AERONAUTICAL CHARTS

by

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Early aeronautical charts utilized available marine and other charts and maps with the added features of aeronautical aids to navigation. Each country undertook this work independently with the result that there was little uniformity in symbols, scales and other chart data.

To correct this condition, an international conference on navigation met at Paris in 1919. In 1922 another convention met at Paris and organized the International Commission for Air Navigation (I.C.A.N.) and planned the construction of the following international aeronautical maps:

INTERNATIONAL AERONAUTICAL MAPS.

	Scale.	*Projection.*	*Remarks.*
I. Basic...	1: 10,000,000.....	Mercator to Lat. 72°. Stereographic above Lat. 72°.	
II. Route	1: 10,000,000.....	Oblique true projection on cylinder tangent along great circle route.	KAHN Charts, etc...
III. General	1: 3,000,000..... at equator.	Mercator to Lat. 68°.	
IV. Local	1: 1,000,000.....	Modified Polyconic (Lallemand).	Aeronautical features added to the International Map of the World. The latter was planned at the London Conference 1909.

In 1928, when only a few countries, such as the United States of America, France, Germany and England had started publishing air maps for aerial navigation, Admiral NIBLACK foresaw the difficulties which would arise should each nation go its own way with regard to the signs and symbols adopted for the conventional representation of objects, beacons, landing fields, rivers and other topographical features. In the course of time the confusion arising from a multiplicity of symbols, differing for each nation, would become hopeless and difficult to straighten out by future agreements.

Admiral NIBLACK then, in 1928, undertook to publish a chart showing the symbols and conventional signs in use up to that time by the various nations and hydrographic offices then publishing air maps. He then sought to bring order out of chaos by proposing the adoption of certain signs and symbols most nearly conforming to those in use by the majority of the countries and also in conformity with the standard symbols adopted by the States Members of the International Hydrographic Bureau for marine charts. It was considered highly desirable that the air maps conform as far as possible with the marine charts in this respect.

The symbols proposed by Admiral NIBLACK and the charts showing those in use on the air maps of various countries were submitted to the I.C.A.N. (International Commission for Air Navigation), in Paris. These were then referred by the Commission to the Sub-Committee on Maps and as a result of numerous conferences the greater part of the symbols proposed by Admiral NIBLACK were incorporated in the Appendix "F" of the Protocol which was ratified by the States Members of the I.C.A.N. comprising most of the civilized nations of the world.

In the course of time the number of symbols has been increased over and above those proposed by Admiral NIBLACK, but credit must be given him for the basic proposal and the laying of the ground-work, thus allowing the air maps to be produced in all countries with uniform symbols and conventional signs.

The United States has not published to exact specifications the general and local aeronautical map planned by the I.C.A.N. However, the United States has a programme of aeronautical

chart construction admirably suited to its needs. The sectional aeronautical charts for the entire United States to a scale of 1: 5,000,000 has been completed and is in wide use; and a programme is under way to complete the regional aeronautical charts, scale 1: 1,000,000 on the Lambert projection with a Mercator chart to the same scale on the back of it for night navigation. The big advantage of the Lambert projection is the fact that adjacent sections of the charts may be joined exactly, which is not so in the case of the modified polyconic LALLEMAND projection.

In addition to the sectional and regional series being published by the U. S. Department of Commerce, this Department has also published an outline chart of the United States on the Lambert projection to be used as a control chart, scale 1:5,000,000, and a similar chart on the gnomonic projection. In addition, six radio D. F. charts of the United States on the Lambert projection, scale 1: 2,000,000, are being prepared by the Department of Commerce.

Similar D/F charts for special routes have been published by Transcontinental and Western Air.

To meet the needs of long-distance, high-speed planes, a series of four skeleton navigation charts of the world has been published privately. The projection used in each case is the one judged most suitable for the problems of navigation in the region under consideration — that is, the projection which affords the least distortion in the measurement of distance and direction. These are the two fundamental factors in all navigation problems, whether in the field of dead reckoning, radio, or celestial navigation.

