LORAN CHARTS

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With the introduction of the Loran system in marine navigation the need developed for special treatment of nautical charts of the coastal waters of the United States to show the intersecting sets of hyperbolas required for Loran interpretation. Soon after the advent of Loran the Coast and Geodetic Survey initiated a charting program for adapting the standard nautical chart for use with the new electronic aid. The development of a simple method of graphic presentation of Loran information was of primary importance. The objective was to take advantage of this new aid to navigation without the necessity of carrying an additional series of charts and to eliminate the necessity of using Loran tables for plotting Loran positions.

From the beginning it was recognized that to obtain maximum usefulness of charts while approaching the coast, the conventional hydrographic data should be combined with the Loran information. Numerous suggestions were considered for showing Loran information on charts. Study was given to the feasibility of printing the Loran system on the back of the standard chart for use over a light-table ; to print the Loran information on a separate transparent overlay; or to print the pairs of intersecting lines in a fluorescent ink which would be invisible under ordinary light but would glow under an infrared light. After thorough investigation critical objections were found in each of these proposed methods.

The light-table method offered the most promise but it was found that regardless of how translucent the paper or how bright the lighting from below, difficulty was encountered in identifying the Loran lines. The overlay method whereby Loran data are printed on tracing paper or on a thin plastic to the scale of the chart added to the number of charts required which was one of the basic difficulties to be overcome. The fluorescent ink method required a special printing as well as special equipment aboard ship.

The first charts published by the Survey with the Loran system were special editions of nautical charts 1000 and 1001 covering the Atlantic coast of the United States. Special Loran charts 1000-L and 1001-L were reproduced on the reverse side of the standard editions of the respective charts. On these charts the hyperbolas representing Loran lines of position, their designation as to station pairs by color, and microsecond value by numeration are overprinted in distinctive colors on a base chart containing selected details from the conventional nautical chart.

The Loran lines are spaced at 20-microsecond intervals with stations identified by low and high pulse recurrent rates. Sky-wave corrections for L (low) and H (high) recurrent rates are identified by vertical and italic numerals, respectively. The recurrence rate is indicated by the numerical exponent and sky-wave correc-

