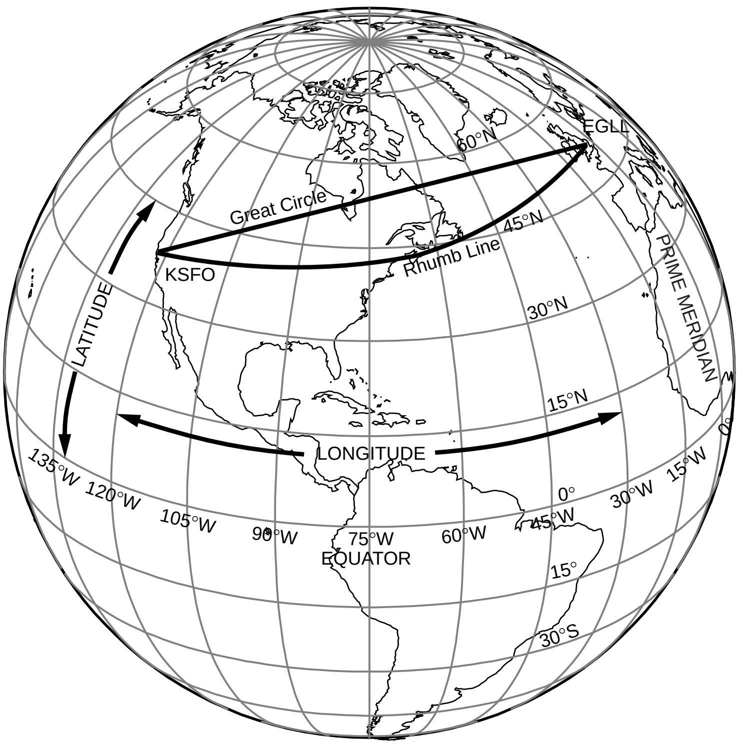
With commerce growing, it became apparent that map makers needed a common reference for coordinates. To this end, in October 1884 the first International Meridian Conference adopted the Observatory of Greenwich, England, as the prime meridian. Longitude was reckoned in two directions, east and west of the Greenwich meridian.

The original aeronautical chart service used the Lambert conformal projection while the Navy's Hydrographic Office employed the Mercator projection. For planning and operating within a global system, new projections were introduced and old systems adapted. The Lambert conformal was preferred for its accuracy in air navigation for most parts of the world; however, for navigation in polar regions, charts using the transverse Mercator or polar stereographic projections were selected.

Today's aerial navigators have a variety of highly accurate aeronautical charts that cover the world. Aeronautical charts and chart making have made tremendous progress since their inception at the beginning of the twentieth century. But, like aviation weather and weather products, aeronautical charts have limitations that must be understood by the pilot. A sound understanding of chart purpose and limitations are necessary to safely and efficiently apply the assortment of charts in an operational environment.

Only a globe can accurately portray locations, directions, and distances of the earth's surface. The earth is not actually a sphere, but a spheroid. The earth only approximates a true sphere because of the force of rotation that expands the earth at the equator and flattens it at the poles. This elliptical nature of the earth is a concern to cartographers; for most practical purposes of navigation, the earth can be considered a sphere. On the earth, meridians of latitude are straight and meet at the poles; parallels of longitude are straight and parallel, as shown in Fig. 1-1. Meridian spacing is widest at the equator and zero at the poles; parallels are equally spaced. Scale is true for every location.

Because a globe is not possible for practical aeronautical charts, mathematicians and cartographers have devised a number of systems, known as projections, to describe features on the earth in the form of a plane or flat surface; several have already been mentioned. A map projection is



1-1 *Only on a globe are areas, distances, directions, and shapes true.*

a system used to portray the sphere of the earth, or a part thereof, on a plane or flat surface.

Locations on the earth are described by a system of latitude and longitude coordinates. By convention, latitude is named first, then longitude. Refer to Fig. 1-1. The reference point for latitude is the equator, with latitude measured in degrees north and south of the equator. Longitude is measured east and west of the prime, or Greenwich, meridian.

