WILD GOOSE ASSOCIATION

RADIONAVIGATION
JOURNAL
1977

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INTERNATIONAL NAVIGATION CORPORATION

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EDITORIAL COMMENT

This has been a year of substantial growth in the sales of both Loran-A and Loran-C receivers. Perhaps in making Loran-A users aware of Loran-C, the Coast Guard has made many more potential users aware of loran!

On top of this, it's the year the microprocessor/microcomputer made it from the designers workbench to the Loran-C receivers on the dealers' shelves. The microcomputer lets the manufacturer use a wide range of imaginative techniques in aiding the operator and displaying navigation information — all without the large increases in price one might in the past have associated with the use of computers. We are happy to see this trend as it is well appreciated by the users, but we should all be wary of the effect of rampaging technology on competitive pricing and ultimately the survival of the many small companies in the business of manufacture and sales of loran sets.

For the first time this year we have tabulated data on Loran-C receivers. We expect that many manufacturers will take exception to the way the sets are described — but we think that ultimately the users will benefit.

Without even considering the data we have presented on the performance of sets, some manufacturers may feel that we have incorrectly described the functioning and controls of their sets. We can only first refer you to last year's Journal. We discussed the "Characterization of Loran-C Sets" at length, and asked for (and did not receive) comments, as we intended to propose that the characterization be applied to commercially available Loran-C sets. Secondly, we request once again that you contact us and offer corrections and alternative proposals for presenting data.

As for the performance data, it is presented exactly as claimed by the manufacturers. It is obvious that the manual sets out-perform the automatic sets, and cost much less. (Of course if this is true, why does one manufacturer offer an expensive automatic set and a lower cost manual set?) The problem is obviously in the tests performed to make these claims. We can only hope for substantial improvement in the way claims are made, to give the consumer some more accurate idea of what he is buying.

The Coast Guard, the Radio Technical Commission for Marine (RTCM), and the WGA are all concerned about the lack of standards. The Coast Guard is attempting to publish in the Federal Register the characterization and specifications for the Loran-C system. RTCM is attempting to set up minimum performance standards for marine Loran-C equipment. The WGA is assisting in both these tremendously important efforts. We suggest that all manufacturers closely watch, understand and participate in these efforts to assure that ultimately all Loran-C sets are accurately and fairly represented to the public.

It is with great pleasure that I announce Bahar Uttam's promotion to Associate Editor. I take this opportunity to thank him for his thorough and timely work. If it were not for Bahar, I may never have got around to this editorial! Thanks are also due to Dennis Granato of DMAHC for his assistance.

BILL ROLAND
Editor

THE COMMANDANT OF THE UNITED STATES COAST GUARD
WASHINGTON, D. C. 20590

FOREWORD

Since its incorporation in 1972, the Wild Goose Association has been instrumental in maintaining national and international interest in Loran, and has fostered the preservation of the art of Loran. The promotion of an exchange of ideas and information in the field of Loran and the recognition of system advances has been high on the list of the Association's aims and purposes, as has been the documentation of the history of Loran. The Coast Guard notes with pleasure the admirable manner in which the Wild Goose Association is pursuing these aims and purposes.

I salute and congratulate the Wild Goose Association in this their fifth year for their steadfastness of purpose in assuring that the public and private sectors of the radionavigation community are fully apprised of the significant advances in the field of Loran. The Radionavigation Journal is an excellent example of the Association's means of assuring that timely and accurate information reaches the Loran community.

Therefore, it gives me great pleasure to wish the Wild Goose Association success in its ongoing endeavors in the art of Loran. I am confident that its dedication will contribute immeasurably to the continued success of the Loran system and to the benefit of the navigating public.

I shall follow your progress with enthusiasm, and I look forward to forthcoming issues of the Journal.

Sincerely,

O. W. SILER
Admiral, U. S. Coast Guard

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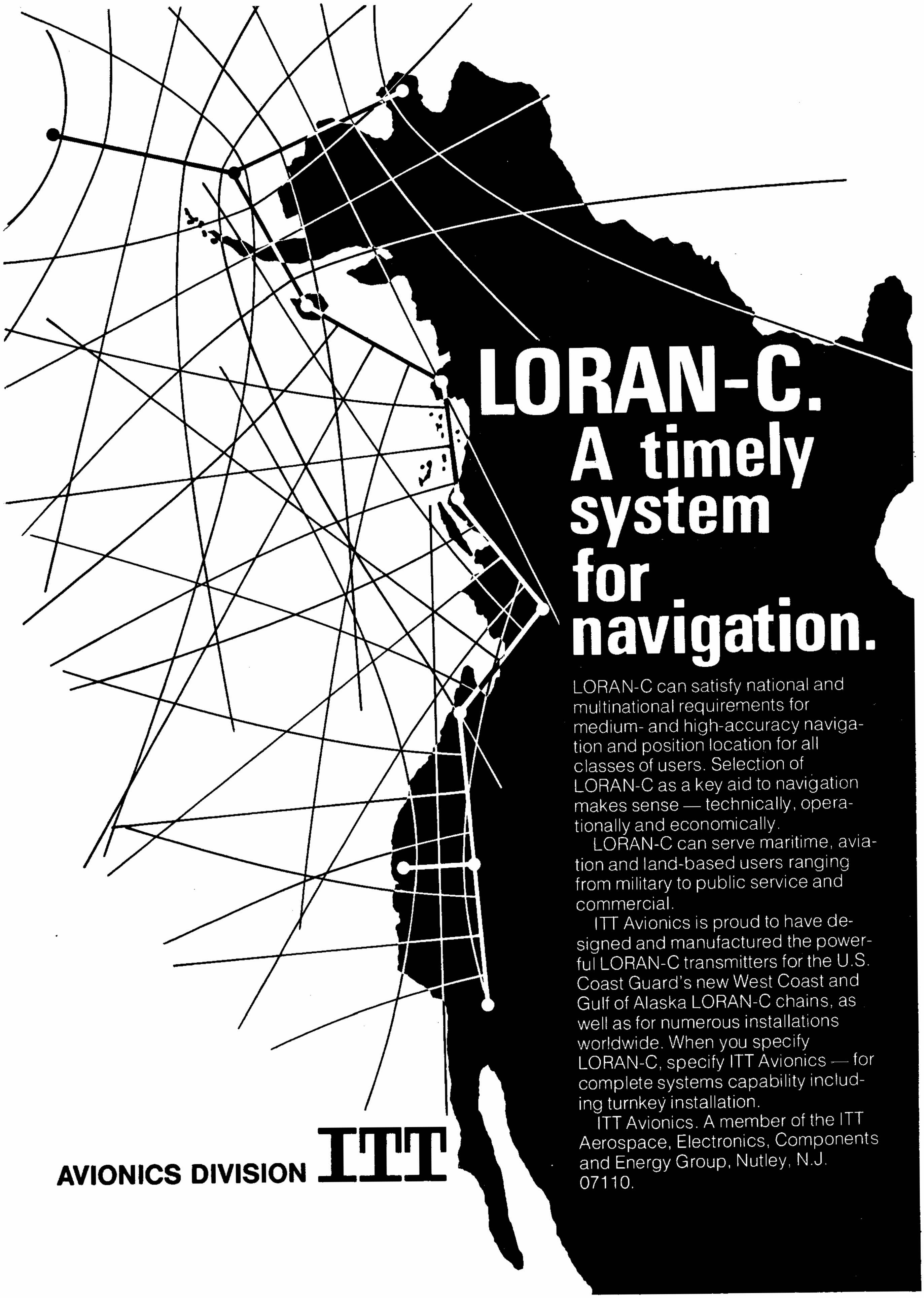

PRESIDENT'S PAGE

Dear Member,

During the year 1976-7 we passed a significant milestone in the Loran-C implementation program. The West Coast chain transmitters were turned on and at the time of writing this page, a demonstration of the use of Loran-C for vessel and helicopter position and tracking in the San Francisco area is to be given by the 12th Coast Guard District to the press. Of no less importance but with little fanfare the year has also seen implementation of a number of privately owned "mini-chains" now in regular use for navigation and positioning. The benefits of using Loran-C for helicopter navigation to oil rigs and both helicopter and fixed wing aircraft in crop spraying have obtained official recognition. The fisherman continues to be convinced of the direct relationship of Loran-C accuracy to his pocketbook.

With this type of activity and an increasing user population the challenge to our association is changing. No longer can we consider ourselves an elite group of technologists exchanging esoteric and abstract ideas. We find ourselves in the real world of collisions, oil spills, fisherman's nets and pesticides. The user wants service and expects to get this within his economic framework. A 95% third cycle identification probability won't wash anymore; purveyors of substandard receiving equipment that brings with it intolerable system accuracies have to be discouraged.

What are we doing to meet this challenge? In the first place any active voluntary organization faces the problem finding sufficient manhours to accomplish the tasks at hand. I am pleased to report that I consider the record of our board of directors and special committees to be excellent; I congratulate and thank them for all their work. The work load brings with it significant administrative problems in record keeping; we feel that we can be more effective if this burden is borne by full time paid personnel. To this end we are seeking to share this type of service with another similar organization.

The WGA is guided by its charter and operated under its bylaws. As you know we recently voted a constitutional amendment and at our last board meeting the directors adopted a revision to the bylaws of the organization. These changes are designed to make it easier for the organization to address itself the challenges of today and tomorrow.

There should be no question that the most important aspects of system implementation and use are the specifications that govern the systems parameters and performance. Only when these are in place can the system user be confident that the promises made by the technologists and promoters will be met in practice. WGA members have been active in maintaining a steady pressure on the government to prepare and publish Loran-C system and signal specifications. In addition a recently formed RTCM Committee is considering the minimum performance specification for Loran-C receivers; members are active on this committee.

Another aspect important to system performance is the question of inband and out-of-band radio transmission interference. We have been vocal in calling for a clearing of the Loran-C band of 90-110 kHz and for a change to the ITU regulations governing priority of radio navigation transmissions in this band in regions other than North America. WGA members have been active in the preparation of a "Question" to be considered by Study Group 8 of the CCIR. This Question obtained State Department approval and was sent to Geneva. Study Group 8 will meet to discuss this matter in January 1978 prior to the World Administrative Radio Council Meeting in 1979.

Our board of directors have met every other month during the year and attendance has been excellent. At these meetings chairmen present reports of their committees activity which are then discussed. Actions are noted and volunteers are appointed to follow through. I think it important for you to know of the committees; these are listed below:

Standing Committees

Awards	Leo Fehlner
Constitution	Vernon Johnson
Convention	Red Frederick
Executive	John Beukers, Capt. Jim Culbertson, William Polhemus, Capt. William Roland
Historical	Walter Dean
Membership	Lloyd Higginbotham
Nominating & Election	Walter Dean

Special Committees

Congressional & DOT Liaison	Ed McGann
Radionavigation Journal	William Roland
World Administrative Radio Council (ITU)	Leo Fehlner
Publicity	Samuel Goldstein
Loran-C System Characterization	Jim Van Etten
FAA Loran-C Certification	Richard Pasciuti

We are always seeking members to act as chairmen or committee members. Please, if you have an interest and would like to contribute contact those named above or myself.

Our current membership count is 454. During the year we enrolled 35 new members. The Treasurer, Bill Roland, reports that the organization is financially strong and that both last year's convention and the Journal provided income in excess of expenditure.

We announced at the last convention that the 1977 convention would be in Seattle. Plans are well underway and we expect to have an interesting, well attended two days arranged in conjunction with Fish Expo '77. We all owe our thanks to those who have worked so hard to make this event possible.

One last word, I am honored that you have elected me to serve as President for a second term. I will do my best to guide the Association during this challenging time.

John M. Beukers
President
July 1977

MARINE LORAN-C RECEIVERS

On the following pages we have cataloged data on all of the known commercial marine Loran-C receivers on the market today. The information should prove helpful to potential equipment buyers, in determining which receivers should best meet their needs. In no way do we intend to rate the comparative performance of these sets. The best set for any given application depends on the application and the operator. The information here should simply ease the job of gathering facts to make a selection.

The presentation is divided in sections. The brand names and model numbers are listed alphabetically on the left in all sections of the data. There are five data sections: Controls; Signal Processing; Displays and Outputs; Advertised Performance; and Hardware Information. We have also listed the names, addresses, contact name, and telephone numbers for technical information from each of the manufacturers. Major distributors and foreign manufacturers are listed to the extent information has been provided. General Services Administration contractors are also noted.

Opposite each page of data is an explanation of the terms and abbreviations used in the data, as well as the implications and significance of the items. Comments on untabulated information is also provided.

Any manufacturer believing his receiver to be improperly represented is requested to contact the editors at his earliest convenience. Also in the future we are intending to present similar data on airborne sets, as well as coordinate converters and guidance equipment available for use with Loran-C. Manufacturers interested in presenting ideas on the form of such information are welcome to present them to the editorial staff.

NOTES ON LORAN-C RECEIVER CONTROLS

1. CH SEL indicates the type and range of chain rate selection controls. 'O' means the set operates on **only** the original 28 Loran-C rates. 'A' indicates that the set will handle **all** possible rates. 'P' means only **preset** rates can be used, either the set is preset to only one or two rates or special plug-ins must be purchased for each rate.

2. SEC IDENT indicates the manner in which the operator identifies to the set which secondary time differences are desired. 'P' means the operator must adjust the set controls to **preset** one or more digits of the secondary time difference or coding delay. 'S' means that the operator must **select** from the sequence of all secondaries being tracked those he wants displayed. 'F' means that the secondaries are **fixed** usually by the factory or by the plug-in modules used to select the chain. The Decca DL-91 is unique in that it selects those two secondaries having the strongest signals.

3. NO. OF SEC is the **number of secondary** signals which the set is capable of simultaneously tracking. Ability to track or match one secondary means that the operator must go through the acquisition process twice to obtain the two LOP's required for a fix. Ability to track or match two secondaries provides sufficient information for a fix at any time. Ability to track more than two provides the operator with the flexibility to quickly select an alternate secondary should the geometry be better or one of the secondaries in use go off-air, or to provide confirmation of the fix.

4. SLEW is used in manual acquisition sets to align signals on the oscilloscope and is called a drift (D) control. In automatic acquisition sets, slew is used to assist the automatic acquisition and cycle selection, and is called slew or step (S). Slew may, if 10 usec increments are provided, permit offset TD's.

5. OFF-SET TD permits the operator to select a rf cycle farther up on the pulse than the third cycle so that operation at longer ranges is possible. Also this ability will permit forcing correct TD's when the exact position is known.

6. INDEX INHIB prevents operation of the sets' automatic cycle selection circuits when noise conditions may cause undesired cycle jumps, or when the offset TD function is in use.

7. HOLD is used to freeze the displayed time differences to give the operator time to write them down for future reference.

8. NOTCH indicates the number of notch filters available in the set. 'F' means the filter is fixed tuned and not available to the operator. 'T' means the filters are operator adjusted. '(O)' means the filters are optional.

MARINE LORAN-C RECEIVER SURVEY

CONTROLS DATA

BRAND NAME	MODEL	CH SEL	SEC IDENT	NO. OF SEC	OFF-SET TD's	SLEW	INDEX INHIBIT	HOLD	NOTCH
Austron	5000	A	P	7	Yes		Yes		
Decca	DL-91	O	F	2	Yes		Yes		2T/6(0)
Decca	708	A	P	2	–				2F
Decca	701	P	F	2	–			Yes	2F
Epsco	4010-4060	O	P	2	Yes	S	Yes	Yes	2T
Epsco		O	P	2	Yes	S	Yes	Yes	2T/2F
Gemtronics	GT206C	P	P	2	Yes	S	Yes		2T
Gemtronics	GT207CM	P	P	1		D			
Gemtronics	GT2500	O	P	1		D			
Gemtronics	GT2550	O	P	1		D			
Micrologic	ML-200	A	S	5	Yes	S	Yes	Yes	4T
Micrologic	ML-1000	A	S	5	Yes	S	Yes	Yes	4T
Mieco	CDX-1	O	P	1		D		Yes	4T
Mieco	CDX-2	O	P	1		D		Yes	4T
Morrow	950	A	P	1		D			2T/2F
Morrow	1950	A	P	1	Yes	D	Yes	Yes	2T/2F
Morrow	2950	A	P	2	Yes	S	Yes	Yes	2T/2F
Nelco Autofix	500	O	P	1		D			
Nelco Autofix	700	A	P	2	Yes	S	Yes	Yes	
Northstar	6000	A	S	5	Yes	S	Yes	Yes	2T/2F
Sitex-Koden	777	O	P	2	Yes	S	Yes	Yes	2T/2F
Simrad-Internav	104	O	P	2	Yes	S	Yes	Yes	2T
Simrad-Internav	204	O	P	2	Yes	S	Yes	Yes	2T
Simrad-Internav	123	A	S	4	Yes	S	Yes	Yes	2T(0)
SRD Labs	Model -C	A	S	7	Yes	S	Yes	Yes	2T/2F
Texas Instruments	9000	A	S	5	Yes	S	Yes	Yes	2F

NOTES ON LORAN-C RECEIVER SIGNAL PROCESSING DATA

1. AMP describes the type of rf amplifier used in the set.

   a) Linear amplification (LA) receivers use automatic or manual gain control to adjust the level of the signal from all stations so they are all the same. Gain control adjustment must be done in conjunction with the groundwave location process to ensure proper receiver operation. When gain adjustment must be done manually, extensive operator training or experience is required to assure proper oscilloscope display interpretation. LA tends to offer greater signal dynamic range, but is sensitive to noise and cross rate interference.

   b) Hard limited (HL) amplification is generally applicable only to sets with coherent detection and automatic processes. HL simplifies the receiver and tends to limit the dynamic range. HL is relatively insensitive to burst noise and cross rate interference, but may be effected by CW interference.

2. DET describes the receiver's detection process.

   a) Coherent detection (CH) is a signal processing method which permits: a) operation at low signal-to-noise ratios; b) measurement of carrier phase; c) rf processing of the pulse envelope; d) signal-to-noise ratio improvement by sampling all eight pulses in a group.

   b) Diode detection (DD) is the detection method used in Loran-A receivers and which permits simplified receiver designs requiring manual operations and operators trained to interpret signals on an oscilloscope. Diode detection's limitations are: a) inability to operate at the signal-to-noise ratios specified in establishing the maximum coverage range for the US Loran-C coverage; b) makes separation of ground wave and sky wave signals difficult; c) is most useful where signals are quite strong and occasional but substantial position errors will not endanger a vessel.

3. ACQ describes the method and philosophical approach of the set designer to initially locating the signals in time.

   a) All station acquisition (ASA) implies that, once the operator has selected the chain, the receiver will acquire the master and all secondaries with sufficient signal-to-noise ratio (practically this number is limited to 4 to 8 secondaries). The operator may select the display of only those TD's of interest.

   b) Limited automatic acquisition (LAA) implies that the master and a limited number of secondaries (usually two) will be acquired, and that the operator must set controls which initialize the TD's of interest.

   c) Segmented automatic acquisition (SAA) is LAA in which the operator can cause one or more secondary tracking intervals to revert to acquisition status to acquire a new secondary, without causing the master interval to revert to acquisition status. This feature is useful when the ship moves to a part of the coverage area where a different secondary has more favorable geometry than one of those being tracked, or the station goes off air.

   d) Manual acquisition (MA) is generally associated with combined Loran-A and Loran-C receivers which use diode detection of signals. Manual acquisition with such receivers requires higher signal-to-noise ratio than is provided by the Coast Guard at the limits of the coverage area. Closer in the signals are generally adequate, but crossing rate signals may be a problem. Manual acquisition in a coherent detector equipped receiver is improved by decoding signals on the oscilloscope, but long ranges and cross rate signals remain a limitation.

4. GW is the ground wave location process, which assures that the ground wave signal from each station is used in the measurement of time differences. In an automatic receiver after acquisition, the circuits are sampling the signals from each station, but the receiver is not certain if the signals are sky waves or ground waves. In a manual receiver the operator is likewise not sure initially that he has found ground wave signals. Since the ground wave is always the first signal arriving at the receiver, and is often lower level than the skywaves which follow, the method of finding the ground wave is to look earlier and earlier in time until no signal can be found, and then to look later for the first detectable signal and presume this is the ground wave.

   a) Guard sampling (GS) means electronically looking or guard sampling in front of the pulses while continuing to track with signal samples. Then moving both the guard and signal sampling circuits earlier in time until the guard sampling detects no signal. The signal sampling is then on the ground wave. Although this adds complexity to the receiver, it permits continuous checking not only for ground waves, but also for interference.

   b) Sequential sampling (SS) means signal sampling the pulse as found during the acquisition process, and then sequentially stepping forward on the pulse until the sampling sees no signal at all, and then returning to the earliest time at which signal was detected. SS is simpler in hardware, but requires more time to assure that the ground wave has been found.

   c) Manual gain adjustment (MG) implies that the operator, having found signals, increases the rf gain of the receiver while observing the signals on the oscilloscope to look for ground wave signals in front of the signal he found while acquiring.

5. All loran sets have internal timing circuits which are referenced or synchronized (manually or automatically) to the received signals. The time difference (TD) display, which may be switch positions, illuminated digital displays, or coded electrical signals to a computer, is actually the TD between the internal timing circuits' references. To achieve accurate TD's these internal references must be related exactly to the timing of the received signals. The pulse group time reference (PGTR) process is the method of achieving exact synchronization.

   a) DE is the derived envelope which is a method of electronically altering the received signal so that it has an easily measurable reference time. This reference time is compared to the rf signal and the nearest appropriate carrier zero crossing is selected by the receiver as the tracking point for its time reference. Errors in tracking the DE of greater than 5 microseconds will result in rf carrier tracking errors which are multiples of 10 microseconds. DE is used in hard limited and the more sophisticated linear amplifier receivers, and is generally associated with automatic receivers. There is significant variation in the design and performance of DE circuits in various receivers, as it is the function most susceptible to atmospheric noise and to incorrect adjustment.

   b) RS is ratio sampling which is similar to the derived envelope, but is only used in linear receivers and may be used in manual receivers if a supplemental meter is provided for the display. The performance is subject to the same limitations as the derived envelope.

   c) EM is envelope matching, which is a manual operation requiring the operator, after having completed ground wave location, to adjust the receiver gain and timing controls to match the shape of the leading edge of the master station signal and the secondary station signal by overlaying them on the oscilloscope display. This process requies +6 to +10db signal-to-noise ratio and is very sensitive to the receiver front end bandwidth, to sky wave interference, and to operator training and experience.

   d) CM is cycle matching and requires first that EM be accomplished with less than 5 microseconds error. Then the operator displays the rf signals and obtains a fine grain adjustment of timing to exactly overlay the master and secondary signals. It is subject to the same multiples of 10 microsecond errors as are DE and RS.

   e) The number in parenthesis indicates the number of pulses in a pulse group used in the PGTR and tracking process. 8 is the maximum and provides the best performance. 1 is the minimum.

6. Automatic tracking or manual matching are the final steps in obtaining TD information from a receiver. Automatic tracking implies that electronic circuits are used to sample, store and average the tracking errors. It also usually implies that all eight pulses in each pulse group from each station are sampled, effectively increasing the signal-to-noise ratio of the samples. The average tracking errors are used to electrically correct the receiver time references, and then new time differences are displayed. This process is repeated so quickly that continuously updated TD's are always available. The averaging ability of automatic tracking is substantially greater than the matching ability of the human operator observing signals on an oscilloscope. Also the oscilloscope usually only presents one of the group of eight pulses in the group from each station. For these reasons receivers with matching processes do not perform as accurately or at as long ranges as tracking receivers. Receivers with manual ACQ, GW, and PGTR processes, but with automatic tracking usually will track at long ranges, but should the signals be lost for any reason, will not reacquire.

   CT is automatic cycle tracking and is the most accurate means of obtaining time differences, as the receiver time reference is compared to one particular rf zero crossing of every pulse received.

   MC is manual cycle matching and has significantly reduced accuracy and range compared to cycle tracking.

   ET is automatic envelope tracking. In a receiver using coherent detection, ET could be expected to provide moderate tracking accuracy at greater ranges than matching receivers. However, the envelope time differences may differ from cycle TD's by several microseconds due to the secondary factor and 'ASF' in propagation. Printed charts are designed to be used with cycle time differences, so the use of envelope time differences may result in substantial position errors. In a receiver using diode detection, the range would be substantially limited in addition to the envelope TD' errors.

   ME is manual envelope matching, and would have all the limitations of automatic envelope tracking with a diode detector, plus the limitations of the human operator interpreting the oscilloscope.