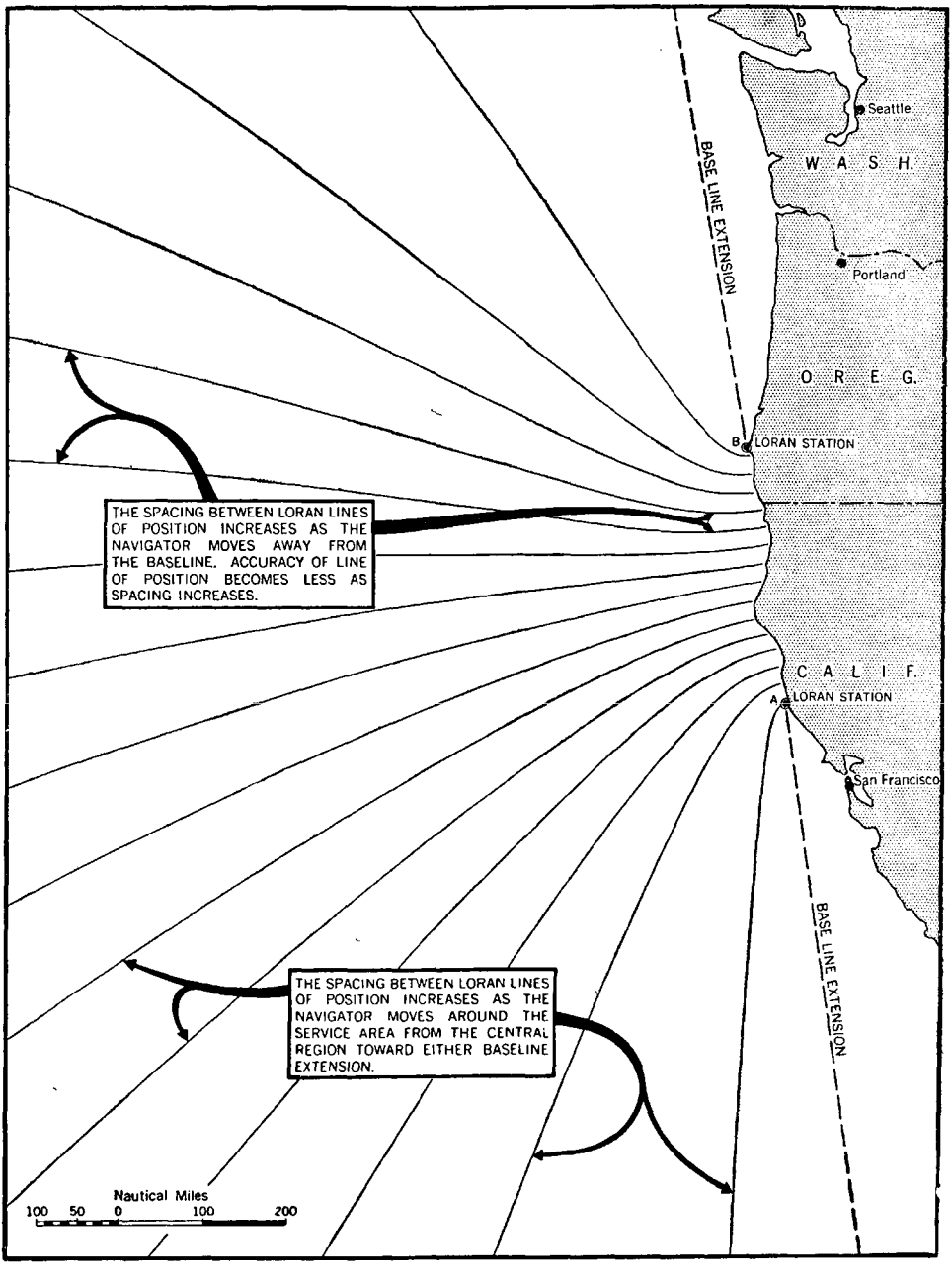

Fig. 2

The ship's position in relation to the Loran stations determines the accuracy of th. Loran system which is inversely proportional to the spacing between lines.

