

WILD GOOSE ASSOCIATION

RADIONAVIGATION

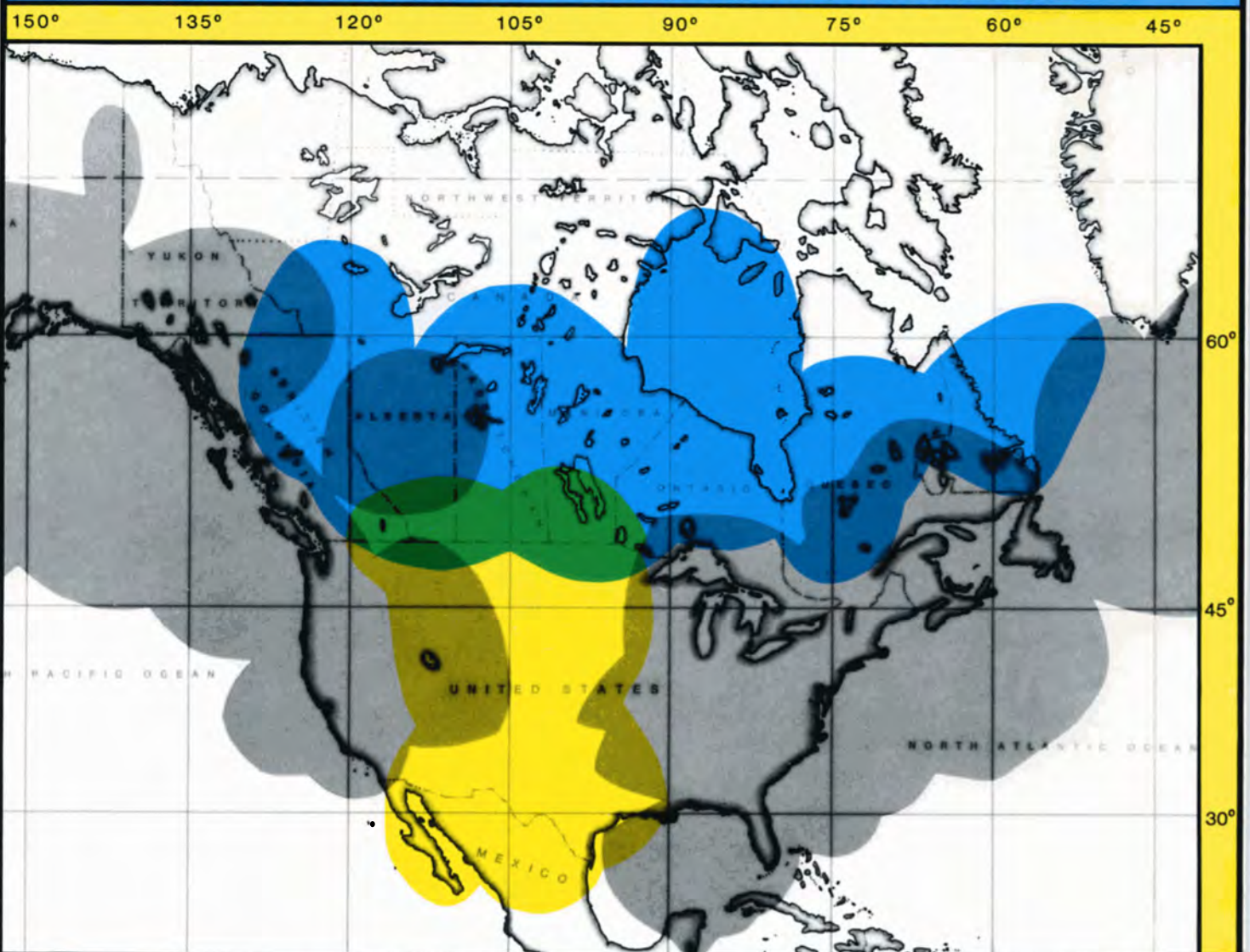
JOURNAL

1985-1986



LORAN-C NORTH AMERICAN EXPANSION

Existing and potential future coverage of Loran-C in North America



CANADA

Proposed Loran-C expansion extends well above 60° north—adding 3.5 million square kilometers to present Canadian coverages.

U.S.A.

Closing the Mid-Continent Gap—completes coast to coast Loran-C coverage: 2 million square kilometers of new coverage area.

Extending the economic and safety benefits of Loran-C in North America:
RNAV, NPA's, SAR, forestry, farming, survey, river navigation, med evac...

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(617) 275-2010 Telex 92-3358 RACAL MEG BFRD

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Association Memberships: Box 556, Bedford, MA 01730
 Advertising: Bernard Ambroseno, 411 Providence Highway, Westwood, MA 02090

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FOREWORD



U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

In June 1986, the Federal Aviation Administration and the United States Coast Guard completed a Memorandum of Agreement that outlined the roles of both agencies for the operation of Loran-C as a radionavigational aid in the National Airspace System. This Memorandum of Agreement was a central accomplishment of a fiscal year during which I had the honor of flying the first nonprecision approach using Loran C (at Hanscom Field Airport in Bedford, Mass., November 4, 1985), and during which I authorized the purchase of 112 Loran-C monitor receivers. We have made substantial progress toward incorporating Loran-C into the National Airspace System, where we expect it to provide valuable navigational assistance to civilian users for the next twenty years.

The monitor receivers installed in fiscal year 1987 will monitor the signal integrity of the United States Coast Guard's Loran-C System, support nonprecision approaches, provide data to forecast changes in Loran-C signal time differences, and provide a data source for notices to airmen (NOTAMS). This equipment will be installed along the eastern and western coasts of the United States at first, but I am fully committed to strengthening radio signals to close the "midcontinent gap." Current plans call for the complete installation of monitors by mid-1988.

Development of effective Loran-C operational procedures has depended upon extensive cooperation throughout the civil aviation community. The FAA has worked closely with Special Committee 137 of the Radio Technical Commission for Aeronautics in its development of Minimum Operational Performance Standards for Loran-C. We have also had excellent cooperation with our early implementation program from the National Association of State Aviation Officials.

Continued strong cooperation from civil aviation users of Loran-C is essential to its effective development within the National Airspace System. Current procedures require two pilots for Loran-C approaches, which overlay an instrument landing system (ILS) approach. One pilot must monitor the ILS localizer, while the other monitors the Loran-C avionics course deviation indicator. Only authorized users are issued Loran-C approaches, and we strongly request feedback from them about their success with each approach. This information is essential to the full development of the system.

The Wild Goose Association has been especially effective in its promotion of Loran-C among potential civil aviation users. I appreciate your ardent support, and I assure you that the FAA remains fully committed to the success of the Loran-C program.

Donald D. Engen
Administrator

EDITOR'S PAGE

EMERITUS. - Our last annual WGA meeting was the occasion of the retirement from the Board of Directors of a gentleman who was the first President of the WGA. Most of us "old Geesers" know him as the founder of the WGA. Through the years, his association with the WGA has been characterized by a career of tireless effort and a wealth of contributions. His work for the WGA has been reflected in the many awards he has earned, most notably the Medal of Merit, the highest award the WGA can bestow. His retirement does not mean that he is stepping down, for he has been deservedly made an Honorary Member. So we'll be seeing Lloyd Higginbotham at future WGA meetings for many years to come.

PRESENT POSITION, AND A LOT MORE. - Loran-C has established a long line of commercial and pleasure craft users throughout the world. One need only to visit a fishing vessel to see the vast amount of Loran-C equipment on board. The Loran equipment has proved essential in providing the excellent navigation required for a successful fishing trip and that feeling of security in knowing where you are precisely at any given moment should it be necessary to require assistance. To the fisherman, the Loran-C receiver of today gives more than the important continuous information of present position. Loran also provides range and bearing to destination, vessel speed, as well as output information for driving autopilots and submarine cable alert systems. Moreover, because of its low cost, Loran-C permits the fisherman and other users to have redundant equipment. Other applications of the Loran-C signal widely used are timing information and vehicle location systems.

ABOUT PHASE(OUT). - For all the praise that Loran-C receives, we still hear the pessimistic talk about "phase out". This gloomy talk is really not new. The following, from the Goose Gazette editorial, at the time of our first annual meeting, indicates how long this has been going on:

"Today having demonstrated superb accuracy and remarkable availability, Loran-C is once again on a low burner and no strong advocate has risen to advance its implementation. Worse yet, Loran-C phase out is being discussed not in terms of why, but in terms of when."

Needless to say, fifteen annual meetings later, talk of "phase out" is still being associated with Loran-C. Surprisingly, as time goes by, another country is added to the service of Loran navigation. Further proof that Loran is here to stay is a recent event of significant



Dr. Lodewijk vanDenBerg

importance to the Loran-C community, which took place at the first FAA-approved IFR non-precision approach, a flight using Loran-C signals at L.G. Hanscom Field in Bedford, Mass.

Looking forward to the next few years, we will see the added coverage in Alaska and the mid-continent United States, as well as the expansion of Canadian Loran-C. Further strengthening Loran-C's position is the installation of a new chain in China, with the likelihood of added chains in that country.

BANQUET SPEAKER. - We were honored at our Santa Barbara Convention to have as guest speaker Dr. Lodewijk vanDenBerg whose talk was both interesting as well as entertaining.

On April 29, 1985, Dr. vanDenBerg, after eight years of research and two years of astronaut training, was rocketed into space aboard the space shuttle Challenger. He was on one of the last successful flights of the Challenger.

Dr. vanDenBerg is an expert in crystalline materials, and his experiments were focussed on growing pure crystals of mercuric oxide from vapor in the weightlessness of space.

Bernard Ambroseno, Editor

PRESIDENT'S PAGE

The theme of the 1986 Technical Symposium in New Orleans, "The Quiet Revolution," is particularly appropriate. The increased interest in Loran being shown by aviation and terrestrial users is gratifying, particularly to us old timers.

Improvements in the U.S. coverage are slowly coming about, first by the dual rating of Port Clarence to provide much needed improved coverage in the Anchorage-Fairbanks area of Alaska. Funding for four new stations to fill the 'mid-continent gap' is in the 1987 budget for the FAA, and planning work by the Coast Guard is under way. The first Loran non-precision approach was inaugurated by the FAA Administrator Don Engen last November, and at least three more have been established since then.

The Peoples Republic of China has one chain being installed and plans to make Loran their national system.

An experimental operating dual rating Sylt to form a triad with the two French stations to cover France, Germany, and the Low Countries, was a technical success, but as of this writing, it has not generated excitement required to make it a permanent arrangement. As in this country, appreciation of the benefits of Loran is slow to find the level of decision makers.

Canadians are also seriously considering adding to the existing coverage to provide navigation up to the 60th parallel. The problems here appear to be other than technical, and WGA members are active in setting the record straight on the benefits of Loran.

In July, the WGA Board of Directors prepared a four-page commentary on the Federal Radionavigation Plan, which I presented at a public meeting in Washington.

The Association's officers, directors, and committees for the current year are listed below and on the opposite page.

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Membership	Jimmy Toms
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As always, we welcome members to join or chair committees. If any member has an interest, please contact the President or any WGA Board Member

Walter N. Dean
President
Wild Goose Association

BOARD OF DIRECTORS 1985-1986

PRESIDENT:

Walter N. Dean
ARNAV Systems Inc.
16100 S.W. 72nd Avenue
P.O. Box 23939
Portland, OR 97223

TREASURER:

David A. Carter
15922 Paisley Lane
Bowie, MD 20716
301-249-5496

VICE PRESIDENT:

James F. Culbertson
15781 Exeter Street
Westminster, CA 92683
714-531-7974

SECRETARY:

Leo Fehlner
118 Quaint Acres Drive
Silver Spring, MD 20904
301-622-0529

James Alexander
3262 Tigertail Drive
Los Alamitos, CA 90720

Lloyd D. Higginbotham
4 Townsend Road
Acton, MA 01720
617-263-8554

Bernard Ambroseno
EPSCO, Inc.
411 Providence Highway
Westwood, MA 02090
617-329-1500

John Illgen
Kaman-TEMPO
816 State Street
Santa Barbara, CA 93102
805-963-6458

A.W. Marchal
Offshore Navigation Inc.
P.O. Box 23504
Harahan, LA 70183
504-733-6790

Vernon L. Johnson
17 Maple Drive
North Caldwell, NJ 07006
201-228-2642

William L. Polhemus
Polhemus Associates Inc.
P.O. Box 5
Cambridge, VT 05444
802-644-5569

James P. Van Etten
230 Rutgers Place
Nutley, NJ 07110
201-661-0876

Edward L. McGann
Megapulse, Inc.
8 Preston Court
Bedford, MA 01730
617-275-2010

Carl S. Andren
3160 Readsboro Court
Fairfax, VA 22030
703-560-2198

William Schorr
4523 Arendale Square
Alexandria, VA 22309
703-360-2046

WGA AWARDS - 1985-1986

THE AWARDS LISTED BELOW WERE PRESENTED AT THE FOLLOWING ANNUAL CONVENTIONS:

	SANTA BARBARA	NEW ORLEANS
MEDAL OF MERIT	1985	1986
<p>THE MEDAL OF MERIT IS AWARDED TO A PERSON OR PERSONS FOR A PARTICULAR CONTRIBUTION OF OUTSTANDING VALUE TO THE DEVELOPMENT OR FOSTERING OF LORAN. THIS AWARD IS NORMALLY GIVEN ONLY AFTER THE EXCEPTIONAL NATURE OF THE CONTRIBUTION IS CLEARLY RECOGNIZED.</p>	<p>JAMES I. MERANDA</p>	<p>R. ADM. ALFRED P. MANNING</p>

SERVICE AWARD

<p>THE SERVICE AWARD IS GIVEN TO MEMBERS WHO DISTINGUISH THEMSELVES BY SERVICE TO THE WILD GOOSE ASSOCIATION.</p>	<p>CARL ANDREN President Wild Goose Association 1984-1985</p>	<p>JOHN D. ILLGEN Chairman, 1985 Convention</p>
	<p>LARRY SARTIN Chairman, 1984 Convention</p>	<p>JAMES F. CULBERTSON Chairman, 1985 Technical Symposium</p>
	<p>ROGER HASSARD Chairman, 1984 Technical Symposium</p>	
	<p>BERNARD AMBROSENO Journal Editor, 1980-1984</p>	
	<p>FRANK RADIN Art Direction and Mechanical Design of Journal, 1982-1984</p>	

PAPER AWARD

<p>THE PAPER AWARD IS GIVEN TO A MEMBER OF THE WILD GOOSE ASSOCIATION FOR THE BEST PAPER PUBLISHED ON THE SUBJECT OF LORAN.</p>	<p>LT. RICHARD J. HARTNETT, USCG and LT. RONALD T. HEWITT, USCG</p>	<p>R.A. DOUGHTY and CDR. WILLIAM K. MAY, USCG</p>
	<p>"The U.S. Coast Guard's Loran-C Remote Operating System"</p>	<p>"Differential Loran-C...Where Do We Really Need It?"</p>

PRESIDENT'S AWARD

<p>FOR HIS ADVOCACY AND ENCOURAGEMENT OF USE OF LORAN-C AS A SUPPLEMENTAL NAVIGATION AND APPROACH SYSTEM IN THE NATIONAL AIR SPACE</p>	<p>DONALD D. ENGEN, R. ADM., USN (RETIRED)</p>
--	--

Wild Goose Association

CITATION on the award of the MEDAL OF MERIT to

JAMES I. MERANDA

The Medal of Merit of the Wild Goose Association is awarded to James I. Meranda in recognition of his extensive contributions to the development and fostering of Loran, including pioneering work on digital microcircuit Loran-C receivers and the reduction of costs by use of hard-limiting signal processing.

As early as 1962, at Sperry Gyroscope Company, he was a major contributor to the digital design of the first digital microcircuit receivers AN/ARN-76, 78, 85, and a few years later the first manpack Loran receiver. He suggested the use of hard limiting in certain areas of the former and all of the latter designs and devised the application details. In his subsequent work at Teledyne, Litcon, Beukers Laboratories and other companies, his ideas were spread in the Loran community, and ultimately were a major contribution to the reduction of costs of commercial receivers. His work is documented by a number of patents and published papers, and many unpublished reports.

The Wild Goose Association gratefully acknowledges these and other valuable contributions which have been a significant factor in the promotion of Loran to the important state it enjoys today.

Awarded this 24th day of October, 1985,

Carl S. Andren

Carl S. Andren, President.



Wild Goose Association

CITATION on the award of the MEDAL OF MERIT to

ALFRED P. MANNING, R. Ada. USCG

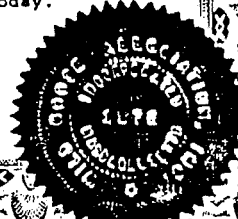
The Medal of Merit of the Wild Goose Association is awarded to Admiral Alfred P. Manning in recognition of his extensive contributions to the fostering of Loran, including improvement of equipment and the deployment and use of the system, over a quarter-century period.

As Lt. Manning, in the late 1950's, he helped instal the first overseas Loran-C chain and then commended it. In successive assignments, at the CG Engineering Center (Wildwood), Activities Europe (London), as head of the Loran-C Branch and later as Chief of Electronics Engineering (CG Headquarters, Washington) in the mid-1970's, he was a driving force in the growth of Loran-C. In addition to many equipment and system improvements to which he personally contributed, his far-sightedness was a major factor in the coastal confluence expansion and in the procurement of the solid state synchronizers and transmitters which contribute so much to the present high performance and relative economy of Loran-C. As a Flag Officer, in his district and headquarters assignments, he has among his many responsibilities, continued to promote the use of Loran-C where applicable.

The Wild Goose Association gratefully acknowledges these activities which have contributed so much to the important state Loran-C enjoys today.

Awarded this 23rd day of October, 1986.

Walter M. Dean
Walter M. Dean, President.



FRENCH LORAN-C WITH POTENTIAL EUROPEAN EXPANSION

Carl Bellinger, Racal Megapulse, Inc.

The photo on the back cover shows the 213 meter antenna and the transmitter building of the Loran-C station at Lessay in northwestern France. This station, with its companion station at Soustons in the south of France, has been operating since June 1985. Together they are part of a sophisticated two-transmitter system--the "Systeme National de Radionavigation"--maintained by the French Navy.

In addition to the transmitter sites at Lessay and Soustons the French Loran-C system includes a "Chain Control Station" at Ile Longue which contains monitoring devices, an extremely accurate master clock, and a computer installation which governs system automation (the transmitter sites are unmanned) and maintains system synchronization. An elaborate synchronization algorithm uses both a satellite-based timing reference and a ground-based cross-monitoring scheme employing 5 atomic clocks. Synchronization to a real time reference is accurate to + or - 50 nanoseconds, and between Lessay and Soustons synchronization is accurate to + or - 30 nanoseconds. The transmitters operate at a

radiated power of 250 kW yielding the coverage area shown in Figure 1. The French system was designed and manufactured by Racal Megapulse Inc., Bedford, Massachusetts.

To date, use of the system has been more or less restricted to operations of the French Navy itself. This is because the two-station, "range-range" configuration requires that each navigating vehicle carry a very expensive Loran receiver with an integral atomic clock. Recently, however, tests have been conducted which combine the signals from the two French transmitters with signals from the Loran Transmitter at Sylt, Germany, part of the Norwegian Sea Chain. For purposes of the test, the Sylt station was dual-rated, allowing it to operate in synchronism with the French and Norwegian chains simultaneously.

Figure 2 shows the expanded European coverage that could result from a multi-national agreement to link the Sylt and the French transmissions. The resulting three-transmitter system would be useable by any vehicle, vessel, or aircraft equipped with a standard Loran receiver.

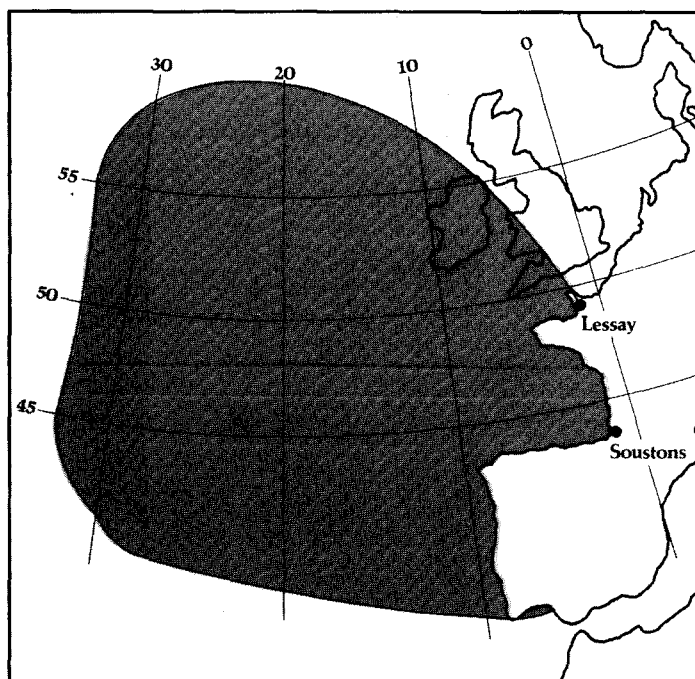


Fig. 1 French Navy Loran-C coverage area

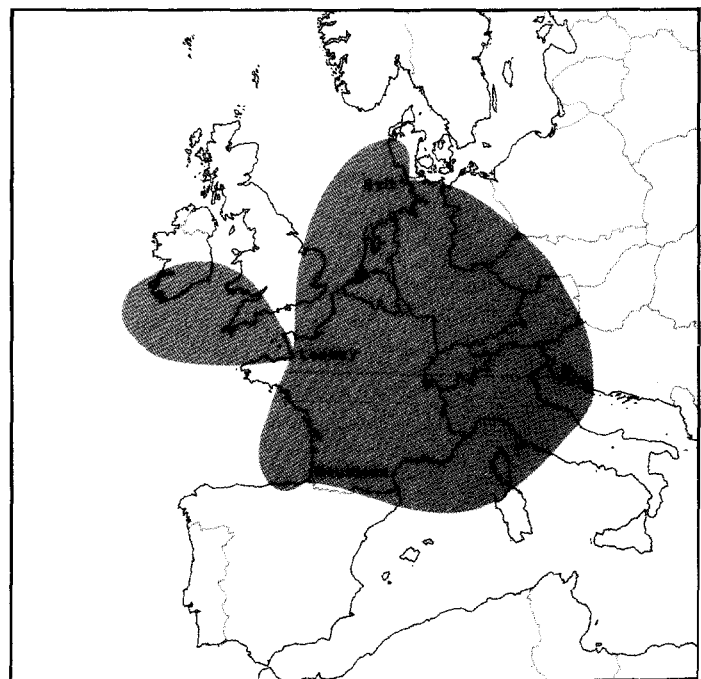


Fig. 2 French + Sylt coverage estimate

First FAA Approved LORAN-C IFR Nonprecision Approach.

November 4, 1985

A revolutionary new instrument landing system was demonstrated at Hanscom Field, Bedford, Massachusetts.

The first FAA-approved instrument landing using a Loran-C navigation system was flown into Hanscom Field in Bedford on November 4th. This historic event was made possible through the cooperation of government agencies and civilian organizations.



NEW ENGLAND REGION

FAA Administrator Donald D. Engen made this inaugural landing in a corporate Beech King Air 200 turboprop airplane provided by the Sprague Electric Company of Lexington.

This event will make Loran-C, long a mainstay of marine navigation, available as a landing aid to navigation. This system will soon be able to be used at any location nationwide without the requirement of facilities at any airport.

Aboard the flight, in addition to FAA Administrator Engen, were the following (See Seating Arrangement, Figure 1): FAA New England Regional Director Robert E. Whittington; Norman J. Fredkin, Chairman, Massachusetts Aeronautics Commission; Massachusetts Aviation Director Arnold R. Stymest;

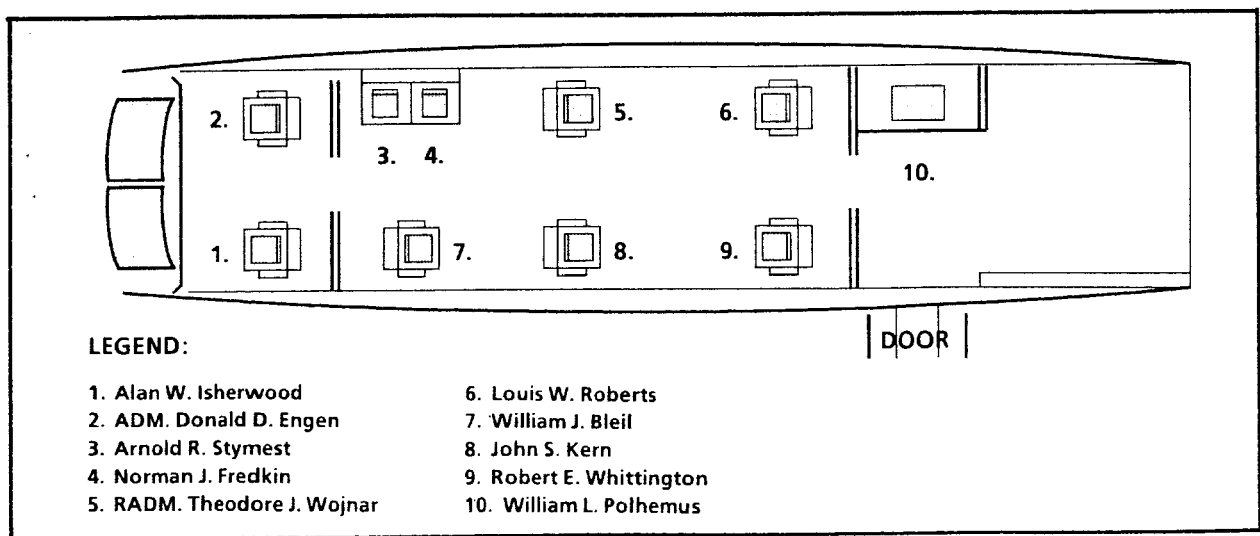


Figure 1

Sprague Electric Company V.P. William J. Bleil; DOT/Transportation Systems Center Director Louis W. Roberts; Rear Admiral T.J. Wojnar, Office of Navigation, USCG; John S. Kern, Director, Office of Flight Operations, FAA; William L. Polhemus, Polhemus Associates Inc.; and the pilot Alan W. Isherwood, Sprague Electric Company.

Welcoming remarks by Robert E. Wittington appear on the facing page.