Any point on the earth can be described using the system of latitude and longitude in degrees, minutes, and seconds. (There are 60 minutes per degree and 60 seconds per minute.) With the sophistication of today's navigational systems, aeronautical charts and publications can express latitude and longitude in degrees, minutes, and hundredths of a minute. A degree is an arc $1/360$ of a circle; therefore, a point with latitude 47°N longitude 122°W would be the intersection of the parallel 47° north of the equator and the meridian 122° west of the Greenwich meridian. Degrees can be further subdivided into minutes (′), which represent $1/60$ of a degree, and seconds (″), which represent $1/60$ of a minute. For example, the Seattle-Tacoma International Airport is located N47°26.28′ W122°18.67′ (47 degrees 26.28 minutes north; 122 degrees 18.67 minutes west).

Speculation

Many have wondered why a circle is divided into 360 degrees, a degree into 60 minutes, and a minute into 60 seconds? Why not divide a circle into 100 units or 400 units? It appears the reason for the selection was due to the mathematical sophistication at the time when this system was originally developed. Three hundred and sixty can be divided evenly by the most whole numbers (i.e., 2, 3, 4, 5, 6, 8, 9, 10, etc.).

Each degree of latitude equals 60 nautical miles (nm). Because meridians meet at the poles, a degree of longitude decreases in length with distance north or south of the equator; therefore, only for the special case of the equator does a degree of latitude equal 60 nautical miles.

Projections

The goal of the map projection is to accurately portray true areas, shapes, distances, and directions. This includes the condition that lines of latitude are parallel and meridians of longitude pass through the earth's poles and intersect all parallels at right angles.

- **Areas.** Any area on the earth's surface should be represented by the same area at the scale of the map. These projections are termed *equal area* or *equivalent.*
- **Distances.** The distance between two points on the earth should be correctly represented on the map. These projections are termed *equidistant.*
- **Directions.** The direction or azimuth, from any point to any other points on the earth should be correct on the map. These projections are termed *azimuthal* or *zenithal.*
- **Shapes.** The shape of any feature should be correctly represented. The scale around any point must be uniform. These projections are termed *conformal.*

Because it is possible to obtain all these properties only on a globe, the cartographer must select the projection that preserves the most desired properties on the basis of the chart's use. Figures 1-2 through 1-4 illustrate the three projections most often used on aeronautical charts: Mercator, Lambert conic conformal, and polar stereographic. Table 1-1, Chart Projections, compares the different projections used on aeronautical charts.