MARINE LORAN-C RECEIVER SURVEY
SIGNAL PROCESSING DATA

BRAND NAME	MODEL	AMP	DET	ACQ	G.W.	PGTR	TRK
Austron	5000	LA	CH	SAA	GS	DE(8)	CT
Decca	DL-91	LA	CH	LAA	GS	RS(8)	CT
Decca	708	HL	CH	LAA	GS	DE(8)	CT
Decca	701	HL	CH	LAA	GS	DE(8)	CT
Epsco	4010-4060	HL	CH	LAA	GS	DE(8)	CT
Epsco		HL	CH	–	GS	DE(8)	CT
Gemtronics	GT206C	HL	CH	MA	GS	DE(8)	CT
Gemtronics	GT207CM	LA	DD	MA	MG	CM(8)	MC
Gemtronics	GT2500	LA	DD	SAA	MG	CM(1)	MC
Gemtronics	GT2550	LA	CH	MA	MG	CM(1)	CT
Micrologic	ML200	HL	CH	ASA	SS	DE(8)	CT
Micrologic	ML1000	HL	CH	ASA	SS	DE(8)	CT
Mieco	CDX-1	LA	CH	LAA	MG	RS(1)	CT
Mieco	CDX-2	LA	CH	SAA	SS	RS(8)	CT
Morrow	950	LA	DD	MA	MG	CM(1)	MC
Morrow	1950	LA/HL	CH	LAA	SS	CM(1)	CT
Morrow	2950	LA/HL	CH	LAA	SS	DE(8)	CT
Nelco Autofix	500	LA	DD/CH	MA	MG	RS(1)	CT
Nelco Autofix	700	–	CH	SAA	GS	DE(8)	CT
Northstar	6000	HL	CH	ASA	SS	DE(8)	CT
Sitex-Koden	777	HL	CH	LAA	SS	DE(8)	CT
Simrad-Internav	104	HL	CH	SAA	SS	DE(8)	CT
Simrad-Internav	204	HL	CH	SAA	SS	DE(8)	CT
Simrad-Internav	123	HL	CH	ASA	SS	DE(8)	CT
SRD Labs	Model -C	HL	CH	ASA	SS	DE(8)	CT
Texas Instruments	9000	HL	CH	ASA	SS	DE(8)	CT

NOTES ON DISPLAY DATA

Displays are used to convey information to the operator. Digital displays convey numerical data. By driving digital displays in non-standard ways, words can be formed and alarm, status and guidance information can be presented. Discrete displays indicate yes/no or go/no go conditions such as alarms or equipment status. Analog displays such as meters convey continuously variable data, such as interference levels, for use in setting notch filters. Oscilloscopes provide the ultimate flexibility in displaying analog, digital and discrete data, depending only on the designer's ingenuity. Displays can be mechanical (meters and switches), illuminated (LED's, lamps, or oscilloscopes), or electrical (communications to a teleprinter, or computer). (A check mark in the table indicates that a particular display function is provided in the respective set.)

1. Numeric Data
   a) TD (x/y) indicates the presence of a TD numeric display, where x is the number of TD's available and y is the number of digits in each display.
   b) ALT indicates that alternative numeric data may be displayed, such as signal-to-noise, oscillator offset, or receiver status.
   c) RMT indicates the availability of a remote data display, such as a remote TD display, position plotter, or connection to a computer.

2. Discrete Data, Alarms – Alarms may be provided as necessary. The possible alarms are:
   a) SNR meaning that less than the design minimum signal-to-noise ratio is present on one or more signals.
   b) BLK meaning one or more signals are blinking.
   c) IDX meaning one or more signals do not have proper synchronization in the receiver.
   d) HST meaning that since the last time the receiver was checked by the operator, the history of the alarms is unsatisfactory. One or more was illuminated, the condition corrected itself and although indications are correct, the receiver synchronization should be checked, and then the HST indication cleared.

3. Discrete Data, Status
   a) SCH indicates the receiver is in search mode.
   b) IDX indicates the receiver is in the index mode.
   c) TRK indicates the receiver is in the track mode.

4. Oscilloscope Data – Generally oscilloscopes are provided because the operator must make decisions with respect to the identity and synchronization of the rf and/or video signals displayed. However oscilloscopes also allow the operator interpretation of signal conditions, subjectively evaluating the usefulness of a line of position. Blink and lost signal conditions are also easily observed on an oscilloscope. The major display types are:
   a) RF meaning that an rf display is available.
   b) VID meaning that a video display is available.
   c) PAN meaning that a frequency scan (panoramic scan) display is available. This is helpful in setting notch filters.

5. Meters – At present meters are only used for adjusting notch filters, however they can also be used for indexing and for checking power supply operation. Check marks indicate the availability of a meter for setting notch filters.

   The following notes apply only to specific receivers:

6. The Austron 5000 provides a computer terminal output on which all pertinent data is available, and from which all receiver functions may be controlled.

7. These receivers have switches which provide the TD readout.

8. These receivers use a mechanical readout of tenths of microseconds.

9. The Micrologic 1000 provides computation and display of latitude longitude, range and bearing to a destination, time to go, cross track error, ground speed, and track angle.

10. The Northstar 6000 provides computation and display of left/right steering indications to the helmsman to go to a destination. Also, the notch timing meter is an analog display using discrete LED lights.

MARINE LORAN-C RECEIVER SURVEY
DISPLAY DATA

BRAND NAME	MODEL	Numeric (1)			Alarm (2)				Mode (3)			Scope (4)			Meter (5)
		TD	ALT	RMT	SNR	BLK	IDX	HST	SCH	IDX	TRK	RF	VID	PAN	NOTCH
Austron	5000	2/6	–	(6)								✓			
Decca	DL-91	2/6		(0)	✓	✓	✓				✓				✓
Decca	708	2/6	✓	(0)	✓	✓	✓								
Decca	701	2/6		(0)	✓	✓	✓								
Epsco	4010-4060	2/6		✓	✓		✓		✓	✓					✓
Epsco		2/6		✓	✓		✓		✓	✓					✓
Gemtronics	GT206C	2/6			✓		✓				✓				
Gemtronics	GT207CM	1/5	(8)(7)									✓	✓		
Gemtronics	GT2500	1/5	(8)(7)									✓	✓		
Gemtronics	GT2550	1/5	(8)(7)	✓			✓			✓		✓	✓		
Micrologic	ML200	2/6	✓	✓	✓	✓	✓				✓				✓
Micrologic	ML1000	2/8	✓ (9)	✓	✓	✓	✓				✓				✓
Mieco	CDX-1	1/6			✓	✓	✓			✓		✓	✓	✓	✓
Mieco	CDX-2	2/6			✓	✓	✓			✓		✓	✓	✓	✓
Morrow	950	1/5	(7)									✓	✓		✓
Morrow	1950	1/5	(7)(8)				✓					✓	✓		✓
Morrow	2950	2/6			✓	✓	✓								✓
Nelco Autofix	500	1/5	(8)												
Nelco Autofix	700	2/6			✓	✓	✓				✓				✓
Northstar	6000	2/6	(10)	(0)	✓	✓	✓			✓	✓				(10)
Sitex-Koden	777	2/6		(0)	✓	(0)	✓			✓					✓
Simrad-Internav	104	1/7		(0)	✓			✓		✓					✓
Simrad-Internav	204	2/7		✓	✓			✓		✓					✓
Simrad-Internav	123	2/7	✓	✓	✓			✓		✓					
SRD Labs	Model -C	2/6		(0)	✓	✓	✓								
Texas Instruments	9000	1/6	✓	✓	✓	✓	✓			✓	✓				

NOTES ON LORAN-C RECEIVER HARDWARE DATA

1. Height (H), Width (W), and Depth (D) are given in centimeters. Multiply by 0.4 to get inches. These dimensions do not include mounting brackets or the space needed to clear connectors.

2. Line voltages below 100 volts are DC, above 100 are 50 or 60 Hz AC. Power consumption is with the standard supply.

3. R is rack mounted, D is desk or shelf mounted, and U is u-bracket or trunion mounted, desk, wall, or ceiling.

4. A few of the sets do not provide an antenna in order to save the shipping cost of an out-sized box. These sets generally use a standard 2.6 meter 'CB' whip available at most radio stores. The Nelco sets use a long wire (LW) antenna which can be made up by most dealers.

5. An active (A) antenna coupler has an amplifier which increases the level of the signal on the cable coming from the coupler to the set, which in turn reduces the effect of pickup of stray electrical noise on the antenna cable. A passive (P) coupler does not require power and therefore results in less costly antenna hardware.

6. Twin conductor shielded cable (T) provides the best immunity to stray noise pickup between the antenna and the set, and is appropriate with a passive coupler. Coaxial cable is most commonly used with an active coupler. Multi-conductor cable is used to simplify the antenna installation of an active coupler when the coupler power is not provided on the same cable as the signal.

MARINE LORAN-C RECEIVER SURVEY

HARDWARE DATA

BRAND NAME	MODEL	H CM	W CM	D CM	WT KG	115 VAC	10/40 VDC	PWR	Mount	Ant. fur-nished	Height	Coupler	Ant. Cable
Austron	5000					Yes	No		R	Yes	3	P	C
Decca	DL-91	21.6	44.4	33.3	10	Yes	Opt	35	D	Yes	1.8	P	T
Decca	708	12.8	23.6	29.2	3.9	No	12	25	U	Yes	1.8	A	C
Decca	701	6.4	23.6	29.2	2.6	No	12	20	U	Yes	1.8	A	C
Epsco	4010-4060	20.9	34.0	36.1	13.1	Yes	No	100	U	Yes	2.6	P	C
Epsco	–	–	–	–	–		Yes	35	U	Yes	2.6	P	C
Gemtronics	GT206C	21.6	29.2	40.0	12.5		12	60	D	No	2.6	A	M
Gemtronics	207CM	14.6	24.1	30.2	5.6		12	6	D	No	2.6	P	C
Gemtronics	GT2500	14.6	24.1	30.2	5.6		12	6	D	No	2.6	P	C
Gemtronics	GT2550	21.3	35.3	36.1	12.0		12	12	D	No	2.6	P	C
Micrologic	ML200	21.6	36.8	25.9	11.3	Yes	Opt	45	U	Yes	1.8	A	C
Micrologic	ML1000	21.6	48.5	26.7	15.0	Yes	Opt	60	U	Yes	1.8	A	C
Mieco	CDX-1	19.1	40.6	34.3	11.3	Opt	12 24 32	40	D	Yes	2.3	A	C
Mieco	CDX-2	24.1	26.7	30.5	11.3	Opt	12 24 32	62	D	Yes	2.3	A	C
Morrow	LAC-950	21.3	34.5	19.7	5.7	Opt	12 24 32	24	U	Yes	4.6	A	C
Morrow	LCA1950	21.3	34.5	19.7	5.7	Opt	12 24 32	28	U	Yes	4.6	A	C
Morrow	LCA2950	13	26.7	31.8	4.4	Opt	12 24 32	18	U	Yes	4.6	A	C
Nelco Autofix	500	21.6	35.6	31.8	8.2	Opt	10 to 70	22	D	No	LW	No	No
Nelco Autofix	700	–	–	–	–	Opt	10 to 70	–	–	No	LW	No	No
Northstar	6000	24.1	40.6	28	11.4	Opt	Yes	45	U	Yes	2.6	A	C
Sitex-Koden	777	20.3	38.1	33	15.0	100 to 230	11 to 40	12	U	Yes	2.6	A	T
Simrad-Internav	104	20.3	36.8	40.6	13.6	Yes	11 to 45	65	U	Yes	2.6	A	T
Simrad-Internav	204	20.3	36.8	40.6	13.6	Yes	11 to 45	65	U	Yes	2.6	A	T
Simrad-Internav	123	14.5	32.0	33.5	9.1	Opt	11 to 45	40	U	Yes	2.6	A	T
SRD Labs	Model -C	15.2	35.6	35.6	7.7	No	10 to 40	40	D	Yes	2.6	A	C
Texas Instruments	9000	8.6	24.6	31.8	3.9	No	12	18	U	No	2.6	A	C

NOTES ON LORAN-C RECEIVER PERFORMANCE DATA

All performance data quoted is as stated by the manufacturer. Because there are no standard testing procedures, any comparisons made should be used cautiously. Lack of a data entry means simply that the manufacturer has not stated the performance claim.

1. Minimum signal-to-noise ratio (SNR) is a statement of the lowest SNR at which the set will search for and acquire signals. When two readings are given, the second is the lowest SNR at which the set will continue to track, having once acquired at the higher SNR.

2. Dynamic range is a statement which indicates the ratio of the lowest level signal which can be acquired, to the highest level which can be acquired. Acquisition means that the correct cycle is selected in this instance. The lowest level signal is usually limited by set noise, and the highest level signal by front end overload which distorts the signal, preventing correct cycle selection.

3. Differential signals indicates the maximum ratio of a secondary signal to a master signal at which the average time difference error does not exceed the claimed standard deviation of time difference at -10 db SNR. This number indicates the quality of the signal handling circuits from the standpoint of variations of amplifier delay, which is dependent on signal level.

4. TD resolution is simply the smallest increment of time difference which can be displayed by the set.

5. σTD is the standard deviation of the TD readout at -10 db SNR. This significant, as present day US Coast Guard claims for coverage call for a receiver with a σTD of 0.1 microseconds at -10 db SNR.

6. Manufacturers suggested retail price is simply that. (G) after the price means that the receiver is available to US Government Agencies on a General Services Administration general schedule contract.

MARINE LORAN-C RECEIVER SURVEY
PERFORMANCE DATA

BRAND NAME	MODEL	Minimum SNR (1)	Dynamic Range (2)	Differential Signals (3)	TD Resolution (4)	σTD -10 db SNR (5)	Mfg. Sugg. Retail Price (6)
Austron	5000	–	–	–	0.1	–	
Decca	DL-91	-10db	100db	80db	0.1	–	$4995
Decca	708	-10db	100db	80db	0.1	–	
Decca	701	-10db	100db	80db	0.1	–	
Epsco	4010-4060	–	100db	80db	0.1	0.3	$4345 (G)
Epsco		–	100db	80db	0.1	0.3	Avail. 1/78
Gemtronics	206-C	–	–	–	0.1	0.1	$3195
Gemtronics	207-CM	–	–	–	0.2	0.1	$1295
Gemtronics	2500	–	–	–	0.2	0.1	$1495
Gemtronics	2550	–	–	–	0.1	0.1	$2395
Micrologic	ML200	-16db	90db	60db	0.1	0.1	$4195
Micrologic	ML1000	-16db	90db	60db	0.01	0.1	$5995
Mieco	CDX-1	+10db/-20db	120db	–	0.1	–	$2595
Mieco	CDX-2	+10db/-20db	120db	–	0.1	–	$3995
Morrow	950	+6db	100db	60db	0.2	–	$1095
Morrow	1950	0db	100db	80db	0.1	–	$1995
Morrow	2950	-10db	100db	80db	0.1	0.3	$2995
Nelco Autofix	500	+10db/-10db	120db	120db	0.1	0.2	$2195
Nelco Autofix	700	-15db	120db	120db	0.1	0.1	Avail. 2/78
Northstar	6000	-26db	110db	110db	0.1	0.2	(G)
Sitex-Koden	777	-20db	100db	80db	0.1	0.25	$3595
Simrad-Internav	104	-15db	105db	60db	0.01	0.15	$3595 (G)
Simrad-Internav	204	-15db	105db	60db	0.01	0.15	$4595 (G)
Simrad-Internav	123	-15db	105db	60db	0.1	0.15	$2995 (G)
SRD Labs	Model -C	-20db	100db	–	0.1	–	$2895
Texas Instruments	9000	-15db	100db	80db	0.1	–	$2095

MARINE LORAN-C RECEIVER SURVEY

BRAND NAME	For further information: U.S. DISTRIBUTOR
Austron	Austron Inc. 1915 Kramer Lane, Austin, TX 78758
Decca	ITT Decca Marine Inc. P.O. Box G, Palm Coast, FL 32037 (904-445-2400)
Epsco	Epsco Inc. 411 Providence Highway, Westwood, MA 02090 (B. Ambroseno – 617-329-1500)
Gemtronics	Gem Marine Products, Inc. 356 South Boulevard, Lake City, SC 29560 (L. Haynes – 803-394-3565)
Micrologic	Micrologic, Inc. 9436 Irondale Avenue, Chatsworth, CA 91311 (W. Thompson – 213-998-1216)
Mieco	Mieco 109 Beaver Court, Cockysville, MD 21030 (Stan Berger – 301-667-4660)
Morrow	Morrow Electronics-International, Inc. P.O. Box 7064 4740 Ridge Drive NE, Salem, OR 97303 (Ray Morrow – 503-393-2550)
Nelco Autofix	Nautical Electronics Co., Inc. 7095 Milford Indust. Road, Baltimore, MD 21208 (Bob Tabler – 301-484-3284)
Northstar	Digital Marine Electronics, Inc. Civil Air Terminal, Bedford, MA 01730 (C. Malaquias – 617-274-7130)
Sitex-Koden	Smith Industries, Inc. P.O. Box 5389, Clearwater, FL 33518 (F. Reed – 813-531-7781)
Simrad-Internav	Simrad, Inc. 1 Lambriola Court, Armonk, NY 10504 (G. Nelson)
SRD Labs	SRD Labs, Inc. 645 McGlincey Lane, Campbell, CA 95002 (B. Cato – 408-371-2666)
Texas Instruments	Texas Instruments, Inc. P.O. Box 6080 M.S. 3101, Dallas, TX 75222 (G. Robinson – 214-689-4312)

For further technical information, government and international sales, contact the manufacturer or overseas sales representatives as appropriate. Use the names and addresses listed above except in these instances:

Decca Model DL-91	Manufacturer, Government Sales Navigation Systems, Inc. 8841 Monard Drive, Silver Spring, MD 20910 (C. Andren – 301-585-7480)
Decca Models 701, 708	Manufacturer, Government Sales Teledyne Systems Co. 19601 Nordhoff Street, Northridge, CA 01324 (L. Speelman – 213-886-2211)
Decca-international Sales	Decca Navigator Co. Ltd. 247 Burlington Road, New Malden, Surrey, England
Epsco-international Sales	Krupp-Atlas-Electronick Div. Krupp International, Inc. P.O. Box 58218, Houston, TX 77058 (713-488-0784)
Simrad-Internav	Manufacturer, International Sales, Government Sales International Navigation Inc. 65 Wiggins Avenue, Bedford, MA 01730 (J. Currie – 617-275-2970)

LORAN AND OMEGA CHART AVAILABILITIES

On the following pages we have attempted to present data on available charts, including areas covered and sources of information. We strongly suggest that if you have a continuing need for charts that you obtain the indicated chart catalogs for the areas of interest.

The chart data is presented in tabular form. Table #1 is a list of nautical charts of U.S. waters printed by the National Ocean Survey. Table #2 is a list of charts known to be published by other nations. Table #3 is a list of world-wide charts printed by the U.S. Defense Mapping Agency Hydrographic Center (DMAHC). Table #4 lists world-wide aviation charts prepared by the U.S. Defense Mapping Agency, Aerospace Center (DMAAC). Table #5 is a list of loran and Omega tables which are prepared by the DMAHC.

ORDERING INFORMATION:

NATIONAL OCEAN SURVEY:

National Ocean Survey and Defense Mapping Agency Aerospace Center charts may be ordered from the nearest N.O.S. sales agent or from:

DISTRIBUTION DIVISION (C-44)
NATIONAL OCEAN SURVEY
RIVERDALE, MD. 20840

Nautical Chart Catalogs are available from the same source, at no charge:

CHART NO.	CATALOG TITLE
1.	Atlantic and Gulf Coasts, including Puerto Rico and the Virgin Islands
2.	Pacific Coast, including Hawaii, Guam, and the Samoa Islands
3.	Alaska
4.	Great Lakes and Adjacent Waterways

Also, a quarterly subscription to 'Dates of Latest Editions, Nautical Charts' is available. This list indicates the lines-of-position available on each chart edition.

DEFENSE MAPPING AGENCY HYDROGRAPHIC CENTER:

Requests for DMAHC charts should be directed to:

DEFENSE MAPPING AGENCY TOPOGRAPHIC CENTER
6500 BROOKS LANE
ATTN: DDCP
WASHINGTON, D.C. 20310
TEL: 301-227-2495

A Catalog of Nautical Charts is available at no charge (Publication No. 1-N-A.) This catalog lists regional catalogs available at nominal charge, and lists DMAHC and British Admiralty Charts sales agents.

CANADIAN HYDROGRAPHIC SERVICE:

HYDROGRAPHIC CHART DISTRIBUTION OFFICE
MARINE SCIENCES DIRECTORATE
DEPARTMENT OF THE ENVIRONMENT
OTTAWA, ONTARIO, CANADA K1A OE6

ICELANDIC HYDROGRAPHIC SERVICE:

SJÓMAELINGAR ISLANDS
PÓSTHÓLF 7094
SELJAVEGI 32
REYKJAVIK, ICELAND

NORWEGIAN HYDROGRAPHIC OFFICE:

NORGES SJØKARTVERK
KLUBBT 1, P.O. BOX 60,
4001 STAVANGER, NORWAY

GERMAN HYDROGRAPHIC INSTITUTE:

DEUTSCHES HYDROGRAPHISHES INSTITUTE (D.I.H.)
BERNHARD - NOCHT STR. 78
2000 HAMBURG 4,
GERMANY

Some three dozen charts are reportedly available from D.I.H. for waters between Iceland, Norway, and Great Britain. (Possibly charts for U.S. waters as well). We have not determined the exact areas and availability.

TABLE #1
NATIONAL OCEAN SURVEY CHARTS
WITH LORAN-C OVERLAYS

Old Chart #	New Chart #	Title	Scale	Proposed NOAA(NOS) Issue Date
70	13006	West Quoddy Head to N.Y.	1:675,000	Avail.
71	13009	Gulf of Maine & Georges Bank	1:500,000	Avail.
77	12260	Chesapeake Bay-Northern Part	1:197,250	Avail.
78	12220	Chesapeake Bay-Southern Part	1:200,000	Avail.
243	13279	Ipswich Bay to Gloucester Harbor	1:20,000	Avail.
246	13270	Boston Harbor	1:2500	Avail.
612	13204	Georges Bank	1:220,000	Avail.
1000	13003	Cape Sable to Cape Hatteras	1:1:200,000	Avail.
1001	11009	Cape Hatteras to Straits of Florida	1:1,200,000	Avail.
1002	11013	Straits of Florida and approaches	1:1,200,000	Avail.
1003	11006	Gulf Coast-Key West to Mississippi River	1:875,000	Avail.
1007	411	Gulf of Mexico	1:2,160,000	Avail.
1050	11352	New Orleans to Calcasieu River, East Section	1:175,000	Avail.
1051	11345	New Orleans to Calcasieu River, West Section	1:175,000	Avail.
1106	13260	Bay of Fundy to Cape Cod	1:378,838	Avail.
1107	13200	Georges Bank-Nantucket Shoals	1:400,000	Avail.
1108	12300	Approaches to N.Y., Nantucket Shoals	1:400,000	Avail.
1109	12200	Cape May to Cape Hatteras	1:416,944	Avail.
1110	11520	Cape Hatteras to Charleston	1:432,720	Avail.
1111	11480	Charleston Lt. to Cape Canaveral	1:449,659	Avail.

Table #1 continued

Old Chart #	New Chart #	Title	Scale	Proposed NOAA(NOS) Issue Date
1112	11460	Cape Canaveral to Key West	1:446,940	Avail.
1114	11400	Tampa Bay to Cape San Blas	1:456,394	Avail.
1115	11360	Cape St. George to Mississippi River	1:456,394	Avail.
1116	11340	Mississippi River to Galveston	1:458,596	Avail.
1117	11300	Galveston to Rio Grande	1:460,732	Avail.
1201	13325	Quaddy Narrows to Petit Manon I.	1:80,000	Avail.
1204	13288	Monhegan Island to Cape Elizabeth	1:80,000	Avail.
1205	13286	Cape Elizabeth to Portsmouth	1:80,000	Avail.
1206	13278	Portsmouth to Cape Ann	1:80,000	Avail.
1207	13267	Massachusetts Bay	1:80,000	Avail.
1208	13246	Cape Cod Bay	1:80,000	Avail.
1209	13237	Nantucket South and approaches	1:80,000	Avail.
1210	13218	Martha's Vineyard to Block Island	1:80,000	Avail.
1211	13205	Block Island Sound and approaches	1:80,000	Avail.
1212	12354	Long Island Sound-Eastern Part	1:80,000	Avail.
1213	12363	Long Island Sound-Western Part	1:80,000	Avail.
1215	12326	Approaches to N.Y.- Fire Isl. Lt. to Sea Girt Lt.	1:80,000	Avail.
1216	12323	Sea Girt to Little Egg Inlet	1:80,000	Avail.
1217	12318	Little Egg Inlet to Hereford Inlet	1:80,000	Avail.
1218	12304	Delaware Bay	1:80,000	Avail.
1219	12214	Cape May to Fenwick Isl. Lt.	1:80,000	Avail.
1220	12211	Fenwick Isl. Lt. to Chincoteaque Inlet	1:80,000	Avail.
1221	12210	Chincoteaque Inlet to Gt. Machipongo Inlet	1:80,000	Avail.
1222	12221	Chesapeake Bay Entrance	1:80,000	Avail.
1223	12225	Chesapeake Bay-Wolf Trap to Smith Point	1:80,000	Avail.
1224	12230	Smith Point to Cove Point	1:80,000	Avail.
1225	12263	Cove Point to Sandy Point	1:80,000	Avail.
1226	12273	Sandy Point to Head of Bay	1:80,000	Avail.
1227	12207	Cape Henry to Currituck Beach Lt.	1:80,000	Avail.
1229	12204	Currituck Beach Lt. to Wimble Shoals	1:80,000	Avail.
1231	11548	Pamlico Sound-Western Part	1:80,000	Avail.
1232	11555	Cape Hatteras-Wimble Shoals to Oracoke Inlet	1:80,000	Avail.
1233	11544	Portsmouth Island to Beaufort	1:80,000	Avail.
1234	11543	Cape Lookout to New River	1:80,000	Avail.
1236	11536	Approaches to Cape Fear River	1:80,000	Avail.
1238	11531	Winyah B. Entrance to Isle of Palms	1:80,000	Avail.
1239	11521	Charleston Harbor and approaches	1:80,000	Avail.
1241	11509	Tybee Island to Doboy Sound	1:80,000	Avail.
1242	11502	Doboy Sound to Fernandina	1:80,000	Avail.
1245	11484	Ponce de Leon Inlet to Cape Kennedy	1:80,000	Avail.
1246	11476	Cape Canaveral to Bethel Shoal	1:80,000	Avail.
1247	11474	Bethel Shoal to Jupiter Inlet	1:80,000	Avail.
1256	11424	Lemon Bay to Passage Key Inlet	1:80,000	Avail.
1257	11412	Tampa Bay & St. Joseph's Sound	1:80,000	Avail.
1258	11409	Anclote Keys to Crystal River	1:80,000	Avail.
1261	11405	Apalachee Bay	1:80,000	Avail.
1262	11401	Apalachicola Bay to Cap San Blas	1:80,000	Avail.
1263	11389	St. Joseph & St. Andrew Bay	1:80,000	Avail.
1264	11388	Choctawhatchee Bay	1:80,000	Avail.
1265	11382	Pensacola Bay and approaches	1:80,000	Avail.
1266	11376	Mobile Bay	1:80,000	Avail.
1267	11373	Mississippi Sound and approaches	1:80,000	Avail.