The primary FAA objective of the program is to conduct a nationwide effort to approve the use of Loran-C for IFR nonprecision approach (NPA) operations in the National Airspace System. A secondary objective of the program is to enable the FAA to gain operational experience with a navigation system which is not owned, operated, or controlled by the FAA. The FAA initiated this program to meet these objectives and in response to a growing number of user requests.

Eight airports were chosen to participate in this program. The FAA has visited regional offices with jurisdiction over these eight airports to bring their staffs up to date on the Loran-C program. The FAA is installing monitors at each of these airports and developing approach procedures. For a year, starting in December 1985, the FAA will operate these monitors as a subset of a future nationwide monitor network. At the end of this period the FAA will have an experienced cadre capable of operating a nationwide system of operational monitors. The immediate goal of the program is to assure the first approved NPA approach would take place in 1985.

As planned, the first major program milestone took place on November 4, 1985 at the L.G. Hanscom Field, Bedford, Massachusetts, when the first FAA approved IFR, nonprecision approach was flown using Loran-C signals (See Figure 2).

It has taken some time for this outstanding aviation achievement to occur. In 1974 the U.S. Coast Guard equipped an aircraft with Loran-C to demonstrate the potential of the Loran-C system to provide navigation and guidance information with an accuracy suitable for approaches to small, isolated airports in Vermont. A major advance toward the goal of nonprecision approaches was made in 1981 when the FAA New England Region awarded the first En Route Supplemental Type Certificate to the State of Vermont to use Loran-C signals for navigation and guidance.

Now when the FAA New England Region awards the first nonprecision approach Supplemental Type Certificate, Loran-C will be officially recognized for the major navigational contribution it can make to the general aircraft community, as well as small commuter and cargo airlines.

Attendees at this event are listed below. The commemorative signed approach plate of the event is also reproduced below.

*Department of Transportation
Federal Aviation Administration
New England Region*



Director

November 4, 1985

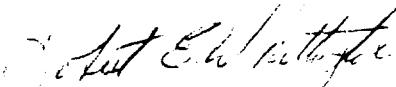
It gives me great pleasure to welcome you here today for this very special event in aviation history. We here in New England have participated in the LORAN-C program for the past decade and have supported this program with enthusiasm. The first major event toward complete FAA approval of LORAN-C for navigation and guidance came in October of 1981, when the FAA presented the first En Route Supplemental Type Certificate (STC) to the State of Vermont to use LORAN-C for airborne guidance.

Today, November 4, 1985, we will present Sprague Aviation with the first STC for an IFR nonprecision approach. Sprague in their Beech King Air and FAA Administrator Engen will in turn make the first ever nonprecision approach.

With FAA approval of LORAN-C for en route, terminal and nonprecision approach, the use of LORAN-C will mushroom in the General Aviation field. Most of the small isolated airports in the United States having instrumentation will be eventually open to General Aviation.

This was a cooperative effort of the Federal and State governments working directly with the private sector. It will be officially recognized as a major navigation contribution to General Aviation as well as to commuter airlines.

Sincerely,


Robert E. Whittington

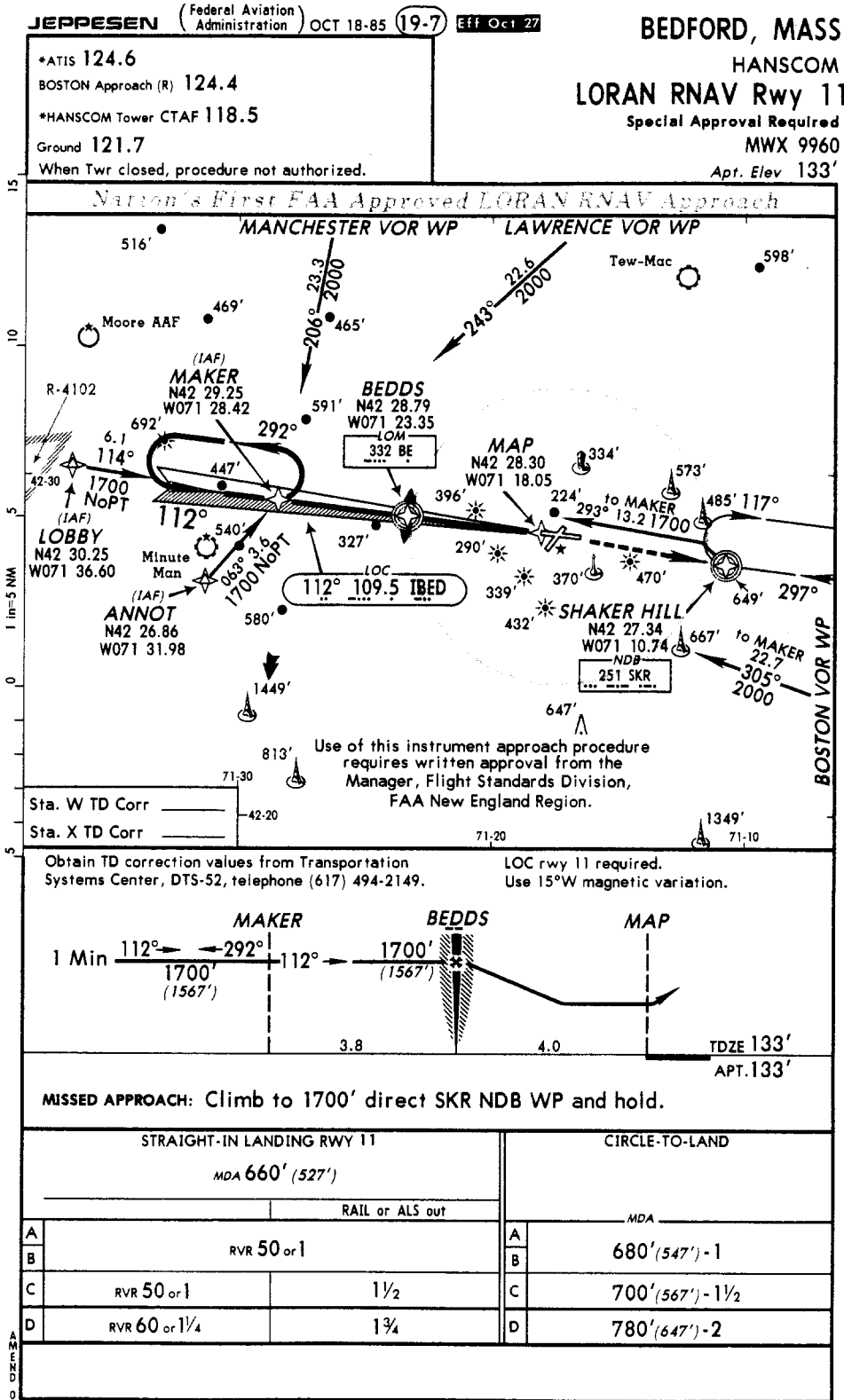


Figure 2. Approach Procedure - RWY 11, Hanscom

WILD GOOSE ASSOCIATION RADIONAVIGATION JOURNAL 1985-1986

ATTENDEES AT THE FIRST FAA APPROVED LORAN-C NONPRECISION APPROACH
 NOVEMBER 4, 1985
 HANSCOM AIR FORCE BASE, BEDFORD, MASSACHUSETTS

FLIGHT MEMBERS

W.J. Bleil
 ADM. D.F. Engen
 N.J. Fredkin
 A.W. Isherwood
 J.S. Kern
 W.L. Polhemus
 L.W. Roberts
 A.R. Stymest
 R.E. Whittington
 RADM. T.J. Wojnar

ATTENDEES

A. Alexander
 J. Allen
 B. Ambroseno
 CDR D. Amos
 A. Anderson
 W. Anderson
 P. Ardizzon
 M. Arnold
 A. Baddour
 E. Becotte
 J.C. Beisson
 R. Billings
 P. Bloodworth
 R. Bolin
 P. Boyajian
 J. Boyce
 J. Bradley
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 R. Bunker
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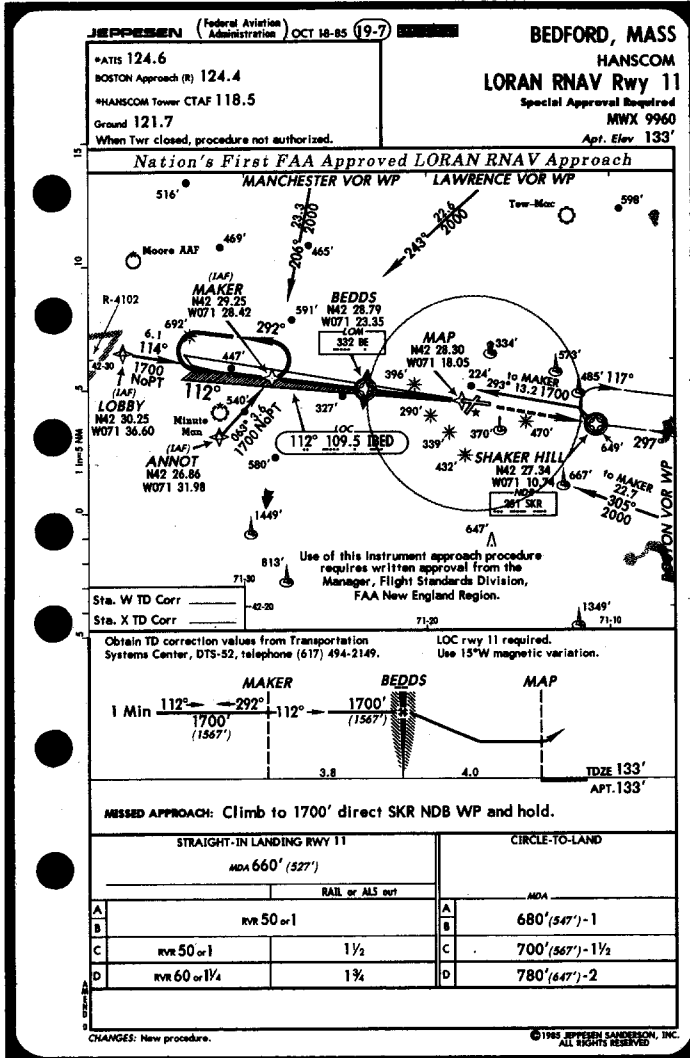
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U.S. Department
of Transportation
**Federal Aviation
Administration**

First FAA Approved LORAN-C IFR Nonprecision Approach.

November 4, 1985



Flight Members

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Ted Wagner
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Norman J. Friedman
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Alan W. Howard
Arnold R. Stymest



WGA Response to the Federal Radionavigation Plan 1984

INTRODUCTION

These comments have been prepared by the Board of Directors of the WILD GOOSE ASSOCIATION (WGA), an organization for individuals who have a common interest in loran and who wish to foster the art of loran. The WGA has over 500 members in the U.S. and overseas representing users, manufacturers and operators of loran and associated systems. The material to follow concerns itself with the Federal Radionavigation Plan (FRP), both generally and specifically, with regard to its treatment of all systems.

The Loran-C user community--that is, the number of Loran-C receivers in service worldwide--is estimated at 200,000 marine and 30,000 airborne units in 1986. The current rate of marine fittings is about 75,000 per year, and the current rate of airborne fittings is about 10,000 per year. New Loran-C systems have been installed by several foreign countries and further expansion of the U.S. coverage is budgeted.

Loran-C was initially developed, installed and operated in support of the U.S. Navy Polaris program. Work initiating this development started in 1957. Loran-C coverage, in support of the DOD, grew steadily throughout the next decade.

In 1974, the DOT selected Loran-C as the most cost-effective radio-navigation system for the coastal confluence region and established a plan to implement the required coverage and to phase out the predecessor radio-navigation system, Loran-A. (This decision and plan to establish Loran-C as the government-provided marine radio aid to navigation system for the coastal confluence zone was documented in the Annex to the DOT National Plan for Navigation, published in the Federal Register in July, 1974.)

Full Loran-C civilian radionavigation service for the coastal confluence zone was completed in 1980, some 23 years after its initial military application. In this time interval, receivers were reduced in cost from about \$50,000 to \$100,000 for the early receivers in 1960 to about \$500 and up today. In these 25 years of steady progress, receiver prices decreased by a factor of 100 and performance and reliability increased very, very significantly. These dramatic gains were made by taking advantage of breakthroughs in the fields of digital electronics and solid state technology and by continuous evolutionary development of improved products by the Loran-C engineering and manufacturing community.

The histories of many predecessor systems reveal that while military systems are on the leading edge of technology (and must be to achieve a military advantage), the civil user must field a system which has achieved low cost and high reliability advantages through system and equipment maturity. The cycle from leading edge to mature technology is generally 10 years or more. The WGA believes that a similar process will be required for cost-effective "civilization" of the GLOBAL POSITIONING SYSTEM (GPS).

GENERAL COMMENTS ON THE FRP PROCESS

It should be recognized that the FRP is the result of an intensive promotional and lobbying campaign, successfully carried out in 1977 and 1978 by proponents of GPS. This resulted in several reports from the General Accounting Office (GAO) decrying the "proliferation" of radionavigation systems and proposing that all be supplanted by GPS. Typical of the information in the 1978 GAO report on Navigation Planning is the opening statement on GPS, "The NAVSTAR system could be made to provide global, two-dimensional coverage by 1981".

The authors of the FRP should recognize that the FRP is becoming a model for similar documents in other nations. Therefore, it is imperative that the document very clearly define its purpose, contents and terms of reference in unambiguous terms. Since the FRP policy is said to be the reference as to what U.S. radionavigation policy is at any given time, then major policy decisions involving this policy must only become effective with the issuance of a new edition of the FRP. Decisions made between editions leave the national and international communities confused as to what the U.S. policy is at any given time. No government employee should represent U.S. policy as being anything except that which is in the current issue of the FRP.

The FRP must be explicit with regard to existing radionavigation systems in terms of the user requirements they meet, what national and/or international regulations or agreements are concerned, which U.S. agency is responsible for each system and when and how each system might be replaced.

Before a new system can become a candidate to replace another, it must have reached the stage of maturity where all its operational characteristics can be determined. This includes a realistic deployment schedule, firm technical performance characteristics and reliable development/production/deployment and logistics support costs of the system and related user equipments. National and international regulatory implications must also be considered.

After a system becomes a valid candidate to replace another, the points of comparison between the candidates must be defined according to prescribed criteria. If the candidate system is found to have the necessary characteristics to replace an existing one, then a firm decision should be made and a schedule established.

On the occasions of rulemaking by the Coast Guard or the FAA, the proposed rules are published in the Federal Register for public comment before taking effect. The FRP does not provide for this process, so that specific comments are possible only after the new edition of the Plan is published, to remain unchanged for two years.

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The EPSCO Integrated Navigation Plotter Model 4436 (Patent # 4,393,448) is a large surface (31" x 36") flatbed X-Y plotter and maneuvering table. The plotter shows the vessel's relative position based on TD inputs from a Loran-C receiver or from a device providing position data in a L/L format such as a satellite-based positioning system. A permanent record of the vessel's track is drawn on the plotting surface, while the vessel's present position is also indicated by an image projected on the glass top which forms the maneuvering table.

The plotter is microprocessor-controlled, and operated-selected variables are entered from a control panel keyboard.

OPTIONS

The integrated plotter may be interfaced with multiple sources of navigation and target information, including Radar, Sonar, Gyro Compass/Speed Log, and IEEE 488 bus. Other options include accommodation of additional inputs and the use of larger plotting surfaces.



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GENERAL COMMENTS ON THE 1984 FRP

The 1984 FRP is still directed toward replacement of most radionavigation systems by GPS, despite, or perhaps because of, its great cost. No details are presented regarding the acceptability of GPS as a national or international civil aid to navigation. Nevertheless, it is presented as the probable or even certain, not just possible, replacement for all systems.

Even today there is little, if any, factual and creditable information regarding the issues related to the "civilization" of GPS. There are a number of specific points to be made.

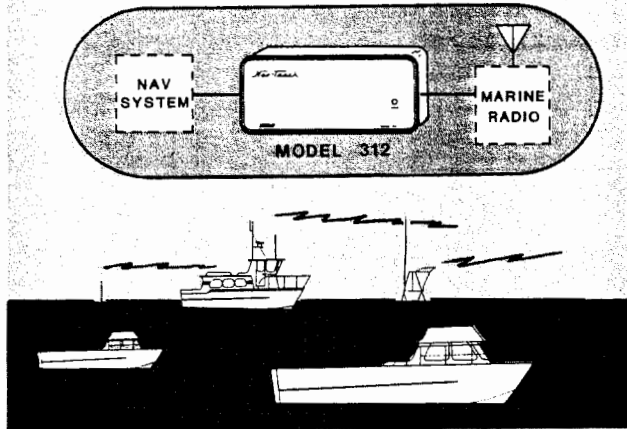
- * The FRP refers to the DOT Economic Planning Model as the means of determining the economic suitability of various systems. No details of the methodology or results are presented, so there is no opportunity for independent analysis. Indeed, there is no indication that DOT has actually derived any results from use of the model.
- * Specific information on the acquisition and operating costs of the various systems is completely lacking. For example, it is impossible to evaluate the cost of GPS relative to the systems it is proposed to replace.
- * Cost recovery is treated in circuitious ways in the FRP. If GPS is run by DOD rather than DOT, will there be no pressure to raise fees (license, landing, etc.) to help pay for GPS?
- * Since widespread civil use of GPS is still speculative, it is proper also to speculate on what would happen to GPS if and when DOD should develop a successor to that system. How would the continuing cost of GPS be funded?
- * The available accuracy from the operational GPS SPS signal has been variously specified as "60 meters, CEP" and "100 meters, 2 drms". Unfortunately, 60 meters, CEP is approximately 150 meters, 2 drms. Since this order of accuracy is critical to some prospective users, the authors of the FRP should determine from DOD which accuracy level is intended.
- * The User Schedules for Loran-C, Omega and Transit (Tables I-4.4, I-4.5 and I-4.9), show no increases in civil users after 1980 on the basis that the expected 1987 National Decision makes their future uncertain. This gives an erroneous impression of the future use of these systems as they will be operational for many more years whatever the decision, and their use will continue to increase.

INTRODUCING

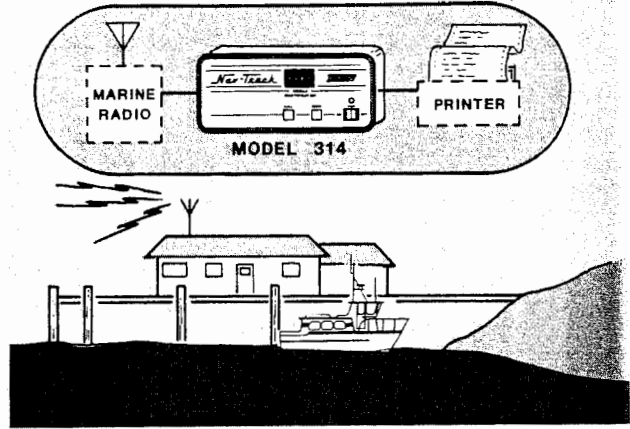
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BASE STATION



BOAT LOCATION IS THE KEY TO SUCCESS

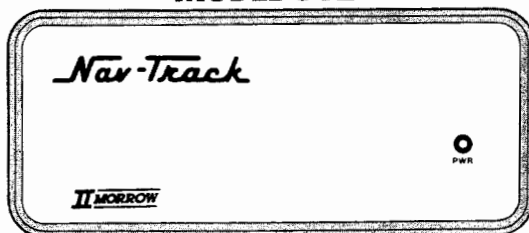
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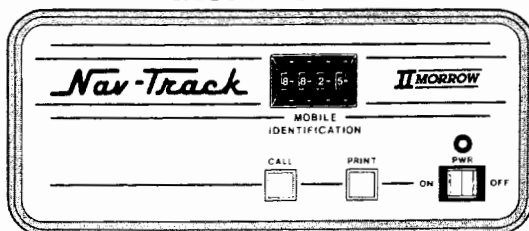
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- * The question of the effect on national security of providing a worldwide system with the accuracy of GPS is still pertinent. Also to be considered is possible liability for system malfunctions producing navigation mishaps.

The radionavigation user base is growing by leaps and bounds ... and the number of different applications are so diverse ... that annual debate as to what systems should be shut down, what new system will replace what proven system, etc. cannot be tolerated by the U.S. taxpayer. Society as a whole is becoming so dependent upon the availability of precise radiolocation information that we believe there should be a redundancy of signals provided such that no natural or politically motivated interference or act can wipe out all signals. Following is a partial listing of the many air, sea and land users of radionavigation services.

Air navigation	Vessel traffic systems
Airport/separation access	Law enforcement
Aircraft surveillance.	Fish/wildlife management
Search and rescue	Environmental protection
Emergency medical services	Forest spraying/surveying
Disaster/crisis management	Fire detection/suppression
Harbor/harbor entrance	Custom/immigration/drug control
Canal/lock access	Agricultural applications
River hazard marking	Highway safety/resource mgmt.
Health services	Public utilities
Census records	Surveying
Military applications	Meteorological measurements
Fisheries/fishing industry	Land vehicle (trucking, railroad, hazardous cargo, autos, etc.)
National security services	
Rural area locations	

Considering the lack of information on the issues itemized above and the growing and diverse user community whose needs have not been adequately addressed, it is difficult to understand how GPS could have been proposed in 1984 as the radionavigation system to replace virtually all others in the civil community.

The recent shuttle tragedy illustrates that inadequate planning had been given to long-term support of the GPS system. Will the U.S. support the shuttle for 20-40 years? If not, what is the backup? (At present, Block II GPS satellites cannot be launched by any means other than the shuttle.) Does GPS have shuttle launch priority? How quickly can even the 18 satellite configuration be corrected for satellite failures by spare satellite movement and replenishment?

RECOMMENDATIONS RE: THE FRP

1. Set the schedule of issuance of the FRP to coincide with U.S. national policy decisions.
2. Establish a mechanism whereby public comment on a draft is feasible, so that each issue receives the benefit of the latest public opinion as well as DOD and DOT inputs.
3. Provide realistic cost data so that the public can properly evaluate the choices being presented.
4. Let market forces and operational suitability determine whether one system is sufficiently superior to another that one need no longer be supported. The Loran-A to Loran-C conversion is an example.
5. Even when a system's signals are available for public use under DOD funding (such as may be the case for GPS), a decision on civilian use should be delayed until commercial forces, using the available signals, can factually show advantages to the government, to the taxpayer and to the user. In particular, these advantages should be demonstrated before deciding that such a system will be allowed to supplant existing systems.

SUMMARY OF KEY ISSUES

We concur that GPS has potential as a precision worldwide radionavigation system to satisfy U.S. national defense requirements and many civilian navigation requirements. However, we believe that the effect on national security is still pertinent, particularly if the system is widely used for civil purposes.

It is not clear that the GPS system, as configured, will satisfy all civil users; neither is it clear that redundancy, through a mix of independent radionavigation systems, will not be a more cost-effective approach than reliance upon a single GPS system.

United States civil users are concentrated in the continental U.S. and in the coastal confluence zone. The requirements of these users are now economically satisfied with the existing Loran-C radionavigation system. Whether the many Loran-C users can be persuaded to discard a very satisfactory system and spend more money for an equivalent GPS receiver remains to be seen.

The timetable for making final national decisions regarding civil use of GPS, Loran-C, VOR/DME and Omega in 1987 as announced in the FRP is very premature. These decisions cannot be taken until the procedures outlined in FRP Section 4.5, Selecting Radionavigation Systems to be Used in the Future, are fully followed. In particular, realistic final determinations of combined user/government cost and system and product reliability cannot be made until GPS is fully operational and until civil user equipment is available for use and evaluation.

Historically, FRP timetables have been overly optimistic and unrealistic. The planning process needs to be much more realistic to properly and effectively support the policy decision process.

PROPOSED IMPROVEMENT IN ALASKA LORAN COVERAGE

WALTER DEAN
Arnav Systems Inc.

Loran operation in the state of Alaska suffers from a "Mid-State Gap" analogous to the "Mid-Continent Gap" in the lower 48.

Loran coverage in Alaska is provided by two Loran chains. In the west, the North Pacific Chain (9990) consists of a master station at St. Paul Island, an X secondary at Attu, Y secondary at Port Clarence, and Z secondary at Narrow Cape, Kodiak. Figure 1 shows most of that chain. The master station at St. Paul is a relatively low power (250 KW peak) transmitter. Since the master station is essential to receiver operation, the relatively weak signal from St. Paul, further attenuated over portions of the Alaska Range, results in marginal operation in the area indicated in Figure 1, which includes the Anchorage-Fairbanks corridor.

In the east, the Gulf of Alaska Chain (7960) provides accurate navigation to the edge of the Anchorage area. The master station at Tok is a high power station and covers the area well. The station at Narrow Cape, Kodiak, is dual rated, serving as the X secondary for this chain. The Y secondary at Shoal Cove is nearly 700 miles away. North of Anchorage, the signal from Shoal Cove is severely attenuated, and the geometric accuracy is poor, so the chain cannot be used in that area.

A simple change can be made which will expand the coverage of the 7960 chain and completely fill the "Gap". The change is to dual-rate the station at Port Clarence to the 7960 chain, in the same manner as Narrow Cape station. The resulting Loran coverage will be as shown in Figure 2. Port Clarence, with its 1350-foot tall antenna, is rated at one megawatt peak power which gives it greater range than St. Paul.

The equipment required to provide the dual rate capability consists principally of an additional timer unit and a pulse generator module. It is understood that there are some of these units available in the Coast Guard Supply Center or the Electronics Engineering Center. In this event, the capital costs to make the change will be negligible. Coast Guard personnel have the required skills to make the installation of the equipment and calibrate the new station.

Control of the new station will be accomplished at the existing control monitor station at Kodiak. This station already monitors the 7960 X secondary (Narrow Cape), and that receiver could be used also to monitor and control the new Z secondary at Port Clarence. The monitor already controls Port Clarence operation as 9990-Y, so additional control lines will not be required.