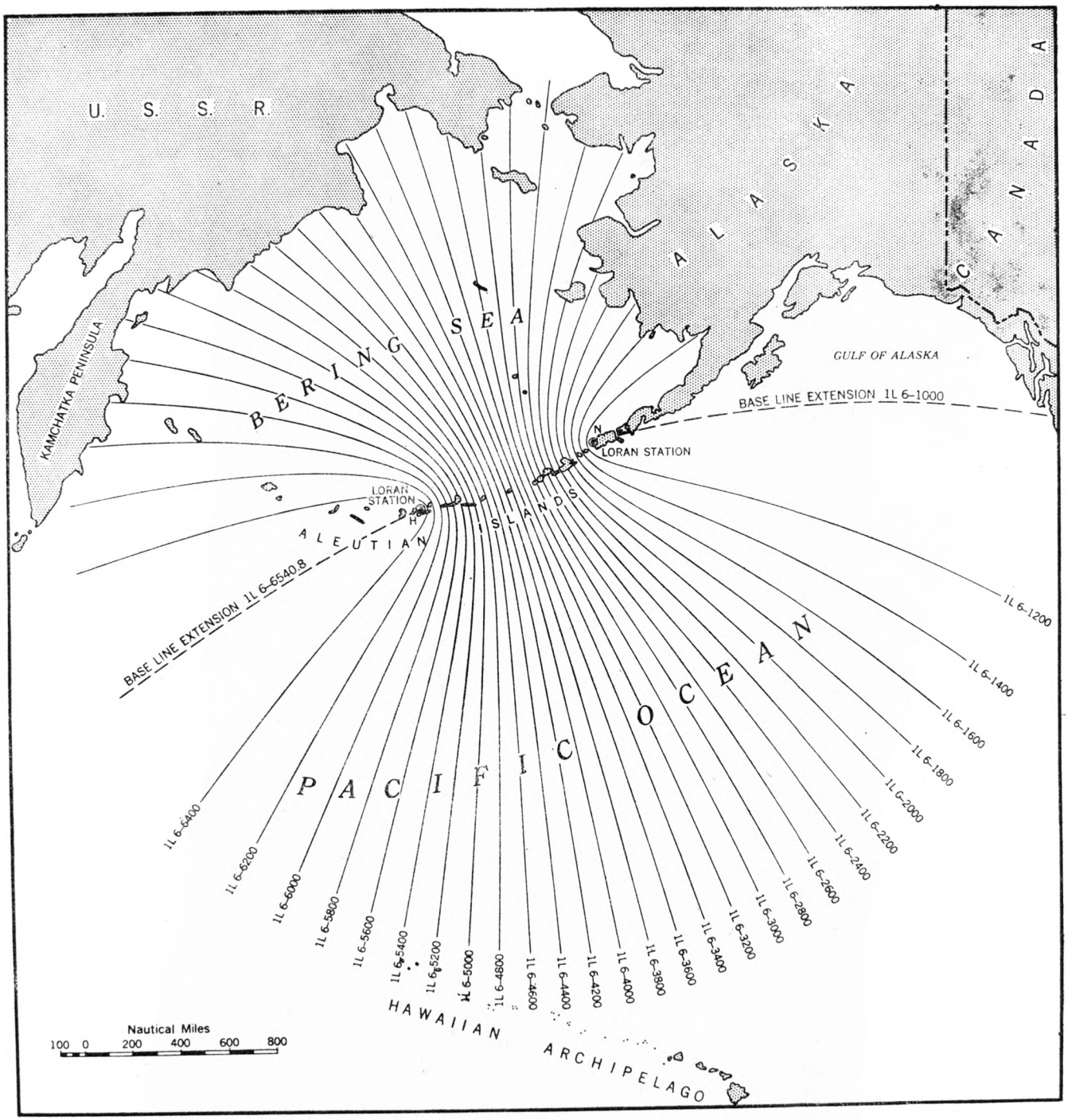

Fig. 1

Typical Family of Loran curves as they appear on Coast and Geodetic Survey Chart 9000. The Loran coverage extends well over 1000 miles from this pair of transmitting stations.

tions with the H recurrence rates shown as dash lines. Standard hydrographic information is printed in black with all sounding figures deleted outside the 10-fathom curve. Depth curves are retained and special ones added for fathometer use. This method had the advantage of eliminating congestion resulting when soundings, depth curves, compass roses, and other hydrographic details are combined with Loran data. The Loran navigator equipped was thus provided a single chart which could be used with or without reference to the Loran system.

Prior to developing this method of charting the Loran system several other experimental charts were produced. On one, the Loran system only was printed in reverse on the back of the standard nautical chart in register with the face of the chart. A position determined by Loran could be transferred to the face of the chart by pricking a hole through the paper. Although this proved to be a quick and positive method of transferring a Loran position it did not provide for correlation with positions determined by other methods, unless they were transferred through the chart in a like manner which was of course a relatively slow process. Another experimental chart was produced whereon the Loran data were overprinted on the conventional chart which was printed in grey instead of black. This method was intended to subordinate details in water areas to the Loran data with these details being available for use when required.

The program of producing Loran charts has been expanded to include nautical charts of the *General* and *Coast* chart series for both the Atlantic and Pacific coasts of the United States. A significant change has been made in the portrayal of Loran data. The Loran lines of position are now being overprinted on the face of the charts instead of on the reverse side. The spacing of the Loran curves has been increased from 20- to 50-microsecond intervals. The reduction in the number of lines was made without in any way impairing the usefulness of the Loran overprint. The Loran lines are broken for soundings and other important details and only the best two rates are shown. Also the lines are being drawn fine enough so as not to interfere with hydrographic details.

Charts 5020, 5021 and 5022 were recently issued with Loran lines of position overprinted on the face of the charts. These three charts provide Loran coverage of the entire Pacific coast of the United States, extending from Cape Flattery to San Diego. They were designed for offshore navigation along the Pacific coast and have other important special features in addition to showing Loran data. Marine radiobeacons are shown with frequency, code signal, and operating schedule indicated for each. The mariner may indentify the stations and plot radio bearings without consulting other publications.

Loran data are shown on chart 1003 for the coastal area of the eastern half of the Gulf of Mexico. In addition to charts 1000 and 1001, Loran information is being added to the « 1100 » series of charts of the Atlantic coast of the United States. *General* charts 71, 1108, 1109, 1110, 1111 and 1112, covering the Atlantic coast from Penobscot Bay to the Straits of Florida are now available in the Loran edition. Nautical charts 1207, 1215 and 1222, covering Massachusetts Bay, the approaches to New York, and the Chesapeake Bay entrance, respectively, are the first of the *Coast* charts to be issued with the Loran overprint.