Table #1 continued

Old Chart #	New Chart #	Title	Scale	Proposed NOAA(NOS) Issue Date
1268	11371	Lake Borgne and approaches	1:80,000	Avail.
1269	11369	Lakes Pontchartrain & Maurepas	1:80,000	Avail.
1270	11363	Chandeleur & Breton Sounds	1:80,000	Avail.
1271	11364	Mississippi River-Venice to New Orleans	1:80,000	Avail.
1272	11361	Mississippi River Delta	1:80,000	Avail.
1273	11358	Barataria Bay and approaches	1:80,000	Avail.
1274	11357	Timbalier & Terrebonne Bays	1:80,000	Avail.
1275	11356	Isles Dernieres to Point au Fer	1:80,000	Avail.
1276	11351	Point au Fer to Marsh Island	1:80,000	Avail.
1278	11344	Rollover Bayou to Calcasieu Pass	1:80,000	Avail.
1279	11341	Calcasieu Pass to Sabine Pass	1:80,000	Avail.
1282	11323	Approaches to Galveston Bay	1:80,000	Avail.
1283	11321	San Luis Pass to E. Matagorda Bay	1:80,000	Avail.
1284	11316	Matagorda Bay and approaches	1:80,000	Avail.
1288	11301	Southern Part of Laguna Madre	1:80,000	Avail.
4000	540	Hawaiian Archipelago	1:3,121,170	Avail.
4102	19004	Hawaiian Islands	1:600,000	Avail.
4110	19357	Island of Oahu	1:80,000	Avail.
4116	19340	Hawaii to Oahu	1:250,000	Avail.
4140	19327	West Coast of Hawaii-Cook Pt. to Upolu Pt.	1:80,000	Avail.
4172	19401	French Frigate Shoals	1:80,000	Avail.
4174	19441	Maro Reef	1:80,000	Avail.
4179	19010	Hawaiian Islands-Southern Part	1:675,000	Avail.
4182	19019	French Frigate Shoals to Laysan Island	1:653,219	Avail.
4183	19022	Laysan Island to Kure Island	1:642,271	Avail.
4185	19480	Midway Islands and approaches	1:180,000	Avail.
5002	18020	San Diego to Point St. George	1:1,412,349	Avail.
5020	18022	San Diego to San Francisco Bay	1:868,003	Avail.
5021	18010	Monterey Bay to Coos Bay	1:811,980	Avail.
5022	18003	Cape Blanco to Cape Flattery	1:736,560	Avail.
5052	18007	San Francisco to Cape Flattery	1:1,200,000	Avail.
5072	18640			Avail.
5142	18746	San Pedro Channel	1:80,000	Avail.
5402	18680	Point Sur to San Francisco	1:210,668	Avail.
5502	18640	San Francisco to Point Arena	1:207,840	Avail.
5602	18620	Point Arena to Trinidad Head	1:200,000	Avail.
5702	18600	Trinidad Head to Cape Blanco	1:196,948	Avail.
5802	18580	Cape Blanco to Yaquina Head	1:191,730	Avail.
5902	18520	Yaquina Head to Columbia R.	1:185,238	Avail.
6002	18500	Columbia R. to Destruction Is.	1:180,789	Avail.
6102	18480	Approach to Strait of Juan De Fuca Destruction Is.	1:176,253	Avail.
6300	18400	Strait of Georgia & Strait of Juan de Fuca	1:200,000	Avail.
6401	18440	Admiralty Inlet and Puget Sound	1:150,000	Avail.
8002	16016	Dixon Entrance to Cape St. Elias	1:969,756	Avail.
8054	17425	Portland Canal-North of Hattie Island	1:80,000	Avail.
8102	17420	Hecate Strait to Etolin Island, incl. Behm and Portland Canals	1:229,376	Avail.
8152	17400	Dixon Entrance to Chatham Strait	1:229,376	Avail.
8202	17300	Stephens Passage to Cross Sound, incl. Lynn Canal	1:209,978	Avail.
8252	17320	Coronation Is. to Lisianski Strait	1:217,828	Avail.
8402	16760	Cross Sound to Yakutat Bay	1:300,000	Avail.
8455	16761	Yakutat Bay	1:80,000	Avail.
8500	531	Gulf of Alaska–Strait of Juan De Fuca to Kodiak Is.	1:2,100,000	Avail.
8502	16013	Cape St. Elias to Shumagin Islands	1:969,761	Avail.
8513	16723	Controller Bay	1:100,000	Avail.

Old Chart #	New Chart #	Title	Scale	Proposed NOAA(NOS) Issue Date
8515	16701	Prince William Sound-Western Entrance	1:81,436	Avail.
8517	16705	Prince William Sound-Western Part	1:80,000	Avail.
8519	16708	Prince William Sound-Port Fidalgo & Valdez Arm	1:79,291	Avail.
8520	16709	Prince William Sound-Eastern Entrance	1:80,000	Avail.
8528	16683	Point Elrington to Cape Resurrection	1:81,436	Avail.
8529	16682	Cape Resurrection to Two Arm Bay	1:81,847	Avail.
8530	16681	Seal Rocks to Gore Point	1:83,074	Avail.
8532	16606	Barren Islands	1:77,062	Avail.
8533	16604	Shuyak & Afognak Islands & Adjacent Waters	1:78,000	Avail.
8536	16592	Gull Point to Kugayak Bay	1:80,728	Avail.
8537	16590	Sitkinak Strait & Alitak Bay	1:81,529	Avail.
8540	16601	Cape Alitak to Cape Ikolik	1:80,905	Avail.
8541	16598	Cape Ikolik to Cape Kuliuk	1:80,000	Avail.
8542	16597	Uganik and Uyak Bays	1:80,000	Avail.
8551	16700	Prince William Sound	1:200,000	Avail.
8552	16680	Point Elrington to East Chugach Island	1:200,000	Avail.
8554	16640	Cook Inlet-Southern Part	1:200,000	Avail.
8556	16580	Kodiak Island Southwest Anchorage, Chirikof Is.	1:53,600	Avail.
8700	16552	Shumagin Islands-Nagai Is. to Unga Is.	1:100,000	Avail.
8701	16535	Morzhovoi Bay & Isanotski Strait	1:80,660	Avail.
8703	16549	Cold Bay and approaches, Alaska Pen.	1:80,000	Avail.
8704	16551	Unga Is. to Pavlof Bay, Alaska Pen.	1:80,000	Avail.
8705	16547	Sanak Island and Sandman Reefs	1:81,326	Avail.
8710	16566	Chignik & Kusulik Bays, Alaska Pen.	1:77,477	Avail.
8720	16531	Krenitzin Islands	1:80,000	Avail.
8802	16011	Alaska Pen. & Aleutian Isl. to Sequan Pass	1:1,023,188	Avail.
8833	16363	Port Moller & Herendeen Bay	1:80,000	Avail.
8834	16343	Port Heiden	1:80,000	Avail.
8859	16549	Shumagin Islands to Sanak Islands	1:300,000	Avail.
8860	16520	Unimak & Akutan Passes and approaches	1:300,000	Avail.
8861	16500	Unalaska Island to Amukta Island	1:300,000	Avail.
8862	16480	Amukta Island to Igitkin Island	1:300,000	Avail.
8863	16460	Igitkin Island to Semisopochnoi Is.	1:300,000	Avail.
8864	16440	Rat Islands-Semisop. Isl. to Buldir Isl.	1:300,000	Avail.
8865	16420	Near Islands-Buldir Isl. to Attu Isl.	1:300,000	Avail.
8868	16568	Wide Bay to Cape Kumlik, Alaska Pen.	1:106,600	Avail.
8995	16380	Pribolof Islands	1:200,000	Avail.
9000	530			
9030	16501	Islands of Four Mountains, Aleutian Is.	1:80,000	Avail.
9051	16323	Bristol Bay-Kvichak Bay & Approaches	1:100,000	Avail.
9052	16322	Bristol Bay-Nushagak B. and Approaches	1:100,000	Avail.
9102	16012	Aleutian Isl.-Amutka Isl. to Attu Isl.	1:1,126,321	Avail.
9103	16300	Kuskokwin Bay	1:200,000	Avail.
9180	16441	Kiska Islands & Approaches, Rat Island	1:80,000	Avail.
9198	16421	Near Isl.-Ingenstrem Rocks to Attu Isl.	1:160,000	Avail.
9302	16006	Bering Sea-Eastern Part	1:1,534,000	Avail.
9369	16204	Port Clarence & Approaches	1:100,000	Avail.
9370	16240	Cape Romanzof to St. Michael	1:300,000	Avail.
9380	16200	Norton Sound	1:400,000	Avail.
9402	16005	Cape Prince of Wales to Pt. Barrow	1:700,000	Avail.
LSO		Great Lakes-General Chart (Polyconic P.)	1:1,500,000	Avail.
LS7	14901	Lake Michigan (Polyconic P.)	1:500,000	Avail.
LS7M		Lake Michigan (Mercator P.)	1:500,000	Avail.
NOS9		Lake Superior (Polyconic P.)	1:600,000	Avail.
	14500	Great Lakes-Lake Champlain to Lake of the Woods	1:1,500,000	Avail.
	14900	Lake Michigan	1:500,000	Avail.
	97026	Asia-Phillipine Sea (Ryukyn Is) inc Daito Juna	1:983,500	Avail.

TABLE 1
NATIONAL OCEAN SURVEY CHARTS *
WITH LORAN-C OVERLAYS

***Southeast U.S. LORAN-C CHAIN**
+Northeast U.S. LORAN-C CHAIN

Old Chart #	New Chart #	Title	Scale	PROPOSED NOAA (NOS) Issue Date
70	13006	West Quoddy Head to N.Y.	1:675,000	9/78+
71	13009	Gulf of Maine & Georges Bank	1:500,000	2/78+
77	12260	Chesapeake Bay-Northern Part	1:197,250	5/78+
78	12220	Chesapeake Bay-Southern Part	1:200,000	1/78+
1000	13003	Cape Sable to Cape Hatteras	1:1,200,000	11/77+
1001	11009	Cape Hatteras to Straits of Florida	1:1,200,000	11/78*
1002	11013	Straits of Florida and approaches	1:1,200,000	11/77*
1003	11006	Gulf Coast-Key West to Mississippi River	1:875,000	3/78*
1007	411	Gulf of Mexico	1:2,160,000	3/78*
1106	13260	Bay of Fundy to Cape Cod	1:378,838	11/77+
1107	13200	Georges Bank Nantucket Shoals	1:400,000	1/78+
1108	12300	Approaches to N.Y. Nantucket Shoals	1:400,000	5/78+
1109	12200	Cape May to Cape Hatteras	1:416,944	5/78+
1110	11520	Cape Hatteras to Charleston	1:432,720	3/78+
1111	11480	Charleston Lt. to Cape Canaveral	1:449,659	2/78*
1112	11460	Cape Canaveral to Key West	1:446,940	2/78*
1113	11420	Havana to Tampa Bay	1:470,940	5/78*
1114	11400	Tampa Bay to Cape San Blas	1:456,394	3/78*
1115	11360	Cape St. George to Mississippi River	1:456,394	5/78*
1116	11340	Mississippi River to Galveston	1:458,596	11/77*
1117	11300	Galveston to Rio Grande	1:460,732	1/78*
1201	13325	Quaddy Narrows to Petit Manon I.	1:80,000	3/78+
1202	13312	Frenchman & Blue Hill Bays and approaches	1:80,000	6/78+
1203	13302	Penobscot Bay and approaches	1:80,000	2/79+
1204	13288	Monhegan Island to Cape Elizabeth	1:80,000	2/78+
1205	13286	Cape Elizabeth to Portsmouth	1:80,000	4/78+
1206	13278	Portsmouth to Cape Ann	1:80,000	12/77+
1207	13267	Massachusetts Bay	1:80,000	2/78+
1208	13246	Cape Cod Bay	1:80,000	2/78+
1209	13237	Nantucket South and approaches	1:80,000	3/78+
1210	13218	Martha's Vineyard to Block Island	1:80,000	8/78+
1211	13205	Block Island Sound and approaches	1:80,000	3/78+
1212	12354	Long Island Sound-Eastern Part	1:80,000	3/78+
1213	12363	Long Island Sound-Western Part	1:80,000	3/78+
1214	12353	Shinnecock Light to Fire Island Light	1:80,000	11/78+
1215	12326	Approaches to N.Y. Fire Island Lt. to Sea Girt Lt.	1:80,000	1/78+
1216	12323	Sea Girt to Little Egg Inlet	1:80,000	10/77+
1217	12318	Little Egg Inlet to Hereford Inlet	1:80,000	1/78+
1218	12304	Delaware Bay	1:80,000	3/78+
1219	12214	Cape May to Fenwick Isl. Lt.	1:80,000	3/78+
1220	12211	Fenwick Isl. Lt. to Chincoteaque Inlet	1:80,000	4/78+
1221	12210	Chincoteaque Inlet to Gt. Machipongo Inlet	1:80,000	4/78+
1222	12221	Chesapeake Bay Entrance	1:80,000	11/77+
1223	12225	Chesapeake Bay-Wolf Trap to Smith Point	1:80,000	1/78+
1224	12230	Smith Point to Cove Point	1:80,000	10/77+
1225	12263	Cove Point to Sandy Point	1:80,000	10/77+
1226	12273	Sandy Point to Head of Bay	1:80,000	10/77+

Table 1 continued

Old Chart #	New Chart #	Title	Scale	PROPOSED NOAA(NOS) Issue Date
1227	12207	Cape Henry to Currituck Beach Lt.	1:80,000	5/78+
1229	12204	Currituck Beach Lt. to Wimble Shoals	1:80,000	4/78+
1231	11548	Pamlico Sound-Western Part	1:80,000	2/78+
1232	11555	Cape Hatteras-Wimble Shoals to Oracoke In.	1:80,000	1/78+
1233	11544	Portsmouth Island to Beaufort	1:80,000	5/78+
1234	11543	Cape Lookout to New River	1:80,000	4/78+
1235	11539	New River Inlet to Cape Fear	1:80,000	6/78+
1236	11536	Approaches to Cape Fear River	1:80,000	4/80*+
1237	11535	Little R. In. to Winyah Bay Entr	1:80,000	2/79*
1238	11531	Winyah B. Entrance to Isle of Palms	1:80,000	4/78*
1239	11521	Charleston Harbor and approaches	1:80,000	9/78*
1240	11513	St. Helena Sd. to Savannah R.	1:80,000	6/78*
1241	11509	Tybee Island to Doboy Sound	1:80,000	4/78*
1242	11502	Doboy Sound to Fernandina	1:80,000	12/77*
1243	11488	Amelia Island to St. Augustine	1:80,000	3/79*
1244	11486	St. Augustine Lt. to Ponce deLeon Inlet	1:80,000	6/78*
1245	11484	Ponce de Leon Inlet to Cape Kennedy	1:80,000	7/78*
1246	11476	Cape Canaveral to Bethel Shoal	1:80,000	4/78*
1247	11474	Bethel Shoal to Jupiter Inlet	1:80,000	10/79*
1249	11462	Fawey Rocks to Alligator Reef	1:80,000	7/78*
1250	11452	Alligator Reef to Sombrero Key	1:80,000	2/78*
1251	11442	Sombrero Key to Sand Key	1:80,000	5/78*
1252	11439	Sand Key to Rebecca Shoal	1:80,000	8/78*
1253	11431	East Cape to Mormon Key	1:80,000	1/78*
1254	11429	Chatham River to Clam Pass	1:80,000	2/79*
1255	11426	Estero Bay to Lemon Bay incl. Charlotte H.	1:80,000	9/78*
1256	11424	Lemon Bay to Passage Key	1:80,000	3/78*
1257	11412	Tampa Bay & St. Joseph's Sound	1:80,000	4/78*
1258	11409	Anclote Keys to Crystal River	1:80,000	4/78*
1259	11408	Crystal River to Horseshoe Point	1:80,000	8/78*
1260	11407	Horseshoe Point to Rocks Island	1:80,000	2/79*
1261	11405	Apalachee Bay	1:80,000	3/78*
1262	11401	Apalachicola Bay to Cap San Blas	1:80,000	5/78*
1263	11389	St. Joseph & St. Andrew Bay	1:80,000	5/78*
1264	11388	Choctawhatchee Bay	1:80,000	1/78*
1265	11382	Pensacola Bay and approaches	1:80,000	1/78*
1266	11376	Mobile Bay	1:80,000	2/78*
1267	11373	Mississippi Sound and approaches	1:80,000	5/78*
1268	11371	Lake Borgne and approaches	1:80,000	4/78*
1269	11369	Lakes Pontchartrain and Maurepas	1:80,000	1/78*
1270	11363	Chandeleur and Breton Sounds	1:80,000	3/78*
1271	11364	Mississippi River-Venice to New Orleans	1:80,000	5/78*
1272	11361	Mississippi River Delta	1:80,000	10/78*
1273	11358	Barataria Bay and approaches	1:80,000	2/78*
1274	11357	Timbalier and Terrebonne Bays	1:80,000	3/78*
1275	11356	Isles Dernieres to Point au Fer	1:80,000	3/78*
1276	11351	Point au Fer to Marsh Island	1:80,000	4/78*
1277	11349	Vermilion Bay and approaches	1:80,000	5/78*
1278	11344	Rollover Bayou to Calcasieu Pass	1:80,000	1/78*
1279	11341	Calcasieu Pass to Sabine Pass	1:80,000	5/78*
1280	11332	Sabine Bank to East Bay including Heald Bank	1:80,000	5/78*
1282	11323	Approaches to Galveston Bay	1:80,000	4/78*

1283	11321	San Luis Pass to E. Matagorda Bay	1:80,000	3/78*
1284	11316	Matagorda Bay and approaches	1:80,000	1/78*
1285	11313	Matagorda Light to Aransas Pass	1:80,000	3/78*
1286	11307	Aransas Pass to Baffin Bay	1:80,000	3/78*
1287	11304	Northern Part to Laguna Madre	1:80,000	2/81*
1288	11301	Southern Part of Laguna Madre	1:80,000	2/78*
1351	11434	Florida Keys-Sombrero Key to Dry Tortugas	1:180,000	7/78*

* These charts will substitute existing charts when new chains become operational.

SPECIAL MAPS

Chart #	Title	Scale	PROPOSED NOAA (NOS) Issue Date
1113A	Havana to Tampa Bay (offshore Mineral Leasing Areas)	1:456,394	5/78*
1114A	Tampa Bay to Cape San Blas (offshore Mineral Leasing Areas)	1:456,394	3/78*
1115A	Cape St. George to Miss. Passes (offshore Mineral Leasing Areas)	1:458,596	5/78*
1116A	Miss. River to Galveston (offshore Mineral Leasing Areas)	1:460,732	11/77*
1117A	Galveston to Rio Grande (offshore Mineral Leasing Areas)	1:100,000	1/78*

TABLE #2

Chart #	Title	Scale	British Admiralty Issue Date	Canadian Hydro Serv Issue Date	Icelandic Hydro Serv Issue Date	Norwegian Hydro Office Issue Date	Price Code
245	Scotland to Iceland		Avail.				
4102	Western approaches to Br. Isles	1:3,500,000					
L8005	Georges Bank	1:300,000		Avail.			C$2.00
20C	Iceland-Jan Mayen	1:200,000			Avail.		I.K.475
25C	Iceland-Austurhluti	1:750,000			Avail.		I.K.475
26C	Iceland-Vesturhluti	1:750,000			Avail.		I.K.475
56C	Iceland-Kolbeinsey	1:200,000			Avail.		I.K.475
306	Skagerrak vestre blad	1:350,000				Avail.	
307	Utsira to Kinn	1:350,000				Avail.	
308	Kinn to Trondheimsleden	1:350,000				Avail.	
309	Smøla to Vegg	1:350,000				Avail.	
311	Stott to Andenes	1:350,000				Avail.	
310	Lekaand Sklima to Vestfjorden	1:350,000				Avail.	
321	Andenes to Grøtsund	1:200,000				Avail.	
552	Vesteralen—Vest Finnmark-Bjørnøya	1:700,000				Avail.	NKr20.00
554	Bjørnøya-Spitsbergen	1:700,000				Avail.	
555	Barentshavet, nordvestlige del	1:700,000				Avail.	
557	Haltenbanken-Vesteralen	1:700,000				Avail.	NKr20.00
558	Vikingbanken-Haltenbanken	1:700,000				Avail.	NKr20.00
559	Birdshøen, nordre blad	1:800,000				Avail.	NKr20.00
560	Nordsjøen, søre blad	1:800,000				Avail.	NKr20.00

TABLE #3

CHARTS PUBLISHED BY THE DEFENSE MAPPING AGENCY, HYDROGRAPHIC CENTER

Chart #	Former #		Scale
19009	HO/BC 4744	Hawaiian Islands	1:1,030,000
28031	HO/BC 2056	Tampico to Progreso (Mexico-East Coast)	1:1,023,400
42720		Mys Litskiy to Mys Bd'shoy Gorodetskiy	1:200,000
51014		Cabo de Sao Vicente to Beddouza including Strait of Gibraltar	1:898,500
52000	HO/BC 3915	Gibraltar to Cabo de San Antonio & Cap Tenes	1:778,800
52010	HO/BC 3916	Cabo de Palos & Cap Tenes to Sardegna including the Balearic Islands	1:757,900
52020	HO/BC 3920	Tunis to Surt including Sicily and Malta	1:798,700
53000	HO/BC 3917	Barcelona to Roma including Island of Corsica	1:713,400
53020	HO/BC 3918	Tyrrhenian Sea including Sardegna (Sardinia) and	1:754,330
54000	BC 3919	Adriatic Sea	1:713,400
54010	BC 3921	Malta to Kriti (Crete) including the Ionian Sea	1:768,500
54020	BC 3923	Aegean Sea (Greece-Turkey)	1:768,450
54030	BC 3924	Antalya Korfezi to Al Iskandariyah including Cyrpus	1:817,600
56000	BC 3925	Tubrug to Al Iskandariyah including Kriti and the Dhodhekanisos	1:817,600
56020	BC 3926	Ras at Barq to Tubruq (Libya)	1:817,600
71028	HO/BC 5501	Pulau Bintan to Mui Bai Bung	1:1,091,700
91006	HO/BC 14706	Philippines — Central Part	1:1,068,000
91011	HO/BC 14705	Philippines — Northern Part	1:1,031,800
92006	HO/BC 14707	Philippines — Southern Part	1:1,089,900
94002	HO/BC 5495	Shen Ch'uan Chiang to San-Men Wan including Taiwan to Iwo Jima	1:985,600
94028	HO/BC 5494	San-Men to Korea Strait	1:927,700
94033	HO/BC 5993	Northern Part of Yellow Sea	1:864,700
95016	HO/BC 3320	Korea Strait to Mys Nizmennyy	1:852,800
96039		Approaches to Vladivostok (U.S.S.R. & Korea)	1:291,360
97021	HO/BC 5492	South Coast of Honshu including Shikoku & Kyushu	1:925,200
97026	HO/BC 5499	Nansei (Ryukyu Islands) Shoto including Daito Jima	1:983,500
7300 Series		Loran-A Plotting Charts	1:2,188,800
7400 Series		Loran-C Plotting Charts	1:2,188,800
7500 Series		Omega Position Plotting Charts (contains Trinidad)	1:2188,800
7600 Series		Omega Position Plotting Charts (contains Liberia)	1:2188,800
7700 Series		Omega Position Plotting Charts (contains Liberia)	1:2188,800
7800-7900 Series		Loran-C Plotting Charts	1:2,187,400

TABLE #4

Charts published by the Defense Mapping Agency, Aerospace Center. The area coverage charts are used with the permission of DMAAC.

Chart #	Title	Scale
	GLOBAL LORAN CHARTS	1:5,000,000
GLC-1,3,6,7,8,9,10 Loran-A		
GLC-C-1,3,4,6,7,8,9,10,11,13 Loran-C		
	See Figure 3 for areas covered	
	USAF LORAN-C NAVIGATION CHARTS	1:3,000,000
LCC-1A,2A,3A,4A	North Polar Region	
	See Figure 4 for areas covered	
	USAF LORAN NAVIGATION CHARTS	1:2,000,000
LJC-6,7,15,16	Loran-A North Polar Region, Alaska, and Bering Sea	
	USAF CONSOL-LORAN NAVIGATION CHART	1:2,000,000
CJC-9	Consol & Loran-A, North Sea Area	

TABLE #5

Loran-A and Loran-C Rate Tables and Omega Lattice and Propagation Correction Tables published by Defense Mapping Agency, Hydrographic Center.