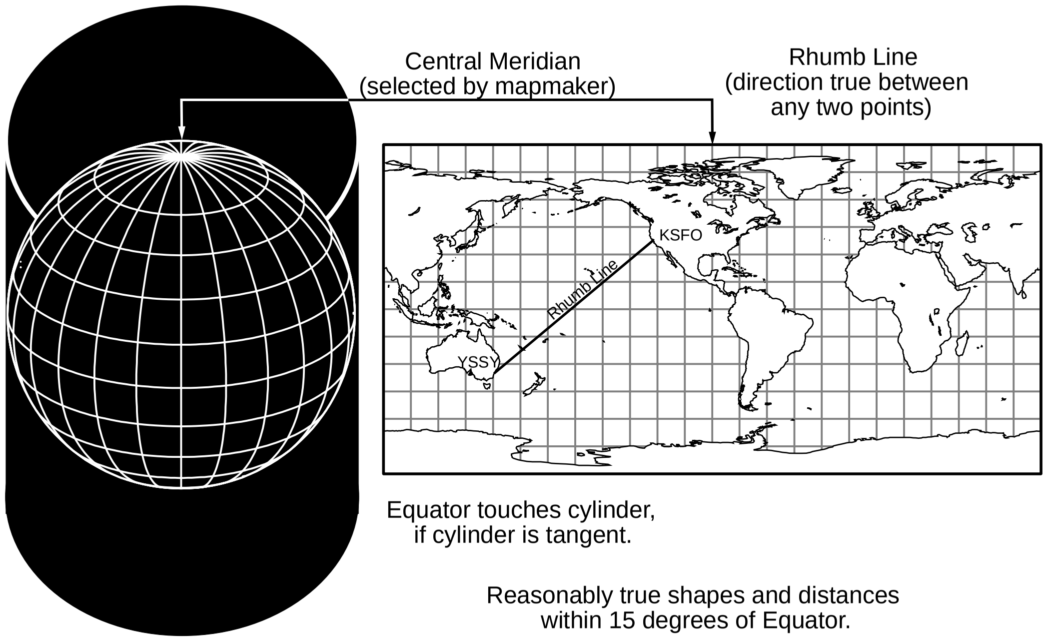
Mercator projection

The Mercator projection transfers the surface of the earth onto a cylinder tangent at the earth's equator. This is illustrated in Fig. 1-2. On the Mercator projection, meridians and parallels appear as lines crossing at right angles. Meridian graticule spacing, the network of parallels and meridians forming the map projection, is equal and parallel as shown in Table 1-1 and Fig. 1-2.

Meridians are parallel on the Mercator projection, unlike meridians on the earth that meet at the poles. This results in

Table 1-1. Chart projections.

Projection	Lines of longitude (meridians)	Lines of latitude (parallels)	Graticule spacing	Scale	Uses
Globe/earth	Straight and meet at poles	Straight and parallel	Meridian spacing maximum at equator, zero at poles; parallels equally spaced	True	Impractical for navigation
Mercator	Straight and parallel	Straight and parallel	Meridian spacing equal; parallel spacing increases away from the equator	True only along equator; distortion increase away from equator	Dead reckoning; celestial
Lambert conic conformal	Straight con-verging at poles	Concave arcs	Parallels equally spaced	True along standard parallels	Pilotage; dead reckoning
Polar stereographic	Straight radiating from the poles	Concentric circles; unequally spaced	Conformal	Increases away from pole	Polar navigation



1-2 *The Mercator projection transfers the surface of the earth onto a cylinder tangent at the earth's equator; meridians and parallels appear as lines crossing at right angles.*

increasingly exaggerated areas toward the poles. Scale, which is the relationship between distance on a chart and actual distance, changes with latitude.

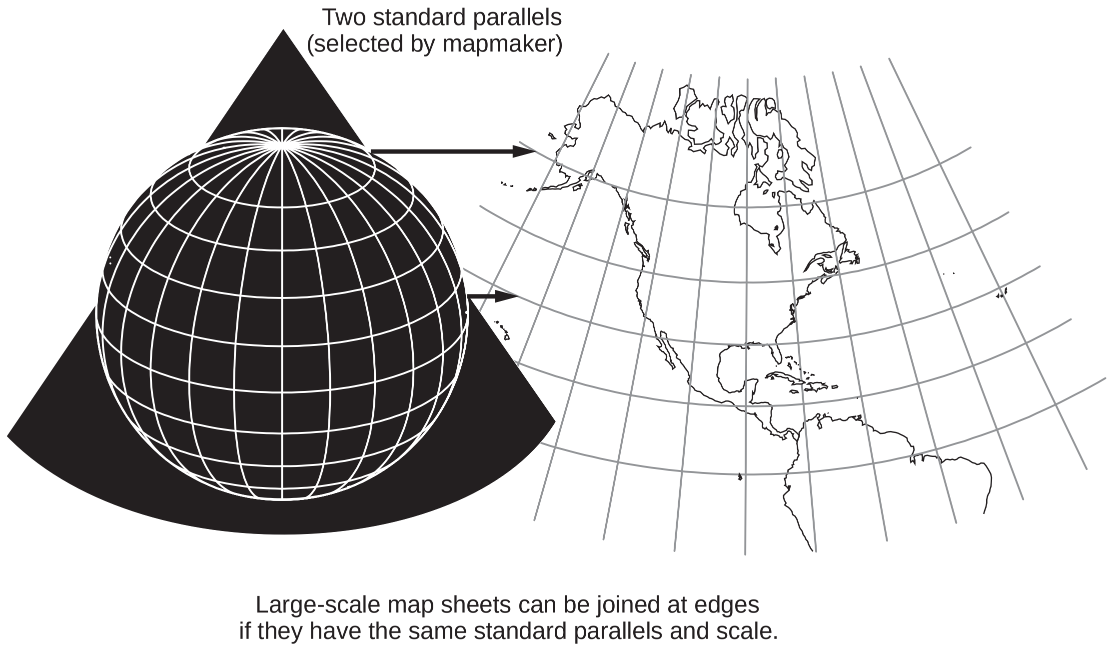
The advantage of the Mercator is that a straight line on this projection crosses all meridians at the same angle. This allows the navigator to set a constant course from one point to another. A course crossing all meridians at a constant angle is known as a rhumb line. Figure 1-1 shows a rhumb line from San Francisco, United States (KSFO) to London, England (EGLL). Figure 1-2 illustrates a rhumb line from Sydney, Australia (YSSY) to San Francisco (KSFO).