The navigator equipped with Loran instruments and the necessary charts may employ the system merely as a new method of determining lines of position. Experience indicates that in some localities and under certain conditions a Loran position may be strengthened by using in conjunction with it an astronomical line of

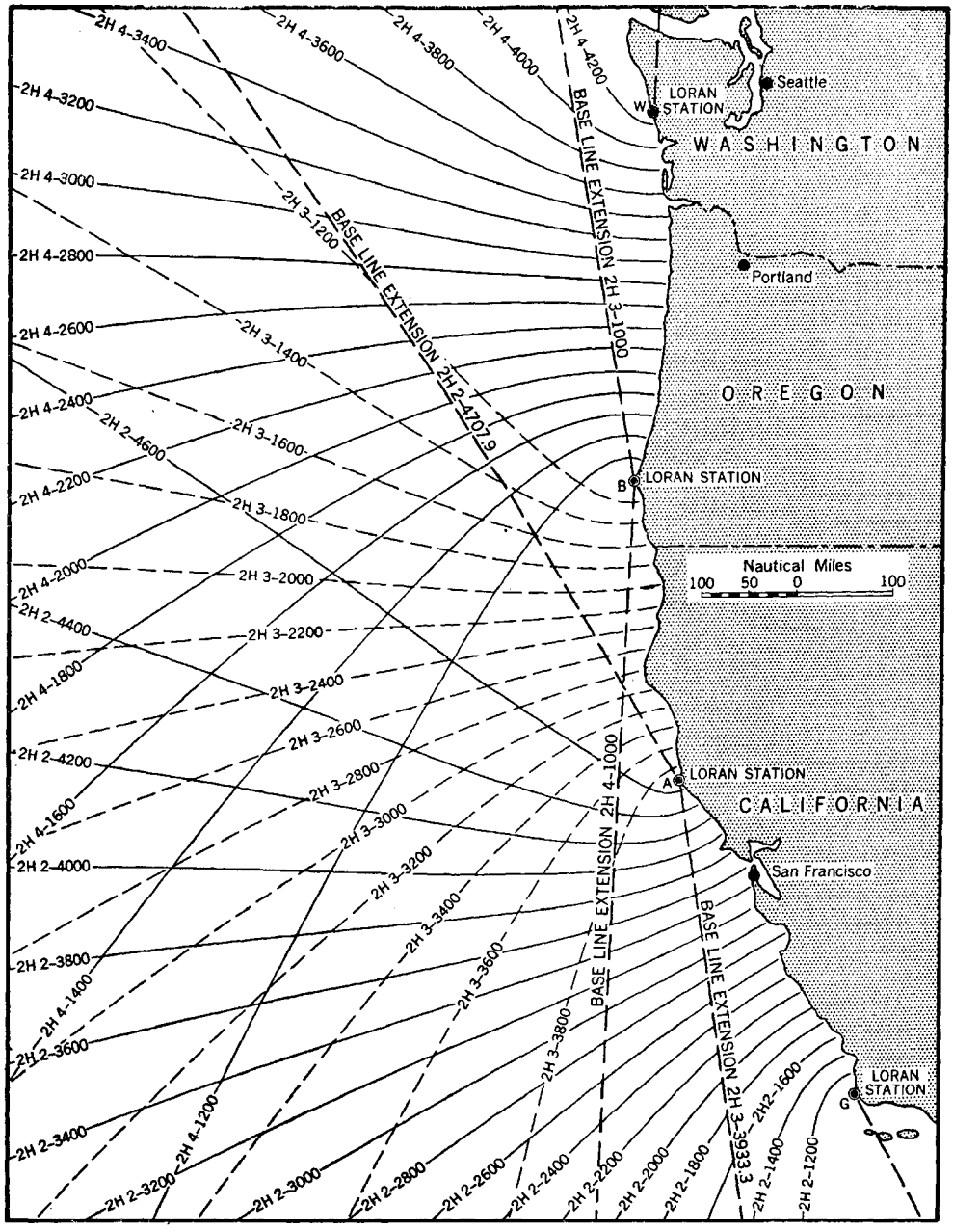

Fig. 3

The development of the Loran system for the Pacific coast of the United States.