LORAN RATE TABLES

INDIVIDUAL LORAN-A TABLES ($.70)

Pub. No.	Title	Pub. No.	Title
221 (103)	North Atlantic (Rate 1L6)	221 (117)	North Atlantic (Rate 1H2)
221 (104)	North Atlantic (Rate 1L7)	221 (118)	North Atlantic (Rate 1H3)
221 (105)	North Atlantic (Rate 1L2)	221 (119)	North Atlantic (Rate 3H5)
221 (106)	North Atlantic (Rate 1L3)	221 (120)	North Atlantic (Rate 3H4)
221 (107)	North Atlantic (Rate 1H1)	221 (121)	North Atlantic (Rate 3H6)
221 (108)	West Indies (Rate 3L2)	221 (122)	North Sea (Rate 1S1) (Intermittent use only)
221 (109)	West Indies (Rate 3L3)		
221 (110)	North Atlantic (Rate 1L0)	221 (123)	North Sea (Rate 1S2) (Intermittent use only)
221 (111)	North Atlantic (Rate 1L1)		
221 (112)	Denmark Strait (Rate 1L5)	221 (124)	West Portugal (Rate 1S5)
221 (113)	Denmark Strait (Rate 1L4)	221 (125)	Azores (Rate 1S6)
221 (114)	East Coast U.S. (Rate 3L1)	221 (126)	Azores (Rate 1S7)
		221 (127)	Gulf of Mexico (Rate 3H0)
		221 (128)	Gulf of Mexico (Rate 3H1)
		221 (129)	Gulf of Mexico (Rate 3H2)
		221 (130)	Gulf of Mexico (Rate 3H3)

Pub. No.	Title
221 (131)	Southeast U.S.A. (Rate 3L5)
221 (132)	Gulf of Maine (Rate 1H7)
221 (133)	Bay of Biscay (Rate 1H5)
221 (201)	South Japan (Rate 2S7)
221 (202)	South Japan (Rate 2H6)
221 (203)	South Japan (Rate 2H7)
221 (204)	Central Pacific (Rate 2L7)
221 (205)	Asiatic Area (Rate 2H4)
221 (206)	Asiatic Area (Rate 2H3)
221 (207)	Asiatic Area (Rate 1L6)
221 (208)	Asiatic Area (Rate 1L7)
221 (209)	Central Pacific (Rate 2L6)
221 (210)	Central Pacific (Rate 1H2)
221 (211)	Central Pacific (Rate 1H1)
221 (213)	Central Pacific (Rate 2L5)
221 (214)	West Coast U.S. (Rate 1H5)
221 (215)	West Coast U.S. (Rate 1H6)
221 (216)	West Coast U.S. (Rate 2H4) (Changed to 1L0 May 1971)
221 (217)	West Coast U.S. (Rate 1L1)
221 (218)	Japanese Area (Rate 2S3)
221 (219)	Japanese Area (Rate 2S4)
221 (220)	West Japan (Rate 2S5)
221 (221)	West Japan (Rate 2S6)
221 (222)	South Pacific (Rate 2L1)
221 (223)	South Pacific (Rate 2L2)
221 (224)	South Pacific (Rate 2L3)
221 (225)	East Japan (Rate 2S1)
221 (226)	East Japan (Rate 2S2)
221 (227)	North Pacific (Rate 1L2)
221 (228)	North Pacific (Rate 1L3)
221 (229)	North Pacific (Rate 1L7)
221 (230)	North Pacific (Rate 1L6)
221 (231)	Philippine Sea (Rate 2H5)
221 (232)	West Coast U.S. (Rate 2H1) (Changed to 1H4 May 1971)

Pub. No.	Title
221 (233)	South Japan (Rate 2S0)
221 (234)	West Coast Canada (Rate 1L4)
221 (235)	West Coast Canada (Rate 1L5)

LORAN-C TABLES ($2.25)

221 (1001)	East Coast U.S.A. (Pair 9930-W)
221 (1002)	East Coast U.S.A. (Pair 9930-Y)
221 (1003)	Mediterranean Sea (Pair 7990-X)
221 (1004)	Mediterranean Sea (Pair 7990-Y)
221 (1005)	Norwegian Sea (Pair 7970-X)
221 (1006)	Norwegian Sea (Pair 7970-Y)
221 (1007)	Norwegian Sea (Pair 7970-Z)
221 (1008)	Mediterranean Sea (Pair 7990-Z)
221 (1009)	North Sea (Pair 7970-W)
221 (1010)	North Atlantic (Pair 7930-W)
221 (1011)	North Atlantic (Pair 7930-X)
221 (1012)	North Atlantic (Pair 7930-Z)
221 (1013)	East Coast U.S.A. (Pair 9930-X)
221 (1014)	Eastern U.S.A. (Pair 9930-Z)
221 (2001)	North Pacific (Pair 9990-Z)
221 (2002)	North Pacific (Pair 9990-X)
221 (2003)	Central Pacific (Pair 4990-X)
221 (2004)	Central Pacific (Pair 4990-Y)
221 (2005)	North Pacific (Pair 9990-Y)
221 (2006)	Northwest Pacific (Pair 9970-W)
221 (2007)	Northwest Pacific (Pair 9970-X)
221 (2008)	Northwest Pacific (Pair 9970-Y)
221 (2009)	Northwest Pacific (Pair 9970-Z)
221 (2018)	West Coast, U.S.A. (Pair 9940-X)
221 (2019)	West Coast, U.S.A. (Pair 9940-Y)
221 (2018)	West Coast, U.S.A. (Pair 9940-X)
221 (2019)	West Coast, U.S.A. (Pair 9940-Y)
221 (2013)	Gulf of Alaska (Pair 7960-X)
221 (2014)	Gulf of Alaska (Pair 7960-Y)
221 (2015)	West Coast, Canada (Pair 5990-X)
221 (2016)	West Coast, Canada (Pair 5990-Y)
221 (2017)	West Coast, U.S.A. (Pair 9940-W)

AUXILIARY LORAN TABLES AND DIAGRAMS

Chart No.	Title	Price	Scale
5130	Loran-C Coverage Diagram	3.00	1:45,000,000
5131	Loran-A Coverage Diagram	3.00	1:45,000,000
16 or 55 (March 1976)	Omega Coverage Diagram	2.45	1:58,500,000

Code N.O. 7300/7400

Code N.O. 7300/7400

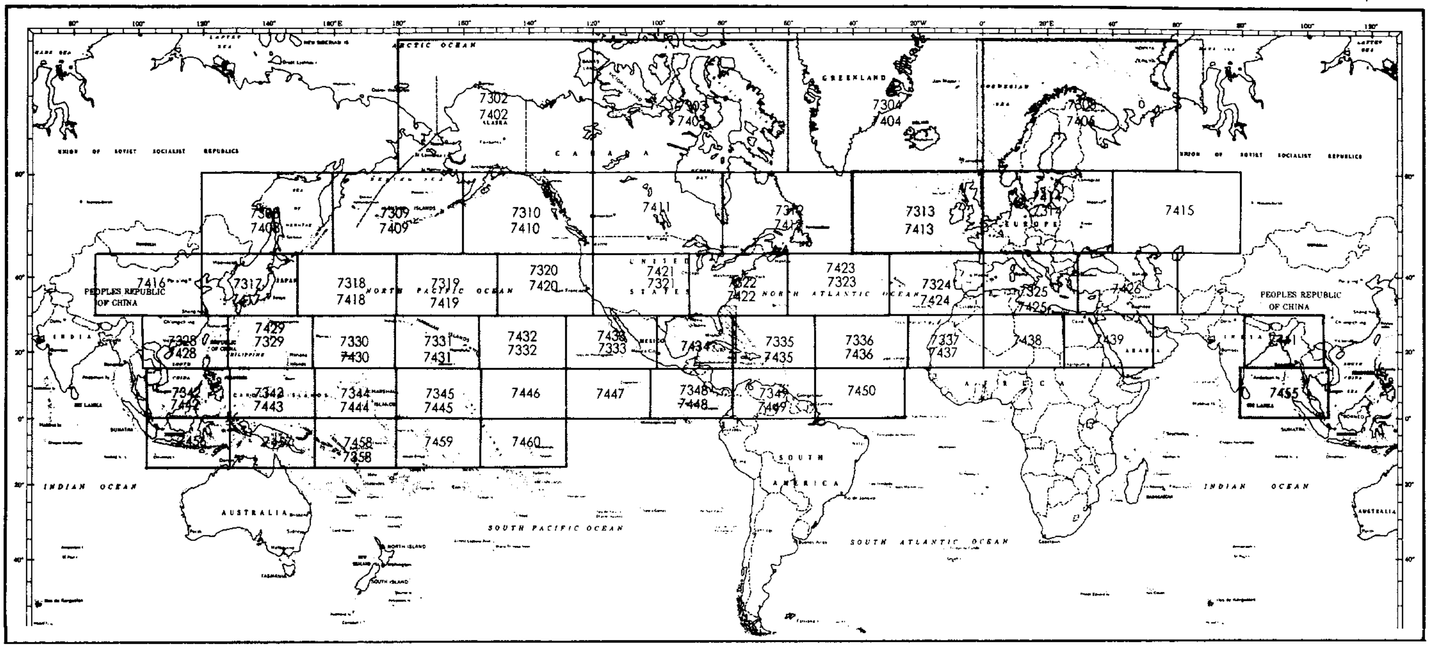

FIGURE 1 - LORAN POSITION PLOTTING CHARTS

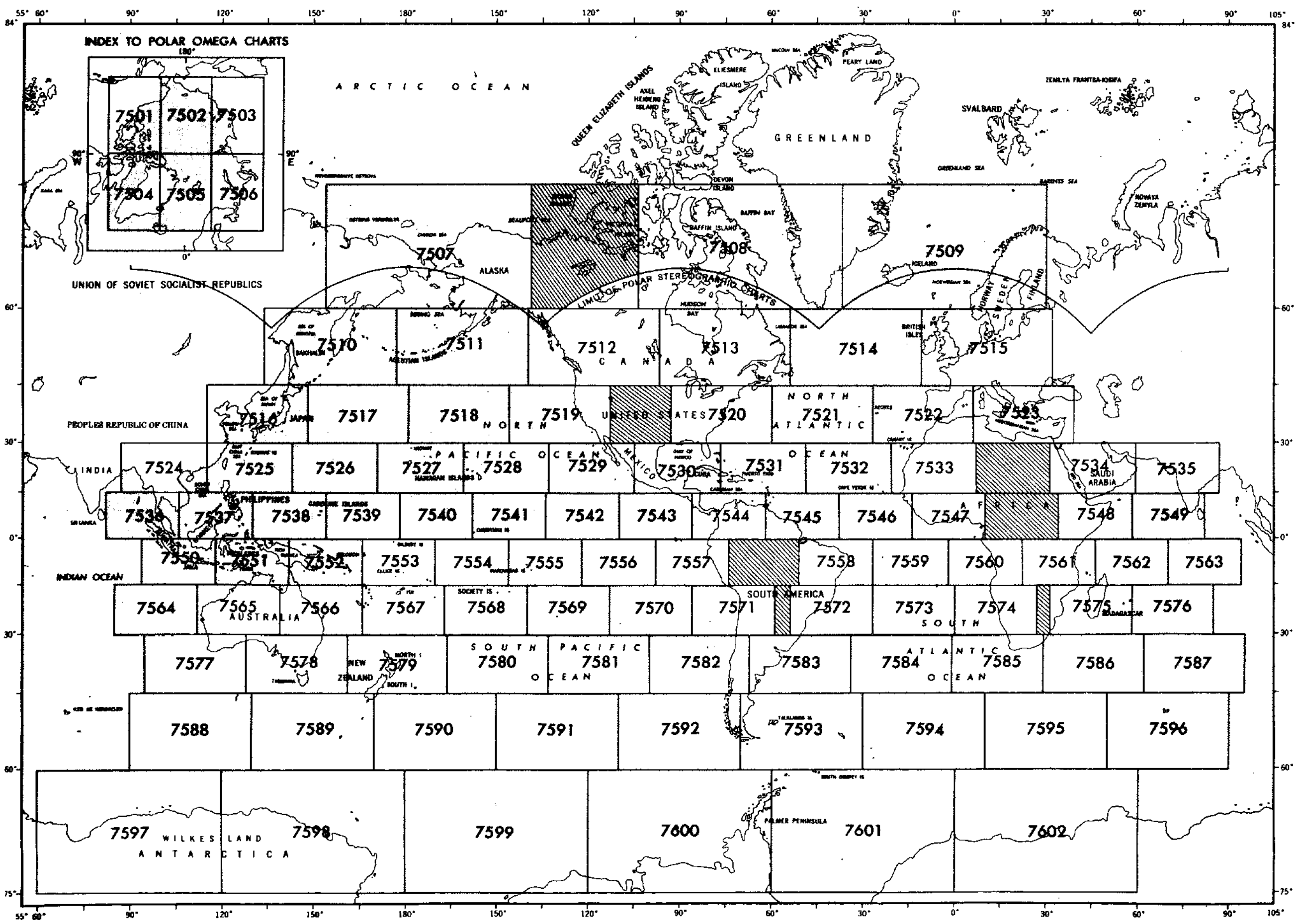

FIGURE 2 - OMEGA POSITION PLOTTING CHARTS

CURRENT AS OF 1 MARCH 1974

DEFENSE MAPPING AGENCY HYDROGRAPHIC CENTER

34 charts remaining in the series. Entire 7500 series to be discontinued when Omega Trinidad is removed from service.

LORAN-C RELIABILITY DIAGRAMS

5592	Mediterranean Sea	7990 XZ	1:5,000,000	Available
5593	Norwegian Sea	7970 WXYZ	1:5,000,000	Available
5594	East Coast, U.S.A.	9930 WXYZ	1:5,000,000	Available
5595	North Pacific	9990 XYZ	1:5,080,144	Available
5596	Central Pacific	4990 XY	1:5,000,000	Available
5597	Northwest Pacific	9970 WXYZ	1:6,000,000	Available
5598	North Atlantic	7930 WXZ	1:6,000,000	Available
5600	Gulf of Alaska	7960 XY	1:5,000,000	Available
5601	West Coast, Canada	5990 XY	1:5,000,000	Available
5602	West Coast, U.S.A.	9940 WXY	1:5,000,000	Available
5603	Southeast, U.S.A. (Interim)	7980 WXY	1:5,000,000*	June 1978
5604	Northeast, U.S.A. (Interim)		1:5,000,000*	June 1978
5605	Great Lakes		1:5,000,000*	Sept. 1978
5606	Northeast, U.S.A.		1:5,000,000*	Sept. 1978

* Proposed Scale

SPECIFICATIONS FOR OMEGA
(7 July 1977

1. Transmitting Station Locations:

Station Letter	Location	Latitude	Longitude
A	Aldra, Norway	66°25′12.″62 N	13°08′12.″52 E
G (Temporary)	Trinidad	10°41′58.″12 N	61°38′17.″73 W
B	Monrovia, Liberia	6°18′19.″11 N	10°39′52.″40 W
C	Haiku, Oahu, Hawaii	21°24′16.″78 N	157°49′51.″51 W
D	La Moure, North Dakota	46°21′57.″29 N	98°20′08.″77 W
E	La Reunion I., France	20°58′27.″03 S	55°17′23.″07 E
F	Golfo Nuevo, Argentina	43°03′12.″89 S	65°11′27.″36 W
G	South Pacific Area	(proposed)	
H	Tsushima, Japan	34°36′52.″93 N	129°27′12.″57 E

2. Transmitter Position Datum: World Geodetic System 1972 (WGS-72)

3. Datum Reference Spheroid:

WGS-72

Equatorial Radius (a) = 6,378,135.000 meters
Polar Radius (b) = 6,356,750.520 meters
Flattening (a-b) /a = 1/298.26

4. Synchronization:

Coordinated Universal Time (UTC)

5. Frequencies:

10.2 kHz (= 29,468,087)
11 1/3 kHz (= 26,521.279 meters)
13.6 kHz (= 22,101.066 meters)
3.4 kHz (Difference frequency: 13.6 – 10.2)

6. Propagation Velocity:

Free space (group velocity) . . . . c = 299,793 km/sec
Nominal charted (phase) velocity . . . . v = 300,574 km/sec
Nominal ratio . . . . $\frac{c}{v}$ = 0.9974

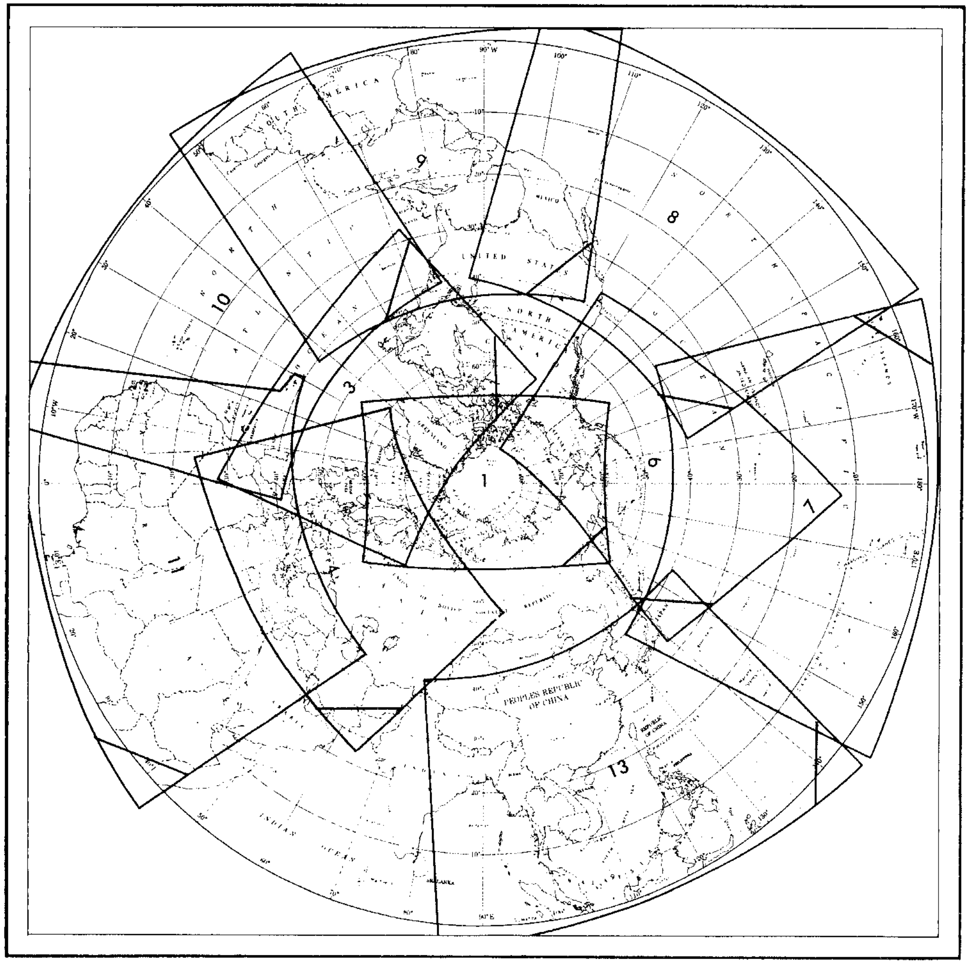

FIGURE 3 - GLOBAL LORAN NAVIGATION CHARTS

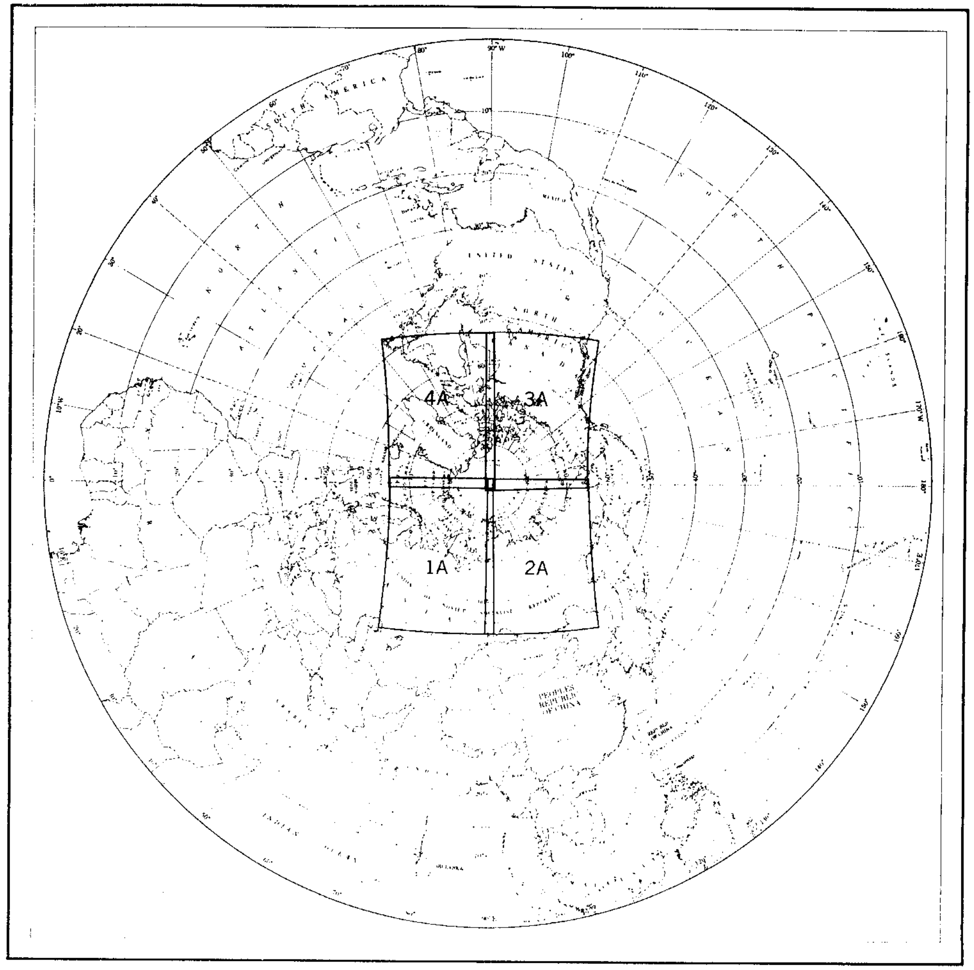

FIGURE 4 - USAF LORAN C NAVIGATION CHARTS

SPECIFICATIONS FOR OMEGA (Cont'd)

7. Hyperbolic Lattice (Minimum/Maximum Lane Counts):

A fictitious coding delay (minimum lane count) must be inserted in the lattice computations to provide a 10.2 kHz lane count of 900 lanes on the perpendicular bisector of the baseline. The purpose is to impose an orderly lane counting system for chart portrayal. This makes the quantity B + D, baseline distance plus minimum lane count, a constant equal to 900, 1000, 1200, and 300 for 10.2, 11 1/3, 13.6, and 3.4 kHz respectively for all Omega pairs. The minimum lane count will be read on the great circle baseline extension behind the first designated station of a station pair. A maximum lane count equal to twice the baseline length plus the minimum lane count, will be read on the baseline extension behind the second designated station.