Data on this series of navigation charts is shown on the following table:

TABLE N° 1

Chart N°	*Latitude N. or S.*	*Projection used*	*Standard Parallels*	*Latitude*	*Scale Distortion*
1	0° — 30°	Mercator.	15°	0°	— 3.4 %
				15°	0.0
				25°	+ 6.6
				30°	+ 11.2
2	25° — 55°	Lambert.	33°	25°	+ 2.3 %
			45°	33°	0.0
				39°	— 0.5
				45°	0.0
				55°	+ 3.8
3	50° — 80°	Lambert.	55°	50°	+ 1.7 %
			75°	55°	0.0
				65°	— 1.5
				75°	0.0
				80°	+ 2.7
4	75° — 90°	Stereographic.	85°	75°	+ 1.5 %
				85°	0.0
				90°	— 0.2

Fig. 1 illustrates the development and properties of the projections used for the WSN (WEEMS System of Navigation) Charts.

CHART N° 1.

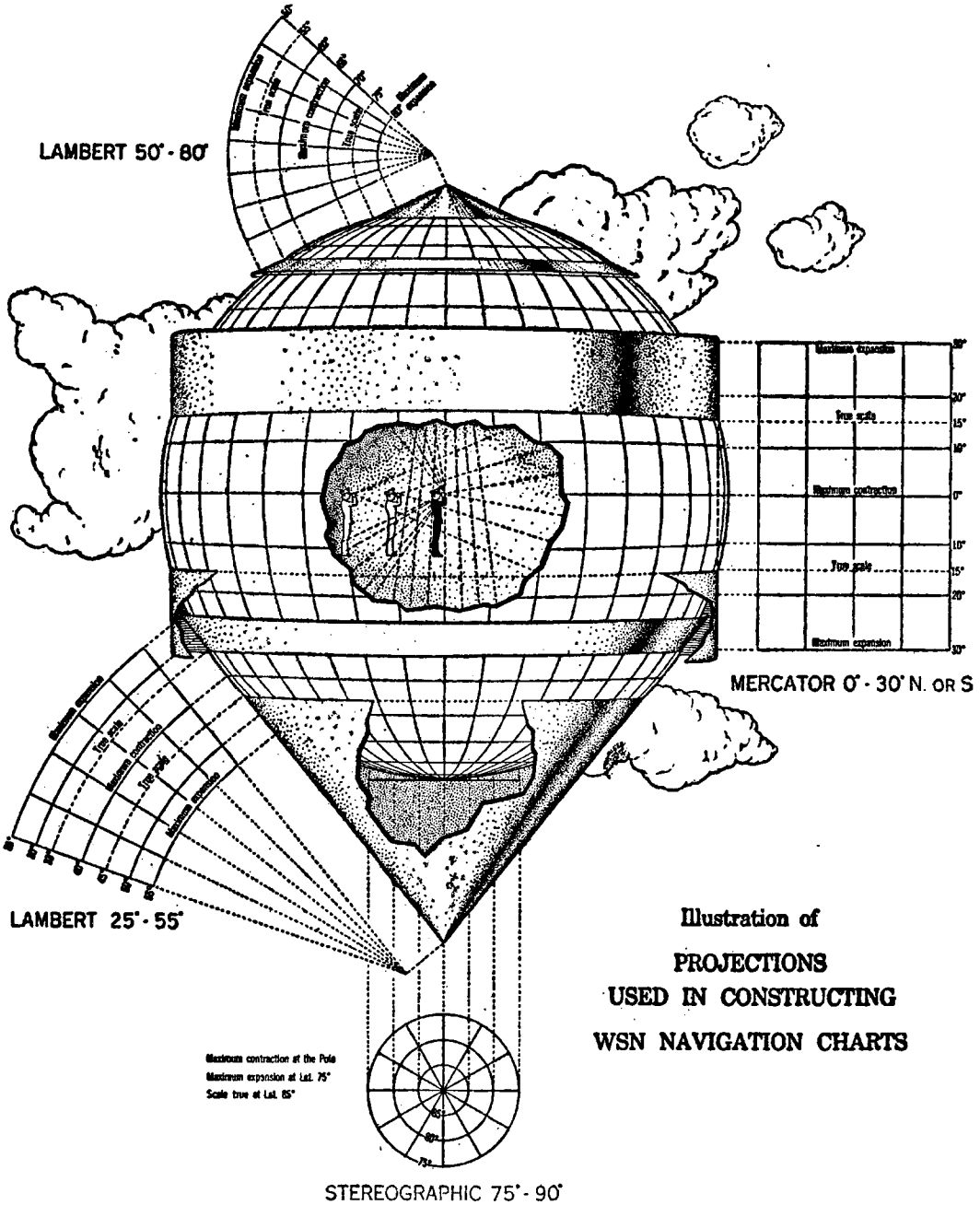
The Mercator projection (latitudes 30° N to 30° S) is developed upon a cylinder intersecting the sphere at parallels of 15° N and 15° S. These are known as the "standard parallels". Along these two parallels the scale is exactly 1: 5,000,000; between these, the representation of the sphere on the cylinder is slightly smaller, and outside, larger than the sphere.