A rhumb line is not normally the shortest distance between two places on the surface of the earth. The great circle distance is always the shortest distance between points on the earth. A great circle is an arc projected from the center of the earth through any two points on the surface. A great circle arc is illustrated in Fig. 1-1. A great circle, unlike the rhumb line, crosses meridians at different angles, except in two special cases: where the two points lie along the equator or the same meridian. In both of these cases the rhumb line and great circle coincide.

For practical purposes at low latitudes, rhumb and great circle distances are nearly identical. As latitude and distance increase, differences become increasingly significant, as illustrated in Fig. 1-1. However, the projection is conformal in that angles and shapes within any small area are essentially true.

Lambert conformal conic projection

A projection widely used for aeronautical charts is the Lambert conformal conic, with two standard parallels. This is illustrated in Fig. 1-3. As the name implies, a cone is placed over the earth and intersects the earth's surface at two parallels of latitude. Scale is exact everywhere along the standard parallels; between the parallels scale decreases and beyond the parallels scale increases. Distortion of shapes and areas are minimal at the standard parallels, but distortion increases away from the standard parallels.



1-3 *With the Lambert conformal conic, a cone is placed over the earth and intersects the earth's surface at two parallels of latitude.*

All meridians are straight lines that meet at a point beyond the map; parallels are concentric circles. Meridians and parallels intersect at right angles. The chart is considered conformal because scale is almost uniform around any point; scale error on any chart is so small that distances can be considered constant anywhere on the chart. A straight line from one point to another very closely approximates a great circle.

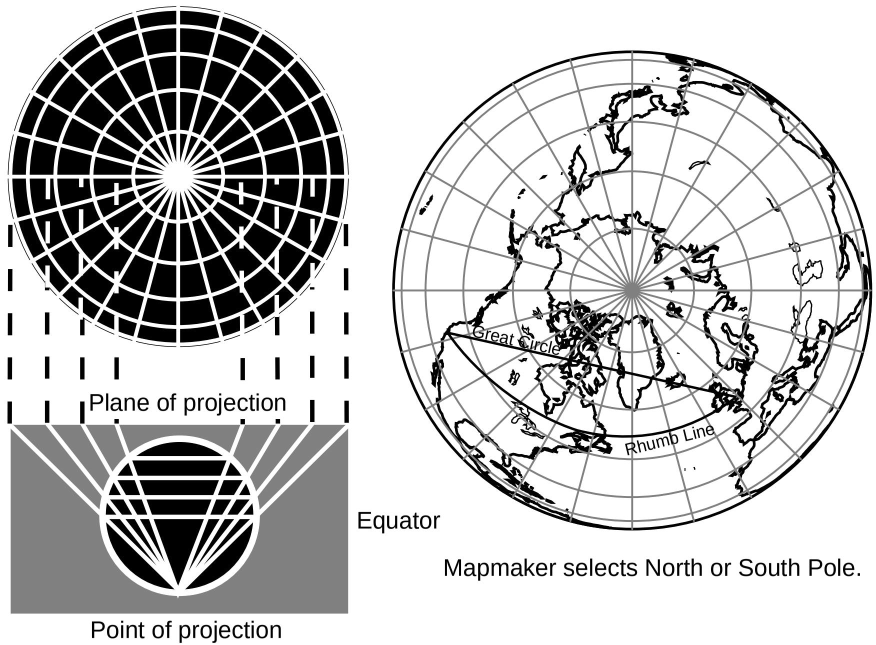
Polar stereographic projection

The standard Lambert is too inaccurate for navigation above a latitude of approximately 75° to 80° north or south of the equator. The polar stereographic projection is sometimes used for polar regions. A plane tangent to the earth at the pole provides the projection. This is illustrated in Fig. 1-4. Meridians are straight lines radiating from the pole and parallels are concentric circles. A rhumb line is curved and a great circle route is approximated by a straight line. Directions are true only from the center point of the projection. Scale increases away from the center point. The projection is conformal, with area and shape distortion increasing away from the pole.