Pair	Baseline Length (B) Meters	*Wavelengths	*Minimum Lane Count	*Maximum Lane Count
A-G (Temp)	8,244,307.5392	279.7707	620.2293	1179.7707
A-B	6,919,746.7657	234.8217	665.1783	1134.8217
A-C	10,236,840.6931	347.3874	552.6126	1247.3874
A-D	6,222,401.1391	211.1573	688.8427	1111.1573
A-E	10,309,404.9646	349.8498	550.1502	1249.8498
A-F	13,820,017.0013	468.9825	431.0175	1368.9825
A-G				
A-H	7,578,833.7261	257.1878	642.8122	1157.1878
G (Temp) -C	10,217,627.3288	346.7353	553.2647	1246.7353
B-C	15,305,696.7822	519.3991	380.6009	1419.3991
G (Temp) -D	5,255,553.8688	178.3473	721.6527	1078.3473
B-D	9,327,766.8459	316.5379	583.4621	1216.5379
G (Temp) -E	13,221,491.9205	448.6715	451.3285	1348.6715
B-E	7,807,101.5361	264.9341	635.0659	1164.9341
G (Temp) -F	5,962,868.0104	202.3500	697.6500	1102.3500
B-F	7,743,249.2757	262.7673	637.2327	1162.7673
B-G				
G (Temp) -H	14,855,430.8129	504.1193	395.8807	1404.1193
B-H	13,849,302.2397	469.9763	430.0237	1369.9763
C-D	5,992,019.4180	203.3393	696.6607	1103.3393
C-E	16,599,716.4801	563.3116	336.6884	1463.3116
C-F	11,811,167.9628	400.8122	499.1878	1300.8122
C-G				
C-H	7,152,185.4489	242.7095	657.2905	1142.7095
D-E	16,318,306.1858	553.7620	346.2380	1453.7620
D-F	10,432,113.8583	354.0139	545.9861	1254.0139
D-G				
D-H	9,842,056.0317	333.9903	566.0097	1233.9903
E-F	10,674,797.2623	362.2494	537.7506	1262.2494
E-G				
E-H	9,957,458.2535	337.9065	562.0935	1237.9065
F-G				
F-H	18,441,300.2604	625.8058	274.1942	1525.8058
G-H				

* Frequency of 10.2 kHz

OMEGA LATTICE TABLES

H.O. Pub. No.	Area of Coverage	Area
224 (100) A-D	North Polar	00
224 (100) A-H	North Polar	00
224 (100) B-C	North Polar	00
224 (100) B-D	North Polar	00
224 (100) B-H	North Polar	00
224 (100) C-H	North Polar	00
224 (100) G-C	North Polar	00
224 (120) G-H		
224 (101) A-B	Northern Europe	01
224 (101) A-C	Northern Europe	01
224 (101) A-D	Northern Europe	01
224 (101) A-E	Northern Europe	01
224 (101) A-H	Northern Europe	01
224 (101) B-C	Northern Europe	01
224 (101) B-D	Northern Europe	01
224 (101) B-E	Northern Europe	01
224 (101) B-H	Northern Europe	01
224 (101) C-D	Northern Europe	01
224 (101) C-E	Northern Europe	01
224 (101) G-D	Northern Europe	01
224 (101) G-H	Northern Europe	01
224 (102) A-B	Central U.S.S.R.	02
224 (102) A-C	Central U.S.S.R.	02
224 (102) A-D	Central U.S.S.R.	02
224 (102) A-E	Central U.S.S.R.	02
224 (102) A-G	Central U.S.S.R.	02
224 (102) B-C	Central U.S.S.R.	02
224 (102) D-E	Central U.S.S.R.	02
224 (102) D-H	Central U.S.S.R.	02
224 (102) G-C	Central U.S.S.R.	02
224 (103) A-C	Eastern U.S.S.R.	03
224 (103) A-D	Eastern U.S.S.R.	03
224 (103) A-G	Eastern U.S.S.R.	03
224 (103) A-H	Eastern U.S.S.R.	03
224 (103) B-C	Eastern U.S.S.R.	03
224 (103) B-H	Eastern U.S.S.R.	03
224 (103) C-D	Eastern U.S.S.R.	03
224 (103) C-H	Eastern U.S.S.R.	03
224 (103) D-H	Eastern U.S.S.R.	03
224 (103) G-C	Eastern U.S.S.R.	03
224 (104) A-C	Alaska	04
224 (104) A-D	Alaska	04
224 (104) A-G	Alaska	04
224 (104) A-H	Alaska	04
224 (104) C-D	Alaska	04
224 (104) C-H	Alaska	04
224 (104) D-H	Alaska	04
224 (104) G-C	Alaska	04
224 (104) G-H	Alaska	04
224 (105) A-B	Canada	05
224 (105) A-C	Canada	05
224 (105) A-D	Canada	05
224 (105) A-G	Canada	05
224 (105) B-C	Canada	05
224 (105) B-D	Canada	05
224 (105) B-F	Canada	05
224 (105) B-H	Canada	05
224 (105) B-H	Canada	05
224 (105) C-D	Canada	05
224 (105) C-H	Canada	05
224 (105) D-H	Canada	05
224 (105) G-C	Canada	05
224 (105) G-D	Canada	05
224 (105) G-H	Canada	05
224 (106) A-B	Greenland	06
224 (106) A-C	Greenland	06
224 (106) A-D	Greenland	06
224 (106) A-G	Greenland	06
224 (106) B-C	Greenland	06
224 (106) B-D	Greenland	06
224 (106) B-E	Greenland	06
224 (106) B-F	Greenland	06
224 (106) B-H	Greenland	06
224 (106) G-C	Greenland	06
224 (106) G-D	Greenland	06
224 (106) G-H	Greenland	06
224 (107) A-B	Mediterranean	07
224 (107) A-D	Mediterranean	07
224 (107) A-E	Mediterranean	07
224 (107) A-F	Mediterranean	07
224 (107) A-G	Mediterranean	07
224 (107) B-D	Mediterranean	07
224 (107) B-E	Mediterranean	07
224 (107) B-H	Mediterranean	07
224 (107) D-E	Mediterranean	07
224 (107) E-H	Mediterranean	07
224 (107) G-C	Mediterranean	07
224 (107) G-D	Mediterranean	07
224 (108) A-B	Asia	08
224 (108) A-C	Asia	08
224 (108) A-E	Asia	08
224 (108) A-H	Asia	08
224 (108) B-E	Asia	08
224 (108) B-H	Asia	08
224 (108) C-E	Asia	08
224 (108) E-H	Asia	08
224 (109) A-C	Northwest Pacific	09
224 (109) A-E	Northwest Pacific	09
224 (109) C-D	Northwest Pacific	09
224 (109) C-E	Northwest Pacific	09
224 (109) C-H	Northwest Pacific	09
224 (109) D-H	Northwest Pacific	09
224 (109) E-H	Northwest Pacific	09
224 (110) A-B	Central Pacific	10
224 (110) A-C	Central Pacific	10
224 (110) A-G	Central Pacific	10
224 (110) C-D	Central Pacific	10
224 (110) C-H	Central Pacific	10
224 (110) D-F	Central Pacific	10
224 (110) D-H	Central Pacific	10
224 (110) F-H	Central Pacific	10
224 (111) A-B	North America	11
224 (111) A-C	North America	11
224 (111) A-F	North America	11
224 (111) A-G	North America	11
224 (111) B-C	North America	11
224 (111) B-D	North America	11
224 (111) B-F	North America	11
224 (111) B-H	North America	11
224 (111) C-D	North America	11
224 (111) C-F	North America	11
224 (111) D-H	North America	11
224 (111) F-H	North America	11
224 (111) G-C	North America	11
224 (111) G-D	North America	11
224 (111) G-F	North America	11
224 (112) A-B	North Atlantic	12
224 (112) A-C	North Atlantic	12

H.O. Pub. No.	Area of Coverage	Area
224 (112) A-D	North Atlantic	12
224 (112) A-E	North Atlantic	12
224 (112) A-F	North Atlantic	12
224 (112) A-G	North Atlantic	12
224 (112) B-C	North Atlantic	12
224 (112) B-D	North Atlantic	12
224 (112) B-E	North Atlantic	12
224 (112) B-F	North Atlantic	12
224 (112) D-E	North Atlantic	12
224 (112) D-F	North Atlantic	12
224 (112) G-C	North Atlantic	12
224 (112) G-D	North Atlantic	12
224 (113) A-B	Africa	13
224 (113) A-E	Africa	13
224 (113) A-F	Africa	13
224 (113) B-E	Africa	13
224 (113) B-F	Africa	13
224 (113) B-H	Africa	13
224 (113) D-E	Africa	13
224 (113) D-F	Africa	13
224 (113) E-F	Africa	13
224 (114) A-B	Indian Ocean	14
224 (114) A-E	Indian Ocean	14
224 (114) A-F	Indian Ocean	14
224 (114) A-H	Indian Ocean	14
224 (114) B-F	Indian Ocean	14
224 (114) B-H	Indian Ocean	14
224 (114) E-H	Indian Ocean	14
224 (114) F-H	Indian Ocean	14
224 (115) C-E	Australia	15
224 (115) C-F	Australia	15
224 (115) C-H	Australia	15
224 (115) E-F	Australia	15
224 (115) E-H	Australia	15
224 (115) F-H	Australia	15
224 (116) C-E	South Pacific	16
224 (116) C-F	South Pacific	16
224 (116) C-H	(Avail. June 76)	16
224 (116) D-F	South Pacific	16
224 (116) D-H	(Avail. June 76)	16
224 (116) E-F	South Pacific	16
224 (116) E-H	South Pacific	16
224 (116) F-H	(Avail. June 76)	16
224 (116) G-C	South Pacific	16
224 (117) A-B	East Pacific	17
224 (117) A-C	East Pacific	17
224 (117) A-G	East Pacific	17
224 (117) B-C	East Pacific	17
224 (117) B-D	East Pacific	17
224 (117) B-F	East Pacific	17
224 (117) C-D	East Pacific	17
224 (117) C-F	East Pacific	17
224 (117) D-F	East Pacific	17
224 (117) F-H	East Pacific	17
224 (117) G-C	East Pacific	17
224 (118) A-B	South Atlantic	18
224 (118) A-C	South Atlantic	18
224 (118) A-D	South Atlantic	18
224 (118) A-E	South Atlantic	18
224 (118) A-F	South Atlantic	18
224 (118) A-G	South Atlantic	18
224 (118) B-D	South Atlantic	18
224 (118) B-E	South Atlantic	18
224 (118) B-F	South Atlantic	18
224 (118) D-E	South Atlantic	18
224 (118) D-F	South Atlantic	18
224 (118) E-F	South Atlantic	18

H.O. Pub. No.	Area of Coverage	Area
224 (118) G-F	South Atlantic	18
224 (119) A-F	Queen Maud Land	19
224 (119) B-E	Queen Maud Land	19
224 (119) B-F	Queen Maud Land	19
224 (119) D-E	Queen Maud Land	19
224 (119) E-F	Queen Maud Land	19
224 (119) G-F	Queen Maud Land	19
224 (120) A-F	Wilkes Land	20
224 (120) A-H	Wilkes Land	20
224 (120) B-F	Wilkes Land	20
224 (120) B-H	Wilkes Land	20
224 (120) E-F	Wilkes Land	20
224 (121) B-H	Victoria Land	21
224 (121) C-E	Victoria Land	21
224 (121) C-F	Victoria Land	21
224 (121) C-H	Victoria Land	21
224 (121) E-F	Victoria Land	21
224 (121) E-H	Victoria Land	21
224 (121) F-H	Victoria Land	21
224 (122) C-E	Ross Sea	22
224 (122) C-F	Ross Sea	22
224 (122) E-F	Ross Sea	22
224 (122) E-H	Ross Sea	22
224 (122) F-H	Ross Sea	22
224 (122) G-C	Ross Sea	22
224 (123) B-C	Amundsen Sea	23
224 (123) B-D	Amundsen Sea	23
224 (123) B-E	Amundsen Sea	23
224 (123) C-D	Amundsen Sea	23
224 (123) C-E	Amundsen Sea	23
224 (123) C-F	Amundsen Sea	23
224 (124) B-C		24
224 (124) B-D		24
224 (124) B-E		24
224 (124) B-F		24
224 (124) D-E		24
224 (124) E-F		24
224 (124) G-F		24

OMEGA PROPAGATION TABLES— 10.2 kHz

H.O. Pub. No.	Area of Coverage	Area
224 (100-C) A	North Polar	00
224 (100-C) B	North Polar	00
224 (100-C) C	North Polar	00
224 (100-C) D	North Polar	00
224 (100-C) G	North Polar	00
224 (100-C) H	North Polar	00
224 (101-C) A	Northern Europe	01
224 (101-C) B	Northern Europe	01
224 (101-C) C	Northern Europe	01
224 (101-C) D	Northern Europe	01
224 (101-C) E	Northern Europe	01
224 (101-C) G	Northern Europe	01
224 (101-C) H	Northern Europe	01
224 (102-C) A	Central U.S.S.R.	02
224 (102-C) B	Central U.S.S.R.	02
224 (102-C) C	Central U.S.S.R.	02
224 (102-C) D	Central U.S.S.R.	02
224 (102-C) E	Central U.S.S.R.	02
224 (102-C) G	Central U.S.S.R.	02
224 (102-C) H	Central U.S.S.R.	02
224 (103-C) A	Eastern U.S.S.R.	03
224 (103-C) B	Eastern U.S.S.R.	03

H.O. Pub. No.	Area of Coverage	Area
224 (103-C) C	Eastern U.S.S.R.	03
224 (103-C) D	Eastern U.S.S.R.	03
224 (103-C) G	Eastern U.S.S.R.	03
224 (103-C) H	Eastern U.S.S.R.	03
224 (104-C) A	Alaska	04
224 (104-C) B	Alaska	04
224 (104-C) C	Alaska	04
224 (104-C) D	Alaska	04
224 (104-C) G	Alaska	04
224 (104-C) H	Alaska	04
224 (105-C) A	Canada	05
224 (105-C) B	Canada	05
224 (105-C) C	Canada	05
224 (105-C) D	Canada	05
224 (105-C) F	Canada	05
224 (105-C) G	Canada	05
224 (105-C) H	Canada	05
224 (106-C) A	Greenland	06
224 (106-C) B	Greenland	06
224 (106-C) C	Greenland	06
224 (106-C) D	Greenland	06
224 (106-C) E	Greenland	06
224 (106-C) F	Greenland	06
224 (106-C) G	Greenland	06
224 (107-C) H	Mediterranean	07
224 (107-C) A	Mediterranean	07
224 (107-C) B	Mediterranean	07
224 (107-C) C	Mediterranean	07
224 (107-C) D	Mediterranean	07
224 (107-C) E	Mediterranean	07
224 (107-C) F	Mediterranean	07
224 (107-C) G	Mediterranean	07
224 (107-C) H	Mediterranean	07
224 (108-C) A	Asia	08
224 (108-C) B	Asia	08
224 (108-C) C	Asia	08
224 (108-C) E	Asia	08
224 (108-C) H	Asia	08
224 (109-C) A	Northwest Pacific	09
224 (109-C) C	Northwest Pacific	09
224 (109-C) D	Northwest Pacific	09
224 (109-C) E	Northwest Pacific	09
224 (109-C) H	Northwest Pacific	09
224 (110-C) A	Central Pacific	10
224 (110-C) C	Central Pacific	10
224 (110-C) D	Central Pacific	10
224 (110-C) F	Central Pacific	10
224 (110-C) G	Central Pacific	10
224 (110-C) H	Central Pacific	10
224 (111-C) A	North America	11
224 (111-C) B	North America	11
224 (111-C) C	North America	11
224 (111-C) D	North America	11
224 (111-C) F	North America	11
224 (111-C) G	North America	11
224 (111-C) H	North America	11
224 (112-C) A	North Atlantic	12
224 (112-C) B	North Atlantic	12
224 (112-C) C	North Atlantic	12
224 (112-C) D	North Atlantic	12
224 (112-C) E	North Atlantic	12
224 (112-C) F	North Atlantic	12
224 (112-C) G	North Atlantic	12
224 (113-C) A	Africa	13
224 (113-C) B	Africa	13
224 (113-C) D	Africa	13
224 (113-C) E	Africa	13
224 (113-C) F	Africa	13
224 (113-C) H	Africa	13
224 (114-C) A	Indian Ocean	14
224 (114-C) B	Indian Ocean	14
224 (114-C) E	Indian Ocean	14
224 (114-C) F	Indian Ocean	14
224 (114-C) H	Indian Ocean	14
224 (115-C) B	Australia	15
224 (115-C) C	Australia	15
224 (115-C) E	Australia	15
224 (115-C) F	Australia	15
224 (115-C) H	Australia	15
224 (116-C) C	South Pacific	16
224 (116-C) D	South Pacific	16
224 (116-C) E	South Pacific	16
224 (116-C) F	South Pacific	16
224 (117-C) A	East Pacific	17
224 (117-C) B	East Pacific	17
224 (117-C) C	East Pacific	17
224 (117-C) D	East Pacific	17
224 (117-C) F	East Pacific	17
224 (117-C) G	East Pacific	17
224 (117-C) H	East Pacific	17
224 (118-C) A	South Atlantic	18
224 (118-C) B	South Atlantic	18
224 (118-C) C	South Atlantic	18
224 (118-C) D	South Atlantic	18
224 (118-C) E	South Atlantic	18
224 (118-C) F	South Atlantic	18
224 (118-C) G	South Atlantic	18
224 (119-C) A	Queen Maud Land	19
224 (119-C) B	Queen Maud Land	19
224 (119-C) D	Queen Maud Land	19
224 (119-C) E	Queen Maud Land	19
224 (119-C) F	Queen Maud Land	19
224 (120-C) A	Wilkes Land	20
224 (120-C) B	Wilkes Land	20
224 (120-C) C	Wilkes Land	20
224 (120-C) F	Wilkes Land	20
224 (120-C) H	Wilkes Land	20
224 (121-C) B	Victoria Land	21
224 (121-C) C	Victoria Land	21
224 (121-C) E	Victoria Land	21
224 (121-C) F	Victoria Land	21
224 (121-C) H	Victoria Land	21
224 (122-C) C	Ross Sea	22
224 (122-C) E	Ross Sea	22
224 (123-C) B	Amundsen Sea	23
224 (123-C) C	Amundsen Sea	23
224 (123-C) D	Amundsen Sea	23
224 (123-C) E	Amundsen Sea	23
224 (123-C) F	Amundsen Sea	23
224 (123-C) H	Amundsen Sea	23
224 (124-C) B		24
224 (124-C) E		24
224 (124-C) F		24

OMEGA PROPAGATION TABLES – 3.4 kHz

H.O. Pub. No.	Area of Coverage	Area
224 (201-C) A	Northern Europe	01
224 (201-C) B	Northern Europe	01
224 (201-C) C	Northern Europe	01
224 (201-C) D	Northern Europe	01
224 (201-C) G	Northern Europe	01
224 (201-C) H	Northern Europe	01
224 (202-C) B	Central U.S.S.R.	02
224 (202-C) H	Central U.S.S.R.	02
224 (204-C) A	Alaska	04
224 (204-C) C	Alaska	04
224 (204-C) D	Alaska	04
224 (204-C) G	Alaska	04
224 (204-C) H	Alaska	04
224 (205-C) A	Canada	05
224 (205-C) B	Canada	05
224 (205-C) C	Canada	05
224 (205-C) D	Canada	05
224 (205-C) G	Canada	05
224 (205-C) H	Canada	05
224 (206-C) A	Greenland	06
224 (206-C) B	Greenland	06
224 (206-C) C	Greenland	06
224 (206-C) D	Greenland	06
224 (206-C) G	Greenland	06
224 (206-C) H	Greenland	06
224 (207-C) A	Mediterranean	07
224 (207-C) B	Mediterranean	07
224 (207-C) D	Mediterranean	07
224 (207-C) F	Mediterranean	07
224 (207-C) H	Mediterranean	07
224 (208-C) B	Asia	08
224 (208-C) H	Asia	08
224 (209-C) A	Northwest Pacific	09
224 (209-C) C	Northwest Pacific	09
224 (209-C) D	Northwest Pacific	09
224 (209-C) H	Northwest Pacific	09
224 (210-C) A	Central Pacific	10
224 (210-C) C	Central Pacific	10
224 (210-C) D	Central Pacific	10
224 (210-C) F	Central Pacific	10
224 (210-C) G	Central Pacific	10
224 (210-C) H	Central Pacific	10
224 (211-C) A	North America	11
224 (211-C) B	North America	11
224 (211-C) C	North America	11
224 (211-C) D	North America	11
224 (211-C) F	North America	11
224 (211-C) G	North America	11
224 (211-C) H	North America	11
224 (212-C) A	North Atlantic	12
224 (212-C) B	North Atlantic	12
224 (212-C) C	North Atlantic	12
224 (212-C) D	North Atlantic	12
224 (212-C) F	North Atlantic	12
224 (212-C) G	North Atlantic	12
224 (213-C) B	Africa	13
224 (213-C) F	Africa	13
224 (213-C) H	Africa	13
224 (214-C) A	Indian Ocean	14
224 (214-C) B	Indian Ocean	14
224 (214-C) H	Indian Ocean	14
224 (215-C) C	Australia	15
224 (215-C) H	Australia	15

H.O. Pub. No.	Area of Coverage	Area
224 (216-C) C	South Pacific	16
224 (216-C) D	South Pacific	16
224 (216-C) F	South Pacific	16
224 (216-C) H	South Pacific	16
224 (217-C) B	East Pacific	17
224 (217-C) C	East Pacific	17
224 (217-C) D	East Pacific	17
224 (217-C) F	East Pacific	17
224 (217-C) G	East Pacific	17
224 (218-C) A	South Atlantic	18
224 (218-C) B	South Atlantic	18
224 (218-C) D	South Atlantic	18
224 (218-C) F	South Atlantic	18
224 (218-C) G	South Atlantic	18

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7610	7644	7678
7611	7645	7680
7612	7646	7681
7613	7647	7682
7614	7648	7683
7616	7649	7684
7617	7650	7685
7618	7651	7686
7619	7652	7687
7620	7653	7688
7621	7654	7690
7622	7655	7691
7623	7656	7692
7624	7657	7693
7625	7658	7695
7628	7659	7695
7629	7660	7696
7630	7661	7697
7631	7662	7698
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LORAN CHAIN DATA

The information on loran chains is provided primarily to indicate coverage areas. The information on U.S. Coast Guard chains is sufficient for use as the data base in a computerized solution for latitude and longitude from time differences. The information on the U.S.S.R. chains is based on derived information. Before use is made of these systems for navigation, the data should be confirmed and refined.

Privately owned chains are presently in operation in the Gulf of Mexico and Java Sea and planned for operation in the North Sea, Celtic Sea and Hudson's Bay. The USCG and USAF have installed chains utilizing this same low power commercial equipment, to cover respectively, the St. Mary's River and Southwestern, Southeastern and Central European test ranges.

The information on planned chains is tentative and must be confirmed with the owner or operator before use is made of the information. In particular, site locations are not confirmed. The names of towns indicate only general areas. Where a latitude and longitude are given, the site location is determined, but the final survey may not have been made.

General Specifications and Notes

The latitude, longitude, and baseline lengths herein were furnished by the Defense Mapping Agency, Hydrographic Center and are based upon World Geodetic System — 1972 Datum. Appropriate geodetic satellite shifts have been made to relate these coordinates to the center of the earth. The latitudes and longitudes are listed in units of degrees, minutes and seconds.

The following parameters were used in the computations:

a. Signal propogation: Use the velocity of light in free space as 2.99792458 (10^8) meters/second and an index of refraction of 1.000338 at the surface for standard atmosphere.

b. Phase of the groundwave: As described in NBS Circular 573. June 26, 1956.

c. Conductivity: Sigma = 5.0 mhos/meter (seawater). Baseline electrical distance computations were made assuming a smooth, all seawater transmission path between stations.

d. Permittivity of the earth, esu: $e_2 = 80$ for seawater.

e. Altitude in meters: $h_2 = 0$

f. Parameter associated with the vertical lapse of the permittivity of the atmosphere: a = 0.75

g. Frequency: 100 kHz

h. Spheriod: WGS-72 (equatorial radius (a) = 6,378,135.000 meters, polar radius (b) = 6,356,750.500 meters, flattening (f) = (a-b)/a=1/298.26).

Inquiries pertaining to the Loran-C system should be addressed to:

Commandant (G-WAN-3/73)
U.S. Coast Guard
Washington, D.C. 20590

The information contained in the following pages supersedes the information contained in the "Loran-C User Handbook" published by the Coast Guard (CG-462) August 1974.