MARINE ELECTRICAL INTERFERENCE CHECK LIST

Prepared by MARINE TECHNOLOGY, INC. Long Beach, Ca. USA

PROBLEMS	POSSIBLE SOURCES	CURES
Audio/Hi-Fi Equipment:		
Alternator whine in any receiver, tape system, hi-fi loud-hailer or radiophone receiver. Whine varies in pitch with engine speed	The alternator normally develops an audio frequency voltage (1 to 6 KHz), across the battery.	Use the MAR-P5, P10 or P25 in the powerlines to affected receiver (s), depending on the current required
Fixed-frequency whine or whistle in the above equipment	Any DC/DC or DC/AC converter such as is used in: <ul style="list-style-type: none"> • Electronic ignition • Radar set • 12V to 115VAC supplies. 	The MAR-P5, P10 or P25 may be used in the power wiring to the offending device as well as to the affected receivers. However, certain high-power inverters may work only when connected directly to the battery.
HF SSB Marine and Amateur Receivers:		
Regular popping sound at low engine speeds, increasing to a rough sounding roar at high RPM.	Gasoline engine ignition system.	Use a MAR-10A filter on the primary (+ 12 volt) lead from the key to the ignition system. Install at the engine Use resistor-type spark plugs and resistor-type plug wiring. Test or replace resistor-type plug wiring if over three years old Use a MAR-TAC 2 filter at the engine on the line to an electronic tachometer. Also, use a MAR-P5 in the power leads at the tach, especially if it's a digital unit.
Intermittent trying noises.	Mechanical voltage regulator.	Install two MAR-ACE2 filters on the four leads to the regulator.
Grinding noise when in gear.	Intermittent electrical grounding of shaft due to oil film in transmission and bearings.	Install shaft brush to provide a good electrical connection between propeller shaft and engine ground.
All of above.	Residual rf noise in the vessel's electrical system.	MAR-HF in powerline to radiotelephone. MAR-HF2 in ground lead to radiotelephone.
Loran C. Radionavigation System:		
System can't be used while engines are running. Symptoms are: <ul style="list-style-type: none"> • Can't acquire LOP's • Can't hold LOP's when engine started. • Cycle jumps (10-count errors) • SNR unacceptably low. 	Alternator diode noise, gas or Diesel engines. Electronic ignition, gasoline engines. Note: Interference may appear more severe at some engine speeds than at others.	MAR-70A or MAR-120A on each alternator. MAR-10A in +12V or "booby-light" lead to alternator voltage regulator. MAR-10A in +12V wire to ignition circuits, gas engine. MAR-TAC 2 at electronic tach connection on gas engine. MAR-P5 filter in the power wires to each electronic tach unit. MAR-LC kit on Loran C receiver power and ground wire (gas or Diesel).
System can't be used while certain accessories operate. (Symptoms same as above).	Television set.	Turn the ... thing off.
	DC Motors on pumps, blowers, refrigerators, wipers, bait tanks, bilge pumps heads, ice-makers, etc.	Install a MAR-P5 (5 amps) or MAR-P10 (10 amps) or MAR-P25 (25 amps) in the powerlines to the offending motor. Also use MAR-LC.
	Fluorescent lights—Strobe lights,—All digital instruments ... (Tachometers, wind speed and distance etc.) Computers, calculators on ships power.	Install a MAR-P5 in the power leads to the unit. Use MAR-LC. Use short pieces of wire to bond fluorescent light chassis parts together and to the negative power lead.
	DC/DC and DC/AC power converters (as in some Radars).	Use the MAR-P10 or P25 in the powerleads to the unit. Use the MAR-LC.
Depth Sounders, Sonar:		
Excessive background hash, obscuring indication and reducing range.	Same sources as affect Loran C.	Same cures useful for Loran C engine and accessory noise problems. The MAR-P5 is effective in the powerlines to the depth sounder.
Interference at top speeds only.	Propeller cavitation, transducer mount cavitation.	Review propeller selection. Review mount location.

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Data are available which show that the new station configuration will provide the required signals. In 1983, signal strength and signal-to-noise measurements were made in conjunction with STC flight tests in Central Alaska. Figure 3 shows the points at which data were collected. At each of these points, the signals from the three stations which would provide the new coverage, Port Clarence, Narrow Cape, and Tok, showed signal-to-noise ratios of better than 1:1. This is more than adequate for good Loran receiver performance. This provides a high degree of confidence that the proposed dual-rating of Port Clarence will provide the expected performance.

Installation and testing of the required equipments and calibration of the new station should require only a few months time. It is estimated that the total cost of the project should be less than \$100,000.

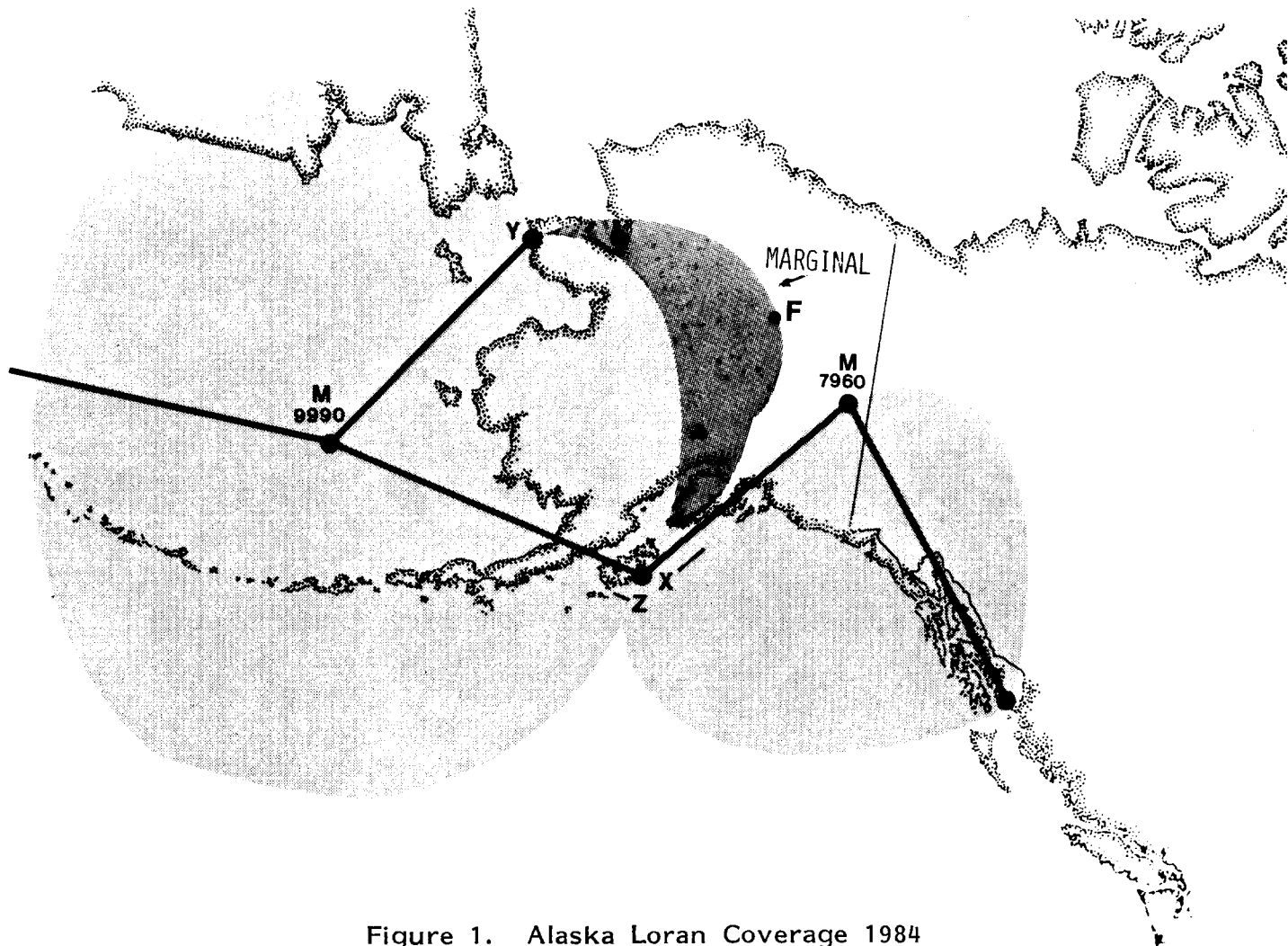


Figure 1. Alaska Loran Coverage 1984

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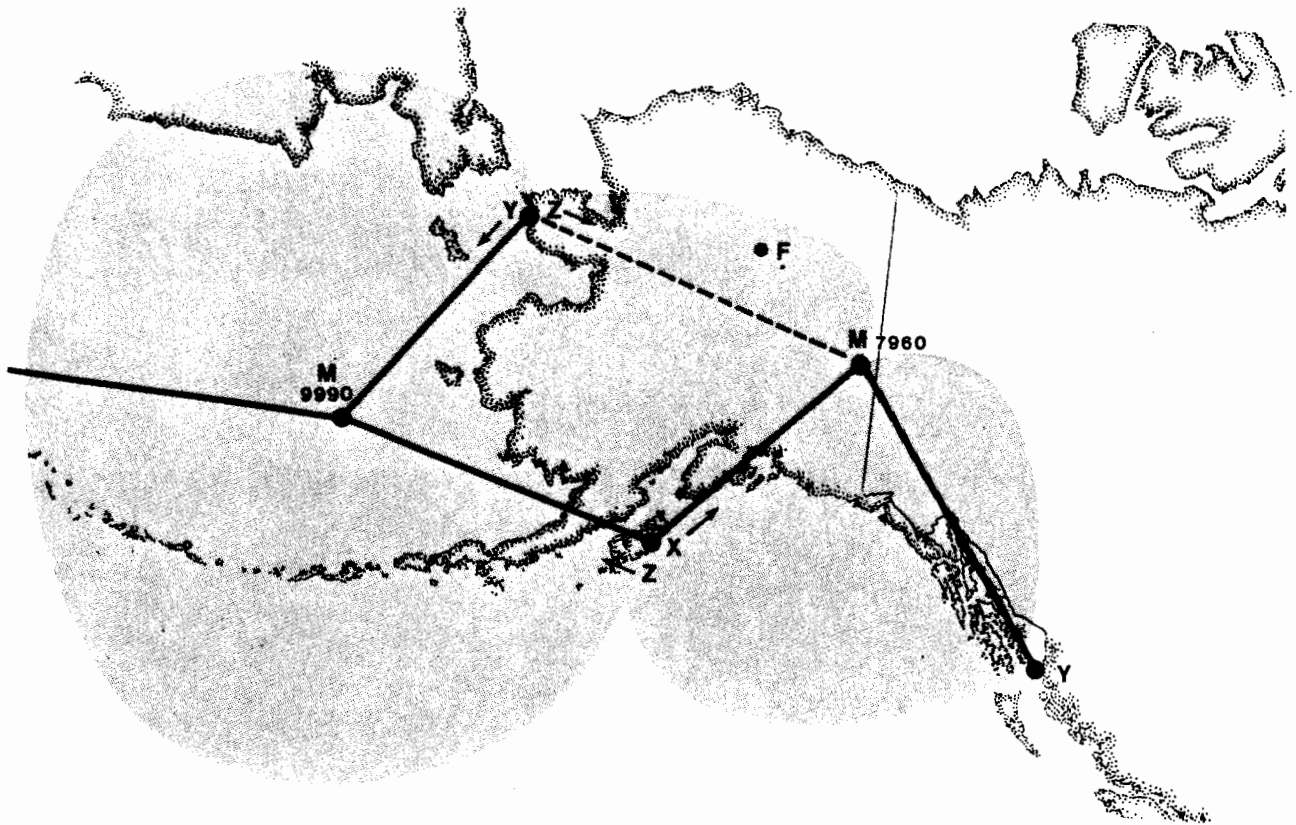


Figure 2. Alaska Loran Coverage with Port Clarence Dual Rated

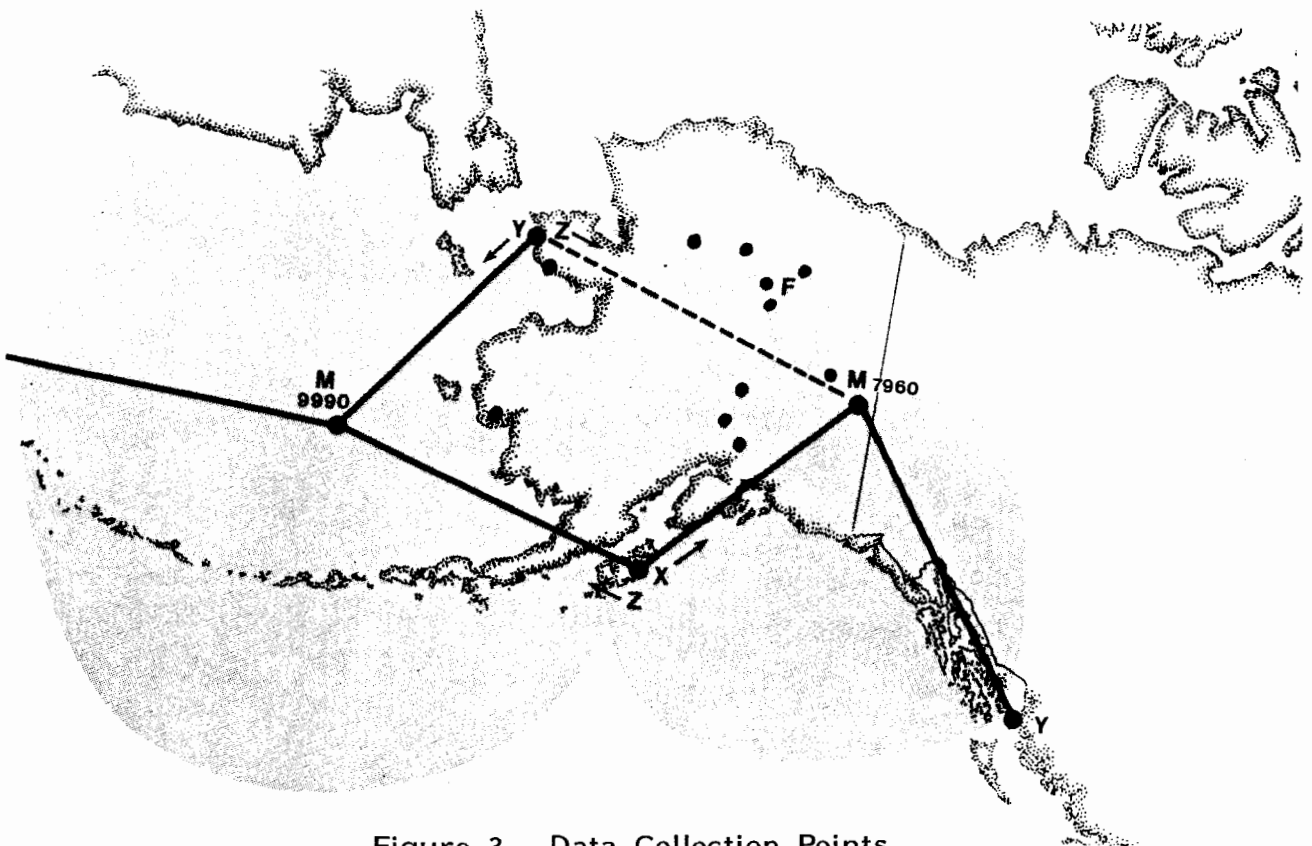


Figure 3. Data Collection Points

DOD/DOT POLICY FOR THE FUTURE RADIONAVIGATION SYSTEMS MIX

PURPOSE: This statement sets forth the policy for Federally funded radionavigation systems to be supported for the remainder of this century and into the early part of the next.

BACKGROUND: Section 507 of the International Maritime Satellite Communications Act of 1978 (PL 95-564) requires the development of a plan to determine the most cost effective method of reducing proliferation and overlap of Federally funded radionavigation systems. That plan, the Federal Radionavigation Plan (FRP), was developed through the joint efforts of the Departments of Defense and Transportation. The FRP (current edition March 1982) cites key events in selecting radionavigation systems to be used in the future. One of these events is publication of a DOD/DOT policy statement that sets forth a preliminary selection of Federally funded radionavigation systems. This policy statement will provide the basis for revising the FRP. Subsequent reviews of the FRP will be undertaken, at least biennially or more frequently, if necessary.

All common user systems currently operating or planned were considered in reaching this selection for the future mix of Federally funded radionavigation systems. This policy statement addresses how and for what period each system should be a part of the Federal radionavigation system mix. When a decision is made to terminate a navigation system, an appropriate transition period will be provided.

The Department of Transportation (DOT) is responsible for ensuring safe and efficient transportation. Radionavigation systems play an important role in carrying out this responsibility. The two main elements within DOT that operate radionavigation systems are the United States Coast Guard and the Federal Aviation Administration (FAA).

The Coast Guard has the statutory responsibility to define the need for, and to provide aids to navigation and facilities needed for safe and efficient navigation. The FAA has the responsibility for development and implementation of radionavigation systems to meet the needs for safe and efficient navigation and control of all civil and military aviation, except for those needs of military agencies which are peculiar to air warfare and primarily of military concern. The FAA also has the responsibility to operate aids to air navigation required by international treaties.

The Department of Defense (DOD) is responsible for developing, testing, evaluating, implementing, operating, and maintaining aids to navigation and user equipment required for National Defense and ensuring that military vehicles operating in consonance with civil vehicles have the navigational capabilities required to operate in a safe and expeditious manner.

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TACAN: TACAN is a short range navigation system used primarily by military aircraft. DOD will phase out land-based TACAN by 1997 assuming GPS, integrated with other onboard aircraft systems, proves acceptable as a sole means radionavigation system for military use in controlled airspace. Shipboard TACAN systems will continue in operation after that period.

ILS/MLS/PDME: These are precision approach systems for aircraft. MLS will replace ILS.

TRANSIT: TRANSIT is a satellite based radionavigation system operated by the DOD. It will be replaced with GPS by 1994. TRANSIT will not be operated by or transferred to a civilian agency of the U.S. Government.

GPS: GPS is a DOD developed worldwide satellite based radionavigation system that is scheduled to be operational with three dimensional coverage in 1988. The GPS Precise Positioning Service (PPS) will be restricted, due to national security considerations, primarily to the military. The GPS Standard Positioning Service (SPS) will be made continuously available to all users, worldwide, and will provide 100 meter 2 drms navigation accuracy.

AIR USE: GPS has the potential to become a sole means air navigation system for the United States. The adequate control of aircraft in national and international controlled airspace must be assured if GPS is relied upon, and those agencies with safety and operational responsibilities will determine when GPS, properly integrated with other aircraft navigation systems, is acceptable. Approval of civil navigation receivers to operate with the GPS system is initially expected to be on a supplementary system basis. Resolution of coverage and integrity issues is needed in order to certify GPS as a sole means system.

SURFACE USE: The GPS SPS, as currently proposed, provides better accuracy than the predictable accuracy of LORAN-C. It does not, however, have the capability of LORAN-C in the repeatable mode, and it cannot provide as good accuracy as LORAN-C in some locations. It is possible that some enhanced form of GPS may provide accuracy equivalent to existing systems for harbor and harbor approach areas, and for coastal and land radionavigation. Several enhancement techniques are currently being investigated.

CIVIL USER CHARGES: There should be no direct charges to civil users of GPS service. GPS costs should be underwritten through other mechanisms such as those provided for by existing statute(s).

PHASE OUT OF EXISTING SYSTEMS: It is the goal of the DOD to phase out use of TACAN, VOR/DME, OMEGA, LORAN-C and TRANSIT in military aircraft and other platforms. Civil user phase out of LORAN-C and OMEGA would be keyed to (a) resolution of GPS accuracy, coverage, integrity, and financial issues; (b) GPS meeting civil air, marine, and land needs currently met by LORAN-C and OMEGA; (c) GPS civil user equipment being available at prices that would be economically acceptable to LORAN-C and OMEGA users; (d) a transition period of 15 years; and (e) resolution of international commitments in the case of LORAN-C and OMEGA.

WILL GPS REPLACE LORAN?

By KIT MURA-SMITH

Vice-President, Trimble Navigation, Ltd.

Will GPS replace loran? The answer cannot simply be found in the Federal Radionavigation Plan or anywhere else. NAVSTAR GPS (Global Positioning System) is advertised as a replacement for all of the systems now in use. GPS plans to provide 24-hour continuous and very accurate position and time information anywhere in the world. Using information provided by GPS, the latitude and longitude of a receiver can be calculated as well as its distance from the center of the earth. If at this position the distance between the surface and the center of the earth is known, altitude can be calculated. It uses a constellation of satellites orbiting 10,900 nautical miles above the earth's surface. Unlike communication satellites which are in stationary orbit around the equator, or Transit satellites which circle the globe about every one hundred minutes in polar orbit, GPS satellites complete an orbit every 12 hours, in orbital planes inclined at 55°. Current plans call for 21 satellites, three equally spaced satellites in each of six different orbit planes, plus three orbiting spares. Twelve satellites will provide two-dimensional, nearly continuous 24-hour coverage worldwide. Eighteen satellites are required for three-dimensional continuous 24-hour coverage worldwide. The high altitude of GPS satellites provides for line of sight signal reception over wide areas.

Loran stands for Long Range Navigation. The system is made up of loran transmitter stations which are grouped into chains and provide coverage over most of the northern hemisphere, including the North Pacific, North Atlantic, the Mediterranean, Japan, Korea, Saudi Arabia, and more recently the English Channel. A single chain is made up of a master and two or more secondary stations. The differences in time of arrival of signals from any three or more stations are used to compute position. The range of these navigation signals is 1000 to 1500 miles from the transmitters. The accuracy of the system is about 200 meters, in general, if the conversion time differences to geodetic position is done by charts or an uncalibrated coordinate converter. Accuracy depends on how well the ground wave propagation velocity is known; also on the severity of atmospheric noise and man-made interference, and on the quality of signal processing. Propagation velocity varies as a function of the surface conductivity of the earth, which in turn is affected by seasonal variations in some areas. These effects are commonly referred to as ASF (Additional Secondary phase Factors).

From a pure technology point of view, the answer is yes to the question "Could GPS replace loran?". GPS presents a better technical solution because it is more accurate without user calibration, it's worldwide, it provides three-dimensional position, accurate time, and its signal propagation problems are minimal. GPS signals are affected as they pass through the ionosphere, but the amount of delay caused by the ionosphere (measured in 10s of meters) can be predicted and compensation made for it. From the military perspective, the encrypted code not only denies access to unfriendly users, but provides protection against jamming.

Since GPS is predicted to do everything loran can do, the minimum cost solution to the U.S. taxpayer is to phase loran out as soon as GPS is operational. Make sense? That certainly was the conclusion of the United States General Accounting Office in their 1978 published report entitled "Navigation Planning - Need for a New Direction," in which they proposed what is now the Federal Radionavigation Plan (FRP). The plan's objective is to preclude proliferation and overlap of radionavigation systems and thereby government waste. There is complete overlap of GPS on loran.

Somewhere beyond the basic technological and economic considerations lies a better answer. And this answer cannot realistically be determined without including some very practical and emotionally-based factors that the 1984 Federal Radionavigation Plan does not fully address.

One such issue is that of international acceptance of GPS as a replacement of loran. The level of trust that a foreign fisherman or ship owner, let alone U.S. vessel owners, would put in a single system controlled by the U.S. Department of Defense to do coastal navigation is not very high. Most of our systems were developed for military use (defense electronics is always at the leading edge of technology). Loran-C was initially developed, installed, and operated in support of the U.S. Navy's Polaris program, and has enjoyed wide civilian use in the U.S. and internationally. Today, loran systems continue to grow outside of the U.S. The same is true for the Transit system. Transit is a system controlled by the U.S. Navy and has gained international acceptance as a standard. Why, then, should GPS not gain the same level of international acceptance? It probably will when costs become competitive with other available equipment, but where the military control factor will play a role is in preventing it from ever totally replacing loran. Loran-C has had such a profound influence on civilian navigation. No other system, Decca, Transit or Omega, has brought about the enormous changes to the navigation function that loran has. Government denial of civilian access to GPS for any reason leaves a very large gap in navigation capability, if there is no loran backup. The contribution that loran class navigation capabilities can make to the economics and safety of marine businesses, pleasure craft and related services is so widely recognized that Loran-C stations are still being proposed and installed in other countries by other governments, in spite of GPS on the horizon. The People's Republic of China has a system underway scheduled for completion in 1988. Norway, Denmark and Germany may soon build stations, and informal inquiries from several South American nations have been made to the United States.

Another important factor is that Loran-C's revolutionary contribution to navigational technology and its consequent impact on safety, productivity, and availability will not be repeated by GPS. The features of GPS that make it unique are its accurate, continuous, world-wide, three-dimensional positioning service and accurate time dissemination. From a user's standpoint, this does not necessarily equate to superiority over every other navigational service. The services of both Transit and GPS overlap loran and can be used to turn the excellent precision of loran into accuracy. Redundancy has been the foundation of navigational security for generations and should not be ruled out of today's systems for economic reasons.

The tragedy of Challenger has caused many of us to rethink the viability of being dependent on a single system - whether it's a new technology that does everything or the only train out of town. The life of promising innovations depending on a single source is very risky. Deprivation of that source creates as much economic and intellectual resource waste as the alternative.

Loran-C, being a terrestrial system, can be built and controlled by any nation with the resources to do so, and thereby provide precise navigation capability to their vessels where it is most necessary to have precision -- along the coast and within the territorial limits that need to be monitored. Few mariners anywhere will ever accept a navigation system that provides less capability than loran.

Today loran and GPS can be integrated to establish the kind of symbiotic relationship that creates a system better than either one can as a single component. There are other possible combinations of navigation technologies; INS, Omega, Transit, or Decca and GPS, but loran and GPS create the most cost-effective and complementary system. Loran is the only 24-hour continuous and very accurate system that has any future viability and that can TODAY make GPS more usable. By combining loran and GPS lines of position, GPS can be used with fewer satellites and loran service is enhanced as well. By the time GPS can provide 24-hour continuous coverage worldwide (1990), loran may also very well cover as much of the world as is economically necessary.

As our GPS technology matures, history tells us that low cost and high reliability advantages will follow. Will it make sense to replace loran with GPS at that point? Does low cost and high reliability insure against the risks of total system failure? Our fisherman, even in today's economically depressed times, goes out with enough navigation electronics onboard to equip three vessels. This insures against downtime due to equipment failure, system glitches, et al. It costs him so much more to not be able to fish today or not be able to get to his destination on time. Does he know something we don't?

Tomorrow, loran and GPS will still make sense in a world in which symbiosis or redundancy is survival. Both will exist in synergistic harmony.

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Loran:

Getting Ready for Expansion

by Edward L. McGann*

In the early 1950's, Loran-C was deployed in strategic areas of the globe to meet U.S. military requirements. By 1974, however, Loran was selected by the U.S. Coast Guard as the official aid-to-navigation for waters of the United States. What began for a few hundred maritime users (plus a few hundred Russian and Eastern block vessels in U.S. coastal fisheries areas) has grown to over 300,000 in the United States and over 100,000 in the rest of the world. This makes Loran-C the most widely used navaid, excepting omnidirectional beacons, in the world.