Horizontal datum

Cartographers need a defined reference point upon which to base the position of locations on a chart. This is known as the horizontal datum, or horizontal constant datum, or horizontal geodetic datum. The horizontal datum used as a reference for position is defined by the latitude and longitude of this initial point. Prior to 1992 the horizontal datum for the United States was located at Meades Ranch, Kansas, referred to as the North American Datum 1927 (NAD 27).

With the introduction of geodetic satellites for mapping the earth's surface and satellite navigation systems for innumerable applications, there were recommendations to revise NAD 27. Beginning October 15, 1992, the horizontal geodetic referencing system used in all charts and chart products was changed from the North American Datum of 1927 to the North American Datum of 1983 (NAD83). This resulted in differences of only approximately 1000 ft between NAD 27



1-4 *On the polar stereographic projection, a rhumb line is curved and a great circle route is approximated by a straight line.*

and NAD 83 positions. The greatest coordinate shifts occurred in Alaska and Hawaii where latitude was moved by as much as 1200 ft and longitude by up to 950 ft. In the conterminous United States, the maximum change was approximately 165 ft in latitude and 345 ft in longitude.

Limitations

In addition to the limitations of chart projections, cartographers and chart users are faced with the problems of scale, simplification, and classification. Finally, chart users, especially pilots, are faced with the tremendous issue of current information. With visual charts updated only annually or semiannually, and instrument charts every 28 to 56 days, the pilot must understand the system used to provide the latest information between routine chart revisions.

Scale

Charts provide a reduced representation of the earth's surface. Scale defines the relationship between a distance on a chart and the corresponding distance on the earth. Scale is generally expressed as a ratio: the numerator, customarily 1, represents chart distance, and the denominator, a large number, represents horizontal ground distance. For example: 1:500,000 (sometimes written 1/500,000) states that any unit, whether inch, foot, yard, statute mile, nautical mile, or kilometer, on the chart, represents 500,000 units on the ground. That is, one inch on the chart equals 500,000 inches on the earth.

Chart makers provide scales for conversion of chart distance to statute or nautical miles or kilometers. Manufacturers of aeronautical plotters provide scales for standard aeronautical charts; however, the pilot must be familiar with the plotter used and chart scale for accurate calculations.

Case Study

While flying in the annual Hayward–Bakersfield–Las Vegas air race we use sectional charts (1:500,000), except in the Las Vegas area where a terminal area chart (1:250,000) is available. Sure enough, in my haste I measured a leg using the wrong scale. This is dis-

astrous in a race where the finishing order is a matter of seconds and tenths of a gallon of fuel.

Oh yes! When the FAA designs written test questions requiring the pilot to measure chart distance on a sectional chart (1:500,000), one of the answers is always the distance measured using the world aeronautical chart (1:1,000,000) scale on the plotter.

The smaller the scale of a chart, the less detail it can portray. For example, a chart with a scale of 1:1,000,000 cannot provide the detail of a chart with a scale of 1:250,000. Charts with a smaller scale increase the size of the area covered (assuming a constant size), but reduce the detail that can be depicted.

Simplification and classification

Because scale reduces the size of the earth, information must be generalized. Making the best use of available space is a major problem in chart development. The detail of the real world cannot be shown on the chart. The crowding of lines and symbols beyond a specific limit renders the chart unreadable, yet the amount of information that might be useful or desirable is almost unlimited. The smaller the chart scale, the more critical and difficult the problem; therefore, the cartographer is forced to simplify and classify information.

Simplification is the omission of detail that would clutter the map and prevent the pilot from obtaining needed information. The necessity for detail is subjective and not all will agree on what should, or should not, be included. The inclusion of too much detail runs the risk of confusing the reader by obscuring more important information. For example, the chart producer might have to decide whether to include a prominent landmark, the limit of controlled airspace, or a symbol indicating a parachute jump area. The problem of simplification has led directly to the use of aeronautical publications, such as the *Airport/Facility Directory*.