For most projections the eye of the observer (or "the point of projection") is a fixed point. This is not true of the Mercator projection, however; this projection is developed mathematically in order to obtain the desired navigation properties, and in order to represent it graphically, the eye of the observer must be at a different point for each pair of parallels, as shown in the figure.

By using an intersecting cylinder, rather than one tangent at the equator, the outer limits of the chart can be held nearer to the desired average scale of 1: 5,000,000.

CHARTS N° 2 AND N° 3.

The Lambert projection is developed upon a cone, which also intersects the sphere at two standard parallels, with the eye of the observer at the centre of the Earth. As with Chart N° 1, between the standard parallels the scale is slightly too small, beyond them it is slightly too



large. In this case, however, variation in scale is much less as shown on the table of projections above. With Lambert charts it is therefore possible to use a fixed distance scale with little loss of accuracy. Also a straight line on this chart closely approximates a great circle course.

For Chart N° 2 (latitudes 25° to 55°), the standard parallels are at latitudes 33° and 45° (see lower cone in the figure); for Chart N° 3 (latitudes 50° to 80°), the standard parallels are at 55° and 75°, and the cone is much flatter (see upper cone in the figure).

CHART N° 4.

For Chart N° 4 (latitudes 75° to 90°) the stereographic projection is used. This projection is developed upon a plane, with the eye of the observer at the point on the sphere opposite the centre of the plane. For clear representation, the plane in the illustration is shown tangent at the lower pole; however, the plane upon which Chart N° 4 was developed actually intersects the sphere at latitude 85°, which is the standard parallel, and at which the scale is exactly 1: 5,000,000. Within the 85th parallel the scale is slightly too small (about 99.8 % at the pole), and outside this parallel the scale is slightly too large (about 101.5 % at latitude 75°).

Both the Mercator and the Stereographic projections may be considered as special cases of the Lambert projection. In the former, the apex of the cone has receded to an infinite distance, while in the latter, the apex of the cone has been brought down into the plane of the projection itself.

By choosing the most favorable projection for the four bands of latitude, we obtain the following distinctive features:

1. A straight line on any chart of this series closely approximates a great circle on the earth. This is true on Chart N° 1, Mercator projection, due to the fact that the rhumb line and great circle courses very nearly coincide in low latitudes; therefore, these charts may be used for great circle and radio navigation without allowing for convergency of meridians.
2. The distance scales furnished afford sufficient accuracy for practical navigation, except perhaps for latitudes above 20° on Chart N° 1.
3. The chosen scale of 1 : 5,000,000 permits charts of normal size to cover distances up to about 3,600 miles, sufficient for long-distance navigation.