U.S. East Coast Chain - Rate 9930 (SS7)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Carolina Beach, NC	34-03-46.04N 77-54-46.76W	Master	- - -	700 kW
Jupiter, Florida	27-01-58.49N 80-06-53.52W	W Secondary	11.000μs 2695.57μs	300 kW
Cape Race, Newfoundland	46-46-32.18N 53-10-28.16W	X Secondary	28,000μs 8389.55μs	1.8MW
Nantucket, Massachusetts	41-15-11.93N 69-58-39.09W	Y Secondary	49,000μs 3541.27μs	300 kW
Dana, Indiana	39-51-07.54N 87-29-12.14W	Z Secondary	65,000μs 3560.68μs	400 kW
Electronics Engineering Center Wildwood, NJ	38-56-58.22N 74-52-01.57W	T Secondary	82,000μs 2026.13μs	200 to 400 kW

Norwegian Sea Chain - Rate 7970 (SL3)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Ejde, Faroe Islands	62-17-59.68N 07-04-26.71W	Master	- - -	400 kW
Bo, Norway	68-38-06.15N 14-27-47.00E	X Secondary	11,000μs 4048.07μs	200 kW
Sylt, Germany	54-48-29.80N 08-17-36.33E	W Secondary	26,000μs 4065.70μs	300 kW
Sandur, Iceland	64-54-26.58N 23-55-21.75W	Y Secondary	46,000μs 2944.52μs	1.8 MW
Jan Mayen, Norway	70-54-52.61N 08-43-58.69W	Z Secondary	60,000μs 3216.24μs	200 kW

West Coast Canadian Chain - Rate 5990 (SH1)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Williams Lake BC, Canada	51-57-58.78N 122-22-02.24W	Master	- - -	400 kW
Shoal Cove, Alaska	55-26-20.85N 131-15-19.65W	X Secondary	11,000μs 2343.63μs	400 kW
George, Washington	47-03-47.99N 119-44-39.53W	Y Secondary	27,000μs 1927.40μs	1200 kW

Southeast US Chain(Test) - Rate 3970 (L3) USAF, Loran-C/D

Station Name	Location	Function Power	Coding Delay & Baseline Length	
Ft. McClellan, Alabama	33-44- 85-56-	M		
Kisatchie, Louisiana	31-05-42N 92-34-06W	X	11,000μs 1798.82μs	
Raiford, Florida	30-05-15 82-11-43	Y	25,000μs 2304.00μs	

Eastern USSR Chain - Rate 5000 (SO)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Okhotsk				
Vladivostok				
Kamchatka Penninsula				

North Pacific Chain - Rate 9990 (SS1)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
St. Paul Is., Pribiloff Is., Alaska	57-09-09.88N 170-14-59.81W	Master	- - -	300 kW
Attu, Alaska	52-49-45.05 173-10-52.31E	X Secondary	11,000μs 3875.36μs	300 kW
Port Clarence, Alaska	65-14-40.12N 166-53-14.47W	Y Secondary	29,000μs 3069.02μs	1.0 MW
Narrow Cape, Alaska	57-26-20.21N 152-22-11.22W	Z Secondary	43,000μs 3590.13μs	400 kW

Southeast U.S.A. Chain (operational 7/78) - Rate 7980 (SL2)

Station	Approximate Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Malone, Florida	30-59-38N 85-10-11W	Master	- - -	1.0 MW
Grangeville, Louisina	30-43-34N 90-49-41W	W Secondary	11,000μs	1.0 MW
Raymondville, Texas	26-31-54N 97-49-58W	X Secondary	23,000μs	400 kW
Jupiter, Florida	27-01-58.49N 80-06-53.52W	Y Secondary	41,000μs	300 kW
Carolina Beach, N. Carolina	34-03-46.04N 77-54-46.76W	Z Secondary	59,000μs	700 kW

North Atlantic Chain - Rate 7930 (SL7)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Angissoq, Greenland	59-59-17.27N 45-10-27.47W	Master	- - -	1.0 MW
Sandur, Iceland	64-54-26.58N 23-55-21.75W	W Secondary	11,000μs 4068.02μs	1.8 MW
Ejde, Faroe Islands	62-17-59.68N 07-04-26.71W	X Secondary	21,000μs 6803.65μs	400 kW
Cape Race, Newfoundland	46-46-32.18N 53-10-28.16W	Z Secondary	43,000μs 5212.17μs	1.8 MW

Northwest Pacific Chain - Rate 9970 (SS3)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Iwo Jima, Bonin Is.	24-48-04.10N 141-19-29.00E	Master	- - -	1.8 MW
Marcus Is.	24-17-07.70N 153-58-51.50E	W Secondary	11,000μs 4283.99μs	1.8 MW
Hokkaido, Japan	42-44-37.00N 143-43-09.06E	X Secondary	30,000μs 6684.99μs	400 kW
Gesashi, Okinawa, Jap.	26-36-24.99N 128-08-56.21E	Y Secondary	55,000μ 4463.23μs	400 kW
Yap, Caroline Is.	09-32-45.66N 138-09-55.23E	Z Secondary	75,000μ 5746.64μs	1.5 MW

Great Lakes Chain (operational 2/80) - Rate 9930 (SS7)

Station	Approximate Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiatec Peak Power
Dana, Indiana	39-51-07.54N 87-29-12.14W	Master	- - -	400 kW
Malone, Florida	30-59-38N 85-10-11W	W Secondary	11,000μs	1.0 MW
Seneca, New York	42-42-53N 76-49-35W	X Secondary	28,000μs	1.0 MW
Int. Falls, Minnesota	48-45N 94-40W	Y	44,000μs	1.0 MW

Utah (RPV Test) Chain - Rate 4970 (S3), USAF, Loran-D

Station Name	Location	Function Power	Coding Delay Baseline Length	
Little Mountain, Utah	41-14-46.584N 112-13-26.33W	M 125W		
Montello, Nevada	41-16-44.336N 114-09-22-662W	X 125W	11,000μs 541.76μs	
Nephi, Utah	39-44-21.896N 111-51-58.159W	Y 125W	25,000μs 568.77μs	

Mediterranean Sea Chain - Rate 7990 (SL1)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Simeri Crichi, Italy	38-52-20.61N 16-43-05.96E	Master	- - -	200 kW
Lampedusa, Italy	35-31-20.88N 12-31-29.96E	X Secondary	11,000μs 1755.90μs	400 kW
Kargabarun, Turkey	40-58-20.95N 27-52-01.52E	Y Secondary	29,000μs 3273.35μs	200 kW
Estartit, Spain	42-03-36.49N 03-12-15.90E	Z Secondary	47,000μs 3999.75μs	200 kW

St. Mary's River Chain - Rate 4970

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Gordon Lake, Canada	46-24.5353 83-51.9768	Master	- - -	100 W
Pickford, Michigan	46-03.8813 84-21.7117	X Secondary	11000.045μs 221.652μs	100 W
Drummond Island, Michigan	45-57.2326 83-37.2904	Y Secondary	21999.988μs 220.332μs	100 W
Dennis, Canada	46-36.7668 84-26.9115	Z Secondary	32999.988μs 227.934μs	100 W

Western USSR Chain - Rate 8000 (SLO)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay Baseline Length	Radiated Peak Power
Oriol	53-56N 36-05E	Master	- - -	500 kW
Petrovavodesk	61-48N 34-19E	W Secondary	10,000μs	500 kW
Kuibychev	53-11N 49-46E	X Secondary	25,000μs	500 kW
Simferopol	44-58N 32-02E	Y Secondary	50,000μs	500 kW
Baranovichi	53-08N 26-01E	Z Secondary	65,000μs	500 kW

Gulf of Alaska Chain - Rate 7960 (SL4)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Tok, Alaska	63-19-42.81N 142-48-31.90W	Master	- - -	400 kW
Narrow Cape, Alaska	57-26-20.21N 152-22-11.22W	X Secondary	11,000μs 2804.50μs	400 kW
Shoal Cove, Alaska	55-26-20.85N 131-15-19.65W	Y Secondary	26,000μs 3651.21μs	400 kW

Fort Hood Chain - Rate 4970 (S3), US Army, Loran-D

Station Name	Location	Function Power	Coding Delay Baseline Length	
Summerville, Texas	30-20-11.966N 96-32-32.826W	Master 150 W	- - - - - -	
Canyon Lake, Texas	29-54-22.512N 98-13-40.627W	X Sec. 150 W	11,000μs	
Navarro Mill Dam, Texas	31-57-36.960N 96-41-18.163W	Y Sec. 150 W	23,000μs	

Central European Chain - Rate 3970 (L3), USAF, Loran-D

Station Name	Location	Function Power	Coding Delay & Baseline Length	
Baumholder, Germany	49-36-18.813N 07-19-38.277E	Master 5 kW	- - - - - -	
Hokes Mook, Germany	53-39-13.867N 08-43-46.508E	X Sec. 5 kW	11,000μs	
Eching, Germany	48-15-48.929N 11-37-49.263E	Y Sec. 5 kW	25,000μs	

U.S. West Coast Chain - Rate 9940 (SS6)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Fallon, Nevada	39-33-06.62N 118-49-56.37W	Master	- - -	400 kW
George, Washington	47-03-47.99N 119-44-39.53W	W Secondary	11,000μs 2796.97μs	1.2 MW
Middletown, California	38-46-56.99N 122-29-44.53W	X Secondary	27,000μs 1094.52μs	400 kW
Searchlight, Nevada	35-19-18.18N 114-48-17.43W	Y Secondary	40,000μs 1967.22μs	500 kW

Gulf of Mexico - Rate 4864 - Industrial Radiolocation Service

Station Name	Location	Function Power	Coding Delay Baseline Length	
Perry, Louisiana	29-56-02.416N 92-09-22.019W	Master 200W		
Triumph, Louisiana	29-20-27.564N 89-27-59.844W	X Sec. 100W		
San Louis Pass, Texas	29-05-52.747N 95-06-30.133W	Y Sec. 100W		

Northeast U.S.A. Chain (reconfigured 7/78) - Rate 9960 (SS4)

Station	Approximate Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Seneca, New York	42-42-53N 76-49-35W	Master	- - -	1.0 MW
Caribou, Maine	46-48-27.20N 67-55-37.71W	W Secondary	11,000μs	350 KW
Nantucket, Massachusetts	41-15-11.93N 69-58-39.09W	X Secondary	25,000μs	300 KW
Carolina Beach, N. Carolina	34-03-46.04N 77-54-46.76W	Y Secondary	39,000μs	700 KW
Dana, Indiana	39-51-07.54N 87-29-12.14W	Z Secondary		400 KW

Central Pacific Chain - Rate 4990 (S1)

Station	Coordinates Latitude & Longitude	Station Function	Coding Delay & Baseline Length	Radiated Peak Power
Johnston Is.	16-44-43.95N 169-30-31.20W	Master	- - -	300 kW
Upolo Pt., Hawaii	20-14-49.16N 155-53-09.70W	X Secondary	11,000μs 4972.14μs	300 kW
Kure, Hawaii	28-23-41.77N 178-17-30.20W	Y Secondary	29,000μs 5253.14μs	300 kW

RECENT LORAN RELATED PAPERS

U.S. LORAN-C COVERAGE: AN UPDATE, Michael Mulcahy; Sea Technology, March 1977

With the progressive phaseout of Loran-A by 1980 and the construction and operational testing of new Loran-C stations for civilian use around North America in the last year, the radionavigational "face" of the continent is taking on an entirely new shape.

Operating at 100 kHz, Loran-C can penetrate uneven terrain and also carry farther than its predecessor, Loran-A, which operates at 2 MHz. Both began as military navigation systems.

In the early 1970's the U.S. Coast Guard began studies of the feasibility of increasing the amount of area covered by Loran-C. The realities of measures planned at that time are now coming into being. This article will update what has happened in the expansion of Loran-C according to the schedule mentioned in ST in previous issues. (For more information see ST April, 1974, p. 18; May, 1974, p. 29; September, 1974, p. 35; January, 1975, p. 11; June, 1975, p. 35; March, 1976, pp. 7 & 39; April, 1976, p. 45; and June, 1976, p. 37).

Basically the scheme envisioned by the Coast Guard involves the construction of new stations along the west coast of the United States from the Gulf of Mexico to Canada and the Gulf of Alaska; constructing new stations and reconfiguring the east coast network of the U.S.; "double-rating" (designing the capability of transmitting on two distinct rates, to link two adjacent chains together) certain stations; and the construction of a Great Lakes station. All this was anticipated to take place between 1975 and 1980, and this timetable should be met.

GLOBAL RADIO NAVIGATION, John M. Beukers; Navigation: Journal of the Institute of Navigation, Vol. 30, No. 1, January 1977

In the very near future there is a good chance of being able to navigate around the world using one or more of the radio navigation aids currently being implemented. Navigators the world over have long dreamt of a reliable, global, all weather navigational tool and this is now within their grasp. This paper discusses some of the administrative tasks that must be accomplished to make the navigator's dream come true. There are a multitude of radio navigational aids, so many in fact that the U.S. Government has become critical of the technical and user community for the proliferation of these systems. However for global radio navigation the field is narrowed considerably, there being only five contenders.

NEW DMAHC NAVIGATION PUBLICATIONS, Ernest B. Brown; Proceedings of the Institute of Navigation, National Marine Navigation Meeting, San Diego, California, November 1976

This paper addresses the progress being made by the Defense Mapping Agency Hydrographic Center in producing better navigation publications in support of the marine navigator. This progress report includes a brief discussion of the contents of the new edition of Pub. No. 9, American Practical Navigator (Bowditch), which is to be completed early in 1977. This paper also summarizes recent improvements in Sailing Directions, Notice to Mariners, and navigation tables.

THE COAST GUARD TWO PULSE LORAN-C COMMUNICATIONS SYSTEM, D.A. Feldman, M.A. Letts and R.J. Wenzel; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 4, Winter 1976-77

The development of the Colac timer and the Loran Replacement Equipment package has provided two sources of dramatic improvement of the performance of Loran-C transmitting stations: solid state reliability and the ability to have control locally or remotely exerted. The improvement due to solid state reliability has been well documented over the past several years while the exploitation of the remote control capability has begun with the recent test deployment of a calculator based remote chain control unit. Results to date have indicated that chain control tolerances on the order of 40 nanoseconds can be attained.

At the heart of any such tightly controlled system is the requirement for a reliable communications network such as is readily and economically available from commercial sources on the east coast of the U.S. Plans for worldwide implementation, however, hit a snag in the form of the poor reliability of the communications links available at many of the remote or isolated stations such as those of the Central Pacific or Alaskan chains. For these stations the Coast Guard Two Pulse Loran-C Communications system has been developed.

The system, consisting of pulse position modulation (PPM) of two of the pulses of a Group Repetition Interval, has only two performance requirements and these are unique among the various Loran-C communications schemes. One requirement is the transmission of short, infrequent control messages which can be received at baseline distances and, in the face of all the classical interference sources of the Loran-C channel, with a small probability of error. A second requirement is that the PPM impact insignificantly, if at all, on the navigation channel, since improved navigational performance is the primary objective of the system.

As will be developed, these two requirements are not at all inconsistent. A complete description of the features of the transmission scheme and their effects is presented.

THE LORAN-C GROUND STATION, H.T. Sherman and V.L. Johnson; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 4, Winter 1976-77

The Coast Guard has been tasked to implement expanded Loran-C coverage to include the West Coast and Gulf of Alaska. This network of eight transmitting stations will employ the Loran-C Replacement (LRE) and an improved version of Loran Transmitting Set AN/FPN-44 which has been designated as AN/FPN-44A. The AN/FPN-44/45 generation of equipment was developed in 1962-63 by ITT Federal Laboratories and is in use in the North Atlantic, Northwest Pacific, Southeast Asia chains, and at Dana, Indiana in the East Coast chain. The latter station has been used as a prototype for the station configuration to be used in the West Coast and Gulf of Alaska chains. The new station configuration consists of the LRE package, which is described in another paper presented at this meeting, and Loran Transmitting Set AN/FPN-44A.

This paper describes the total Loran-C ground station equipment, with emphasis on improvements made in the transmitter, its characteristics and reliability, and interface with the LRE system. Possible future improvements, power output capability, pulse shape and spectrum considerations, as well as modification for operation into new types of antennas are also discussed.

GLOBAL RADIO NAVIGATION – A CHALLENGE FOR MANAGEMENT AND INTERNATIONAL COOPERATION, J.M. Beukers; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 4, Winter 1976-77

It has been the navigator's dream to have available at all times an accurate all weather global navigation system. This dream has an excellent chance of being realized within the next decade using currently available technology, providing the problems of system implementation are adequately addressed on an international scale. By definition, Global Radio Navigation requires that radio transmissions can be received without interference on land, at sea and in the air no matter what the sovereignty of the reception point may be.

Frequency spectrum utilization on a non-interference basis and publication of radio navigational transmission specifications are considered to be two important prerequisites for adoption of any system for global use. Differing national requirements and conflict between navigation for national security and for civilian purposes pose a significant challenge for national decisiveness and international cooperation.

Two land based long range navigational systems, Loran-C and Omega are currently being implemented and in the future there exists a possibility for an operational global satellite navigation system, all of which suggest that now is the time for action. This paper addresses the need for publication of firm technical specifications of the Loran-C and Omega System and the need for definition of the frequency spectrum required by these navigational signal transmissions. The paper discusses specific technical areas needing attention prior to the World Administrative Radio Conference to be held in Geneva in 1979 under the auspices of the International Telecommunication Union.

THE AN/BRN-5 LORAN RECEIVER, W.N. Dean and D.P. Roth; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 4, Winter 1976-77

The AN/BRN-5 is a part of the Poseidon upgrading of the Ballistic Missile submarine fleet as a replacement for the aging and obsolescent AN/WPN-3. In this application, it is required to have better performance and higher reliability than any existing Loran receiver.

The BRN-5 is actually only a sensor, in that the data processing, filtering and logic functions are performed in the CP-890/UYK Central Navigation Computer. The hardware and software requirements are set by the performance required, which specifies search and settle times, track accuracy in noise and both synchronous and non-synchronous interferences, skywave rejection and a variety of other requirements. In addition, it is required to have an automatic overall self test capability, automatic fault isolation and a manual diagnostic mode.

The system performance specification emphasizes reliability above all, not just hardware, but in the sense of accurate position information under the most severe signal environment conditions. Because of the particularly stringent signal processing requirements, some techniques not generally employed in Loran receivers were utilized. This paper describes some of these techniques, along with parameter tradeoffs and unexpected phenomena uncovered in the course of system debug.

DISCUSSION OF REAL AND APPARENT LORAN-C PROPAGATION LIMITATIONS, R.H. Doherty; Presented at the Meeting on Propagation Limitations of Navigation and Positioning Systems, AGARD, Istanbul, Turkey, Oct. 1976

An attempt to determine Loran-C propagation limitations from measured data is related to the prediction model against which the data are analyzed. Inadequate models have resulted in analysis problems and reported misleading results. After measuring and analyzing Loran-C data throughout the world over a period of 20 years, it has become possible to recognize these analysis problems. Until the modeling limitations are completely understood and resolved, the subject of the propagation limitations of Loran-C cannot be adequately summarized.

Some examples of real versus apparent propagation type errors are presented to show the problems associated with certain analysis techniques. Also, an example of an unfounded assumption is used to show how errors in basic assumptions can affect the evaluation of the entire system's capability.

PREDICTION OF GROUND WAVE PROPAGATION TIME ANOMALIES IN THE LORAN-C SIGNAL TRANSMISSIONS OVER LAND, J. Ralph Johler; Presented at the Meeting on Propagation Limitations of Navigation and Positioning Systems, AGARD, Istanbul, Turkey, Oct. 1976

The ultimate accuracy to which Loran-C can be predicted is dependent firstly upon the repeatability of the Loran chain grid including the measuring equipment and secondly upon the predictability. Prediction of the signal propagation time to full accuracy over land or over seawater involving land masses in the propagation paths to each of the transmitters requires special considerations. This is true both on the ground and aloft in aircraft. We have found that such propagation time may be anomalous. This means that spatial perturbations of the signal propagation time will, without more advanced and sophisticated theory, limit the prediction accuracy of the Loran coordinates (time differences). This limitation arises from the physical nature of the ground and its effect on wave propagation – land is nonhomogeneous and irregular. Thus, classical ground wave theory used in the past, although helpful in removing gross propagation errors in Loran, fails to take into account with sufficient accuracy propagation errors observable on modern Loran receivers. We therefore wish to emphasize that a more sophisticated theory is required to fully exploit Loran receiver and chain precision.

Fortunately, ground wave propagation theory has reached the state of development such that nonhomogeneous and irregular ground in the propagation paths can be taken into account. Previously, when great spatial perturbations of the order of several microseconds were observed, we have called the signal propagation anomalous. It is argued in this paper that such anomalous propagation is a unique function of the geographic location of the propagation path and requires the introduction of terrain, soil and basement rock electrical properties and features along the propagation path. Such detail is readily introduced into the modern solution of the ground wave propagation problem using an integral equation and modern advanced computer data handling capabilities. We believe that Loran coordinates can be predicted from geographic coordinates with an accuracy of 50 ns using such a technique.

STATUS OF GOVERNMENT PROVIDED RADIONAVIGATION SYSTEMS FOR MARINE SERVICE IN THE UNITED STATES, David T. Haislip; Proceedings of the Position Location and Navigation Symposium, Oct. 1976

The decision of 1974 which designated Loran-C as the government provided radionavigation system for the Coastal Confluence Zone (CCZ) of the United States was announced in several public documents and by the media and necessitated the issuance of an operating plan which promulgated the phase-in schedule for Loran-C and the phase-out schedule for Loran-A. In addition, the U.S. Coast Guard is the government agency responsible for the marine radiobeacon system in the United States, as well as the operational and technical aspects of the OMEGA system. The Coast Guard is proceeding with programs to maximize the usefulness of the Loran-C and marine radiobeacon systems, to provide for an orderly phase-out of Loran-A, and to coordinate with the Department of Defense on the operational and technical aspects of the OMEGA system.

LORAN-C DATA ACQUISITION AND HANDLING FOR IMPROVED ACCURACY, Dennis J. Granato and Bahar J. Uttam; Proceedings of the Position Location and Navigation Symposium, Oct. 1976

Loran-C coverage and use as a navigation system is likely to increase since it has been selected as the navigation system for the U.S. Coastal Confluence Region (CCR). As a result objectives that should be addressed are improved accuracy and reliability. A key element in accomplishing these objectives is the use of good quality data. In order to effectively use the data, it is necessary to utilize an efficient data handling system.

In this paper, the design of a Loran-C data handling system is presented. A technique that has the potential of improving Loran-C accuracy and the role of the data handling system in utilization of the technique are also described.

POSITION LOCATION SYSTEMS TECHNOLOGY, N. Lawhead; Proceedings of the Position Location and Navigation Symposium, Oct. 1976

This paper presents a summary of various methods and techniques used for position location. The primary intent is to set the stage for the papers which follow. Emphasis is placed on those techniques which are particularly applicable to navigation and control.

CLARINET PILGRIM – COMMUNICATIONS USING LORAN-C, Walter N. Dean; Proceedings of the Position Location and Navigation Symposium, Oct. 1976

The Clarinet Pilgrim system, presently operational in the Northwest Pacific Loran-C chain, is used to transmit communications using pulse position modulation of some of the pulses from each Loran station. The position shifts are randomized to prevent timing errors.

A theoretical analysis predicts that the effects on navigation receivers, both linear and hard-limiting, should be negligible. A series of controlled tests was made to determine the effects of modulation on hard-limiting receivers. The results show the effects to be truly negligible.

ECCM PROTECTED LORAN RECEIVER PERFORMANCE IN TACTICAL DYNAMIC SYSTEMS, James Harris and Angelo Dimitriou; Proceedings of the Position Location and Navigation Symposium, Oct. 1976

The ECCM signal modulation format for the Tactical Loran-D system has been selected under a government sponsored contract. This paper presents an analysis of the dynamic performance of Loran receivers for tactical aircraft and missile systems in a hostile ECM environment.

The effects of the pseudo-random Loran ECCM modulation and the presence of ECM signals are analyzed for both linear and hard-limited receivers. These effects are analyzed to determine the performance of Loran receivers for dynamic conditions such as those encountered in tactical aircraft and missle systems applications. The resultant jamming immunity for both linear and hard-limited receivers is also analyzed.

The presentation of the material is analytic in nature, utilizing closed-form stochastic analysis techniques, and is closely correlated to hardware test results. The emphasis of the paper is on developing analytic relationships that can be utilized by designers and military system developers to more readily determine the best design approaches – and achievable performance – of ECCM-protected Loran systems.

UNITED STATES COAST GUARD PLANNING FOR THE COASTAL CONFLUENCE ZONE, W.B. Mohin; Canadian Aeronautic and Space Journal, Vol. 21, No. 7, Sept. 1976

This paper discusses the reasons for adoption of Loran-C in preference to three other candidate radionavigation systems for the coastal confluence zone and harbour/estuary areas.

SYNCHRONIZATION BY MEANS OF LORAN-C SIGNALS, L. Buffoni, F. Carta, F. Chlistovsky, A. Manara, F. Mazzoleni; Rend, First Lomb. A (Italy) Vol. 109, No. 2, p. 497-506, 1976

After a brief exposition of the Loran-A and B signals' transmission systems, the characteristics, precision and utilization of the Loran-C system, are discussed. Also described is the reception instrumentation of Loran-C signals at Merate Observatory, the measuring system adopted and the time scale constructed.

THE DEVELOPMENT OF LORAN-C FOR NAVIGATION IN HARBOR AND HARBOR ENTRANCE AREAS, W.A. Walker, J.M. O'Connell; IEEE Marine Technology Society, Washington DC, Sept. 1976

Loran-C can satisfy many navigation requirements, but there is a need for additional development before the navigator of an ocean-going ship can use Loran-C to the full extent of its capability. The U.S. Coast Guard is proceeding with a program to maximize the usefulness of the planned Loran-C system for the coastal/confluence zone, to define the requirements for navigation in specific harbor areas, and to identify the information needs of shipboard navigators.

LORAN-C EXPANSION IN THE COASTAL CONFLUENCE ZONE, F.W. Mooney; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

On May 16, 1974 the Secretary of the Department of Transportation announced the selection of Loran-C as the radio navigation system to serve the coastal confluence zone (CCZ). This paper addresses the implementation of Loran-C in the CCZ. Topics covered include proposed station location, coverage, turn-on schedule (where appropriate) and operational dates for each new chain. Detailed information will be presented concerning the West Coast, Western Canada, and Gulf of Alaska chains which are scheduled to be certified operational January 1, 1977. This latter information will include the construction schedule, characteristics of the electronics equipment and power plants, plus individual station turn-on and chain calibration schedules.

LORAN-C NAVIGATION CHARTS FOR THE COASTAL CONFLUENCE ZONE, W.B. Ferm; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

The availability of accurate charts is a necessary part of a complete and useful navigation system. Realizing this, the Coast Guard has exerted a major effort to ensure that navigation charts with Loran-C lines overprinted on them are available for distribution as soon as possible for areas covered by existing Loran-C chains and throughout the remainder of the Coastal Confluence Zone as Loran-C coverage becomes available. The accurate charting of Loran-C lines-of-position is more difficult than one would think and this paper discusses some of these difficulties encountered. It will also describe the method currently being used to introduce additional secondary phase (ASF) corrections into the charting process to improve the accuracy of the lines. Printing schedules, both present and tentatively planned for the future, will be covered.

LORAN CALIBRATION BY PREDICTION, L.B. Burch, R.H. Doherty and J.R. Johler; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

Loran propagation is uniquely predictable using the integral form of Maxwell's Equations. The demonstrated high-precision repeatability of Loran time differences (TDs) has provided a mechanism with sufficient resolution to detect the extremely small phase variations caused by propagation anomalies. These small variations, denoted by grid warp, can be predicted using surface parameters as input to a computer program based on the theory. This computerized analysis provides a potentially greater accuracy than the conventional measurement process. Further, the computerized technique can be verified with carefully obtained measurements. Thus, a completely unrestricted, three-dimensional, precision calibration is possible and economically attractive.