About a decade ago, impetus for Loran-C in aviation began building. The early users "unofficially" flew with receivers temporarily removed from their boats and placed on a seat in the airplane. This led a few courageous manufacturers to market the first simple aviation receivers.

Meanwhile, the FAA, State of Vermont and NASA were funding research into terminal area and non-precision approach procedures for Vermont airports. (Similar development had already occurred in the Gulf of Mexico for helicopters.) As a result of this promising activity, Texas Instruments began the first effort to certify a Loran aircraft receiver for en

route IFR over most of continental U.S. Their success in certifying a receiver opened the door for other manufacturers to follow.

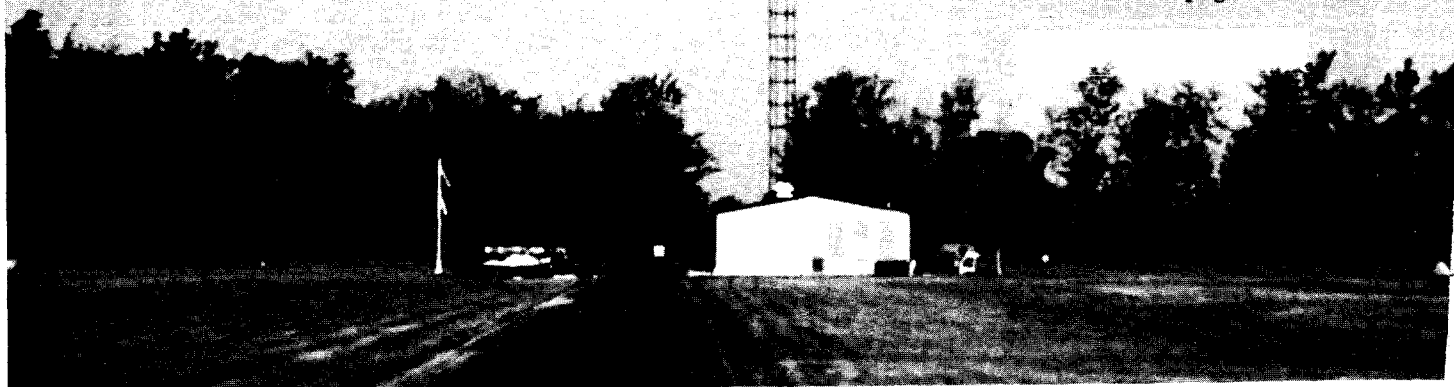
Lively competition quickly improved performance and features, and prices dropped. Over 30,000 aircraft in the U.S. are now equipped with Loran for VFR flight, some are certified for IFR, but all have a capability never before available in aviation.

By 1990, worldwide maritime Loran-C is expected to have well over 500,000 users, while predictions for Loran-equipped aircraft in the U.S. alone are for over 125,000 installations.

The expansion in aviation caught many people by surprise. As recently as 1982, Loran was not included in national airspace planning documents. The Federal Radionavigation Plan, which documents U.S. radionavigation policies and plans, essentially dismissed Loran-C for aviation. Today, this has all changed. Loran is firmly emplaced in airspace planning and the 1986 edition should reflect a significant role well beyond 2000.

Under Administrator Donald D. Engen, FAA and interested parties such as NASAO, AOPA, USCG and equipment suppliers, with the support of the U.S. Congress, have responded

(Continued on page 69)

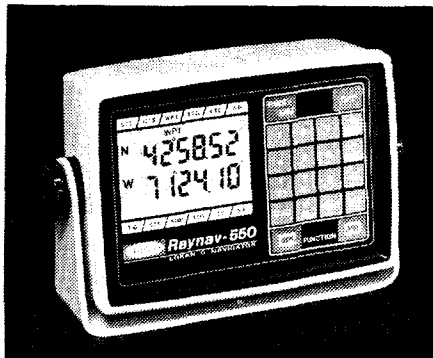


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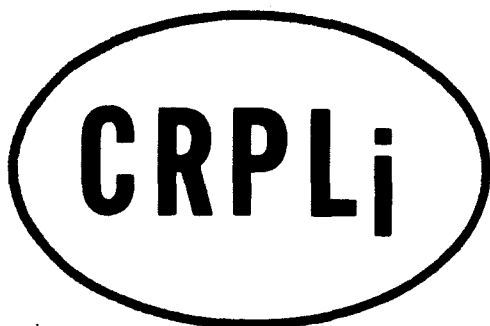
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WHY SHOULDN'T LORAN BE TIMED AS GOOD AS IT COULD BE ?

or more for less

by Leo F. Fehlner
15 November 1986

THE PAST

Once upon a time Americans were involved in a war in Southeast Asia. Planners with imagination at the Pentagon foresaw the usefulness of loran in support of the war effort and sponsored the installation of loran transmitters in Thailand and Viet Nam. In due course, loran user equipment was developed which made possible the aircraft delivery of droppable stores with accuracy on the ground, even in zero visibility, that excelled beyond the expectations of the developers. It also permitted loran-aided pinpoint touchdowns on runways. To accomplish this, the coordinate converter used in the receiver was calibrated in situ, using aerial pictures of geodetic features correlated with loran. This was done all over southern Laos and Viet Nam. Ground scores achieved in dropping stores was rated outstanding for many months when all of a sudden something changed over the whole calibrated area. Loran performance was ruined ! Why ?

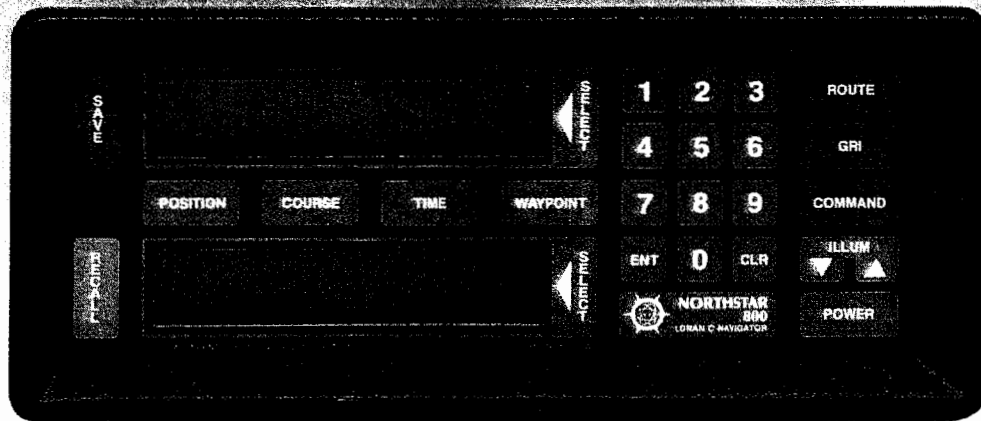
Well, it turned out that loran was in use in northern Laos by another organization. Questionable position fixes there had been attributed to the receiver, and a loran timing problem was suspected. The operators contacted Coast Guard loran headquarters in Bangkok and requested a loran timing change in their favor. Without coordination with other users, a change was made which upset the loran performance in the calibrated area.

A few Coastguardsmen may still be smarting from the rapid sequence of events that set the timing back to the way it was. Loran performance in aircraft returned to outstanding and operators in northern Laos figured out how to solve their loran problem. This was an unfortunate event, but there was a bright side. It taught many of us a lesson. To wit, you can fool Mother Nature everywhere some of the time, and you can fool Mother Nature somewhere all of the time, but you can't fool Mother Nature everywhere all of the time.

THE PRESENT

Here it is almost 20 years later and the lesson learned in Southeast Asia has not rubbed off on the United States, Canada, Europe or anywhere else. Take for example the Northeast U. S. Chain. There is a field monitor station in New Jersey, Maine, and Ohio. We all know that yearly variations in environmental conditions in Maine, Ohio, and New Jersey are widely different. And the chain services users from Laborador to South Carolina and from Indiana to Bermuda. The chain tries to cope with Mother Nature over all of this area on behalf of the users. How ?

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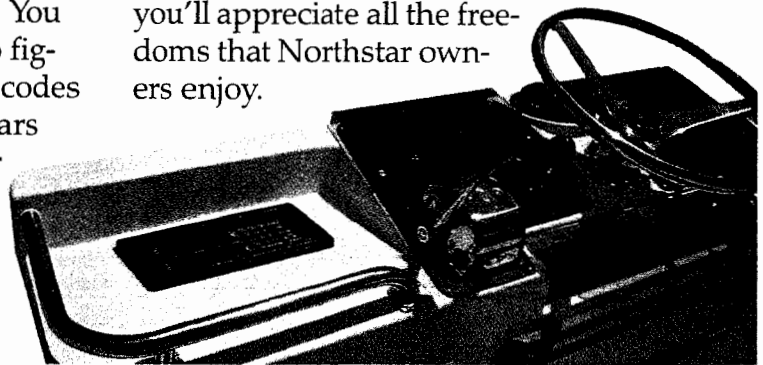
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An attempt is made to keep the numerical designation of the lines of position at the monitors the same at all times. Suppose that the monitor in Maine detects a movement of the lines of position, maybe due to a hard freeze, maybe due to atmospheric - who knows? What options does Maine have? The timing of Seneca can't be changed because it is on Universal Coordinated Time (UTC) - controlled by the Naval Observatory. So Maine has to adjust Caribou and Nantucket. Now New Jersey sees Nantucket move. What did it? New Jersey doesn't know. Could be seasonal changes on propagation paths to New Jersey, or seasonal changes on paths to other monitors, or insufficient monitor immunity from atmospheric, man-made noise or cross rate interference, or transmitter malfunction, or . . . So New Jersey adjusts Nantucket and Carolina Beach. Now Maine is messed up and so is Ohio. A user in North Carolina says to himself "Gee, its beautiful weather today. Wonder why loran is changing".

Obviously, it is not possible to keep the timing observed at the monitors constant at the specified values. The best that can be achieved is some average compromise within specified tolerance. This does not provide within-tolerance service for all users everywhere - only a limited warranty to users near a monitor. Recently the Southeast U. S. Chain was observed near the Mayport Florida monitor to be out of tolerance continuously for over a month - for long periods by as much as 2 to 3 times the specified tolerance. Position errors ranged from 100 to 300 feet. This was subsequently blamed on equipment failure at the Mayport monitor leaving control solely in the hands of the other two.

Long term independent monitoring of the Southeast U. S. Chain has disclosed other deficiencies in timing, dubbed loran anomalies. On the average of about four times a day, timing glitches occur suddenly having amplitudes up to 1.6 microseconds (1600 feet). Recovery takes about a minute. And at other times the timing wanders off in one direction for no apparent reason in 20 nanosecond steps as much as 60 to 120 nanoseconds, stays constant for a while, then steps back to where it was or overshoots. Clearly, the present system of timing control leaves something to be desired.

THE FUTURE

How could loran timing be made better? First listen to the lesson of Southeast Asia. Don't try to fool Mother Nature everywhere all the time. Then make bold changes in the philosophy of operation of the loran system. Give users a rock-solid timing control system that allows them to develop, for themselves, the best coordinate converter for their own area of interest. It would have a solid foundation in the temporal stability of the loran emissions.

We could proceed as follows. There are satellites flying overhead which distribute very precise timing by means of which clocks on the ground can be synchronized to UTC. The master stations of chains now use microphase steppers to adjust the

output of their frequency standards to the rate of going of UTC. The Naval Observatory supplies the sizes of the adjustments.

Let's abandon the monitor stations. Install at each transmitter station a satellite timing receiver and microphase stepper to keep each transmitter clock in UTC. Then freeze all transmitter timing parameters. Now the loran emissions are slaved to UTC and great things happen:

Coordinate converters can be calibrated to any accuracy for any specific use in any specific area, and for any specific season or for all seasons.

There would be no more loran anomalies and no more transmitter wander.

No more timing deviations due to atmospherics or cross rate interference.

Chain controllers wouldn't be responsible for Mother Nature's vagrancies.

Legal responsibility could be limited to the quality of the timing.

New chains wouldn't have to be "calibrated" by the Coast Guard.

No monitor stations would have to be supported.

The Naval Observatory would be relieved of one of its functions.

Airport approach plates could be upgraded from non-precision to precision.

Harbor charts and harbor approach charts could also boast of precision.

Operations and maintenance costs would be reduced.

There would be better (super) loran service at less cost.

And perhaps best of all, with a rock-solid timing foundation, we might be able to finally understand the influence of Mother Nature on ground wave propagation. Isn't the subjunctive mood wonderful ?

CONCLUDING REMARKS

Why shouldn't loran be timed as good as it could be ?

USEFUL LORAN INFORMATION

8940 CHAIN INFORMATION

The following 8940 chain information is provided for those who desire to use the 8940 chain while Sylt is transmitting as the 8940X secondary.

Station	Designation	(Datum Unknown) Position
Lessay	8940M	49-08-55.125N 01-30-17.582W
Soustons	8940W	43-44-22.989N 01-22-50.138W
Sylt	8940X	54-48-29.900N 08-17-36.300E
Shetlands Monitor		60-26-25.300N 01-18-05.200W

Operating Information:

All timing data is obtained from a computer program (ASF not considered) and are theoretical in nature.

Emission delay (Lessay - Soustons):
14008.2 microseconds

Emission delay (Lessay - Sylt):
33072.5 microseconds

8940M-X controlling standard TD at Shetlands:
31707.14

8940M-W is controlled by the French to hold the emission delay

8940M and X power: Estimated to be 275 KW.

RELOCATING LORSTA YAP TO GUAM

By spring 1987, the Coast Guard should be completing operational tests of a new Loran-C transmitting facility, LORSTA Barrigada, on the island of Guam in the West Pacific. This station will operate in place of LORSTA Yap, several hundred miles to the southwest, as the Zulu secondary in the Northwest Pacific Chain.

The Fourteenth Coast Guard District proposed the move as a cost-saving initiative. The facilities at Yap are in need of renovation, including replacement of the 1000-foot tower and improvement to the barracks, both very costly projects. Instead of doing this, the Coast Guard decided to build the new station on Guam.

The advantages of moving the station to Guam are numerous. Yap is an "isolated" station, where the 24 military personnel serve one year, unaccompanied tours. Relocation to Guam will allow longer, accompanied tours. Additionally, the station at Guam will be remotely operated, reducing the number of personnel needed to run the station to six. Renovating Yap, instead of relocating it, would require the Zulu secondary to be off-air for about three months while the new tower was erected. Locating the station at Guam will simplify supply, support, and communications over that of LORSTA Yap.

Exact coordinates for the tower at LORSTA Barrigada are not yet available but will be provided as soon as possible. Hyperbolic users will have to obtain new charts showing new lines of position. Owners of "lat-long" Loran receivers will have to have their receivers modified and should contact their dealer or manufacturer for advice.



DUAL RATING LORSTA PORT CLARENCE

The Federal Aviation Administration plans to fund the addition of LORSTA Port Clarence to the Gulf of Alaska Chain. The Coast Guard now plans to install the necessary equipment at Port Clarence this October. No operational date is set but it should be in the Spring or summer of 1987.

MID-CONTINENT CHAIN

As of the latest reading, the Mid-Continent chain is still on track in the '87 budget. The Coast Guard is in the planning stage with the present plan calling for four new stations in the gap area. The Canadians are showing considerable interest in possible expansion of their Loran chains in cooperation with the U.S. expansion.

LORSTA MARCUS ISLAND BACK IN SERVICE

The 1350-foot antenna at Marcus Island has been replaced with a 700-foot antenna. It was expected that the field strength for Marcus Island would be reduced by 3 dB.

NAD 27 POSITIONS OF U.S. LORAN STATIONS

by LCDR Lee Gazley

A chart datum is, in general terms, the mathematical model of the earth which is used to draw the chart and the LORAN-C lines of position.

Many datums exist. Most are "local" datums, in that they apply to a specific part of the world. An example is the North American Datum of 1927 (abbreviated NAD-27) which applies to North America. Several datums are global, i.e. they are designed to represent the entire earth. An example is the World Geodetic System of 1972 (abbreviated WGS-72).

Nautical charts for U.S. coastal waters currently use NAD-27 as their earth reference. This can present problems when transiting from the areas covered by U.S. charts into areas covered by another country's charts, since theirs may assume a different datum.

Realistically, the difference between NAD-27 and WGS-72 is not apparent on small scale charts (the difference is generally less than 120 meters). On large scale charts, such as those of harbors, the difference is very important. For example, a LORAN-C coordinate converter may assume WGS-72 for its reference. Latitude/longitude positions from the converter plotted on a nautical chart may result in a position error of 30 to 120 meters due to the difference in datums. This is in addition to other errors that can occur from using inappropriate values for the LORAN-C phase corrections such as ASF, and from seasonal and diurnal variations in the LORAN-C signals.

The same datum problem exists with respect to the Global Positioning System (GPS) which uses WGS-72 (soon to be WGS-84) for its earth reference. A GPS position plotted on a nautical chart may result in a position error of 30 to 120 meters, in addition to the inherent "best" accuracy of the GPS system itself, which for the Standard Positioning Service (i.e. C/A code) will initially be 100 meters.

The OMEGA System also uses WGS-72 for its datum, and so the same problem exists, but is much less apparent due to the inherent accuracy of the OMEGA System (2-4 miles).

Chart makers have recognized this problem and are planning to change the datum reference of nautical charts from NAD-27 to WGS-72 (or WGS-84 when it is adopted). This will make nautical charts more useful, in that most radionavigation system positions could then be plotted directly on the same chart and directly compared.

However, until all the charts are available in a universally acceptable international datum, the mariner must be able to recognize the differences among datums. He should know the relationship between the chart datum and the reference coordinate system of his radionavigational aid and be able to plot his position fixes on the chart.

In Bulletin No. 12 (March 1983) we published the WGS-72 coordinates and emission delays for the LORAN-C stations. These were intended for use in coordinate converters from LORAN-C time differences to Latitude/Longitude positions and vice versa. However, coordinate conversions will be more applicable to nautical charts if they are done using the same reference datum, i.e. NAD-27.

The list on the following page shows the NAD-27 positions and emission delays for the CONUS LORAN-C stations.

References:

1. M. Kumar and R. Keener, Application of WGS Transformations to Various Chart Datums for Plotting Satellite - Derived Positions, Defense Mapping Agency, Washington, DC, April 1984.
2. T. Seppelin, The Department of Defense World Geodetic System 1972, Defense Mapping Agency, Washington, DC, 1974.

NOTE:

We have since learned that NOAA is shifting to the NAD-83 datum, not WGS-72 or WGS-84. According to NOAA, however, the difference between WGS-84 and NAD-83 is only about 5 meters and will not be observable on charts.

We were asked to add the data for the Central Pacific LORAN-C Chain, on the old Hawaiian datum, Clarke 1866 spheroid. The data are listed below:

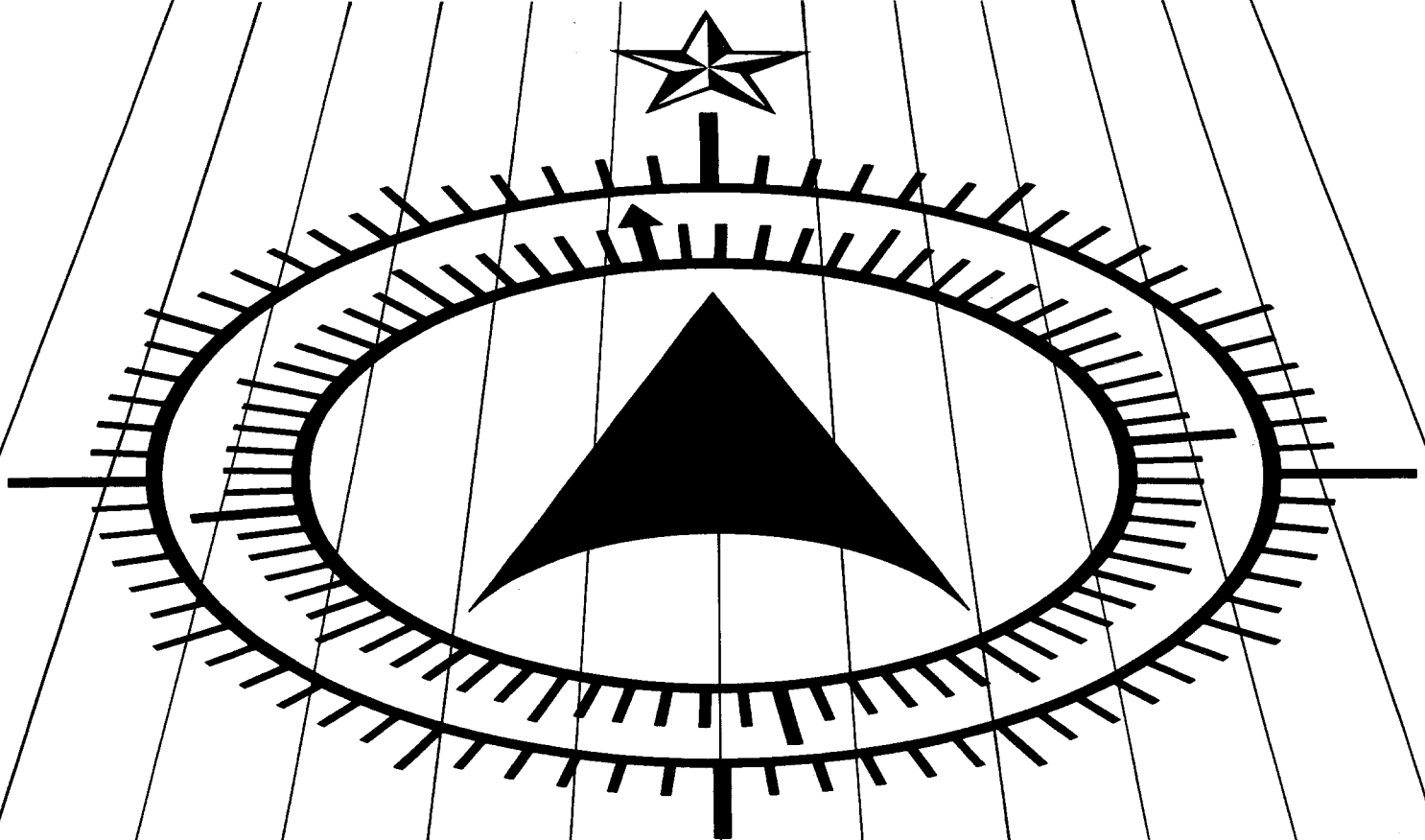
CENTRAL PACIFIC (4990)

STATION	NAME	EMISSION DELAY	CODING DELAY	RADIATED POWER(KW)	Old Hawaiian datum, Clarke 1866 Coordinates
Master	Johnston Is.			325	16°44'53.797"N 169°30'40.501"W
Xray	Upolu Point	15972.22	11000	325	20°15'00.318"N 155°53'19.188"W
Yankee	Kure Is.	34253.15	29000	325	28°23'52.816"N 178°17'40.201"W

WILD GOOSE ASSOCIATION RADIONAVIGATION JOURNAL 1985-1986

STATION	NAME	EMISSION DELAY	CODING DELAY	RADIATED POWER(KW)	NAD-27 COORDINATES	
<u>LABRADOR SEA CHAIN (7930)</u>						
Master	Fox Harbour			800	52°22'35.111"N	55°42'31.353"W
Whiskey	Cape Race	13167.29	11000	1500	46°46'32.396"N	53°10'31.039"W
Xray	Angissoq	29565.47	26000	760	59°59'18.160"N	45°10'32.650"W
<u>CANADIAN EAST COAST CHAIN (5930)</u>						
Master	Caribou			350	46°48'27.130"N	67°55'39.158"W
Xray	Nantucket	13131.88	11000	325	41°15'11.728"N	69°58'40.449"W
Yankee	Cape Race	28755.03	25000	1500	46°46'32.396"N	53°10'31.039"W
Zulu	Fox Harbor	41594.59	38000	800	52°22'35.111"N	55°42'31.353"W
<u>NORTHEAST U.S. CHAIN (9960)</u>						
Master	Seneca			800	42°42'50.465"N	76°49'34.470"W
Whiskey	Caribou	13797.20	11000	350	46°48'27.130"N	67°55'39.158"W
Xray	Nantucket	26969.93	25000	325	41°15'11.728"N	69°58'40.449"W
Yankee	Carolina Bch.	42221.61	39000	550	34°03'45.596"N	77°54'47.143"W
Zulu	Dana	57162.04	54000	400	39°51'07.514"N	87°29'11.543"W
<u>SOUTHEAST U.S. CHAIN (7980)</u>						
Master	Malone			800	30°59'38.236"N	85°10'09.074"W
Whiskey	Grangeville	12809.53	11000	800	30°43'32.493"N	90°49'42.728"W
Xray	Raymondville	27443.35	23000	400	26°31'53.976"N	97°49'58.583"W
Yankee	Jupiter	45201.88	43000	325	27°01'57.294"N	80°06'53.757"W
Zulu	Carolina Bch.	61542.71	59000	550	34°03'45.596"N	77°54'47.143"W
<u>GREAT LAKES CHAIN (8970)</u>						
Master	Dana			400	39°51'07.514"N	87°29'11.543"W
Whiskey	Malone	14355.06	11000	800	30°59'38.236"N	85°10'09.074"W
Xray	Seneca	31162.04	28000	800	42°42'50.465"N	76°49'34.470"W
Yankee	Baudette	47753.72	44000	500	48°36'50.007"N	94°33'16.988"W
<u>WEST COAST U.S. CHAIN (9940)</u>						
Master	Fallon			400	39°33'07.046"N	118°49'52.241"W
Whiskey	George	13796.89	11000	1600	47°03'48.594"N	119°44'34.793"W
Xray	Middletown	28094.50	27000	400	38°46'57.472"N	122°29'40.050"W
Yankee	Searchlight	41967.28	40000	540	35°19'18.342"N	114°48'13.946"W
<u>WEST COAST CANADA CHAIN (5990)</u>						
Master	Williams Lake			400	51°57'59.232"N	122°21'56.644"W
Xray	Shoal Cove	13343.63	11000	540	55°26'21.957"N	131°15'12.829"W
Yankee	George	28927.33	27000	1600	47°03'48.594"N	119°44'34.793"W
Zulu	Port Hardy	42266.60	41000	400	50°36'30.511"N	127°21'22.908"W
<u>GULF OF ALASKA CHAIN (7960)</u>						
Master	Tok			540	63°19'44.183"N	142°48'23.338"W
Xray	Narrow Cape	13804.44	11000	400	57°26'22.702"N	152°22'03.359"W
Yankee	Shoal Cove	29651.19	26000	540	55°26'21.957"N	131°15'12.829"W
<u>NORTH PACIFIC CHAIN (9990)</u>						
Master	St. Paul			325	57°09'15.934"N	170°14'58.344"W
Xray	Attu	14875.00	11000	325	52°49'50.051"N	173°11'00.421"E
Yankee	Pt. Clarence	32068.95	29000	1000	65°14'43.167"N	166°53'02.174"W
Zulu	Narrow Cape	46590.46	43000	400	57°26'22.702"N	152°22'03.359"W

Advanced Navigation Charts The Course of Progress In Loran-C Technology.