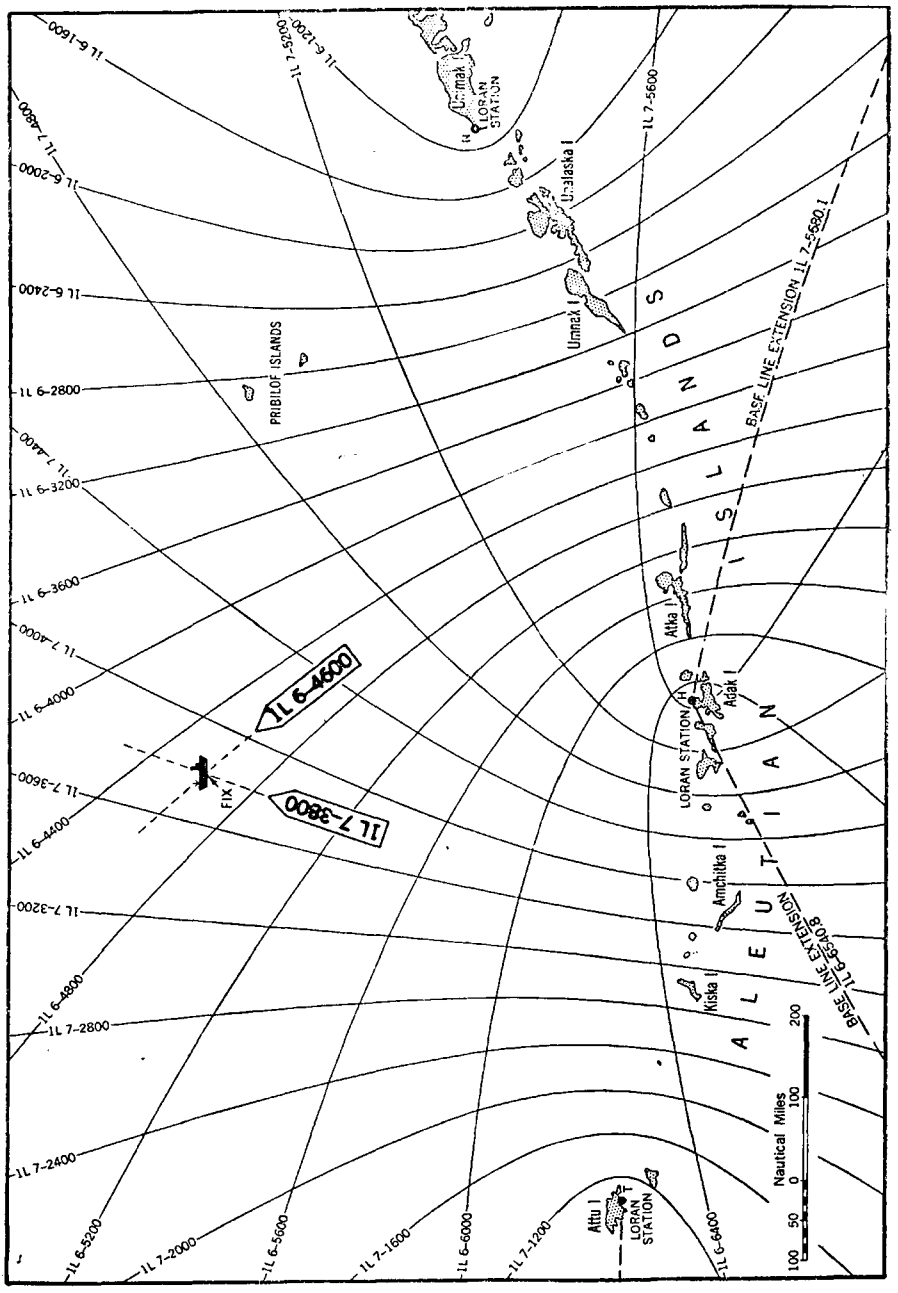

Fig. 4

DETERMINATION OF LORAN FIX : When tuned to Station Pair 1 L6, the navigator obtains a time-difference measurement of 4600 microseconds. Switching to Station Pair 1 L7, navigator obtains time-difference measurement of 3800 microseconds. Intersection of lines 1 L6-4600 and 1 L7-3800 indicates position of ship. For greater clarity lines of position for different stations pairs are shown in different colors on actual Loran charts.

position, a radio bearing, or a line of position obtained by echo-soundings. Loran lines, as indicated on the charts, are fixed with respect to the earth's surface and their determination is not dependent upon the ship's compass, chronometer or other mechanical or electrical devices. They can be crossed with other Loran lines, with sun-sight lines, star-sight lines, soundings, radar-range circles, or with bearings to obtain a fix. Loran, and other modern electronic aids to navigation have to a great extent lessened the burden of a navigator when making a land-fall in thick weather from an uncertain position offshore.

The present format of charts published for use in Loran navigation has resulted to a considerable extent from the suggestions and criticisms received from mariners who have had experience in navigating with the charts. The usefulness of the nautical chart is increased by the addition of Loran information which in turn is an important factor in promoting safety in marine navigation. Constant attention is given to the adaptation of nautical charts to meet the needs in the simplest manner possible of rapidly changing navigational methods.