IMPACT OF LORAN-C DECISION ON OREGON MARITIME INTERESTS, D.A. Panshin; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

There are presently at least 1350 Loran-A users in Oregon representing such major categories as commercial fishermen, recreational boaters, charterboat operators, and towboaters. All existing Loran-A users, plus many others, are potential Loran-C users. The West Coast Loran-C chain is scheduled to start operation on January 1, 1977. Many problems face the prospective Loran-C user in Oregon: receiver cost, charts, lack of information, and misinformation. All of these problems can be alleviated by a longer transition period and a vigorous education program.

LF/VLF NAVAID SIGNAL RELIABILITY IN AIRBORNE APPLICATIONS, J.M.H. Bruckner and R.A. Auerbach; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

The aviation community has been using radio signals for long-range navigation for quite some time. However, with the decommissioning of Loran-A, alternative long-range radio navigation methods are being investigated. The current candidates appear to be Loran-C, VLF comm nav (the VLF communications stations), and Omega. While these signals have seen some use for long-range navigation, there does not appear to be any systematic evaluation of the "service segments' " (ground stations') ability to function reliably for the duration of a given mission.

The authors believe that the often quoted availability ratio (station time available to total time) does not provide sufficient information to judge a signal's usefulness in aircraft navigation. For example, a signal availability of 98 percent could characterize either a transmitter with a mean time to repair (MTTR) of 2 minutes and a mean time between failure (MTBF) of 98 minutes, or a transmitter with MTTR of 2 hours and MTBF of 98 hours. If this particular signal were required throughout a particular flight, the first signal's reliability might be acceptable while the second's would probably be unacceptable unless some form of backup navigation system is provided. Due to lane ambiguity problems, the accuracy of the backup system required for the Omega and VLF comm nav receivers is highly dependent upon the length of time that the primary signal is unavailable. This information is not apparent when only the availability ratio is given.

To obtain more meaningful statistics on radio navigation signal reliability, the authors have maintained a file of Loran-C, Omega and VLF comm nav station failures reported since late 1973. From this failure data, the MTBF and MTTR statistics for individual transmitters as well as averages for transmitter types have been calculated. This basic information has also made it possible to characterize the reliability of each transmitter type in various ground station redundancy situations.

Many of the stated reliabilities are given in terms of mission duration. The mission duration of interest depends of course on the application. Of particular concern is the suitability of the signals to support oceanic or other remote area flights where there are no short-range navaids. Flight times of interest are therefore assumed to be from 2 to 10 hours. Portions of the analysis have been limited to these values.

LORAN-C REPLACEMENT EQUIPMENT (LRE), G.R. Goodman and R.P. Oswitt; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

A program was initiated by the U.S. Coast Guard during 1973 to develop a Loran-C Replacement Equipment (LRE) package to replace or improve the existing Loran-C ground station equipment. The overall goal of this program is to improve LORSTA operational performance while simultaneously reducing personnel and equipment operating costs. Evaluation of the LRE at 12 LORSTAs during the past two years has shown that the program goal has been achieved. In addition, use of the LRE permits operation of secondary LORSTAs in a semi-automated mode. This paper describes a joint effort by the Electronics Engineering Division, Coast Guard Headquarters (G-EEE) and Electronics Engineering Center, Wildwood, NJ. (EECEN) engineers to develop, evaluate, and plan for expansion of the LRE program. In addition, the function, operation, and interaction of each individual LRE unit is described

LORAN-C IN THE EYES OF THE GERMAN HYDROGRAPHIC INSTITUTE (DHI), U. Hammerschmidt; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

Until the development of a new generation of automatic shipborne receivers, Loran-C was of no importance in the maritime world of Western Europe. This old and very expensive automatic system of high accuracy was only used on board special purpose vessels. Loran-A was employed in those cases where more accurate systems were not available due to their prohibitive prices. So, only the German fishing vessels operating in the North Atlantic are making use of this system to date. The combined Loran-A/C receivers were not very useful because the Loran-C chains in the vicinity of Europe have very long base-lines. Very seldom more than two stations could be picked up with a sufficient S/N ratio.

The situation has now thoroughly changed due to the new low-cost automatic receivers which – with regard to their accuracy and sensitivity – more than matched the former automatic equipment, and due to the US plan for phase-out of the Loran-A chains. In Germany, for example, the ocean going fishing vessels have to change their navigation facilities from Loran-A to Loran-C, because their normal working area is the North Atlantic around Iceland and near the North American coast. I believe they will very soon come to appreciate the advantages of Loran-C. I also believe that the German and other merchant fleets of Western Europe sailing to North and Central America will increasingly make use of the Loran-C system, because these areas will be better and more accurately covered with LOPs than ever before, and because the prices for receivers are now reasonable.

The aforementioned development has its influences on the work of the German Hydrographic Institute, too. Previously, we made type tests of Loran-A only, but in the future we will also have to type test the automatic Loran-C receivers.

We also consider the possible technical and economic advantages of an extension of the planned Loran-C coverage and its connection to the Soviety Loran-C system as a big step towards a standardisation in maritime radionavigation.

PROGRESS REPORT ON THE GETTYSBURG WORKSHOP SIXTEEN MONTHS LATER, J.F. Culbertson; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

Sixteen months have passed since the 5-7 June 1974 Gettysburg Workshop that was sponsored jointly by the Coast Guard and the Wild Goose Association. Significant action has been taken and progress is being made on the recommendations documented in the Workshop Proceedings.

This paper examines the recommendations and discusses progress toward meeting the Workshop challenges as viewed by the author. In particular, progress is discussed concerning future workshops, Coast Guard receiver requirements, the CCZ implementation time table, new Loran-C rate structure, CCZ rate assignments, Loran-C charting, East Coast Loran-C chain reconfiguration, Loran-C system standards, Loran-C User Handbooks, Loran-C R & D efforts, CCZ Loran-C Monitor Plans, midcontinental Loran-C plans and Loran-C for area navigation.

Unfortunately, progress has not been made on some important workshop recommendations. These are discussed with respect to what action should be taken and who should accept the challenges.

This paper serves as the first documented update report on the Loran-C Workshop. Subsequent update reports are invited to announce and highlight continuing progress toward fulfilling all the workshop mandates.

A NEW APPROACH TO THE THEORY OF GEODESICS ON AN ELLIPSOID, J.S. Holmstrom; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

The assumption underlying all groundwave radio navigation work, e.g., Loran, is that each signal travels from transmitter to receiver along a geodesic of the Earth's surface. Therefore, accurate estimation of positions and azimuths along geodesics is an important component of radio navigation. Such computations are normally done under the simplifying assumption that the Earth is an oblate spheroid. In this paper, the theory of geodesics is developed for a general ellipsoid with three unequal axes, using cartesian coordinates instead of the customary latitude and longitude. A first-order solution is obtained for the case where the eccentricity of each of the principal cross-sections of the ellipsoid is small. Numerical results obtained for the special case of an oblate spheroid indicate that the first-order solution is sufficiently accurate for most applications involving groundwave radio navigation. The extension of the theory to second- and higher- order solutions, if greater accuracy is desired, is straight-forward.

THE USE OF MICROPROCESSORS IN NAVIGATION SYSTEMS, C.O. Culver and R.W. Danklefs; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 3, Fall 1976

Microprocessors and their application to navigation systems are discussed. A survey of presently available microprocessors is presented, which indicates that only the simplest and slowest devices currently offer any cost advantage over other technologies. A Loran-C receiver using a microprocessor design with a total of 70 integrated circuits is described. A floating point interpreter designed to simplify programming navigational computations on a four bit microprocessor is also described. A coordinate conversion program for Loran using the interpreter has been developed, which uses 4096 words of 8 bit program memory and will compute latitude and longitude to within 50 feet in 22 seconds.

BASIC DESIGN PROCEDURE FOR LORAN TRANSMITTERS USING HIGH POWER, HALF CYCLE GENERATORS, M. Dishal; Navigation: Journal of the Institute of Navigation, Vol. 23, No. 2, Summer 1976

Because of the availability of high level solid state switches, it is now practical to implement efficient pulse transmitters in the 100 kHz frequency region by discharging, in sequence, a multitude of high level half cycle generators into a properly designed RF output circuit; this circuit must include the actual radiating antenna.

This paper presents design equations which are directly applicable to the RF circuit design of such a transmitter, and shows that the simplest practical overall output circuit turns out to be a straightforward double tuned bandpass filter.

Because, in the 100 kHz carrier region being considered, the natural antenna bandwidth is often very much narrower than that required to "pass" the desired pulse rise time, the paper considers in detail both the phenomenon involved and the circuit design involved which will enable an antenna current having any specified pulse rise time to be produced no matter how narrow the natural antenna bandwidth may be. It is important to realize that this capability is accomplished without the addition of power consuming loading resistors.

After the half cycle generators — overall network combination has been designed to produce the desired pulse leading edge, one is faced with the problem of correctly discharging the network so that it produces a specified pulse decay shape. This problem is also considered in this paper and design equations are presented for the switched-in network which must be used to produce a specified pulse decay shape.

THE ESSENTIAL ROLE OF SYSTEMS SPECIFICATIONS FOR GLOBAL RADIO NAVIGATION, J.M. Beukers; Presented at the Thirty-First Annual Meeting of the Institute of Navigation, Washington DC, June 1975

In the course of our day to day activities many decisions are made, but it requires the passage of time to bring to light those decisions which can be looked back upon as being highly significant. The radio navigation discipline is no exception to this observation. Recently, the U.S. Government has made a number of pivotal decisions which will affect long range radio navigation for many years to come. Along with these decisions comes a challenge and a responsibility to non-government controlled organizations, such as the Institute of Navigation, the Wild Goose Association (Loran-C) and the International Omega Association. The United States Government, because of its very position, cannot fully address this responsibility. Today, I would like to discuss with you my reasoning behind this statement and what, in my opinion, we should be doing to get the best out of long range radio navigation for the foreseeable future.

The following papers were presented at the Fifth Wild Goose Association, Washington, DC, October 1976:

Automation of Loran-C Chain Control	R.H. Frazier, J.T. Doherty, U.S. Coast Guard
Coastal Survey in Africa Using Loran-C	R. Marshall, G. Macdonald, R. Bryant, Canadian Hydrographic Service
Loran-C and the 200-Mile U.S. Territorial Limit	Bahar J. Uttam, Radha R. Gupta, TASC
Loran-C User Equipment, Airborne and Shipborne Navigation and Position Reporting Equipment	F.J. Chambers, Teledyne Systems Company
Forest Service Needs for a Precision Navigation System for Spray Aircraft	Tony Jasumback, USDA Forest Service Equipment Development Center
Loran-C Conceptual Analysis	C.W. Mosher, M. Abrams, J.C. Murdock, N.Y. State Traffic Records Project, W.L. Polhemus, F.H. Raab
Flight Testing a Low Cost Airborne Loran-C Navigation System	CDR R.H. Cassis, Jr. U.S. Coast Guard, Office of Research & Development

NOTE: The following presentations were made with the agreement that no paper would be submitted for publication:

U.S. Loran-C Implementation: Status Report	LCDR James L. Walker U.S. Coast Guard
Loran-C: New Tool for Ocean Law Enforcement?	LCDR James L. Walker U.S. Coast Guard
Airborne Navigation Needs for Insect Control	Arthur Gieser U.S. Department of Agriculture

LORAN ASSOCIATED BUSINESSES

The following is a list of businesses which relate to Loran interests. Every effort was made to ensure that no one was left off the list, however the response to our newsletter request for company names, contacts, and brief descriptors was poor. When no response was received, we attempted to get the information by letter or phone. If this was unsuccessful, we named a WGA member employed by the company as a contact and then made up as good a descriptor as possible within our knowledge. Anyone desiring to add, change, or delete a listing in the next edition of the Journal should contact the Editor as soon as possible.

Advanced Marine Electronics Inc.
5014 West Grace Street
Tampa, FL 33607

Advanced Technology Systems
2425 Wilson Blvd.
Arlington, VA 22906

Aerospace Systems, Inc.
One Vine Brook Park, Suite 202
Burlington, MA 10803
John Zvara, 617-272-7517
Analysis, computer simulation and flight test of navigation, guidance, control and display systems.

Amecom Div. Litton Systems Inc.
5115 Calvert Road
College Park, MD 20720
Norman C. Dickerson, 301-864-5600
Development and manufacture of electronic systems including radionavigation transmitting and receiving systems.

Analytical Systems Engineering Corp.
Old Concord Road
Burlington, MA 01803
James W. Henderson, 617-272-7910
Provide systems engineering services in the fields of communication and navigation.

Austron, Inc.
1915 Kramer Lane
Austin, TX 78758
P. B. Mabry, 512-836-3523

Aviation Electric Co. Ltd.
200 Laurentian Blvd.
Montreal, P.Q.
D. Garbutt

Bendix Corporation
Navigation and Control Division
Teterboro, NJ 07608
L. Ranch

Beukers Laboratories, Inc.
30 Orville Drive
Bohemia, NY 11716
John M. Beukers, 516-567-5100
Development and manufacture of radiosonde and radionavigation specializing in retransmission and remote tracking.
Attn: Walter Lewis

Cambridge Engineering
P.O. Box 66
Cambridge, VT 05444
Martin C. Poppe, Jr., 802-644-5196
Electronic Systems, consultation and development.

Canadian Marconi Co.
Marine and Land Communication Div.
2442 Trenton Avenue
Montreal 301, P.O. Canada
Robert Tanguay, 514-341-7630

Collins Radio Company
Dallas, TX 75207
Fred J. Spencer, 214-690-5193
Manufacture and sales of airborne radio equipment, including the AN/APN - 199 Loran-C receiver.

Communications Associates, Inc.
200 McKay Road
Huntington Station, NY 10801
Gerald A. Gutman, 516-271-0800
Manufacture and sales of marine communications and navigation systems.

CRDL
P.O. Box 1056
Boulder, CO 80302
Robert Doherty
Consultants in radiowave propagation.

Dahl Loran Service
46 No. Water Street
New Bedford, MA 02740
Harold Dahl, 617-997-7961
Loran sales and service for vessels and aircraft, consultant for users and manufacturers.

Decca Survey Systems, Inc.
P.O. Box 22397
Houston, TX 77027
C.D. Paget-Clarke, 713-783-8220
Radionavigation services for hydrographic survey.

Develco Inc.
404 Tasman Drive
Sunnyvale, CA 94086

Digital Marine Electronics Corporation
Civil Air Terminal
Bedford, MA 01730
Charles J. Malaquias, Jr., 617-274-7130
Manufacturer and distributors of fully automatic Loran-A and Loran-C receivers.

EDO-AIRE
Division of EDO Corporation
216 Passaic Avenue
Fairfield, NJ 07006
Dick Pasciati, 201-228-1880
Aircraft Flight and Engine Instruments, Flight Control Systems, loran, VOR/DME/ILS Ground Nav Aids, R-Nav, Solid-State Chronometers.

E-Systems, Inc.
P.O. Box 6030
Dallas, TX 75222
Johnnie Walker, 617-861-9050
Intelligence/Recce, command/control, electronic warfare, communications, guidance, controls and navigation, aircraft overhaul and modification.

EPSCO, Inc.
411 Providence Highway
Westwood, MA 02090
Bernard Ambroseno, 617-329-1500
Manufacture of electronic systems including Loran-C receivers, simulators, and guidance devices.

Electro-Nav, Inc.
1201 Corbin Street
Elizabeth Marine Terminal
Elizabeth, NJ 07201
Sales, service and installation of marine electronic systems.

Robert L. Frank
16500 North Park Drive, Apt. 720
Southfield MI 48075
Tele: 313-559-8208
Electronic systems consultant.

Gem Marine Products, Inc.
356 South Boulevard
Lake City, SC 29560
L. Haynes, 803-394-3565

G. E. - TEMPO
816 State Street
Santa Barbara, CA 93102

Griffith Marine Navigation Inc.
134 North Avenue
New Rochelle, NY 10801
Ray Yturraspe, 212-828-5524
Sales, service and installation for VHF radio telephone, radar, depth sounders, loran, Omega wind and speed instruments and autopilots.

HPL Engineering
49 Cleopatra Drive
Ottawa, Ontario, Canada
C.B. Jefferies
Radionavigation system studies and equipment sales.

Hartman Division of ATO Inc.
360 Wolfhill Road
Huntington Station, NY 11746
Robert Romandetto
Development and production of electronic systems.

Integra
P.O. Box 455
Cupertino, CA 95014
Werner Schuerch, 408-252-1495
Consulting services, development and manufacturing of special navigation equipment.

Internav Inc.
65 Wiggins Ave.
Bedford, MA 01730
John Currie, 617-275-2970
Development and manufacture of radionavigation, monitor, survey, and timing receivers for Loran-C.

ITT Avionics Div.
100 Kingsland Road/390 Washington Ave.
Clifton, NJ 07014 /Nutley, NJ 07110
James Van Etten
Development and manufacture of electronic systems including radionavigation transmitting and receiving systems.

R. A. Isberg
1215 Henry Street
Berkeley, CA 94709
Consulting Engineers

Krupp Atlas-Electronick
Div. of Krupp International Inc.
P.O. Box 58218
Houston, TX 77058

Lear Siegler, Inc.
Instrument Division
4141 Eastern Ave., SE
Grand Rapids, MI 49508
H.R. Walton, 616-241-8651
Designs and builds complex modular digital avionics systems to solve navigation, weapon delivery and reconnaissance problems.

The Magnavox Company
Fort Wayne, IN 46802
W.N. Dean, Sr., Staff Engineer
Manufacturers of AN/BRN-5 Loran Receiver for Poseidon/Trident Submarines, AN/FRQ-17 transmitter control set (Clarinet Pilgrim) R-1663/UR digital data receiver.

Marinav Corporation
1140 Morrison Drive
Ottawa, Ontario K2H 859
P. C. Wilson, 613-820-6600
Navigation systems and support services.

Megapulse, Inc.
8 Preston Ct.
Bedford, MA 01730
Edward L. McGann, 617-275-2010
Development and manufacture of Loran-C and D transmitting equipment.

Micrologic, Inc.
9436 Irondale Ave.
Chatsworth, CA 91311
Calvin Culver, 213-998-1216
Manufacturer of commercial marine Loran-C receivers, featuring automatic operation with direct ranging and secondary only operation.

MIECO, Division of Polarad Electronics Corp.
109 Beaver Court
Cockeysville, MD 21030
S.R. Berger, 301-667-4660
Manufacturer of Loran-A and C receivers, Omega receivers, and telephone and voice scramblers.

MITRE Corporation
P.O. Box 208
Bedford, MA 01730

Morrow Electronics-International, Inc.
P.O. Box 7064
4740 Ridge Drive NE
Salem, OR 97303
Robert D. Morrow, Jr., 503-393-2550
Manufacturers of Loran-A and C receivers with manual and automatic tracking.

Nautical Electronics Company, Inc.
7095 Milford Industrial Road
Baltimore, MD 21208
David A. Hutzler, 301-484-3284
Manufacturers of Loran-A and C cycle matching receivers.

Navigation Systems, Inc.
8841 Monard Drive
Silver Spring, MD 20910
Carl Andren
Development and manufacture of airborne and marine radionavigation equipment including Loran-C.

Offshore Navigation Inc.
P.O. Box 23504
Harahan, LA 70183
Bill Marchall
Radionavigation services for hydrographic survey.

Plessey Radar Ltd.
Addlestone
Weybridge, Surrey KT152PW
England
A.M. Patrick, Weybridge 47282
Manufacture and sales of marine communications navigation and radar systems.

Polhemus Associates
P.O. Box 101
Jeffersonville, VT 05464
William L. Polhemus, 802-644-5020
Consultant in navigation and guidance systems

Promar
P.O. Box 22133
Tampa, FL 33622

Redifon Limited
P.O. Box 451
Carlton House
Lower Regent Street
London SW1Y4LS England
W. Blanchard, Tele: 01-874-7281
Manufacturer and sales of marine communications and navigation systems.

Ross Marine Electronics
416 Commercial Street
Portland, ME

Satellite Positioning Corp.
6614 Hornwood Drive
Houston, TX 77036

Simard, Inc.
One Labriola Court
Armonk, NY 10504
Gilbert N. Nelson 914-273-9410
Exclusive U.S. distributors of all Loran-C products manufactured by Internav, Inc. of Bedford, Massachusetts. Distributors of echosounders and sonar manufactured by parent company, Simrad as of Oslo, Norway.

Singer-Kearfott
150 Totowa Road
Wayne, NJ 07470
Development and manufacture of navigation and guidance systems.

Spears Associates, Inc.
188 Needham Street
Newton, MA 02164
M.F. Spears, 617-965-2800
ELF/VLF/LF communications and navigation techniques for extremely sensitive reception.

Sperry Gyroscope
Great Neck, NY 11020
Robert Smith, 516-574-2921

Sperry Systems Management
Marcus Road
Great Neck, NY 11020
Design and management of electronics systems.

SRD Labs
645 McGlincey Lane
Cambell, CA 95008
Bruce G. Gato, 408-371-2666
Manufacturers of manual, tracking and fully automatic Loran-A and C receivers primarily for fishboat, workboat and pleasure craft industry.

Systems Control, Inc.
1801 Page Mill Road
Palo Alto, CA 94304
Fred Karkalik, 415-494-1165
Application of digital computers and modern analysis techniques to complex systems problems.

Telcom, Inc.
8027 Leesburg Pike
Vienna, VA 22180
L.P. Tuttle,
Specializing in low-cost Loran-C receivers, telecommunications systems and engineering consulting services, nationally and internationally.

Teledyne Systems Company
19601 Nordhope Street
Northridge, CA 01324
L. Speelman, 213-886-2211, Ext. 22080
Development and manufacture of communication, navigation, and data processing electronics systems.

Texas Instruments, Inc.
P.O. Box 6080
Dallas, TX 75222
Manufacturer of consumer electronic products, including Loran-C receivers.

The Analytic Sciences Corporation
6 Jacob Way
Reading, MA 01867
James L. O'Hare, 617-944-6850
Applied research in navigation, guidance, and control, in defense, space and public systems.

Tracor, Incorporated
65000 Tracor Lane
Austin, TX 78721
Harry L. Thomas, 512-926-2800
Development and manufacture of electronic systems for navigation and frequency measurement.

TRW, Inc.
3 New England Executive Park
Burlington, MA 01803
B.H. Evans
Electronic system design and management.

Watkins Associates
P.O. Box 205
North Dayton Station
Dayton, OH 45404
Billy J. Watkins, 513-236-2330
Provides representative/marketing consultant services to avionics companies interested in DOD programs.

Western Geophysical
Box 2469
Houston, TX 77001
Radionavigation services for hydrographic survey

Vernon I. Weihe Consulting Service
4133 North 33rd Road
Arlington, VA 22207
703-527-5146

CONSTITUTION

ARTICLE I

NAME

The name of this association shall be the "Wild Goose Association, "hereinafter referred to as the "Association."

ARTICLE II

AIMS AND PURPOSES

The Wild Goose Association is formed to provide an organization for individuals who have a common interest in loran and who wish to foster and preserve the art of loran, to promote the exchange of ideas and information in the field of loran, to recognize the advances and contributions to loran, to document the history of loran, and to commemorate fittingly the memory of fellow Wild Geese.

ARTICLE III

COMPOSITION OR NATURE

The Association shall be composed of individuals who concur in the aims and purposes of the Association and shall not be used for the dissemination of partisan principles, nor for the promotion of the candidacy of any person seeking public office or preferment, nor for promotion of any commercial enterprise.

ARTICLE IV

MEMBERSHIP

SECTION I. MEMBERSHIP. There shall be five (5) classes of membership; regular, honorary, life, associate and corporate. Any individual or organization that has an interest in the field of loran is eligible for membership. Application shall be presented to the Board of Directors or its delegated representative and action to accept or reject the application shall be completed within three (3) months from receipt by the Association.

SECTION 2. REGULAR MEMBER. A regular member is a person whose application has been accepted and elects to pay regular membership dues annually. The right to vote, hold office and serve as chairman or members of committees shall be extended to regular members in good standing.

SECTION 3. HONORARY MEMBER. Honorary membership may be awarded by the Board of Directors to an individual who has made an outstanding contribution to loran. Not more than two persons may be awarded honorary memberships in any one calendar year. An honorary member shall be entitled to all privileges of regular membership except that he shall not have the right to vote or hold office, unless he elects to meet the requirements of regular membership in addition to his honorary membership. Honorary membership shall continue for life unless revoked by the Board of Directors.

SECTION 4. LIFE MEMBER. A life member is a person whose application has been accepted and elects to pay in advance the life membership dues. Such a person shall be a member for life without further payment of annual dues. A life member in good standing shall be entitled to all the privileges and rights of regular membership.

SECTION 5. ASSOCIATE MEMBER. An associate member is an organizational unit, such as a library, whose application has been accepted. Associate members shall receive the publications of the Association and other printed matter having potential interest to non-members. Associate members shall not have the privilege to vote or hold office.

SECTION 6. CORPORATE MEMBER. A corporate member is an organizational unit whose application has been accepted. There shall be two (2) classes of corporate members. Class 1 shall include organizations operated for a profit which have 500 or more employees on the first day of the current calendar year. Class 2 shall include the following:

- Organizational units of a government
- Educational institutions or units thereof
- Bona Fide non-profit organizations
- Organizations operated for profit that have less that 500 employees on the first day of the current calendar year.
- Divisions of corporations that are Class 1 members

A corporate member shall have the privilege of nominating its employees for acceptance as members who shall be extended all the privileges of regular membership. Those accepted shall not exceed then (10) for a Class 1 corporate member or five (5) for Class 2.