For more than 15 years the people at Advanced Navigation have been setting new standards in Loran-C navigation, monitoring and simulation.

Navigation The Model 7000 Airborne Loran-C Navigator is currently being tested to non-precision approach criteria. The system is TSO'd, and existing STCs approve use of the system for IFR flight (enroute and terminal areas) for national airspace. The wide area covered is obtained by a multi-rate approach.

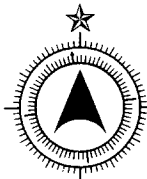
Recent research in the U.S. mid-continent area and Europe has yielded new information on synchronous interference and propagation anomalies. Since the 7000 is software controlled, even our earliest receiver now enjoys the advantages of the latest research.

Simulation Today, ANI is making its most ambitious strides in simulation. The 2500 programmable and dynamic Loran-C Simulator sys-

tem generates four rates—a master station and up to six secondaries on each rate. The ground wave and sky-wave amplitudes are controllable on each station. The System also includes: two CWI sources, a gaussian/atmospheric noise generator, provision for a customer noise source, and ECD control over a ± 4 microsecond range with 10 nanosecond resolution. Testing to RTCA or RTCM MOPS is possible.

How about flight simulation? The IBM personal computer controller allows disk file flight plans with real-time control, including a joystick control for groundspeed and heading. (Also, the Model 2042 Portable Simulator is still available and supported.)

So if you're in search of systems on the frontier of Loran-C technology, contact Advanced Navigation. ANI. The unchallenged leader in Loran-C technology today. Dedicated to creating advanced innovative Loran-C technology for tomorrow.

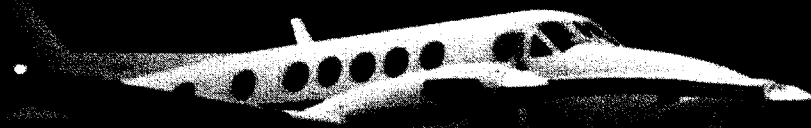


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ADVANCED NAVIGATION INC.

61 Thomas Johnson Drive
Fredrick, MD 21701

Announcing the first FAA Approved Loran-C non-precision approach.



Hanscomb Field, Nov. 4, 1985

ANI leads the way into a new era... Loran-C non-precision IFR approaches.

On November 4, FAA Administrator, Admiral Donald D. Engen, made the first approved Loran-C non-precision IFR approach at Hanscomb Field in Bedford, Massachusetts.

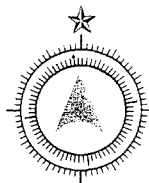
For the inaugural Loran-C approved approach, the aircraft was equipped with the model 7000 Airborne Loran-C Navigator — designed and manufactured by ANI. Regarded as the most technically advanced system of its kind, the software controlled ANI 7000 is TSO'd and has numerous STC'd installations. The 7000 had previously been approved for IFR flight in terminal areas and enroute in the national airspace.

This historic program will qualify Loran-C as an approved landing aid and lead to a greatly increased number of airports available to pilots for IFR approaches. The FAA is systematically testing airports and Loran-C equipment for approved approaches.

In addition, the FAA Tech Center is using ANI's Dynamic Flight Simulator to assist in approving other Loran-C navigation equipment for IFR approaches.

Step up to the system that is TSO'd and STC'd for terminal, enroute and now, approach flight. With more than 15 years at the forefront of Loran technology, Advanced Navigation takes you into a new era with a name you can trust.

Where vision drives technology.



ANI

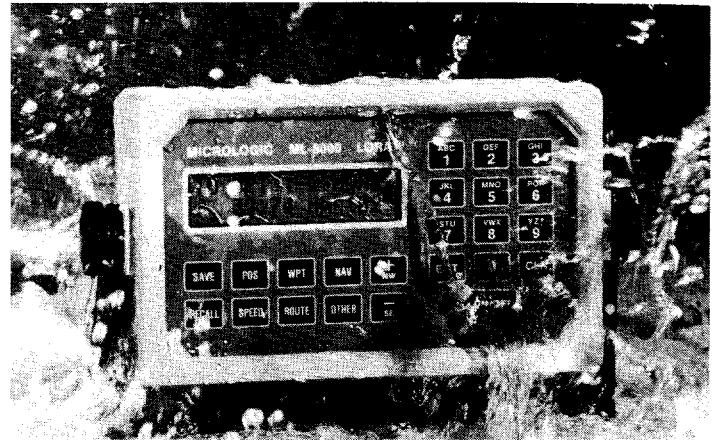
Advanced Navigation, Inc.
61 Thomas Johnson Drive, Fredrick, MD 21701

Martin Carl Poppe, Jr.

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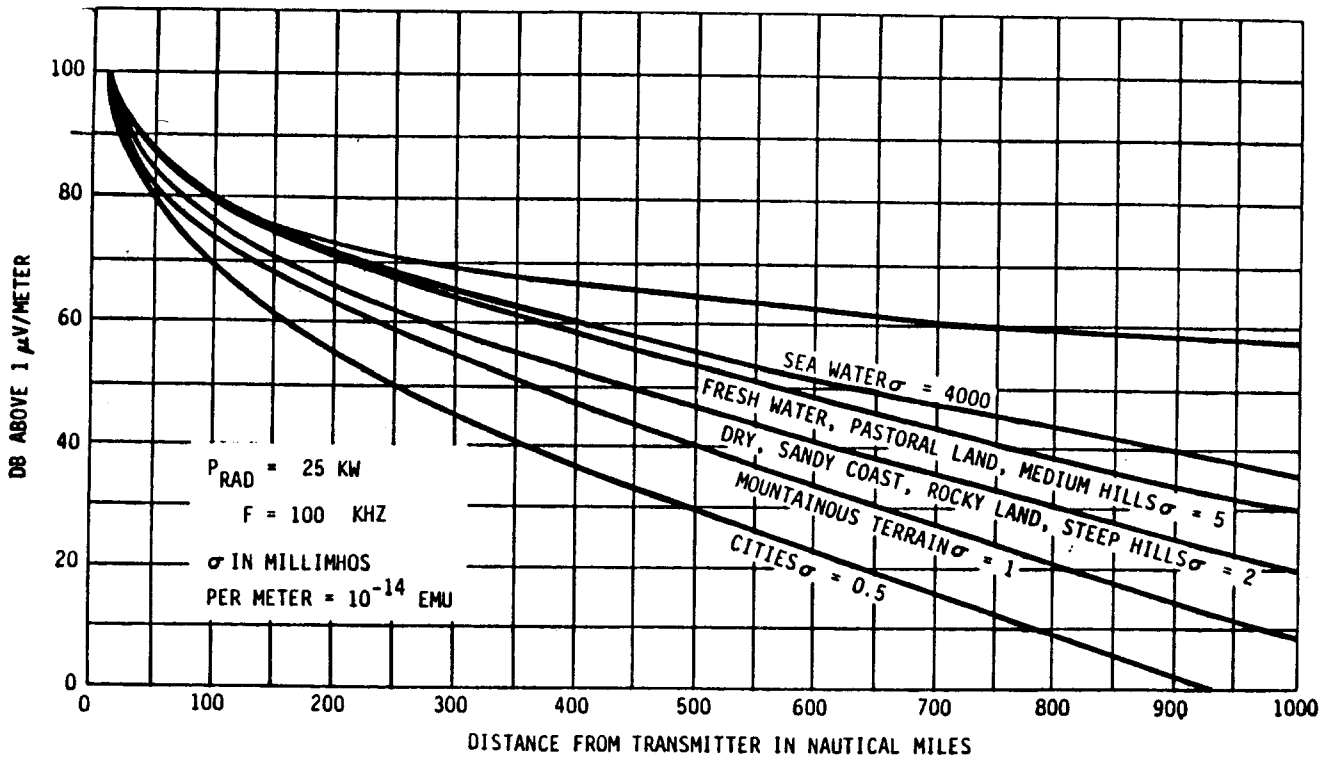
Survival Of The Fittest!

Micrologic's new ML-8000 can survive a direct hit by any wave or foul weather on deck. It's waterproof! (Warning: don't try this test on other Lorans!) ML-8000—the fittest of them all—is made in the U.S.A. It gives you 250 waypoints plus every standard nav-aid in plain English, instead of that confusing jumble of numbers you get from other Lorans. Available now for only \$1,395.

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GROUNDWAVE FIELD STRENGTH



LORAN-A IS ALIVE AND WELL.....

AND LIVING IN CHINA

LORAN-A STATIONS ON CHINESE COAST

The parameters of the following Loran-A stations situated along the China coast are given below :

STATIONS LORAN A SITUÉES SUR LA CÔTE CHINOISE

Les paramètres des stations Loran A situées le long de la côte de la Chine sont indiqués ci-dessous :

Rate (Cadence)	Station function (Fonction de la station)	Station	Coordinates (Coordonnées)	Coding delay (μ s) (Retard codé (μ s))
1L ₁	S (Esclave)	Shanggulin	38°50'09.61"N 117°30'17.31"E	1000
	M (Maître)	Chengshantou	37°23'51.37"N 122°40'47.69"E	
1L ₀	S	Zhuanghe	39°38'21.05"N 122°57'49.81"E	1000
1L ₄	S	Chengshantou	37°23'51.37"N 122°40'47.69"E	3000
	M	Sheyanghe	33°47'56.65"N 120°24'40.77"E	
1L ₅	S	Gouji	30°43'08.11"N 122°46'15.72"E	3000
	M	Shitang	28°15'42.46"N 121°36'45.18"E	1000
1S ₁	S	Tiandashan	25°28'00.18"N 119°42'16.05"E	1000
1S ₂	M	Shibeishan	22°56'26.64"N 116°29'31.88"E	1000
	S	Sanzao	22°00'32.37"N 113°24'10.53"E	
1S ₃	S	Longgun	19°02'55.44"N 110°33'48.06"E	1000
	M			

(Source: Chinese Notices to Mariners, No. 6, March 1986)

LORAN-C CHAIN-TRANSMITTING FACILITIES

NO.	GRI	LOCATION	EMISSION DELAY	ASSIGNED CODING DELAY	RADIATED POWER (KW)	WGS-72 COORDINATES	
1	MEDITERRANEAN SEA CHAIN						
	7990-M	SELLIA MARINA			165	38°52'20.587"N	16°43'06.159"E
	7990-X	LAMPEDUSA	12755.98	11000	325	35°31'20.787"N	12°31'30.245"E
	7990-Y	KARGABARUN	32273.29	29000	165	40°58'20.950"N	27°52'01.520"E
	7990-Z	ESTARTIT	50999.74	47000	165	42°03'36.515"N	3°12'15.512"E
2	NORWEGIAN SEA CHAIN						
	7970-M	EJDE			325	62°17'59.640"N	7°04'26.538"W
	7970-W	SYLT	30065.62	26000	325	54°48'29.872"N	8°17'36.312"E
	7970-X	BO	15048.10	11000	165	68°38'06.150"N	14°27'47.000"E
	7970-Y	SANDUR	48944.54	46000	1500	64°54'26.580"N	23°55'21.750"E
	7970-Z	JAN MAYEN	63216.31	60000	165	70°54'52.610"N	8°43'58.690"W
3	ICELANDIC CHAIN						
	9980-M	SANDUR			1500	64°54'26.580"N	23°55'21.750"W
	9980-W	ANGISSOQ	15068.03	11000	760	59°59'17.270"N	45°10'27.470"W
	9980-X	EJDE	32944.54	30000	325	62°17'59.640"N	7°04'26.538"W
4	LABRADOR SEA CHAIN						
	7930-M	FOX HARBOR				52°22'35.157"N	55°42'28.416"W
	7930-W	CAPE RACE	13167.30	11000	1500	46°46'32.180"N	53°10'28.160"W
	7930-X	ANGISSOQ	29565.38	26000	760	59°59'17.270"N	45°10'27.470"W
5	CANADIAN EAST COAST CHAIN						
	5930-M	CARIBOU			350	46°48'27.199"N	67°55'37.713"W
	5930-X	NANTUCKET	13131.88	11000	275	41°15'11.930"N	69°58'39.090"W
	5930-Y	CAPE RACE	28755.02	25000	1500	46°46'32.180"N	53°10'28.160"W
	5930-Z	FOX HARBOR	41594.58	38000	800	52°22'35.157"N	55°42'28.416"W
6	NORTHEAST U.S. CHAIN						
	9960-M	SENECA			800	42°42'50.603"N	76°49'33.862"W
	9960-W	CARIBOU	13797.20	11000	350	46°48'27.199"N	67°55'37.713"W
	9960-X	NANTUCKET	26969.93	25000	275	41°15'11.930"N	69°58'39.090"W
	9960-Y	CAROLINA BEACH	42221.64	39000	550	34°03'46.081"N	77°54'46.654"W
	9960-Z	DANA	57162.06	54000	400	39°51'07.540"N	87°29'12.140"W
7	SOUTHEAST U.S. CHAIN						
	7980-M	MALONE			800	30°59'38.740"N	85°10'09.305"W
	7980-W	GRANGEVILLE	12809.54	11000	800	30°43'33.018"N	90°49'43.600"W
	7980-X	RAYMONDVILLE	27443.38	23000	400	26°31'55.006"N	97°50'00.093"W
	7980-Y	JUPITER	45201.89	43000	275	27°01'58.393"N	80°06'53.429"W
	7980-Z	CAROLINA BEACH	61542.73	59000	550	34°03'46.081"N	77°54'46.654"W
8	GREAT LAKES CHAIN						
	8970-M	DANA			400	39°51'07.540"N	87°29'12.140"W
	8970-W	MALONE	14355.11	11000	800	30°59'38.740"N	85°10'09.305"W
	8970-X	SENECA	31162.06	28000	800	42°42'50.603"N	76°49'33.862"W
	8970-Y	BAUDETTE	47753.74	44000	500	48°36'49.844"N	94°33'18.469"W

LORAN-C CHAIN-TRANSMITTING FACILITIES

NO.	GRI	LOCATION	EMISSION DELAY	ASSIGNED CODING DELAY	RADIATED POWER (KW)	WGS-72 COORDINATES	
9	WEST COAST U.S. CHAIN						
	9940-M	FALLON			400	39° 33' 06.621"N	118° 49' 56.370"W
	9940-W	GEORGE	13796.90	11000	1600	47° 03' 47.990"N	119° 44' 39.530"W
	9940-X	MIDDLETOWN	28094.50	27000	400	38° 46' 56.990"N	122° 29' 44.529"W
	9940-Y	SEARCHLIGHT	41967.30	40000	540	35° 19' 18.180"N	114° 48' 17.435"W
10	WEST COAST CANADA CHAIN						
	5990-M	WILLIAMS LAKE			400	51° 57' 58.780"N	122° 22' 02.240"W
	5990-X	SHOAL COVE	13343.60	11000	540	55° 26' 20.851"N	131° 15' 19.648"W
	5990-Y	GEORGE	28927.36	27000	1600	47° 03' 47.990"N	119° 44' 39.530"W
	5990-Z	PORT HARDY	42266.61	41000	400	50° 36' 29.731"N	127° 21' 29.043"W
11	GULF OF ALASKA CHAIN						
	7960-M	TOK			540	63° 19' 42.814"N	142° 48' 31.900"W
	7960-X	NARROW CAPE	13804.45	11000	400	57° 26' 20.217"N	152° 22' 11.262"W
	7960-Y	SHOAL COVE	29651.14	26000	540	55° 26' 20.851"N	131° 15' 19.648"W
12	CENTRAL PACIFIC CHAIN						
	4990-M	JOHNSTON IS.			275	16° 44' 43.950"N	169° 30' 31.200"W
	4990-X	UPOLU POINT	15972.23	11000	275	20° 14' 49.160"N	155° 53' 09.700"W
	4990-Y	KURE IS.	34253.18	29000	275	28° 23' 41.770"N	178° 17' 30.200"W
13	NORTH PACIFIC CHAIN						
	9990-M	ST. PAUL			275	57° 09' 12.265"N	170° 15' 06.799"W
	9990-X	ATTU	14875.25	11000	275	52° 49' 44.040"N	173° 10' 48.974"E
	9990-Y	PORT CLARENCE	32068.95	29000	1000	65° 14' 40.306"N	166° 53' 12.550"W
	9990-Z	NARROW CAPE	46590.45	43000	400	57° 26' 20.217"N	152° 22' 11.262"W
14	NORTHWEST PACIFIC CHAIN						
	9970-M	IWO JIMA			1800	24° 48' 03.597"N	141° 19' 30.303"E
	9970-W	MARCUS	15283.98	11000	2100	24° 17' 07.888"N	153° 58' 53.232"E
	9970-X	HOKKAIDO	36685.17	30000	600	42° 44' 37.104"N	143° 43' 09.245"E
	9970-Y	GESASHI	59463.29	55000	600	26° 36' 24.975"N	128° 08' 56.445"E
	9970-Z	YAP	80746.75	75000	1000	9° 32' 45.789"N	138° 09' 54.970"E
15	COMMANDO LION CHAIN						
	5970-M	POHANG			35	36° 11' 05.797"N	129° 20' 27.279"E
	5970-W	HOKKAIDO	15783.68	11000	600	42° 44' 37.104"N	143° 43' 09.245"E
	5970-X	KWANG JU	31947.02	31000	35	35° 02' 23.871"N	126° 32' 26.741"E
	5970-Z	GESASHI	45565.56	42000	600	26° 36' 24.975"N	128° 08' 56.445"E
16	SUEZ CANAL CHAIN						
	4990-M	BILBEIS			6.4	30° 20' 08.69" N	31° 33' 31.60" E
	4990-X	SHALABI EL RUDI	10986.512			31° 23' 28.03" N	32° 01' 12.85" E
	4990-Y	RAS EL SUDR	24988.666			29° 43' 59.96" N	33° 42' 01.23" E

SAUDI ARABIA LORAN-C SYSTEM NORTH CHAIN DATA SHEET - GRI 8990

<u>STATION</u>	<u>FUNCTION</u>	<u>COORDINATES</u>	<u>EMISSION DELAY CODING DELAY (USEC)</u>	<u>POWER, KW</u>
AFIF	MASTER	23 48 36.82 N 42 51 17.63 E		800
SALWA	VICTOR	24 50 01.50 N 50 34 12.02 E	13641.09 11000	800
AR RUQI	WHISKY	29 01 04.61 N 46 37 21.96 E	27298.51 25000	200
ASH SHAYKH HUMAYD	X-RAY	28 09 15.87 N 34 45 39.99 E	43145.53 40000	400
AL LITH	YANKEE	20 13 58.31 N 40 12 31.02 E	57606.26 56000	200
AL MUWASSAM	ZULU	16 25 55.89 N 42 48 04.33 E	71726.94 69000	800
JUBAIL	MONITOR	27 19 36.40 N 49 28 30.67 E		
YANBU	MONITOR	24 04 14.14 N 38 02 35.90 E		
AL QUNFUDHAH	MONITOR	19 08 48.27 N 41 03 40.69 E		

SOUTH CHAIN DATA SHEET - GRI 7170

<u>STATION</u>	<u>FUNCTION</u>	<u>COORDINATES</u>	<u>EMISSION DELAY CODING DELAY (USEC)</u>	<u>POWER, KW</u>
AL KHAMASIN	MASTER	20 28 01.89 N 44 34 52.34 E		800
SALWA	WHISKY	24 50 01.50 N 50 34 12.02 E	13612.55 11000	800
AFIF	X-RAY	23 48 36.82 N 42 51 17.63 E	27371.23 26000	800
AL LITH	YANKEE	20 13 58.31 N 40 12 31.02 E	40526.50 39000	200
AL MUWASSAM	ZULU	16 25 55.89 N 42 48 04.33 E	53617.59 52000	800
JUBAIL	MONITOR	27 19 36.40 N 42 28 30.67 E		
YANBU	MONITOR	24 04 14.14 N 38 02 35.90 E		
AL QUNFUDHAH	MONITOR	19 08 48.27 N 41 03 40.69 E		

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News media information 202/632-5050. Recorded listing of releases and texts 202/632-0002.

October 22, 1986

Status of Power Line Carrier (PLC)

Commercial Telephone Systems

Non-government PLC systems operate on a non-licensed basis as restricted radiation devices under Part 15 of the Commission's Rules. Government PLC systems operate under Chapter 7 of the National Telecommunications and Information Administration (NTIA) Manual of Regulations and Procedures for Federal Radio Frequency Management. As a consequence, all PLC systems may only operate on a sufferance or non-interference basis to authorized radio services and receive no protection from interference which may be caused by authorized radio services. Hence, disruptive interference must not only be contemplated, it must also be expected.

In the event that users subscribing to PLC telephone and data services experience disruptive interference caused by other incidental or restricted radiation devices, industrial, scientific, or medical equipment, or from any authorized radio users this interference must be accepted. In addition, neither the Commission nor NTIA is required to take any action to reduce, resolve, or eliminate any disruptive interference situation experienced by subscribers to PLC systems. On the other hand, should the use of PLC equipment cause disruptive interference to any licensed or authorized radio services, particularly radionavigation systems, the power utility company is compelled by law to discontinue or adjust its operation as may be required to remedy the problem.

PLC systems are now used to provide both voice and data commercial telephone service to some subscribers residing in locations where public telephone service is not available. Therefore, the Commission wishes to alert these subscribers, the industry, and the public, that PLC systems continue to operate with a non-allocated and non-licensed status. Consequently, by this Notice, these users are being given the opportunity to anticipate, assess, evaluate, or make adjustments for, any risks or inconvenience which may be involved if their telephone or data communications are jeopardized.

For further information, contact the Technical Standards Branch at (202) 653-6288, 7313, 7314 or 7316.

LORAN-C INTERFERENCE LIST

EASTERN REGION

Frequency	Transmitter Location (Source of Interference)	Authorized Power (kw)	OBSERVED FIELD STRENGTH (dB/uV/m)						
			Cape Elizabeth ME	Sandy Hook NJ	EECEN Wildwood NJ	Mayport FL	Eglin FL	New Orleans LA	Plumbrook OH
70 - 116 kHz									
70.387	Newfoundland	1.2			31.5				
71.142	Nova Scotia	2.7	43.5		40.8				
71.437	Quebec	1.2			35.7				
73.6	Nova Scotia	250	74.0	65.4	68.0	51.6	39.5	39.8	35.0
76.4	--	--							79.0
77.5	--	--			32.5			40.0	
84.465	Newfoundland	1.2			33.1				
84.73	Ontario	0.9							46.0
85.37	Nova Scotia	2.4	49.6		40.0	38.9			
85.43	Nova Scotia	2.4		44.2					
88.0 (±.85)	Annapolis	50		86.1					
112.3	Ontario	3.0			52.0			35.3	56.0
112.5	Halifax	15.0	66.0			40.7			
113.2	Ottawa	3.0	43.5	49.5	52.3	46.1			51.0
113.627	Nova Scotia	2.4					32.3		
114.3	Quebec	1.2	36.1					37.4	
115.3	Halifax	250		48.0					
116.0	--	--	40 (est)						
116 - 150 kHz									
116.8	--	--	36.0						
117.157	Quebec	1.2		46.2					
119.85	Norfolk	2.0	30 (est)			42.4			
125.8	Manitoba	10		33.9					
128.25	New York	--							
128.25	Newport, RI	--	52.2	66.5	30.6				
131.1	Ontario	3.0	39.7	48.0	37.7				
133.14	Halifax	15	58.1		38.5				
134.9	Annapolis	100		77.7					
137.7	--	--						39.5	58.0
139.8(±.85)	Newport, RI	20							
139.8(±.85)	Norfolk	100		72.4	79.9	57.7	45.2	43.9	64.0
143.6	Nova Scotia	40	56.8		36.3				
145.4	--	--							
148.5	Ontario	3.0		57.3	48.3				

LORAN-C INTERFERENCE LIST
WESTERN REGION

Frequency	Transmitter Location (Source of Interference)	Authorized Power (kw)	OBSERVED FIELD STRENGTH (dB/uV/m)					
			Point Pinos CA	North Bend OR	Comox BC	Juneau AK	Kodiak AK	
70 - 150 kHz								
119.85	San Francisco	50	75.0		55.0	34.3	60.4	
123.0	Nanaimu, BC	3		38.4	80.8	36.1		
128.25	San Diego	--			43.0	36.9		
128.95	Honolulu	--		34.0				
133.15	Vancouver	25		49.1	83.9	40.2		
148.2	San Francisco	50						
148.2	San Diego	50	43.5					

LORAN CHART AVAILABILITIES

On the following pages we have attempted to present data on available charts, including areas covered and sources of information. The listings presented are excerpts from the NOAA Nautical Chart Catalogs listed below and from listings from the Canadian Hydrographic Service. We strongly suggest that, if you have a continuing need for charts, you obtain the indicated chart catalogs for the areas of interest. Each of the catalogs provides greater detail of information than given below.