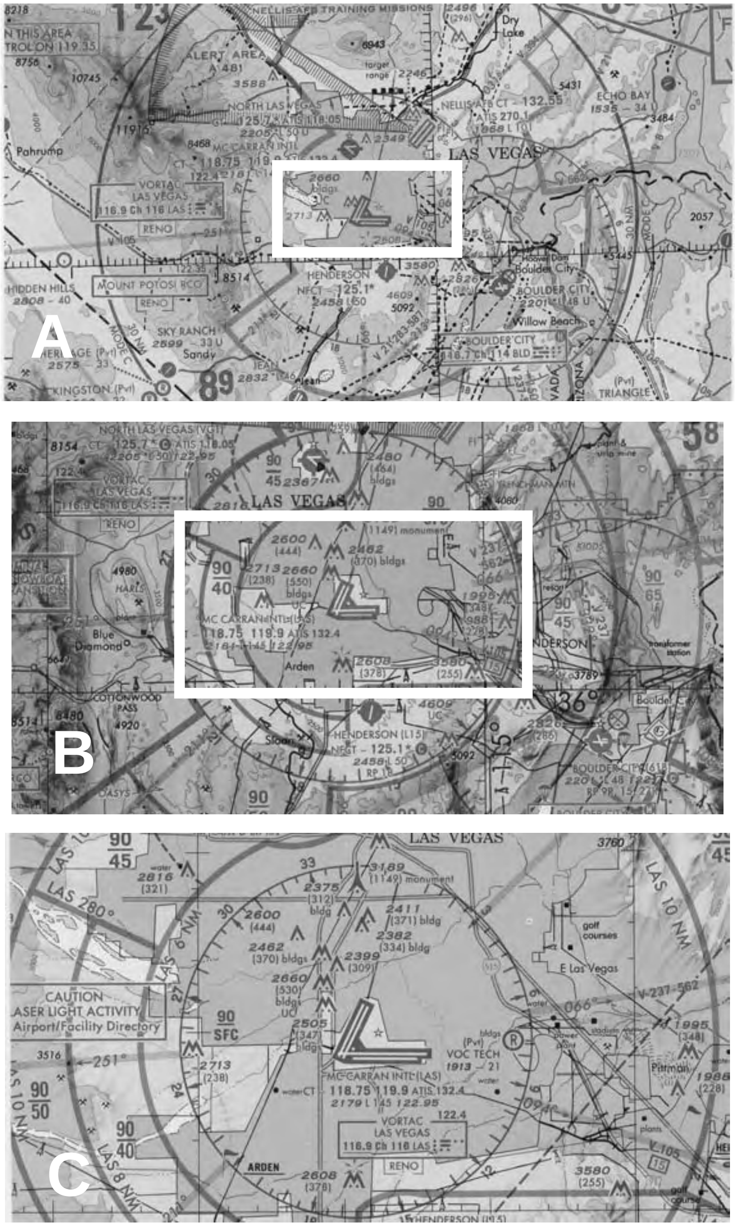
Figure 1-5 illustrates simplification. In Fig. 1-5 picture A depicts a world aeronautical chart with a scale of 1:1,000,000; picture B shows a sectional chart with a scale of 1:500,000; picture C illustrates a terminal area chart (TAC) with a scale of 1:250,000. The inset boxes in A and B cover the same lateral area as the TAC in picture C. Note the additional detail available with the larger scale. The disadvantage is that a relatively large chart covers a relatively small geographical area. Therefore, as we shall see, various charts are designed for specific uses, each with it own purpose of limitations.

The *Airport/Facility Directory* is divided into seven booklets that cover the United States, including Puerto Rico and the Virgin Islands. Alaska is covered by the *Alaska Supplement,* areas of the Pacific by the *Pacific Chart Supplement.* These directories are a pilot's manual containing data on airports, seaplane bases, heliports, navigational aids, communications, special notices, and operational procedures. They provide information that cannot be readily depicted on charts such as airport hours of operation, types of fuel available, runway widths, lighting information, and other data, as well as a means to update charts between editions.

Classification is necessary in order to reduce the amount of information into a usable form. The cartographer must classify towns, rivers, and highways of different appearance on the ground into a common symbol for the chart. The pilot must then be able to interpret this information.