ARTICLE V

MEMBERSHIP FEES AND DUES

SECTION 1. PURPOSE. To provide funds for operating the Association, Dues and Fees may be established to cover the expenses.

SECTION 2. DUES. Annual and Life Membership Dues shall be established by the By-Laws to this Constitution. Annual dues shall apply to the calendar year.

SECTION 3. FEES. Initiation fees may be established by the By-Laws. Special fees may be assessed equally against each regular and life member by the Board of Directors to cover extraordinary expenses. In such instances, special fees shall be assessed against corporate members at ten times the regular member rate for Class 1 and five times for Class 2.

SECTION 4. FISCAL YEAR. The fiscal year shall be established by the By-Laws.

ARTICLE VI

OFFICES AND DIRECTORS

SECTION 1. OFFICERS. The officers of the Association shall be President, Vice-President, Secretary, and Treasurer. All officers shall be members of the Association in good standing.

SECTION 2. ELECTED OFFICERS. The President shall be elected by the Membership of the Association to serve for a period of one (1) year and thereafter until his successor is duly chosen. No person may be elected to the office of President for more than two (2) consecutive terms.

SECTION 3. APPOINTED OFFICERS. The Vice-President, Secretary, and Treasurer shall be appointed by the elected President. The appointments shall be made from among the elected Directors of the Association, and they shall serve for a period of one (1) year and thereafter until their successors have been chosen for the new presidential term.

SECTION 4. ELECTED DIRECTORS. There shall be twelve (12) elected Directors and they shall be elected for a period of three (3) years. One-third (1/3) of the total membership of elected Directors shall be elected each year. The initial Directors shall be designated as one (1) year, two (2) year, and three (3) year Directors, to allow for the election of one-third (1/3) of the Directors each year. Term of office to be served by the initial groups of Directors shall be determined by drawing lots by the founding Directors. All Directors shall be members of the Association in good standing.

SECTION 5. VOTING. Only members eligible to vote and in good standing at the time of ballot counting shall exercise the right of voting. Voting shall be by mail, and the annual election shall be held as prescribed in the By-Laws.

SECTION 6. VACANCIES

a. Vacancies occurring among elected officials between the time of the annual election and the start of the term of office shall be filled by the candidate or candidates for the office next in line according to votes received.

b. Vacancies occurring among elected officials after the start of the term of office shall be appointed by the Board of Directors.

SECTION 7. APPOINTED DIRECTORS. By action of a majority of the Elected Directors, a maximum of three members in good standing may be appointed from the membership of the Association to serve as Appointed Directors for a term of office of one (1) year. Such appointments shall be for the purpose of providing representation on the Board of Directors from new and developing areas of loran activity where membership in the Association has not developed sufficiently to reasonably expect that representation would accrue by elected Directors.

ARTICLE VII

ORGANIZATION AND POWERS

SECTION 1. BOARD OF DIRECTORS. The Board of Directors shall be composed of the President of the Association, the twelve (12) elected Directors of the Association, the appointed Directors of the Association, and the Immediate Past President of the Association.

SECTION 2. BOARD POWERS. The Board of Directors shall be the highest ruling authority of the Association, and shall be responsible for the general management of the affairs of the Association. The Board shall be empowered to enact By-Laws, to incur obligations for which the Association is responsible, to appropriate funds, and to issue directives to officers or committees consistent with the Constitution and By-Laws. The Board shall enact By-Laws to establish any regulation that has a direct and enduring effect on the Membership.

SECTION 3. EXECUTIVE COMMITTEE. The Executive Committee shall consist of the President, Vice-President, Secretary and Treasurer.

SECTION 4. EXECUTIVE COMMITTEE POWERS. The Executive Committee shall be the executive arm of the Board of Directors, empowered to administer the affairs of the Association in accordance with the policies, resolutions, and directives of the Board. The Executive Committee shall not be empowered to enact By-Laws. The Committee shall be empowered to incur obligations for which the Association is responsible and to appropriate funds consistent with policy established by the Board of Directors, and with the Constitution and By-Laws. The Executive Committee shall be accountable to the Board of Directors for its actions.

SECTION 5. PRESIDENT. The President shall be the chief executive officer of the Association.

SECTION 6. POWERS OF THE PRESIDENT. The President shall be empowered to act on his own initiative in managing the affairs of the Association. Actions of the President shall be consistent with management policy established by the Board of Directors, with commitments and appropriations of the Board and Executive Committee, and with the Constitution and By-Laws. The President shall be accountable to the Board for his actions.

ARTICLE VIII

ANNUAL CONVENTION

The Convention shall be held annually at a time and place fixed by the Board of Directors and in accordance with the By-Laws.

ARTICLE IX

STANDING COMMITTEES

The Association may provide by its By-Laws for such Standing Committees as may be deemed necessary. The President, annually, shall appoint the Chairman of each Committee.

ARTICLE X

SPECIAL COMMITTEES

Either the Association's Membership, duly assembled, or the Board of Directors or President may create special Committees and define their respective powers and duties.

ARTICLE XI

DISCIPLINE

SECTION 1. ACTION, HOW TAKEN. The Board of Directors, after notice and a proper hearing, may by majority vote suspend or revoke the membership privileges of any Member.

SECTION 2. CAUSES FOR ACTIONS. Any member of the Association may be suspended or expelled for misconduct reflecting unfavorably upon the Association.

SECTION 3. MEMBER STANDING. A Member shall be in good standing if all dues and fees are paid for the current calendar year and membership has not been suspended or revoked. The membership of members whose dues remain unpaid for two consecutive calendar years shall be revoked.

ARTICLE XII

AMENDMENTS

SECTION 1. The Constitution may be amended by a two-thirds (2/3) majority of the votes cast.

SECTION 2. Proposed changes shall be placed on a ballot and mailed to the membership after approval by the Board of Directors.

ARTICLE XIII

AWARDS

Awards for significant contributions in furtherance of the aims and purposes of the Wild Goose Association may be authorized by appropriate provision in the By-Laws.

ARTICLE XIV

REGIONAL CLUBS

Regional clubs in furtherance of the aims and purposes of the Wild Goose Association may be organized as authorized by appropriate provision in the By-Laws.

ARTICLE XV

PUBLICATIONS

Publications that serve to further the aims and purposes of the Wild Goose Association may be organized as authorized by appropriate provision in the By-Laws.

BY-LAWS

ARTICLE I

OFFICERS

SECTION 1. PRESIDENT. The President shall exercise the powers and perform the duties assigned to him by the Constitution and By-Laws. He shall be Chairman of the Board of Directors. He shall generally supervise the management of the affairs of the Association. He shall enforce the provisions of the Constitution and By-Laws, and be guided by the will of the Annual Convention. He shall preside at the Annual Convention. He shall appoint all necessary committees and shall perform such other duties as are usually incident to the office.

SECTION 2. VICE PRESIDENT. The Vice President shall preside in the absence or disability of the President. The duties of the Vice President shall be such as may be assigned by the President.

SECTION 3. SECRETARY. The Secretary shall keep a record of the proceedings of the Board of Directors and the Executive Committee, of annual meetings of the Association, and of all other matters of which a record shall be ordered by the President, the Board of Directors, the Executive Committee, or the Association. He shall perform such other duties as may be assigned to him by the Constitution and By-Laws of the Association, the President, the Executive Committee and the Board of Directors, and shall perform such other duties as are usually incident to the office.

SECTION 4. TREASURER. The Treasurer shall collect and disburse all funds of the Association and be the custodian of such funds. He shall keep regular accounts on the Association's fiscal year basis in the books belonging to the Association. He shall make annual reports at each National Convention upon the condition of the Treasury and at such other times as shall be required by the Board of Directors or by the President. He shall perform such other duties as may be assigned to him by the Constitution and the By-Laws of the Association, and shall perform such other duties as are usually incident to the office.

ARTICLE II

BOARD OF DIRECTORS AND EXECUTIVE COMMITTEE

SECTION 1. BOARD MEETINGS. The Board of Directors shall meet at such times and places as shall be designated by the President. The Secretary shall call a special meeting upon the written request of five (5) or more members of the Board. The Secretary shall notify all directors of each meeting in advance.

SECTION 2. QUORUM. Seven (7) Directors or Alternates present shall constitute a quorum of the Board of Directors. Alternates counted for a quorum shall not exceed two. If a quorum is present for a meeting, decisions of the Board made by majority vote including absentee ballots shall be binding. If the number of members present is less than a quorum, the meeting may be held and business conducted as if a quorum were present, but no actions shall be binding until ratified by a majority of the entire Board of Directors obtained by written ballot.

SECTION 3. EXECUTIVE COMMITTEE MEETINGS. The Executive Committee may meet for the conduct of the affairs of the Association at times and places that are mutually agreeable to its members. Alternatively, the Executive Committee may conduct its affairs by telephone conferences and/or written communications. Actions taken by the Executive Committee shall be consistent with the consensus of all its members.

SECTION 4. ALTERNATES AND PROXY. A Director unable to attend a Board meeting may appoint an alternate to attend that meeting. An alternate may vote on any matter brought to vote during the meeting provided the alternate is a member in good standing of the Association and provided a signed written proxy assignment to the alternate is in the hands of the Secretary of the Association prior to the meeting.

SECTION 5. ABSENTEE BALLOT. A Director who is to be absent from a Board meeting and is not represented by an alternate may vote by written absentee ballot on questions posed by the meeting agenda. Only absentee ballots that are in the hands of the Secretary of the Association prior to the meeting shall be counted.

SECTION 6. REMOVAL. A Director may be removed from office for lack of participation in the affairs of the Board after a hearing by the Board and upon an affirmative vote of two-thirds (2/3) of the members of the Board of Directors.

ARTICLE III

STANDING COMMITTEES

SECTION 1. AUTHORIZED COMMITTEES. The Standing Committees of the Association shall be as follows:

Audit Committee
Awards Committee
Constitution Committee
Convention Committee
Historical Committee
Journal Committee
Membership Committee
Nominating and Election Committee

SECTION 2. CHAIRMEN OF STANDING COMMITTEES. The President shall appoint the chairman of each committee from members in good standing. Members of the Board of Directors should be selected for chairmen of committees where they can be effective; however, their selection is not mandatory unless specifically required by these By-Laws.

SECTION 3. MEETINGS. Each Standing Committee shall hold meetings at such times as may be specified, after due notice to its members, by its Chairman, by the President of the Association, or upon the request in writing of a majority of its members. Alternatively, the Standing Committees may conduct their affairs by telephone and/or written communications. Committee actions shall be consistent with the consensus of all its members unless member participation is prevented by abnormal circumstances.

SECTION 4. REPORTS. Each Standing Committee shall keep a record of its proceedings and shall make a written report of its activities to the Secretary of the Association.

SECTION 5. REMOVAL. Any member of a Standing Committee may be removed from office by the Committee Chairman with the concurrence of the President, or by the written request of two-thirds (2/3) of the committee members.

SECTION 6. DUTIES. Each Standing Committee shall be charged with the duties assigned to it by the Constitution and By-Laws of the Association or by the President or Board of Directors and shall perform such other duties as are usually incident to committees of its particular function. Any question which may arise as to the jurisdiction of a Committee shall be determined by the President.

SECTION 7. APPROPRIATIONS. The Chairman of any Committee may make application to the Board of Directors or the Executive Committee for appropriations of funds for the work of such Committee. No committee shall have authority to incur any indebtedness or pecuniary obligation for which the Association shall be responsible except to the extent previously authorized by the Board of Directors, or by the Executive Committee.

ARTICLE IV

NOMINATING AND ELECTION COMMITTEE

SECTION 1. CHAIRMAN. The chairman shall be a member of the Board of Directors.

SECTION 2. MEMBERSHIP. The chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. NOMINATIONS. Nominations to any office to become vacant may be made to the Committee in writing by any member of the Association, provided it is accompanied by a short biographical sketch of the person to be nominated, suitable for release to the general membership and a complete but concise justification for nomination.

SECTION 4. SELECTION.

a. The Nominating and Election Committee shall solicit and review all nominations and shall select not less than two (2) nor more than five (5) candidates for President, and not less than eight (8) nor more than twelve (12) candidates for the Board of Directors.

b. The Chairman of the Committee shall submit the Nominating and Election Committee nominations to the President of the Association for Board of Directors action not later than 1 April of each year.

c. The Board of Directors shall review the nominations of the Committee and may add or delete candidates. The Board of Directors shall approve a slate of candidates and the Committee Chairman shall prepare and distribute mail ballots to all members other than Honorary Members regardless of standing.

SECTION 5. ELECTIONS.

a. Ballots shall allow write-in votes for all offices. Ballots shall be mailed to the membership between the first (1) and thirty-first (31) of May and only those ballots received in the Association mail box by 1400 on the thirtieth (30) of June from members in good standing at the time of receipt shall be counted. Ballots shall be returned in the ballot envelopes provided, and they shall not be opened prior to close of the election on thirty (30) June, and then only at such time and place as there are three (3) members of the Nominating and Election Committee present.

b. Results of the election shall be provided to the Secretary of the Association not later than fifteen (15) July. Results shall show each candidate and the number of votes received. The results shall be certified by the three Committee members present for the counting.

c. The Nominating and Elections Committee shall establish the validity of ballots and shall exercise the discretion necessary to resolve voting discrepancies. Offices shall be filled by candidates who are selected in succession from the start of a list of candidates ranked in order of decreasing number of votes received.

d. Immediately after counting, the ballots shall be delivered to the Secretary. The ballots shall remain in the Secretary's jurisdiction for possible recount until after the next Annual Convention, at which time they shall be destroyed.

ARTICLE V

AUDIT COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association who is not an Officer or a Director of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint two (2) members of the Association who are neither Officers nor Directors to serve on the Committee.

SECTION 3. DUTIES. The Audit Committee shall audit the accounts of the Association during the last two weeks of August. The Chairman shall submit a written report of the Committee findings to the Board of Directors prior to the Annual Convention. After approval by the Board of Directors, this report shall be distributed to the membership.

ARTICLE VI

CONVENTION COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. DUTIES. The Convention Committee shall pland and conduct an Annual Convention in September or October of each calendar year at a place and date approved by the Board of Directors. Installation of all officers shall take place at this convention.

ARTICLE VII

MEMBERSHIP FEES AND DUES

SECTION 1. FEES AND DUES. Fees and dues shall be paid on the following basis:

a. Initiation Fee shall be $10.00 for Regular Members, $30.00 for Associate Members, $220.00 for Corporate Members Class 1 and $110.00 for Corporate Members Class 2. This fee shall include dues for the first year. An initiation fee paid after the eighth month of the calendar year shall also cover dues for the next calendar year.

b. Regular Membership dues shall be $7.50 per year.

c. Honorary Members shall be exempt from all Fees and Dues.

d. Life Membership fee shall be $100.00. No initiation fee shall be required in case of Life Membership.

e. Associate Membership Dues shall be $25.00 per year.

f. Corporate Membership Dues shall be $200.00 per year for Class 1.

g. Corporate Membership Dues shall be $100.00 per year for Class 2.

h. The annual dues are payable in advance on 1 January.

SECTION 2. NONPAYMENT. Any member whose annual dues are unpaid on 1 April shall be considered in poor standing until the dues are paid.

ARTICLE VIII

AMENDMENTS

SECTION 1. The By-Laws may be amended with the concurrence of two thirds (2/3) of the members of the Board of Directors.

SECTION 2. Members of the Board shall be provided a copy of all proposed changes and given thirty (30) days after date of mailing to respond. Yeas and Nays shall be recorded by the Secretary, including each member's vote.

ARTICLE IX

AWARDS COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. DUTIES. The Awards Committee shall be responsible for administering the Awards Program of the Association in accordance with the Constitution and By-Laws. The Committee shall prepare a report describing the authorized awards and detailing criteria and procedures for nomination and selection. After approval by the Board of Directors, this report shall be distributed to the membership.

ARTICLE X

CONSTITUTION COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. DUTIES. The Constitution Committee shall be responsible for proper preparation and administration of proposed changes to the Constitution for presentation to the membership, and proposed changes to the By-Laws for presentation to the Board of Directors. Further, the Constitution Committee shall prepare a report detailing procédures for forming Regional Clubs and providing a sample club Charter and Constitution. After approval by the Board of Directors, this report shall be provided on request, to members interested in forming a Regional Club.

ARTICLE XI

AWARDS

SECTION 1. The following non-monetary awards are authorized to further the aims and purposes of the Wild Goose Association:

Medal of Merit:

To be awarded to a person or persons for a particular contribution of outstanding value to the development or fostering of loran. This award shall normally be given only after the exceptional nature of the contribution is clearly recognized.

Paper Award:

To be awarded to a member of the Wild Goose Association for the best paper published on the general subject of loran.

Service Award:

This award will be given to members who distinguish themselves by service to the Wild Goose Association.

President's Award:

To be awarded to the person, persons, or organization as designated by the President of the Association with consent of the Board of Directors. The Award shall be presented at the annual banquet.

ARTICLE XII

REGIONAL CLUBS

SECTION 1. Regional Clubs may be chartered by the Board of Directors to further the aims and purposes of the Wild Goose Association.

SECTION 2. The area of jurisdiction for each club shall be appropriately designated. All Association members in the designated jurisdiction shall be eligible for club membership.

SECTION 3. Members who desire to form a club shall make application for a charter to the Constitution Committee in accordance with the current procedures established by the Committee. The Chairman of the Constitution Committee shall forward the application and proposed Club Constitution with the Committee's recommendations tot he Board of Directors for action. When approved by the Board of Directors, the President of the Association shall issue the Chater. The Charter shall be retained by the Club until such time as the Club may become inactive, at which time the Chater shall be returned to the Assocaition.

SECTION 4. Each Regional Club shall upon issue of the Charter be provided with funds from the Association in the amount of $1.00 per Club member for the purpose of partially defraying the Club operating expenses. Such funds shall be further provided to each active Regional Club on April 1 upon application to and certification by the Membership Committee of the Association as to the current status of membership.

ARTICLE XIII

RADIONAVIGATION JOURNAL

SECTION 1. PURPOSE. To provide to the membership of the Wild Goose Association and to the loran community at large a compendium of current Association and loran information and related topics. It is intended that the Journal will be updated and published annually, closely following the annual elections (approximately July of each year), to provide to the membership an annual report of the significant activities, accomplishments, and objectives of the Association. It is further intended that the Journal will serve the interest of the loran community by providing a compendium of loran information and reference data deemed to be of interest to the community at large.

SECTION 2. JOURNAL COMMITTEE. The Journal Committee shall be constituted to effect the compilation, editing and publication of the Journal. The President of the Association shall annually appoint the Editor of the Journal, who will serve as Chairman of the Committee. The Editor shall appoint not less than two (2) nor more than six (6) members of the Association to serve on the Committee.

SECTION 3. FINANCE. The Journal is intended to be financially self-supporting through the sale of advertising space and copies of the Journal to the loran community at large. The Editor of the Journal may make application to the Executive Committee for the funds necessary to publish a specific issue of the Journal and may make application to the Treasurer for the funds necessary for the administration of the Journal Committee (i.e.: mailings, telephone, etc.). Such application shall be supported by a detailed budget. The Committee shall not have authority to incur any indebtedness or pecuniary obligation for which the Association shall be responsible except to the extent previously authorized by the Executive Committee, or by the Board of Directors.

SECTION 4. CONTENTS. Prior to final editing and publication, the Chairman of the Committee shall submit to the Executive Committee for approval a detailed listing of the contents of the forthcoming issue.

SECTION 5. DISTRIBUTION. At publication, a copy of the Journal shall be provided to each member of the Association at no cost. Copies shall be made available for sale to the loran community at large at prices to be determined by the Chairman of the Committee and approved by the Executive Committee, or Board of Directors.

ARTICLE XIV

HISTORICAL COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. DUTIES. The Historical Committee shall be responsible for recording the history of loran and the history of the Association. After initially preparing a historical manuscript of loran from its beginning to the current calendar year, the manuscript shall be appended annually to record the significant events of the previous year. This same procedure shall be used to record the history of the Association. After approval by the Board of Directors, the manuscript shall be published by the Journal Committee. The Committee shall prepare a report describing the procedures to be used for gathering historical information. After approval by the Board of Directors, this report shall be distributed to the membership.

ARTICLE XV

MEMBERSHIP COMMITTEE

SECTION 1. CHAIRMAN. The Chairman shall be a member of the Association.

SECTION 2. MEMBERSHIP. The Chairman shall appoint an even number of members of the Association, not less than two (2) nor more than six (6), to serve on the Committee.

SECTION 3. DUTIES. The Membership Committee shall be responsible for administering the membership records and affairs of the Association in accordance with the Constitution and By-Laws. The Committee shall review membership applications and provide recommendations to the Board of Directors regarding acceptance. The Committee shall administer the collection of membership dues and shall forward the payments received to the Treasurer. The Committee shall maintain records of current membership including mailing address, type of membership, dues status, and such other considerations as may affect good standing in the Association.

ARTICLE XVI

FINANCES

SECTION 1. FISCAL YEAR. The fiscal year of the Association shall start on the first (1) of September.


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WGA MEMBERSHIP LIST

We have attempted to compile a WGA Membership List and the member's affiliation. To those members included in this list without an affiliation, we apologize. We do not know their current affiliation and would urge them to contact the editorial or membership committee to provide the pertinent information. This list is correct as of 1 May 1977.

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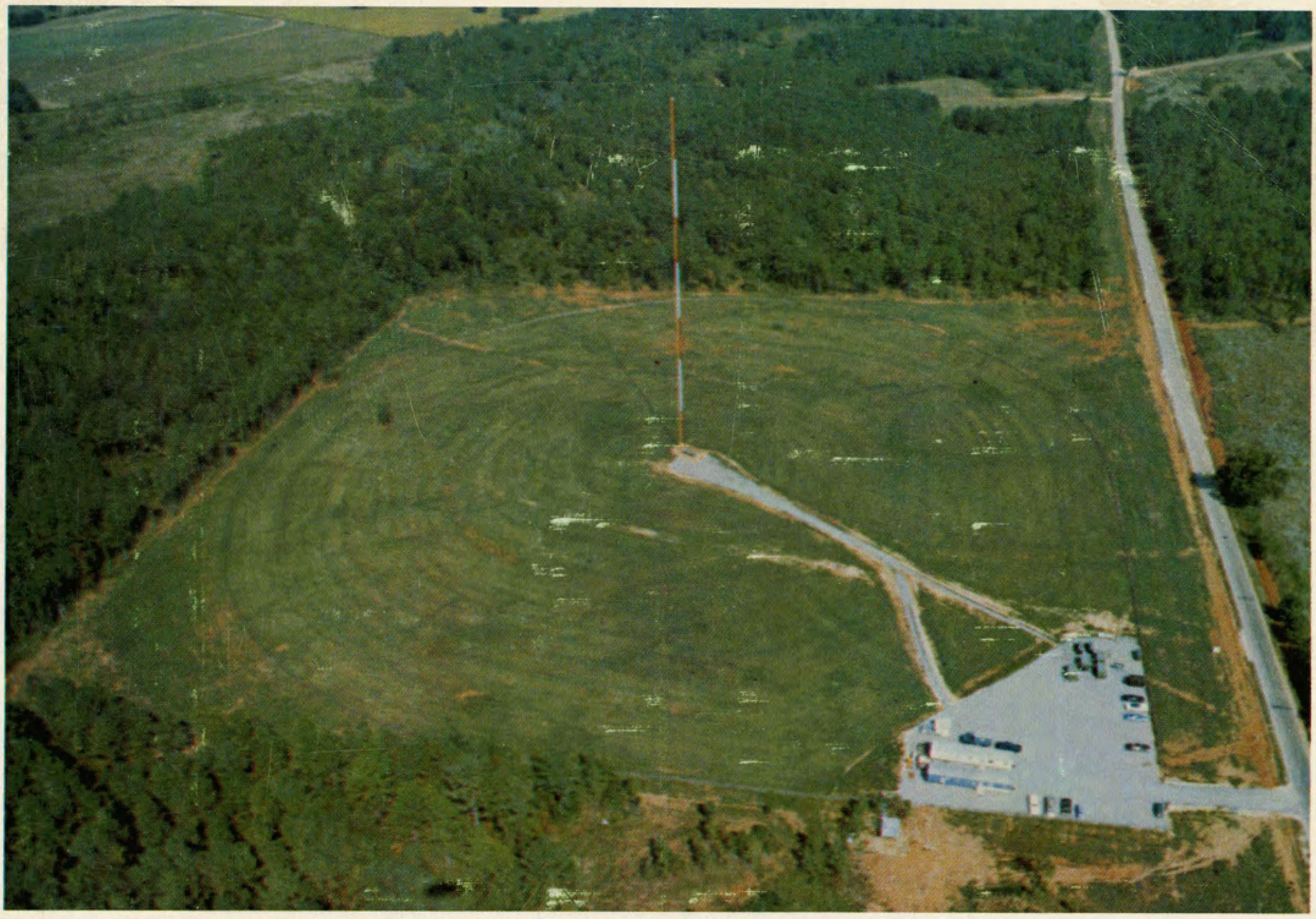

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Wild Goose Association Charter

The Wild Goose Association is formed to provide an organization for individuals who have a common interest in Loran and who wish to foster and preserve the art of Loran, to promote the exchange of ideas and information in the field of Loran, to recognize the advances and contributions to Loran, to document the history of Loran, and to commemorate fittingly the memory of fellow Wild Geese.