ORDERING INFORMATION

NATIONAL OCEAN SERVICE

National Oceanic and Atmospheric Administration (NOAA)

U.S. Department of Commerce

The NOAA charts may be ordered from your nearest sales agent or from:

Distribution Branch (N/CG33)
National Ocean Service
Riverdale, MD 20737
Phone: 301-436-6990

The following Nautical Chart Catalogs (dated October 1984) are available from the same source at no charge:

<u>Nautical Chart Catalog</u>	<u>Area of Coverage</u>
1	Atlantic and Gulf Coasts, including Puerto Rico and the Virgin Islands
2	Pacific Coast, including Hawaii, Guam, and the Samoa Islands
3	Alaska, including the Aleutian Islands
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
Telephone: 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
Department of Fisheries and Oceans
1675 Russel Road, P.O. Box 8080
Ottawa, K1G 3H6, Ontario, Canada
Telephone: 613 998-4931, -4932, -4933
Telex: 053-4228
Cable: (MAR SI-OTT)

ICELANDIC HYDROGRAPHIC SERVICE:

SJOMAELINGAR ISLANDS
POSTHOLF 7094
SELJAVEGI 32
REYKJAVIK, ICELAND

NORWEGIAN HYDROGRAPHIC OFFICE:

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

GERMAN HYDROGRAPHIC INSTITUTE:

Deutsches Hydrographisches Institute
(D.I.H.)
Bernhard - Nocht Str. 78
200 Hamburg 4,
Germany

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

CHARTS OF THE GREAT LAKES

Chart Number	Title	Scale	Chart Number	Title	Scale
© 14500	Great Lakes, Lake Champlain to Lake of the Woods	1:1,500,000	LAKE HURON		
	LAKE ONTARIO		© 14860	Lake Huron	1:500,000
© 14800	Lake Ontario (includes Metric version)	1:400,000	© 14862	Port Huron to Pte aux Barques	1:120,000
© 14802	Clayton to False Ducks Is.	1:80,000		Port Sanilac	1:5,000
© 14803	Six Miles south of Stony Point to Port Bay	1:80,000		Harbor Beach	1:10,000
	North Pond	1:20,000	© 14863	Saginaw Bay	1:120,000
	Little Sodus Bay	1:15,000		Port Austin	1:10,000
© 14804	Port Bay to Long Pond	1:80,000		Caseville	1:10,000
	Port Bay Harbor	1:15,000		Entrance to Au Sable River	1:10,000
© 14805	Long Pond to Thirtymile Point	1:80,000		Sebewaing	1:20,000
	Point Breeze Harbor	1:10,000		Tawas Harbor	1:30,000
© 14806	Thirtymile Point, N.Y., to Port Dalhousie, Ont.	1:80,000	© 14864	Harrisville to Forty Mile Point	1:120,000
	Olcott and Wilson Harbors	1:10,000		Harrisville Harbor	1:12,000
© 14810	Olcott Harbor to Toronto (Metric)	1:100,000		Alpena	1:15,000
	Olcott and Wilson Harbors	1:10,000		Rogers City and Calcite	1:20,000
14811	Chaumont, Henderson and Black River Bays	1:30,000	14865	South End of Lake Huron	1:15,000
	Sockets Harbor	1:5,000	14867	Saginaw River	1:20,000
	Henderson Harbor	1:10,000	14869	Thunder Bay Island to Presque Isle	1:60,000
	Chaumont Harbor	1:12,000		Stoneport Harbor	1:10,000
14813	Oswego Harbor	1:10,000		Presque Isle Harbor	1:15,000
14814	Sodus Bay	1:10,000			
14815	Rochester Harbor, including Genesee River to head of navigation	1:10,000	© Includes LORAN-C Lines of Position		
14816	Niagara Falls to Lake Ontario	1:30,000	SC Indicates Small-Craft Chart		

All Great Lakes Charts are on Polyconic Projection except as follows:
Mercator Projection - 14901, 14961, 14996, 14997, 14998
and all Metric Charts.
Lambert Conformal Projection - 14982 thru 14995.

CHARTS OF THE GREAT LAKES

Chart Number	Title	Scale	Chart Number	Title	Scale
© 14500	Great Lakes, Lake Champlain to Lake of the Woods	1:1,500,000		LAKE MICHIGAN – Continued	
	STRAITS OF MACKINAC		© 14909	Upper Green Bay – Jackson Harbor and Detroit Harbor	1:80,000
© 14880	Straits of Mackinac	1:120,000		Detroit Harbor	1:20,000
© 14881	Detour Passage to Waugoshance Pt. Hammond Bay Harbor	1:80,000		Jackson Harbor	1:20,000
	Mackinac Island	1:10,000	© 14910	Baileys Harbor	1:25,000
	Cheboygan	1:15,000		Lower Green Bay	1:80,000
	Mackinaw City	1:15,000		Oconto	1:20,000
	St. Ignace	1:15,000		Algoma	1:10,000
14882	St. Marys River – Detour Passage to Munuscong Lake	1:40,000	© 14911	Waugoshance Point to Seul Choix Point, including Beaver Island Group	1:80,000
	Detour Passage	1:20,000		Port Inland	1:10,000
14883	St. Marys River – Munuscong Lake to Sault Ste. Marie	1:40,000	© 14912	Beaver Harbor	1:15,000
14884	St. Marys River – Head of Lake Nicolet to Whitefish Bay	1:40,000		Platte Bay to Leland	1:80,000
	Sault Ste. Marie	1:20,000		Leland	1:5,000
14885	Les Cheneaux Islands	1:20,000	© 14913	South Manitou Harbor	1:30,000
14886	SMALL-CRAFT BOOK CHART – Inland Route, Cheboygan to Conway (book of 12 charts)	Various		Grand Traverse Bay to Little Traverse Bay	1:80,000
	LAKE MICHIGAN			Harbor Springs	1:10,000
© 14900	Lake Michigan	1:500,000		Petoskey	1:10,000
© 14901	Lake Michigan (Mercator Projection)	1:500,000		Elk Rapids	1:10,000
© 14902	North end of Lake Michigan, including Green Bay	1:240,000		Suttons Bay	1:10,000
© 14903	Algoma to Sheboygan	1:120,000		Northport	1:10,000
	Kewaunee	1:10,000		Traverse City	1:15,000
	Two Rivers	1:10,000	14915	Little Bay de Noc	1:30,000
14904	Port Washington to Waukegan	1:120,000	14916	SMALL-CRAFT BOOK CHART – Lake Winnebago and Lower Fox River (book of 34 charts)	Various
	Port Washington	1:10,000	14917	Menominee and Marinette Harbors	1:15,000
	Kenosha	1:10,000	14918	Head of Green Bay, including Fox River below De Pere	1:25,000
	Waukegan	1:10,000		Green Bay	1:10,000
	Oak Creek Harbor	1:5,000	14919	Sturgeon Bay and Canal	1:30,000
© 14905	Waukegan to South Haven	1:120,000		Sturgeon Bay	1:10,000
	Michigan City	1:15,000	14922	Manitowac and Sheboygan Harbors	1:10,000
	Burns Waterway Harbor	1:15,000	14924	Milwaukee Harbor	1:10,000
	New Buffalo	1:15,000	14925	Racine Harbor	1:10,000
© 14906	South Haven to Stony Lake	1:120,000	14926	SMALL-CRAFT BOOK CHART – Chicago and South Shore of Lake Michigan (book of 30 charts)	Various
	South Haven	1:10,000	14927	Chicago Lake Front-Wilmette to Gary	1:60,000
	Port Sheldon	1:10,000		Gary Harbor	1:15,000
	Saugatuck Harbor	1:15,000	14928	Chicago Harbor	1:15,000
© 14907	Stony Lake to Point Betsie	1:120,000	14929	Calumet, Indiana and Buffington Harbors, and Lake Calumet	1:15,000
	Pentwater	1:10,000	14930	St. Joseph and Benton Harbor	1:10,000
	Arcadia	1:10,000	14932	Holland Harbor	1:15,000
	Frankfort	1:10,000	14933	Grand Haven, including Spring Lake and Lower Grand River	1:15,000
© 14908	Dutch Johns Point to Fishery Point, including Big Bay de Noc and Little Bay de Noc	1:80,000	14934	Muskegon and Muskegon Lake	1:15,000
	Manistique	1:15,000	14935	White Lake	1:10,000
			14937	Ludington and Pere Marquette Lake	1:5,000
			14938	Manistee and Manistee Lake	1:10,000
			14939	Portage Lake	1:10,000
			14942	Lake Charlevoix	1:30,000
				Charlevoix, South Point to Round Lake	1:10,000

© Includes LORAN-C Lines of Position.

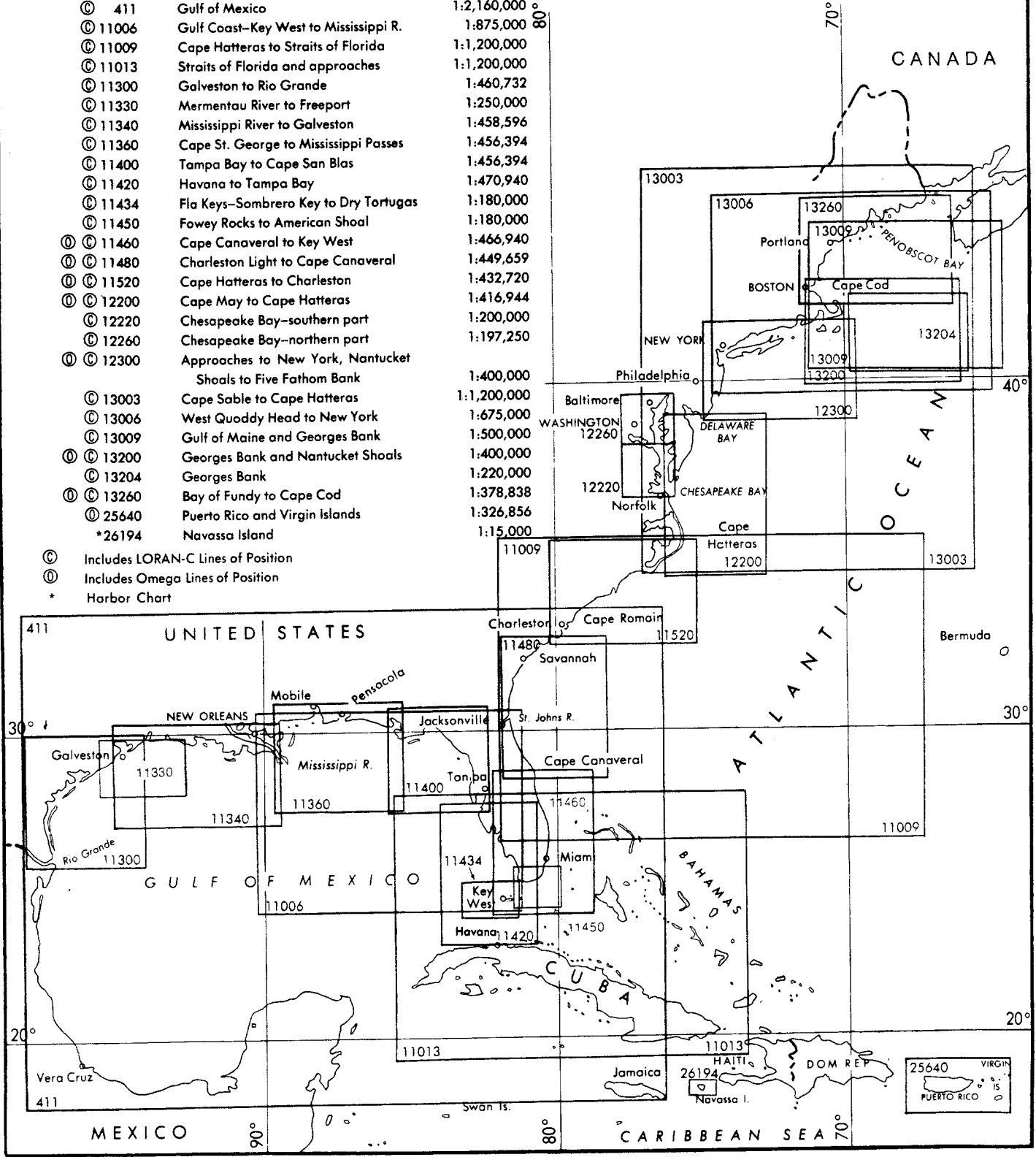
CHARTS OF THE GREAT LAKES

Chart Number	Title	Scale	Chart Number	Title	Scale
LAKE SUPERIOR			LAKE ERIE		
① 14960	Lake Superior	1:600,000	① 14820	Lake Erie (includes Metric version)	1:400,000
① 14961	Lake Superior (Mercator Projection)	1:600,000	① 14822	Approaches to Niagara River and Welland Canal	1:80,000
① 14962	St. Marys River to Au Sable Point	1:120,000	① 14823	Sturgeon Point to Twentymile Creek	1:80,000
	Whitefish Point	1:5,000		Dunkirk Harbor	1:15,000
	Little Lake Harbors	1:5,000		Barcelona Harbor	1:5,000
	Grand Marais Harbor	1:15,000		Buffalo to Erie (Metric)	1:120,000
① 14963	Grand Marais to Big Bay Point	1:120,000		Dunkirk Harbor	1:15,000
	Big Bay Harbor	1:5,000	① 14824	Barcelona Harbor	1:5,000
① 14964	Big Bay Point to Redridge, including Keweenaw Peninsula and Keweenaw Waterway	1:120,000		Sixteenmile Creek to Conneaut	1:80,000
	Grand Traverse Bay Harbor	1:5,000		Conneaut Harbor	1:10,000
	Lac La Belle Harbor	1:20,000	① 14825	Ashtabula to Chagrin River	1:80,000
	Copper and Eagle Harbors	1:15,000		Mentor Harbor	1:10,000
① 14965	Redridge to Saxon Harbor	1:120,000		Chagrin River	1:10,000
	Ontonagon Harbor	1:10,000	① 14826	Mass Point to Vermilion	1:80,000
	Black River Harbor	1:5,000		Beaver Creek	1:5,000
	Saxon Harbor	1:2,500		Vermilion Harbor	1:10,000
① 14966	Little Girls Point to Silver Bay, including Duluth and Apostle Islands	1:120,000		Rocky River	1:10,000
	Cornucopia Harbor	1:5,000	① 14828	Erie to Geneva (Metric)	1:100,000
	Port Wing Harbor	1:5,000	① 14829	Geneva to Lorain (Metric)	1:100,000
	Knife River Harbor	1:5,000		Beaver Creek	1:7,500
	Two Harbors	1:10,000		Rocky River	1:10,000
① 14967	Beaver Bay to Pigeon Point	1:120,000		Mentor Harbor	1:10,000
	Silver Bay Harbor	1:10,000		Chagrin River	1:10,000
	Taconite Harbor	1:10,000	① 14830	West End of Lake Erie	1:100,000
	Grand Marais Harbor	1:10,000		Port Clinton Harbor	1:15,000
① 14968	Grand Portage Bay to Shesheeb Point, Ont., including Isle Royale	1:120,000		Monroe Harbor	1:20,000
14969	Munising Harbor, including Grand Island	1:30,000	① 14830	Lorain to Detroit River (Metric)	1:100,000
	Munising Harbor	1:15,000		Vermilion	1:10,000
14970	Marquette and Presque Isle Harbors	1:15,000	14832	Niagara Falls to Buffalo	1:30,000
14971	Keweenaw Bay	1:30,000	14833	Buffalo Harbor	1:15,000
	L'Anse and Baraga Harbors	1:10,000	14835	Erie Harbor	1:15,000
14972	Keweenaw Waterway, including Torch Lake	1:30,000	14836	Ashtabula Harbor	1:5,000
	Hancock and Houghton	1:10,000	14837	Fairport Harbor	1:8,000
14973	Apostle Islands, including Chequamegon Bay	1:60,000	14839	Cleveland Harbor, including lower Cuyahoga River	1:10,000
	Bayfield Harbor	1:10,000		Lorain Harbor	1:10,000
	Pikes Bay Harbor	1:10,000	14841	Lorain Harbor	1:10,000
	La Pointe Harbor	1:10,000	14842	SMALL-CRAFT BOOK CHART - Port Clinton to Sandusky, including the Islands (book of 35 charts)	Various
14974	Ashland and Washburn Harbors	1:15,000	14843	Huron Harbor	1:5,000
14975	Duluth-Superior Harbor	1:15,000	14844	Islands in Lake Erie, including Sandusky Bay	1:40,000
	Upper St. Louis River	1:30,000		Put-in-Bay	1:10,000
14976	Isle Royale	1:40,000	14845	Sandusky Harbor	1:10,000
			14846	SMALL-CRAFT BOOK CHART - Pte. Mouillee to Toledo to Port Clinton (book of 34 charts)	Various
			14847	Toledo Harbor	1:20,000
				Entrance Channel to Harbor	1:40,000
			14848	Detroit River	1:30,000
			14849 SC	Detroit River (Pocket Fold)	1:30,000
			① 14850	Lake St. Clair	1:60,000
			① 14851 SC	Lake St. Clair (Pocket Fold)	1:60,000
			14852	St. Clair River	1:40,000
				Head of St. Clair River	1:15,000
			14853	SMALL-CRAFT BOOK CHART - Detroit River, Lake St. Clair and St. Clair River (book of 47 charts)	Various
			14854	Trenton Channel and River Rouge	1:15,000
				River Rouge	1:10,000

SAILING AND GENERAL CHARTS - ATLANTIC AND GULF COASTS

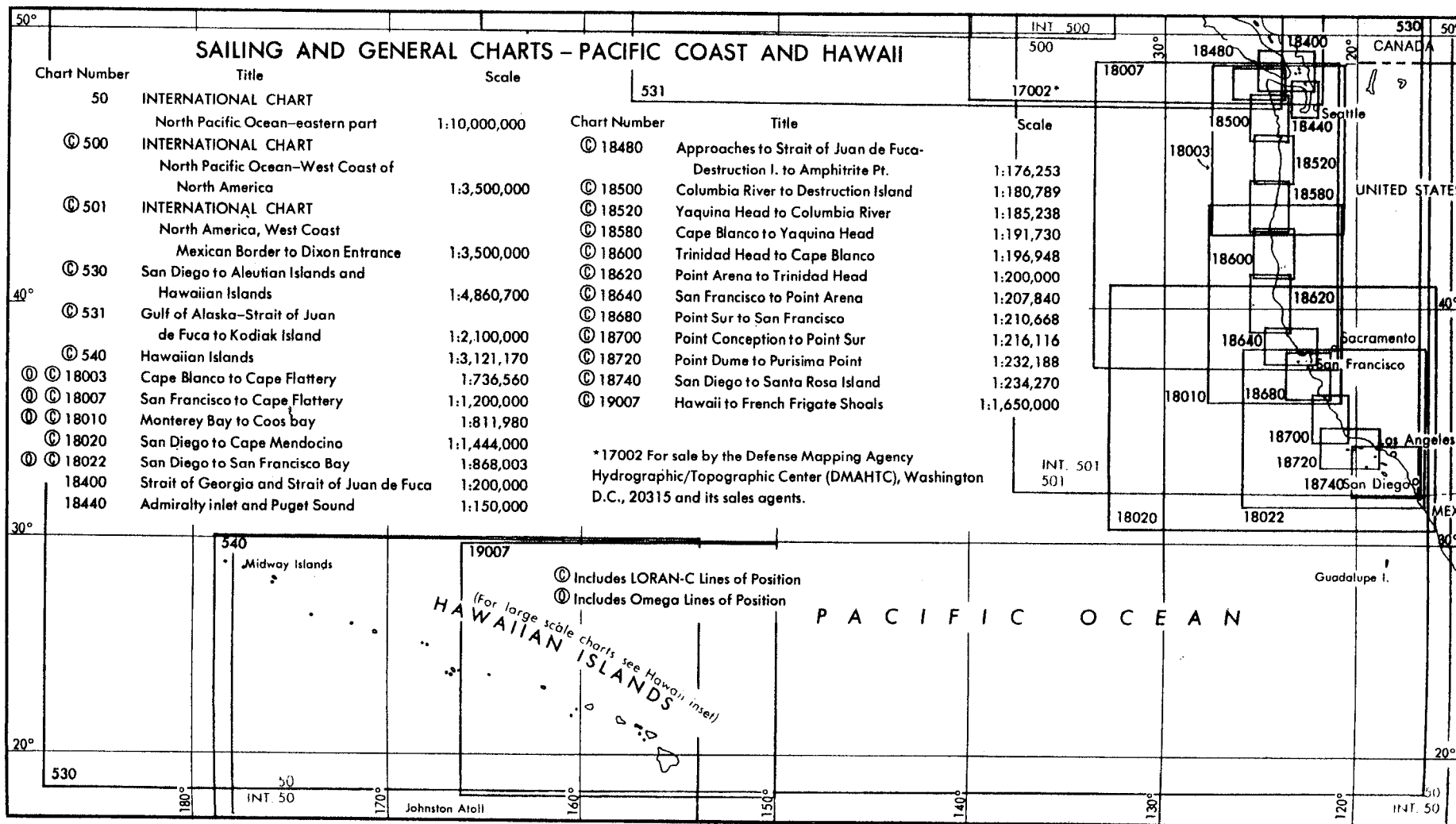
Chart Number	Title	Scale
© 411	Gulf of Mexico	1:2,160,000
© 11006	Gulf Coast-Key West to Mississippi R.	1:875,000
© 11009	Cape Hatteras to Straits of Florida	1:1,200,000
© 11013	Straits of Florida and approaches	1:1,200,000
© 11300	Galveston to Rio Grande	1:460,732
© 11330	Mermentau River to Freeport	1:250,000
© 11340	Mississippi River to Galveston	1:458,596
© 11360	Cape St. George to Mississippi Passes	1:456,394
© 11400	Tampa Bay to Cape San Blas	1:456,394
© 11420	Havana to Tampa Bay	1:470,940
© 11434	Fla Keys-Sombrero Key to Dry Tortugas	1:180,000
© 11450	Fowey Rocks to American Shoal	1:180,000
Ⓞ © 11460	Cape Canaveral to Key West	1:466,940
Ⓞ © 11480	Charleston Light to Cape Canaveral	1:449,659
Ⓞ © 11520	Cape Hatteras to Charleston	1:432,720
Ⓞ © 12200	Cape May to Cape Hatteras	1:416,944
© 12220	Chesapeake Bay-southern part	1:200,000
© 12260	Chesapeake Bay-northern part	1:197,250
Ⓞ © 12300	Approaches to New York, Nantucket Shoals to Five Fathom Bank	1:400,000
© 13003	Cape Sable to Cape Hatteras	1:1,200,000
© 13006	West Quoddy Head to New York	1:675,000
© 13009	Gulf of Maine and Georges Bank	1:500,000
Ⓞ © 13200	Georges Bank and Nantucket Shoals	1:400,000
© 13204	Georges Bank	1:220,000
Ⓞ © 13260	Bay of Fundy to Cape Cod	1:378,838
Ⓞ 25640	Puerto Rico and Virgin Islands	1:326,856
*26194	Navassa Island	1:15,000

- © Includes LORAN-C Lines of Position
- Ⓞ Includes Omega Lines of Position
- * Harbor Chart



PACIFIC COAST AND HAWAII

59



ALASKA AND ALEUTIAN ISLANDS

Chart Number	Title	Scale	Chart Number	Title	Scale
50	INTERNATIONAL CHART		16123	Point Hope to Cape Dyer	1:50,000
	North Pacific Ocean—eastern part	1:10,000,000	16124	Cape Thompson to Point Hope	1:50,000
Ⓢ 500	INTERNATIONAL CHART		Ⓢ 16200	Norton Sound	1:400,000
	North Pacific Ocean—West Coast of North America	1:3,500,000		Golovnin Bay	1:100,000
Ⓢ 501	INTERNATIONAL CHART		Ⓢ 16204	Port Clarence and approaches	1:100,000
	North America, West Coast—Mexican Border to Dixon Entrance	1:3,500,000	16206	Nome Hbr. and approaches, Norton Sound	1:20,000
Ⓢ 513	INTERNATIONAL CHART			Nome Harbor	1:2,500
	North Pacific Ocean—Bering Sea, southern part	1:3,500,000	Ⓢ 16240	Cape Ramanzof to St. Michael	1:300,000
Ⓢ 514	INTERNATIONAL CHART			St. Michael Bay	1:40,000
	North Pacific Ocean—Bering Sea, northern part	1:3,500,000	Ⓢ 16300	Approaches to Cape Ramanzof	1:100,000
Ⓢ 530	San Diego to Aleutian Islands and Hawaiian Islands	1:4,860,700	Ⓢ 16322	Kuskokwim Bay	1:200,000
Ⓢ 531	Gulf of Alaska—Strait of Juan de Fuca to Kodiak Island	1:2,100,000	Ⓢ 16323	Bristol Bay—Nushagak B. and approaches	1:100,000
16003	Arctic Coast	1:1,587,780	Ⓢ 16380	Dillingham small boat basin	1:10,000
Ⓢ 16004	Pt. Barrow to Herschel Island	1:700,000	Ⓢ 16420	Bristol Bay—Kvichak Bay and approaches	1:100,000
Ⓢ 16005	Cape Prince of Wales to Pt. Barrow	1:700,000	Ⓢ 16421	Pribilof Islands	1:200,000
Ⓢ 16006	Bering Sea—eastern part	1:1,534,076	Ⓢ 16421	Near Islands—Buldir I. to Attu Islands	1:300,000
	St. Matthew Island, Bering Sea	1:500,000		Near Islands—	
	Cape Etolin, Achorage, Nunivak Island	1:80,000	Ⓢ 16440	Ingenstrem Rocks to Attu Island	1:160,000
	Nash Harbor, Nunivak Island	1:40,000		Rat Islands—	
Ⓢ 16011	Alaska Peninsula and Aleutian Islands to Segum Pass	1:1,023,188	Ⓢ 16460	Semisopachnoi I. to Buldir Island	1:300,000
Ⓢ 16012	Aleutian Islands		Ⓢ 16471	Igitkin Island to Semisopachnoi Island	1:300,000
	Amukta Island to Attu Island	1:1,126,321		Andreanof Islands—	
Ⓢ 16013	Cape St. Elias to Shumagin Islands	1:969,761	Ⓢ 16480	Atka Pass to Adak Strait	1:120,000
	Semidi Islands, Chirikof Island	1:400,000	Ⓢ 16500	Amukta Island to Igitkin Island	1:300,000
Ⓢ 16016	Dixon Entrance to Cape St. Elias	1:969,756	Ⓢ 16520	Unalaska Island to Amukta Island	1:300,000
16041	Demarcation Bay and approaches	1:51,639		Unimak and Akutan Passes and approaches	1:300,000
16042	Griffin Pt. and approaches	1:51,024	Ⓢ 16540	Shumagin Islands to Sanak Islands	1:300,000
16043	Barter Island and approaches	1:50,819		Mist Harbor	1:15,000
	Bernard Harbor	1:20,000	Ⓢ 16580	Kodiak Island	1:350,000
16044	Camden Bay and approaches	1:50,819		Southwest Anchorage, Chirikof Island	1:53,600
16045	Bullen Pt. to Brownlow Pt.	1:50,615	Ⓢ 16640	Cook Inlet—southern part	1:200,000
16046	McClure and Stockton Islands and vicinity	1:50,204		Ninilchik Harbor	1:5,000
16061	Prudhoe Bay and vicinity	1:50,000	Ⓢ 16660	Cook Inlet—northern part	1:194,154
16062	Jones Islands and approaches	1:49,794		Nikishka	1:40,000
16063	Harrison Bay—eastern part	1:49,590	Ⓢ 16680	Kenai River	1:40,000
16064	Harrison Bay—western part	1:49,794	Ⓢ 16700	Drift River	1:40,000
16065	Cape Halkett and vicinity	1:49,177	Ⓢ 16760	Point Elrington to East Chugach Island	1:200,000
16066	Pitt Pt. and vicinity	1:48,973	Ⓢ 17300	Prince William Sound	1:200,000
16067	Approaches to Smith Bay	1:48,767		Cross Sound to Yakutat Bay	1:300,000
16081	Scott Pt. to Tangent Pt.	1:48,149	Ⓢ 17300	Stephens Passage to Cross Sound, including Lynn Canal	1:209,978
16082	Pt. Barrow and vicinity	1:47,943	Ⓢ 17320	Coronation Island to Lisianski Strait	1:217,828
16083	Skull Cliff and vicinity	1:50,000	17360	Etolin Island to Midway Islands, including Sumner Strait	1:217,828
16084	Pearl Bay and approaches	1:50,000	Ⓢ 17400	Dixon Entrance to Chatham Strait	1:229,376
16085	Wainwright Inlet to Atanik	1:50,000	Ⓢ 17420	Hecate Strait to Etolin Island, including Behm and Portland Canals	1:229,376
16086	Nakotlek Pt. to Wainwright Inlet	1:50,000	Ⓢ 18007	San Francisco to Cape Flattery	1:1,200,000
16087	Icy Cape to Nakotlek Pt.	1:50,000	*17002	For sale by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) Washington, D.C. 20315 and its sales agents.	
16088	Utukok Pass to Blossom Shoals	1:50,000			
16101	Pt. Lay and approaches	1:50,000	Ⓢ	Includes LORAN-C Lines of Position	
16102	Koocheek River to Kukpowruk Pass	1:50,000	Ⓢ	Includes Omega Lines of Position	
16103	Cape Beaufort	1:50,000			
16104	Cape Sabine	1:50,000			
16121	East of Cape Lisburne	1:50,000			
16122	Cape Dyer to Cape Lisburne	1:50,000			