Case Study

On a flight from Phillipsburg, Pennsylvania, to Huntington, West Virginia, we were forced to fly below a 1500-foot overcast because of the weather and radio trouble. Because of poor planning on my part, we had only a world aeronautical chart, instead of the larger-scale sectional chart. I misidentified the Kanawha River as the Ohio River. To verify the position I checked the highways, railroads, and power lines adjacent to the river. Nothing matched. After a few moments of utter confusion I checked the time from last known position and determined we could not have made it all the way to the Ohio. Based on this estimate of distance, I reevaluated our position as over the Kanawha; now everything matched. On the WAC the Kanawha was



1-5 *The inset boxes in A and B cover the same lateral area as the TAC illustrated in C; note the additional detail available with the larger scale.*

represented by a thin blue line, the Ohio by a wide blue line. From the air both rivers appeared identical.

To maximize the amount of information on a chart the cartographer uses symbols. Symbol shape, size, color, and pattern are used to convey specific information. The pilot must be able to interpret these symbols. Lack of chart symbol knowledge can lead to misinterpretation, confusion, and wandering into airspace where one has no business—and has done so.

Figure 1-5 illustrates the depiction of Class B airspace on the three chart scales. Picture A, the WAC, can depict only the outer lateral limits of the Las Vegas Class B airspace. Picture B, the sectional, contains the Class B areas with their bases and tops. Picture C, the TAC, provides much more topographical detail, as well as the arc distances of the various concentric areas.

Currency

With an ever-changing aeronautical environment, charts are outdated almost as soon as they are printed and become available. A pilot's first task when using any chart or publication is to ensure its currency.

Visual charts are revised and reissued semiannually or annually. Changes to visual charts are supplemented by the "Aeronautical Chart Bulletin," in the *Airport/Facility Directory,* revised every 56 days.

National Aeronautical Charting Office (NACO) IFR charts contained in the Terminal Procedures Publication (TPP) are published every 56 days. A 28-day midcycle change notice (CN) volume contains revised procedures that occur between the 56-day publication cycle. (A list of airports in the CN is available on the NACO Web site at; www.naco.faa.gov.) These changes are in the form of new charts. The subsequent publication of the TPP incorporates change notice volume revisions and any new changes since change notice issuance.

With the increased use of aeronautical databases for both VFR and IFR navigation, it's extremely important that pilots understand how their equipment is updated. Aeronautical databases are typically updated on a 28-day cycle. (Normally the new database becomes effective at 0901Z on the date of the change.) The pilot's database must not be updated and flown prior to the effective data and time, nor the equipment used for navigation without the update after the update's effective date and time.

Like databases, some chart providers issue charts to their subscribers prior to their effective date. Pilots must be careful not to attempt to use charts prior to their effective date.

Visual and instrument charts are further supplemented by the FAA's Notice to Airmen system (NOTAMs). The NOTAM publication is published every 28 days and supplements the "Aeronautical Chart Bulletin" in the *Airport/Facility Directory,* The TPP, and change notice volumes. A detailed discussion of the NOTAM publication is provided in Chap. 8.

Aeronautical information not received in time for publication is distributed through the FAA's telecommunications systems. These include unanticipated or temporary changes, or hazards when their duration is for a short period or until published. A NOTAM is classified into one of three groups:

- NOTAM (D)
- NOTAM (L)
- FDC NOTAM

NOTAM (D)s consist of information that requires wide distribution. NOTAM (D)s contain information that might influence a pilot's decision to make a flight, or require alternate routes, approaches, or airports. They are considered "need-to-know" and issued for certain landing area restrictions, lighting aids, special data, and air navigation aids that are part of the National Airspace System (NAS). NOTAM (D)s are issued for all public-use airports listed in the *Airport/Facility Directory.*

NOTAM (L)s include information that requires local dissemination, but does not qualify as a NOTAM (D). The criteria for NOTAM (L)s have changed significantly over the last decade. NOTAM (L)s have always been a bastard operation. However, with the introduction of DUATs most previously NOTAM (L) criteria items now receive NOTAM (D) distribution, for example, all public use airports and most tower light outages. Tower light outages that do not meet the criteria for NOTAM (D) are disseminated as a NOTAM (L). That is any obstruction 200 ft AGL or less and more than 5 statute miles from a public-use airport.