LORAN-C CHARTS AVAILABLE FROM THE CANADIAN HYDROGRAPHIC SERVICE

(As of October 15, 1984)

Atlantic Coast

L/C	1235	1:80,000	Pointe au Boisvert à/to Cap de la Tête au Chien
L/C	1236	1:200,000	Pointe des Monts aux/to Escoumins
L/C	4001	1:3,500,000	Gulf of Maine to/à Strait of Belle Isle
L/C	4002	1:750,000	Golfe du Saint-Laurent/Gulf of St. Lawrence
L/C	4003	1:1,000,000	Cape Breton to/à Cape Cod
L/C	4006	1:3,500,000	Newfoundland/Terre-Neuve to/à Bermuda
L/C	4010	1:200,000	Bay of Fundy (Inner Portion)
L/C	4011	1:300,000	Approaches to/Approches a Bay of Fundy
L/C	4012	1:300,000	Yarmouth to/à Halifax
L/C	4013	1:350,000	Halifax to/à Sydney
L/C	4015	1:350,000	Sydney to Saint-Pierre
L/C	4016	1:350,000	Saint-Pierre to St. John's
L/C	4017	1:350,000	Cape Race to Cape Freels
L/C	4021	1:350,000	Pointe Amour à/to Cape Whittle et/and Cape St. George
L/C	4022	1:350,000	Cabot Strait and Approaches
L/C	4023	1:300,000	Northumberland Strait
L/C	4024	1:350,000	Baie des Chaleurs aux/to Iles de la Madeleine
L/C	4025	1:300,000	Cape Whittle à/to Havre-Saint-Pierre et/and Ile d'Anticosti
L/C	4026	1:300,000	Havre-Saint Pierre et/and Cap des Rosiers à/to Pointe des Monts
L/C	4317	1:109,000	Liscomb Island to Egg Island
L/C	4320	1:145,000	Egg Island to West Ironbound Island
L/C	4321	1:108,800	Cape Canso to Liscomb Island
L/C	4335	1:75,000	Strait of Canso and Approaches
L/C	4363	1:74,500	Cape Smoky to St. Paul Island
L/C	4367	1:75,200	Flint Island to Cape Smoky
L/C	4374	1:75,000	Red Point to Guyon Island
L/C	4375	1:75,700	Guyon Island to Flint Island
L/C	4385	1:36,500	Osborne Head to Betty Island
L/C	4403	1:75,000	East Point to Cape Bear
L/C	4404	1:76,000	Cape George to Pictou
L/C	4405	1:75,700	Pictou Island to Tryon Shoals
L/C	4406	1:75,600	Tryon Shoals to Cape Egmont
L/C	4451	1:110,700	Iles de la Madeleine
L/C	4462	1:75,200	St. George's Bay
L/C	4463	1:75,000	Chêticamp to Cape Mabou
L/C	4464	1:74,488	Chêticamp to Cape St. Lawrence
L/C	4485	1:75,000	Cap des Rosiers à/to Chandler
L/C	4520	1:286,000	Orange Bay to Cape Bonavista
L/C	4622	1:80,000	Cape St. Mary's to Argentic Harbour and Jude Island
L/C	4624	1:80,000	Long Island to St. Lawrence Harbours
L/C	4625	1:75,000	Burin Peninsula to Saint-Pierre
L/C	4626	1:75,000	Saint-Pierre and Miquelon (France)
L/C	4700	1:1,000,000	Belle Isle to Resolution Island
L/C	4730	1:588,000	Nain to Domino Point
L/C	4731	1:250,000	Strait of Belle Isle to Domino Run
L/C	4775	1:250,000	Nain to Saglek Bay
L/C	4776	1:250,000	Entrance to Saglek Bay to Button Islands
L/C	5001	1:3,500,000	Labrador Sea, Strait of Belle Isle to/à Davis Strait
L/C	7011	1:1,500,000	Hudson Strait/Détroit d'Hudson to/à Grønland
L/C	8005	1:300,000	Georges Bank
L/C	8006	1:300,000	Scotian Shelf, Browns Bank to/à Emerald Bank
L/C	8007	1:300,000	Halifax to/à Sable Island including/y compris Emerald Bank and/et Sable Island Bank
L/C	8008	1:300,000	Banquereau and Misaine Bank
L/C	8009	1:350,000	St. Pierre Bank to Whale Bank
L/C	8010	1:350,000	Grand Bank, Southern Portion/Partie Sud
L/C	8011	1:350,000	Grand Bank, Northern Portion

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L/C	8012	1:350,000	Flemish Pass
L/C	8013	1:350,000	Flemish Cap
L/C	8014	1:350,000	Grand Banc/Grand Bank, Partie Nord-est/ Northeast Portion
L/C	8015	1:350,000	Funk Island and Approches/et les Approches
D,L/C	8015	1:350,000	Funk Island and Approches/et les Approches
L/C	8046	1:500,000	Button Islands to Cod Island
L/C	8047	1:500,000	Cod Island to Cape Harrison
D,L/C	8048	1:500,000	Cape Harrison to St. Michael Bay
L/C	8049	1:500,000	St. Michael Bay to Gray Islands
D,L/C	8049	1:500,000	St. Michael Bay to Gray Islands

Great Lakes

L/C	2000	1:400,000	Lake Ontario/Lac Ontario
L/C	2063	1:73,000	Toronto to/à Niagara River
L/C	2064	1:61,200	Kingston to/à False Ducks Island
L/C	2100	1:400,000	Lake Erie/Lac Erié
L/C	2101	1:125,000	Long Point to Niagara River
L/C	2200	1:400,000	Lake Huron
L/C	2300	1:547,200	Lake Superior

Pacific Coast

L/C	3000	1:1,250,000	Juan de Fuca Strait to/à Dixon Entrance
L/C	3001	1:525,000	Vancouver Island, Juan de Fuca Strait to Queen Charlotte Sound
L/C	3002	1:525,000	Queen Charlotte Sound to Dixon Entrance
L/C	3461	1:80,000	Juan de Fuca Strait Eastern Portion/Partie Est
L/C	3462	1:80,000	Juan de Fuca Strait to/à Strait of Georgia
L/C	3463	1:80,000	Strait of Georgia Southern Portion/Partie Sud
L/C	3602	1:150,000	Approches to/Approches à Juan de Fuca Strait
L/C	3603	1:150,000	Ucluelet Inlet to/à Nootka Sound
L/C	3604	1:150,000	Nootka Sound to/à Quatsino Sound
L/C	3605	1:150,000	Quatsino Sound to/à Queen Charlotte Sound
L/C	3606	1:110,000	Juan de Fuca Strait
L/C	3744	1:365,100	Queen Charlotte Sound
L/C	3802	1:200,000	Dixon Entrance
L/C	3902	1:250,000	Hecate Strait

CHARTS IN PREPARATION AS OF OCTOBER 15, 1984

Atlantic Coast

L/C	4003	1:1,000,000	Cape Breton to/à Cape Cod
L/C	4098	1:100,000	East Portion of Sable Island
L/C	4099	1:100,000	West Portion of Sable Island
L/C	4128	1:50,000	Approches to Saint John Harbour, Point Lepreau to Cape Spencer
L/C	4340	1:60,000	Grand Manan
L/C	4486	1:150,000	Baie des Chaleurs
L/C	4574	1:37,500	Approches to St. John's
L/C	4844	1:60,000	Cape Pine to/à Renews Harbour
L/C	4845	1:60,000	Renews Harbour to/à Motion Harbour

Great Lakes

L/C	2060	1:77,700	Main Duck Island to Scotch Bonnet Island
L/C	2201	1:200,000	Georgian Bay
L/C	2243	1:60,000	Bateau Island to Byng Inlet
L/C	2244	1:60,000	Alexander Passage to Beaverstone Bay
L/C	2245	1:60,000	Beaverstone Bay to Lonely Island and McGregor Bay

Pacific Coast

L/C	3512	1:80,000	Strait of Georgia - Central Portion/ Partie Centrale
L/C	3513	1:80,000	Strait of Georgia - Northern Portion/ Partie Nord

SPECIFICATIONS FOR OMEGA

1. TRANSMITTING STATION LOCATIONS

Station Letter	Location	Latitude	Longitude
A	Aldra Norway	66°25'12"62 N	13°08'12"52 E
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	Woodside Australia	38°28'52"53 S	146°56'06"51 E
H	Tsushima Japan	34°35'52"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	($\lambda = 29,468,087$)
11-1/3 kHz	($\lambda = 26,521.279$ meters)
13.6 kHz	($\lambda = 22,101.066$ meters)

6. PROPAGATION VELOCITY:

Free space (group velocity) c = 299,793 km/sec
Normal charted (phase) velocity	. . . v = 300,574 km/sec
Nominal ratio c/v = 0.9974

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.

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PAIR	BASELINE LENGTH (B)		*MINIMUM LANE COUNT	*MAXIMUM LANE COUNT
	METERS	*WAVELENGTH		
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	15,765,309.5872	534.9960	365.0040	1434.9960
A-H	7,578,833.7261	257.1878	642.8122	1157.1878
B-C	15,305,696.7822	519.3991	380.6009	1419.3991
B-D	9,327,766.8459	316.5379	583.4621	1216.5379
B-E	7,807,101.5361	264.9341	635.0659	1164.9341
B-F	7,743,249.2757	262.7673	637.2327	1162.7673
B-G	15,793,102.4835	535.9392	364.0608	1435.9392
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	1643.3116
C-F	11,811,167.9628	400.8122	499.1878	1300.8122
C-G	8,781,994.2305	298.0171	601.9829	1198.0171
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	1245.0139
D-G	14,730,218.8655	499.8702	400.1298	1399.8702
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	8,727,783.5491	296.1775	603.8225	1196.1775
E-H	9,957,458.2535	337.9065	562.0935	1237.9065
F-G	10,412,370.7208	353.3440	546.6560	1253.3440
F-H	18,441,300.2604	625.8058	274.1942	1525.8058
G-H	8,291,433.1698	281.3699	618.6301	1181.3699

* Frequency of 10.2 kHz

Predicted Loran-C Groundwave Coverage

1. INTRODUCTION.

The attached diagram shows the predicted Loran-C groundwave coverage for a chain. A brief discussion of how the coverage diagrams are generated follows:

(a) Geometric-fix-accuracy limits.

Each of two LOP's in each Loran-C chain is assigned a TD standard deviation of 0.1 microseconds. The geometric-fix-accuracy is assigned a value of 1500 feet, 2 dRMS. Using the two constraints above a contour is generated within the area of the Loran-C chain. This contour represents the geometric-fix-accuracy limits.

(b) Range limits.

(1) Predicted atmospheric noise field strength is calculated for a judiciously selected point in the middle of the service area for each chain. The predicted noise is the average of noise levels calculated to be exceeded only 5% of the time over each 4-hour period of a day for each season of the year. (See paragraph 2 below for a sample noise calculation.)

(2) Cross-rate Loran-C signals act as interference and can limit reception in some areas. Where signals from adjacent Loran-C chains are relatively strong, values for noise are generally increased to compensate for the additional interference.

(3) Predicted atmospheric noise for each Loran-C chain is combined with estimated Loran-C signal strength for each Loran-C transmitting station to obtain expected 1:3 SNR range limits for each transmitted signal.

(4) Where valid measurements of signal strength have been made in a Loran-C service area, these have been incorporated into the coverage diagrams in the form of revised limits.

(c) To generate the predicted Loran-C coverage diagrams the geometric-fix-accuracy limits and predicted SNR range limits are combined on a geographic plot for each Loran-C chain. Where the geometric-fix-accuracy limits extend beyond the range limits, the range limits are used on the coverage diagram and vice versa.

2. SAMPLE NOISE CALCULATION.

The predicted noise is determined from data contained in CCIR Report 322, World Distribution and Characteristics of Atmospheric Radio Noise, documents of the Xth Plenary Assembly, Geneva 1963. A sample noise calculation follows:

(a) Definition of terms:

Fa = Effective antenna noise factor which results from the external noise power available from a loss free antenna.

Fam = Median of the hourly values of Fa within a four-hour time block.

Du = Value of the average noise power exceeded for 10% of the hours within a four-hour time block (dB above the time block median).

En = root-mean-square (RMS) noise field strength for a 1kHz bandwidth (dB/1μV/m).

D = RMS noise value added to the time block median to change the percentage of time exceeded from 50% to the desired value; desired value is 5% for calculations below.

CF = Correction factor used to permit calculation for any given bandwidth. $CF = (10 \log_{10} BW) - 30$ in units of dB above 1 $\mu V/m$.

(b) For purpose of this sample noise calculation, assume position with latitude $40^\circ N$ and longitude $135^\circ W$.

(c) Determine F_{am} (1 MHz) from Figures 2A-25A (CCIR 322). For this example F_{am} (1 MHz) is tabulated in Table 1. The first data sample for winter, 0000 - 0400, Figure 2A (CCIR 322), will be used to illustrate how the other rows of Table 1 are calculated.

$$F_{am} (1 \text{ MHz}) = 60.0$$

(d) Determine F_{am} for 100 kHz from Figure 2B (CCIR 322) which uses frequency and curves parametric in F_{am} (1 MHz) as the entering arguments.

$$F_{am} (100 \text{ kHz}) = 108.0$$

(e) Determine D_u for 100 kHz from Figure 2C.

$$D_u (100 \text{ kHz}) = 9.0$$

(f) Calculate E_n using Equation (2), p6, CCIR 322:

$$\begin{aligned} E_n &= F_{am} (100 \text{ kHz}) - 65.5 + 20 \log_{10} f(\text{MHz}) \\ \text{For } F_{am} (100 \text{ kHz}) &= 108.0 \text{ and } f = 100 \text{ kHz,} \\ E_n &= 108.0 - 65.5 + 20 \log_{10}(0.1) \\ E_n &= 22.5 \end{aligned}$$

(g) D , the incremental noise value, is calculated from D_u as follows:

$$D = 1.3 (D_u) = 1.3 (9.0) = 11.7$$

The constant factor, 1.3, has been determined by graphical construction using the technique described on p10, CCIR 322.

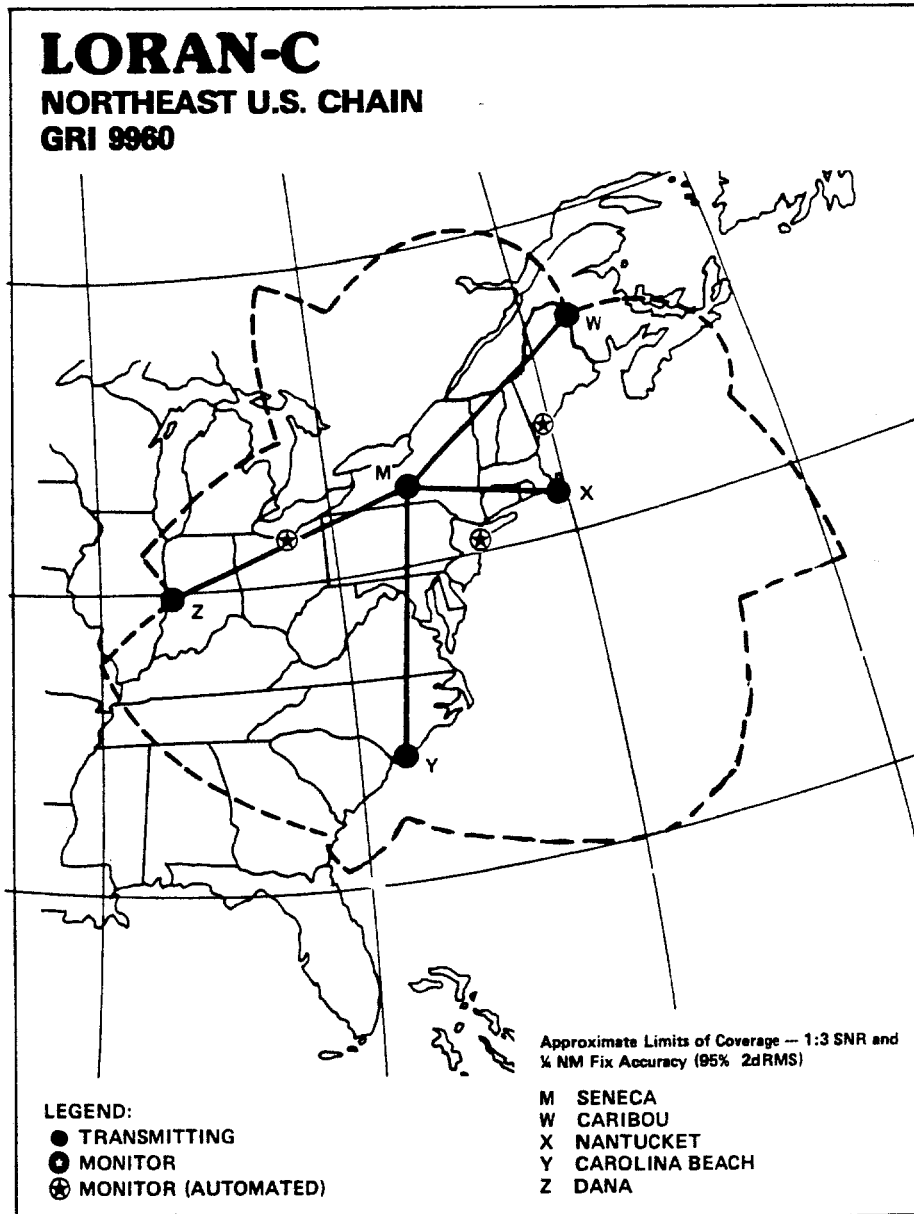
(h) CF is calculated to correct the noise level to the desired noise bandwidth, i.e., 30 kHz:

$$CF = 10 \log_{10} BW - 30 = 14.77$$

(i) The noise level which will not be exceeded more than 5% of the time for a four-hour time block is:

$$\begin{aligned} N &= E_n + D + CF \\ N &= 22.5 + 11.7 + 14.77 \\ N &= 48.97 \text{ dB above } 1 \mu V/m \end{aligned}$$

(j) Steps (b) thru (i) above are repeated for each four-hour time block given in CCIR 322. These calculations are tabulated in Table 1 below.



Time Block	Fam (1 MHz)	Fam (100kHz)	Du (100 kHz)	En	D (5%)	CF	N
00-04/WI	60	108	9.0	22.5	11.7	14.77	48.97
04-08/WI	56	104	13.0	18.5	16.9	14.77	50.17
08-12/WI	25	85	13.8	-0.5	17.9	14.77	32.21
12-16/WI	27	83	13.8	-2.5	17.9	14.77	30.21
16-20/WI	41	95	13.8	9.5	17.9	14.77	42.21
20-24/WI	59	106	9.8	20.5	12.7	14.77	48.01
00-04/SP	65	112	9.0	26.5	11.7	14.77	52.97
04-08/SP	45	99	13.5	13.5	17.6	14.77	45.82
08-12/SP	25	89	15.5	3.5	20.2	14.77	38.42
12-16/SP	32	93	17.0	7.5	22.1	14.77	44.37
16-20/SP	46	97	16.0	11.5	20.8	14.77	47.07
20-24/SP	66	112	10.0	26.5	13.0	14.77	54.27
00-04/SU	58	110	8.0	24.5	10.4	14.77	49.67
04-08/SU	45	103	12.5	17.5	16.3	14.77	48.52
08-12/SU	19	88	13.2	2.5	17.2	14.77	34.43
12-16/SU	36	93	12.5	7.5	16.3	14.77	38.52
16-20/SU	54	106	11.3	20.5	14.7	14.77	49.96
20-24/SU	66	114	7.9	28.5	10.3	14.77	53.54
00-04/AU	70	113	9.0	26.5	11.7	14.77	52.97
04-08/AU	52	105	13.9	19.5	18.1	14.77	52.34
08-12/AU	27	94	16.7	8.5	21.7	14.77	44.98
12-16/AU	30	93	16.5	7.5	21.5	14.77	43.77
16-20/AU	57	106	14.5	20.5	18.9	14.77	54.12
20-24/AU	68	114	9.8	28.5	12.7	14.77	56.01
TOTAL = 1113.50							
AVG = 46.4 dB above 1uV/m							

**TABLE 1 - SAMPLE NOISE CALCULATION FOR
LATITUDE 40° N, LONGITUDE 135° W.**

(k) The average value of the noise levels calculated for each time block (rightmost column, Table 1) becomes the noise level which is used in combination with the Loran-C signal strengths to estimate range limits throughout the Loran-C service area.

SOLID-STATE LORAN-C TRANSMITTER INSTALLATION

Five Loran-C stations operating in four Loran-C chains are having their transmitters upgraded from tube-type to solid-state during the next two years. When the transmitters are replaced, several improvements will occur: peak radiated power (PRP) will increase, the consistency of the pulse shape will improve, and fewer momentary off-air periods will be expected.

The stations, present PRP, approximate new PRP, and estimated date of increased power are shown in the table.

The new PRP for Loran-C stations Caribou and Carolina Beach are present estimates that may be refined later. All dates are as yet best estimates; specific dates will be announced in the future when the off-air periods for replacing the transmitters are advertised.

Station	Present PRP	Approx. New PRP	Date
Baudette (8970-Y)	400 KW	800 KW	Complete
Nantucket (9960-X; 5930-X)	225 KW	400 Kw	December 85
Jupiter (7980-Y)	300 KW	400 KW	March 86
Caribou (5930-M; 9960-W)	350 KW	800 KW	June 86
Carolina Beach (9960-Y; 7980-Z)	550 KW	800 KW	November 86

(Continued from page 34)

to the challenge. The 1987 budget, contains funds for transmitting stations to provide Loran-C signals in parts of the United States not now covered. Additionally, there are funds for monitor receivers throughout the country to ensure signal integrity, particularly during IFR approaches. President Reagan has designated this project as a major policy initiation.

Loran's expansion in aviation is not yet matched outside the United States, but other countries are taking interesting steps. Canada is considering Loran-C for its own mid continent gap, where studies show that a half-dozen transmitters in Canada, working with U.S. stations, can provide much-needed coverage up to 60° north (which runs through Hudson's Bay). In the People's Republic of China, they're considering Loran for aviation in that vast area. The U.S.S.R. recently increased the number of transmitters in eastern Russia, and is establishing a new chain in the north. European nations, led by Norway, are considering Loran for the post-1992 era, when the U.S. no longer funds overseas Loran stations.

The commitment by Europe to an internationally-controlled system would have tremendous implication. Consider navigating from anywhere in the United States, across the North Atlantic and over Europe to the Balkans. Or heading west across the Pacific to Korea, Japan and into the People's Republic of China or Hong Kong; all the way on Loran-C.

When talking about such possibilities, some people see a conflict between Loran-C and the coming satellite systems. The author believes the future will see a mix of Loran-C with satellites, at least on international routes, well beyond the year 2000. The first reason is that Loran will be supported by countries whose nationalistic interests would not allow them to rely completely on a system operated by a foreign government.

Secondly, consider the complementary nature of satellite navigation and Loran-C. Procedures being developed for Loran, such as non-precision approaches, are directly applicable to satellite systems. To the user, the type of signal sensor will (and should) be transparent. Precise timing from satellites can synchronize all Loran-C stations, enabling them to become *pseudo satellites* when there are too few satellites for navigation. With Loran transmitters universally synchronized, a new generation of receivers will have tremendous flexibility in

selecting signals, extending operational areas, improving accuracy and assuring efficient signal reception.

Measurements on signal paths between transmitters will provide a history and real-time assessment of propagation affecting signal accuracy. Then, too, Loran signals could be modulated without affecting navigation; allowing transmission of low-rate data, such as satellite health, weather and emergency warnings. Finally, there is the well known theorem in aviation that is not prudent to rely on a single navigation system.

In looking at Loran today, and speculating about its future, there is ample reason for optimism. Consider these signs:

FAA has authorized an Alaskan carrier to navigate direct between the Aleutians and Seattle (a distance over water of 1600 nautical miles) with dual Loran-C RNAV as sole means.

ICAO, the International Civil Aviation Organization, stated that Loran RNAV may substitute for Omega within the North Atlantic MNPS airspace wherever coverage is determined to be adequate.