FDC NOTAMs consist of information that is regulatory in nature pertaining to charts, procedures, and airspace. They include conditions that fall into the following categories: interim IFR flight procedures, temporary flight restrictions, 14 CFR Part 139 certificated airport condition changes—airport rescue and fire fighting (ARFF) required for air carrier operations, emergency flight rules special data, and laser light activity.

NOTAMs from each category are routinely provided as part of a standard flight service station (FSS) weather briefing. NOTAMs, except (L), are also available through direct user access terminals (DUATs) and other commercial weather vendors. When FDC NOTAMs are associated with a specific facility identifier, they are included as part of the DUAT briefing; however, most enroute chart changes are not associated with a specific facility identifier. DUAT users are faced on every briefing with a disclaimer: "FDC NOTAMs that are not associated with an affected facility identifier will now be presented unless you specifically choose to decline to receive such information." It's almost like looking for the proverbial needle in a haystack, but to be safe, these NOTAMs must be reviewed. DUAT users must remember that, once FDC NOTAMs are published, unlike the FSS briefings, where the pilot has the option to request the data, "Published FDC NOTAM Data are not available, and must be obtained from other publications/charts/etc." Pilots using NACO charts must be aware of these limitations and plan their flight briefings accordingly. This might mean a call to the FSS specifically for any pertinent FDC NOTAMs.

Once a new chart becomes effective, the NOTAMs, including those carried in the *Notice to Airmen* publication and "Aeronautical Chart Bulletin" of the *Airport/Facility Directory,* are canceled and removed. Pilots are presumed to be using current charts.

A major advantage of commercial suppliers of chart services is a more timely revision schedule than is available for most government products. Immediate and short-term changes to the National Airspace System must still be obtained, but this information is normally provided as part of an FSS standard briefing or DUAT briefing.

Case Study

A British friend with whom I flew in England in the middle 1960s was astonished by the frequent revisions to United States aeronautical charts. The British civil charts we had to fly with were infrequently updated and only contained about a fifth of the information of United States charts. For example, all NAVAIDs were shown by a single symbol without any indication of the type or frequency. And, oh yes, during this period the English charts cost about $5 in U.S. currency—at the time U.S. charts went for about 35¢ each! I'm afraid those days are gone forever.

NACO has made every effort to ensure that each piece of information shown on its charts and publications is accurate. Information is verified to the maximum extent possible. According to NACO, "You, the pilot, are perhaps our most valuable source of information. You are encouraged to notify NACO of any discrepancies you observe while using our charts and related publications. Postage-paid chart correction cards are available at authorized chart sales agents for this purpose (or you may write directly to NACO, at the address below). Should delineation of data be required, mark and clearly explain the discrepancy on a current chart (a replacement copy will be returned to you promptly)."

FAA, National Aeronautical Charting Office
AVN-510, SSMC4, Sta. #2335
1305 East West Hwy.
Silver Spring, MD 20910-3281
9-AMC-Aerochart@faa.gov
1-800-626-3677

NACO emphasizes that the "Use of obsolete charts or publications for navigation may be dangerous. Aeronautical information changes rapidly, and it is vitally important that pilots check the effective dates on each aeronautical chart and publication to be used. Obsolete charts and publications should be discarded and replaced by current editions."

NACO cites the following reasons why pilots need to fly with current charts.

- Each sectional chart averages 280 changes every 6 months.
- Each *Airport/Facility Directory* averages 780 changes every 56 days.
- Each Terminal Procedures Publication volume averages 75 changes every 56 days.

Case Study

A pilot called the FSS and requested a briefing from Bishop to Santa Cruz, California. The briefer explained that the airport was closed. The pilot responded, "Oh, I must be using an old chart." Indeed, the airport had been closed for over 2 years. There are no valid reasons for using obsolete charts.

The use of current charts and publications, and the need for obtaining a complete or standard preflight briefing, cannot be overemphasized. It's like using the rest room before a flight, we know we should, but sometimes it's a little inconvenient. Failure, however, has often led to a very uncomfortable flight. Only by understanding the system can pilots ensure they meet their obligation as pilot in command.