Several receivers are already authorized for IFR en route in the U.S. and FAA is in a program of non-precision approaches at an increasing number of airports.

Rotary wing aircraft are strong supporters of Loran, and this advocacy should grow as approaches to a "point in space" are authorized at heliports.

Loran is a useful complement to MLS at airports where high terrain dictates "doglegs to final".

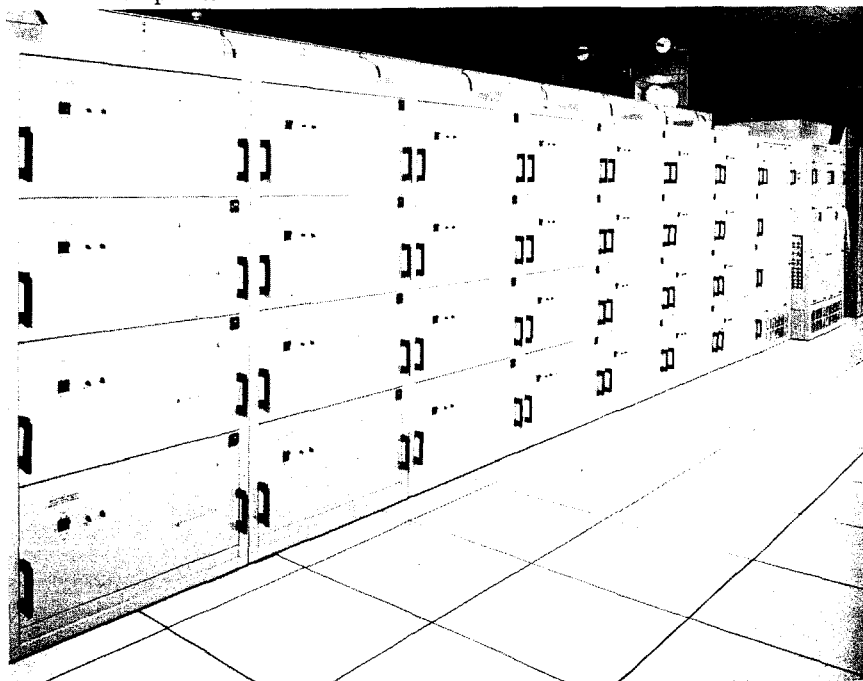
Emergency medical services (State of Illinois and Dominion Pegasus of Thunder Bay, Ontario, for example) operate Loran as a necessary component.

Law enforcement, fish and wildlife, forest management and other agencies at the state level (Ohio, Wisconsin) use Loran as essential equipment.

The U.S. Center for Atmospheric Research is investigating storm conditions with balloon-mounted Loran sensors and ground-based processors to determine, with high accuracy, the wind at many locations in the U.S. The researchers intend to investigate the mid-continent in 1988-89, using the new mid-continent chain.

The future of terrestrially-based radionavigation, we believe, is assured — and the Loran segment will continue to surprise and exceed everyone's expectations. □

* Mr. McGann is president of Racal Megapulse, a manufacturer of Loran-C transmitter stations.



The US Coast Guard has taken delivery of the fifth solid state Loran transmitter. It will replace older vacuum tube transmitters at Carolina Beach, North Carolina. Earlier, tube-type transmitters at Nantucket, MA, Baudette, MN, Jupiter, FL and Caribou, ME were replaced with more reliable AN/FDN-64A(V) solid state transmitters. In most cases the new installation improved signal coverage.

WGA PAST AWARDS

MEDAL OF MERIT

THE MEDAL OF MERIT IS AWARDED TO A PERSON OR PERSONS FOR A PARTICULAR CONTRIBUTION OF OUTSTANDING VALUE TO THE DEVELOPMENT OR FOSTERING OF LORAN. THIS AWARD IS NORMALLY GIVEN ONLY AFTER THE EXCEPTIONAL NATURE OF THE CONTRIBUTION IS CLEARLY RECOGNIZED.

- 1976 - GENERAL JOHN D. LAVELLE, USAF
- 1977 - ROBERT L. FRANK
- 1978 - LLOYD D. HIGGINBOTHAM and VERNON L. JOHNSON
- 1979 - CAPTAIN LOREN E. BRUNNER, USCG
- 1980 - WALTER N. DEAN
- 1981 - JAMES VAN ETTEN
- 1982 - RALPH JOHLER
- 1983 - R. MICHAEL EATON
- 1984 - JOHN M. BEUKERS
- 1985 - JAMES J. MERANDA
- 1986 - REAR ADMIRAL ALFRED P. MANNING, USCG

SERVICE AWARD

THE SERVICE AWARD IS GIVEN TO MEMBERS WHO DISTINGUISH THEMSELVES BY SERVICE TO THE WILD GOOSE ASSOCIATION.

- | | |
|---|--|
| <ul style="list-style-type: none"> 1974 - LLOYD D. HIGGINBOTHAM
KEITH R. BRUHL
EDWARD L. McGANN 1975 - WILLIAM F. ROLAND
BAHAR J. UTTAM
JOHN M. BEUKERS 1976 - MURRAY BLOCK
JAMES P. VAN ETTEN
CLAUDE PASQUIER
WILLIAM VOGLER
WILLIAM REVEILLE
NORMAN DICKERSON 1977 - WILLIAM F. ROLAND
MARGERY S. WEISBERG
MEL CHASKIN 1978 - WARREN J. FREDERICK
THOMAS A. McCARTY
DANIEL PANSHIN
JOHN M. BEUKERS 1979 - LEO F. FEHLNER
LLOYD D. HIGGINBOTHAM
ELLENA ROLAND
JAMES P. VAN ETTEN
VERNON L. JOHNSON | <ul style="list-style-type: none"> 1980 - LLOYD D. HIGGINBOTHAM
RON S. WARREN
BAHAR J. UTTAM 1981 - WILLIAM F. RICE
DAVID H. AMOS
JAMES O. ALEXANDER 1982 - BERNARD AMBROSENO
WALTER N. DEAN
JOHN J. ILLGEN 1983 - DAVID A. CARTER
DAVID H. AMOS 1984 - ROBERT SCHELLHASE
HAROLD T. SHERMAN
BERNARD AMBROSENO
FRANK RADIN 1985 - CARL ANDREN
LARRY SARTIN
ROGER HASSARD
BERNARD AMBROSENO
FRANK RADIN 1986 - JOHN D. ILLGEN
JAMES F. CULBERTSON |
|---|--|

PRESIDENT'S AWARD

THE PRESIDENT'S AWARD IS PRESENTED TO THE PERSON, PERSONS, OR ORGANIZATION AS DESIGNATED BY THE PRESIDENT OF THE ASSOCIATION WITH CONSENT OF THE BOARD OF DIRECTORS. THE PRESIDENT'S AWARD IS PRESENTED AT THE ANNUAL BANQUET.

- 1974 - UNITED STATES COAST GUARD
(ACCEPTED BY DONALD NAPLES)
- 1975 - THE HONORABLE THEODORE C. LUTZ
- 1976 - NO AWARD
- 1977 - PAUL R. JOHANNESSEN
- 1978 - DANIEL PANSHIN, LEO F. FEHLNER
- 1979 - CAPTAIN WILLIAM B. MOHIN
- 1980 - CAPTAIN DONALD FELDMAN, USCG
- 1981 - LEO F. FEHLNER
- 1982 - EDWARD L. McGANN
- 1984 - RICHARD BEAM WILLIAM C. HOFFMAN
CARROLL D. LYTLE FRANKLIN D. MacKENZIE
WILLIAM B. MOHIN WILLIAM L. POLHEMUS
CHARLES R. MIEL (POSTHUMOUSLY)
- 1986 - DONALD D. ENGEN, REAR ADMIRAL, USN (RETIRED)

PAPER AWARD

THE PAPER AWARD IS GIVEN TO A MEMBER OF THE WILD GOOSE ASSOCIATION FOR THE BEST PAPER PUBLISHED ON THE SUBJECT OF LORAN.

- 1973 - ROBERT H. DOHERTY and RALPH JOHLER
- 1974 - WILLIAM F. ROLAND
- 1975 - ROBERT WEHR
- 1976 - ROGER W. HASSARD
- 1977 - ROBERT H. CASSIS and RICHARD J. ADAMS
- 1978 - ARTHUR GOLDSMITH
- 1979 - JAMES P. VAN ETTEN
- 1980 - JACK M. LIGON and CHARLES R. EDWARDS
- 1981 - WILLIAM L. POLHEMUS
- 1982 - JOHN J. ANTHONY and ANDREW J. SEDLOCK
- 1983 - JAMES R. MacCULLOUGH and BARRY J. IRWIN
- 1984 - ROBERT L. FRANK
- 1985 - LT. RICHARD J. HARTNETT, USCG and
LT. RONALD T. HEWITT, USCG
- 1986 - R.A. DOUGHTY and CDR WILLIAM K. MAY, USCG

HONORARY MEMBERSHIP

- 1972 - HORACE "DAN" REDDING
GIFFORD HEFLEY
HARRY DAVIS
- 1974 - THE HONORABLE JOHN MURPHY
- 1979 - CAPTAIN CLYDE L. OLSON, USCG
CAPTAIN RAYMOND BAETSEN, USCG
- 1980 - JOHN A. PIERCE
- 1982 - WINSLOW PALMER
- 1984 - WALTER CRONKITE
- 1986 - LLOYD D. HIGGINBOTHAM

LORAN RELATED PAPERS

1984 - THIRTEENTH ANNUAL TECHNICAL SYMPOSIUM

- Scull, David C. - "Update on the U.S. Federal Radionavigation Plan"
- Thrall, LCDR William J. - "USCG Plans for LORAN-C - The 80's and Beyond"
- Stenseth, Andreas - "European LORAN-C Working Group Activities"
- Bradley, Jerry - "Federal Aviation Administration Radionavigation Plans"
- Pietraszewski, David J. - "A Short and Long Term Comparison of LORAN-C and Civil Navstar GPS Signal Stabilities"
- Erickson, Robert, Fox, Daniel, and Till, Robert D. - "Evaluation of LORAN-C Navigation for Non-Precision Approaches"
- Lilley, Robert W. and Brooks, Kent - "Evaluation of LORAN-C for Instrument Approaches in Ohio"
- King, Larry D., McConkey, Edward D., and Venezia, Kristen J. - "CONUS LORAN-C Flight Test"
- Dull, Charles W. and Clerke, William H. - "LORAN-C Navigation as an Aid to Aerial Photographic Operations"
- Slagle, CWO Daniel C. - "Applying the 'DRD' Model to Inland Airports"
- Mackenzie, Frank and Bleau, Charles A. - "Model for Forecasting LORAN-C Coverage"
- Baer, Glen E. and Edwards, Charles R. - "AAPS: Automated Aids-to-Navigation Positioning System - Integration of LORAN-C and Digital Sextants"

LORAN RELATED PAPERS (CONTINUED)

- Johler, J. Ralph and Cook, Alan R. - "Accurate Position Determination in the Bering Sea Using LORAN-C"
McCullough, J. R., Irwin, B.J., and Hayward, R.C. - "Seasonal LORAN Variations in New England"
Taggart, Lt. Doug - "USCG R&D Differential LORAN-C Study"
Gray, David H. - "Chart Latticing: A Canadian Perspective"
Hartnett, Lt. Richard J, and Hewitt, Lt. Ronald T. - "The U.S. Coast Guard's LORAN-C Remote Operating System"
McKenzie, Bill - "How Good the Aircraft Are Doing with the Signals From Fox Harbor"
Sherman, Harold T. - "Finally - A Practical ECD Estimation Technique"
Illgen, John D. - "LORAN-C 1984: A High Technology Nanosecond Accuracy System for HHE and Restricted Waterway Navigation"
Bregstone, Ed - "Proposed Common View LORAN-C Timing Control"
Bregstone, Ed - "LORAN-C In-Band Notch Filter" (Previous year paper)
Sartin, Larry - "A Quarter Century of LORAN-C" (Previous year paper)

1985 - FOURTEENTH ANNUAL TECHNICAL SYMPOSIUM

- McGann, Edward L. - "Recent International Developments in LORAN-C"
Bradley, Jerry W. - "Future Radionavigation Systems for Civil Aviation"
Burket, Paul E. - "Expanded Use of LORAN-C for Aviation Purposes - State Involvement"
Longman, Chick - "Use of LORAN-C for Nonprecision Approach Operations"
Polhemus, William L. and Hamilton, Gordon B. - "LORAN-C RNAV in the Ontario (Canada) Airspace Plan"
Rogoff, Mortimer - "LORAN-C Coordinate Conversion"
Saether, K and Vestmo, E. - "LORAN-C Signal Stability Study in North-Norway"
Lally, V and Morel, C. - "Wind Measurements Using All Available LORAN Stations"
Mooney, Francis W. - "LORAN-C Signals in the Conterminus United States"
Ginsberg, I. and Butler, J. - "Skywave Interference Problems in the Labrador Sea Chain"
Mooney, Francis W. - "LORAN-C Performance as a Terrestrial RNAV System in Massachusetts"
Blizard, M and Slagle, D. - "LORAN-C West Coast Stability Study"
Goddard, Robert B. - "Synchronization of the French LORAN-C Chain with the Aid of GPS"
Doughty, R., Crowell, R., Birdsell, D., Pianka, D. and Reust, R. - "Ocean Dumping with LORAN-C"
Doughty, R.A. and May, W.K. - "Differential LORAN-C...Where Do We Really Need It?"
Bruckner, D. and Westling, G. - "Differential LORAN-C: Estimator Improvement and Local System Implementation"
Honey, John F. - "New Developments in LORAN-C Interference Control"
Frost, A, Belon, J., Schmottlack, T., and Rossi, S. - "LORAN-C Grid Measurements in Coastal New Hampshire" (A NOAA Sea-Grant Student Project)
Miller, Robert H. - "Gulf Coast and Eastern Seaboard LORAN-C Calibration"
Maynard, Kurtis L. - "LORAN Dynamic Graphics Positioning System"
Anderson, Ralph P. - "Conversion of the LORAN-C Data for the HP-41"
Lilley, R. and McCall, D. - "Operational Considerations for LORAN-C in the Non-Precision Approach Phase of Flight" NASA Technical Memorandum 97
Erickson, Robert H. - "Results of LORAN-C Flight Tests at Bedford, Massachusetts"
Weeks, W., Moroney, M., and MacKenzie, F. - "Update of FAA Pilot Monitor Project"
Cortland, Larry - "A Dramatic Demonstration of LORAN Capabilities"
Polhemus, William L. - "Automatic Dependent Surveillance Information Transfer Requirements"
Dean, Walter N. - "More LORAN Coverage For Little More Money By Dual Rating"

CONSTITUTION AND BY-LAWS

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 1. 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 than 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 ten (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) Directors elected by the membership of the Association to serve for a period of three (3) years and thereafter until their successors have been duly chosen. 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.
(Changed and approved April 1, 1985.)

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 Ioran 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
 Newsletter Committee
 Nominating and Election Committee

ARTICLE IV

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.

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 plan 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 \$15.00 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 \$12.00 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. If dues are not paid by 1 September, the member shall be suspended for a period of 16 months during which time payment of two (2) years dues will restore membership for the 16-month period. Following an increase in annual dues, all back dues shall be paid at the new rate. (As amended 12 October 1983 and 27 July 1984.)

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 procedures 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 Ioran. 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 Ioran.

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 to the Board of Directors for action. When approved by the Board of Directors, the President of the Association shall issue the Charter. The Charter shall be retained by the Club until such time as the Club may become inactive, at which time the Charter shall be returned to the Association.

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 Ioran community at

WILD GOOSE ASSOCIATION RADIONAVIGATION JOURNAL 1985-1986

large a compendium of current Association and Ioran 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 Ioran community by providing a compendium of Ioran 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 Ioran community at large. The Editor of the Journal may make application for the funds necessary to publish a specific issue of the Journal in accordance with By-Laws Article III, Section 7.

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 Ioran 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 Ioran and the history of the Association. After initially preparing a historical manuscript of Ioran 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.

ARTICLE XVII NEWSLETTER

SECTION 1. PURPOSE. To provide to the membership of the Wild Goose Association a means of frequent communications covering information pertinent to the activities of the Association, the Board of Directors, the individual members and the Ioran community at large. It is intended that the Newsletter will complement the Radio Navigation Journal and be published at quarterly intervals as a minimum and monthly as a maximum.

SECTION 2. NEWSLETTER COMMITTEE. The Newsletter Committee shall be constituted to effect the compilation, editing and publication of the Newsletter. The President of the Association shall annually appoint the Editor of the Newsletter, who will serve as Chairman of the Committee. The Chairman 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 Newsletter is not intended to be financially self-supporting, and will be supported from the general funds of the Association as a service to the membership. The sale of advertising space is permitted to defray expenses.

SECTION 4. DISTRIBUTION. At publication, a copy of the Newsletter shall be provided to each member of the Association at no cost.

ARTICLE XVIII

TERMS OF OFFICE

SECTION 1. DEFINITIONS. A one (1) year term of office is deemed to start with completion of the installation ceremony at the Annual Convention and extend to this same event at the next Annual Convention. Multiyear terms of office are multiples of a one (1) year term according to this definition.

SECTION 2. VACANCIES.

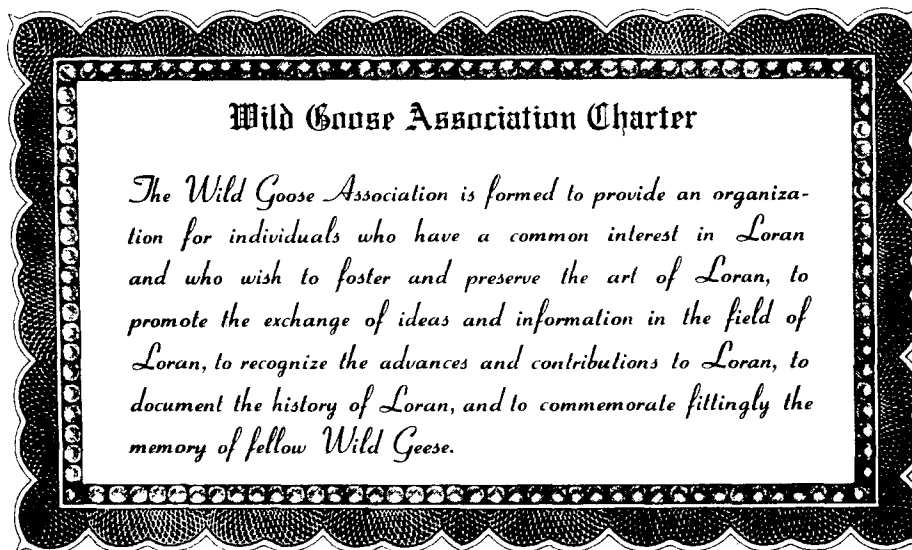
- a. OFFICERS. Vacancies occurring among elected or appointed officers shall be filled in accordance with Article VI of the Constitution for the period remaining of the one (1) year term of office.
- b. DIRECTORS. Under Article VI, Section 4 of the Constitution, one-third (1/3) of the twelve (12) elected Directors are to be elected each year for a three (3) year term of office.

(1) In the event that an elected Director, at the beginning or during his three (3) year term of

office is elected to serve as President, or is serving as Immediate Past President, his term of office as Director shall be considered vacant for the period he is serving as President or Immediate Past President and shall be filled for this period only in accordance with Article VI, Section 6 of the Constitution. Upon completion of his duties as President or Immediate Past President, he shall resume the unexpired portion, if any, of his three (3) year term as an elected Director.

(2) In the event that an elected Director resigns at any time during his three (3) year term of office, the unexpired portion shall be filled in accordance with Article VI, Section 6 of the Constitution.

(3) In the event that an elected Director notifies the Board that he will be unable to serve during any specific portion of his three year term of office, his term shall be filled for this period only in accordance with Article VI, Section 6 of the Constitution, and he shall resume the unexpired portion, if any, of his three (3) year term at the end of the specified period.



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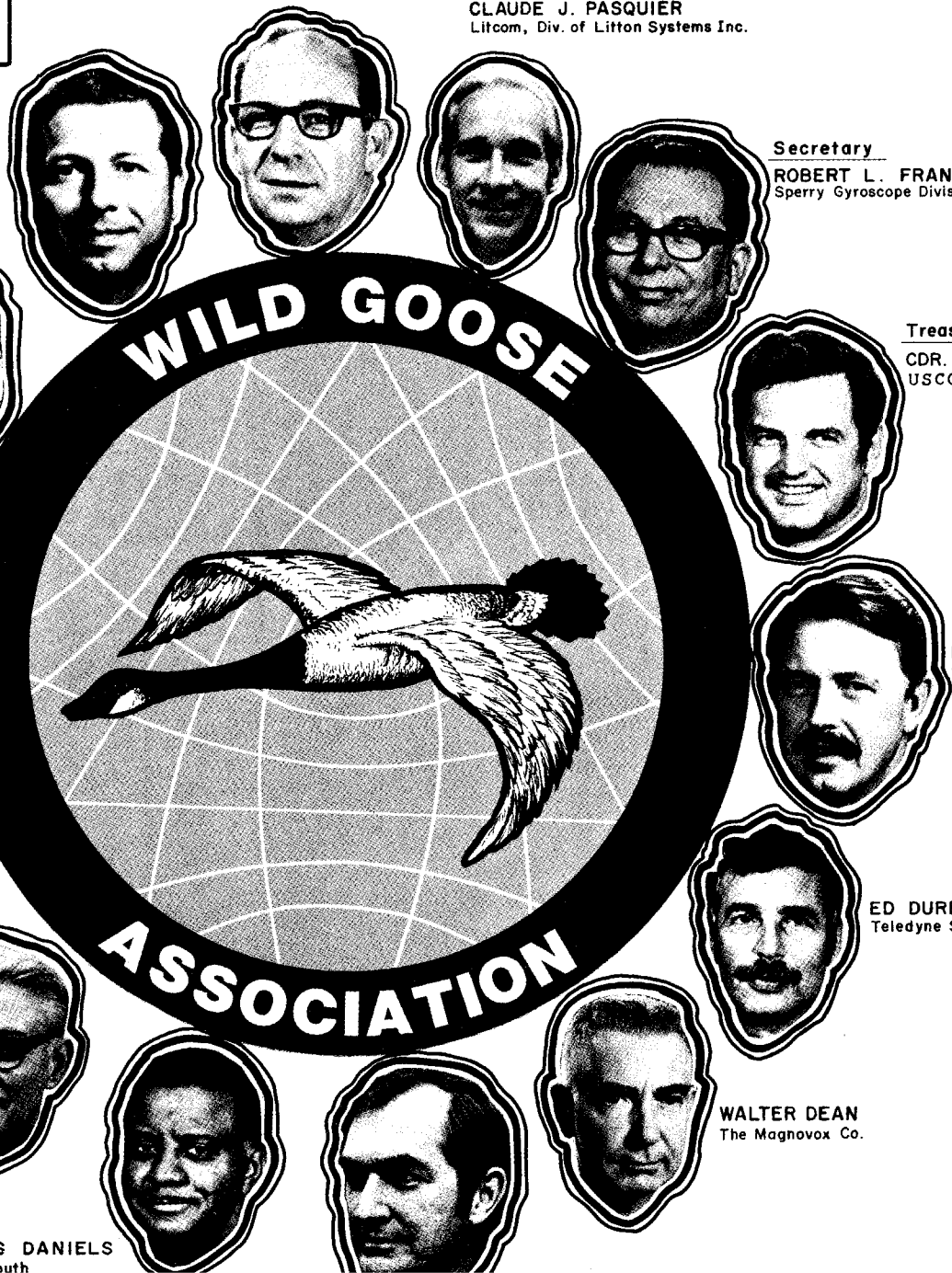
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Goram, N.Y.

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ITT Avionics Division

THOMAS DANIELS
Ft. Monmouth



WGA MEMBERSHIP LIST

To those members who are listed without affiliation or with an incorrect affiliation, we apologize. We urge them to contact the editorial or membership committee to provide the correct pertinent information so that this list can be updated for the next issue.

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101 COLONEL BY DRIVE
OTTAWA, ONTARIO K1A 0K2
CANADA

DeLORME GLOBAL MAPPING & NAV SYS
LOWER MAIN STREET P. O. BOX 298
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FEDERAL AVIATION ADMINISTRATION
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WHAT IS THE WGA?

The Wild Goose Association (WGA) is a professional organization of individuals and organizations having an interest in Loran radionavigation. It is named after the majestic birds that navigate thousands of miles with unerring accuracy. The WGA was organized in 1972 and its membership now includes hundreds of professional engineers, program managers, scientists and operational personnel from all segments of government, industry, and the user community throughout the world, working for the advancement of Loran.

WHAT ARE THE AIMS AND PURPOSES OF THE WGA?

The aims and purposes of the Wild Goose Association are: (1) To foster and preserve the art of Loran; (2) To promote the exchange of ideas and information in the field of Loran; (3) To recognize the advances and contributions to Loran; and (4) To document the history of Loran.

OFFICIAL PUBLICATIONS OF THE WGA

Official publications of the Wild Goose Association include:

(1) Radionavigation Journal - The Journal is a compendium of current Association and Loran information and related facts. It is intended that the Journal will be updated and published annually, after the annual elections, to provide to the membership an annual report of the significant activities, accomplishments, and objectives of the Association. Further, the Journal provides a compendium of Loran information and reference data deemed to be of interest to the community at large.

(2) Newsletter - The Newsletter is intended to provide the membership of the WGA a means of frequent communications covering information pertinent to the activities of the Association, the Board of Directors, the individual members, and the Loran community at large. It is intended that the Newsletter will complement the Radionavigation Journal and be published at quarterly intervals as a minimum and monthly as a maximum.

(3) WGA Proceedings - The Proceedings document the papers presented at the Technical Symposium of the Wild Goose Association's Annual Convention held in October.

MEMBERSHIP

There are five 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. Regular membership is \$15.00 for the first year and \$12.00 per year thereafter. Life membership is \$100.00. Associate membership is \$30.00 for the first year and \$25.00 per year thereafter. Corporate membership is \$220.00 or \$110.00 for large or small organizations, respectively, for the first year and \$200.00 or \$100.00 per year thereafter. Associate memberships are organizations, such as libraries, which are interested only in receiving the WGA publications. Large corporations may nominate 10 of their employees for regular membership and small corporations (less than 500 employees) may nominate five. Additional information may be obtained by contacting:

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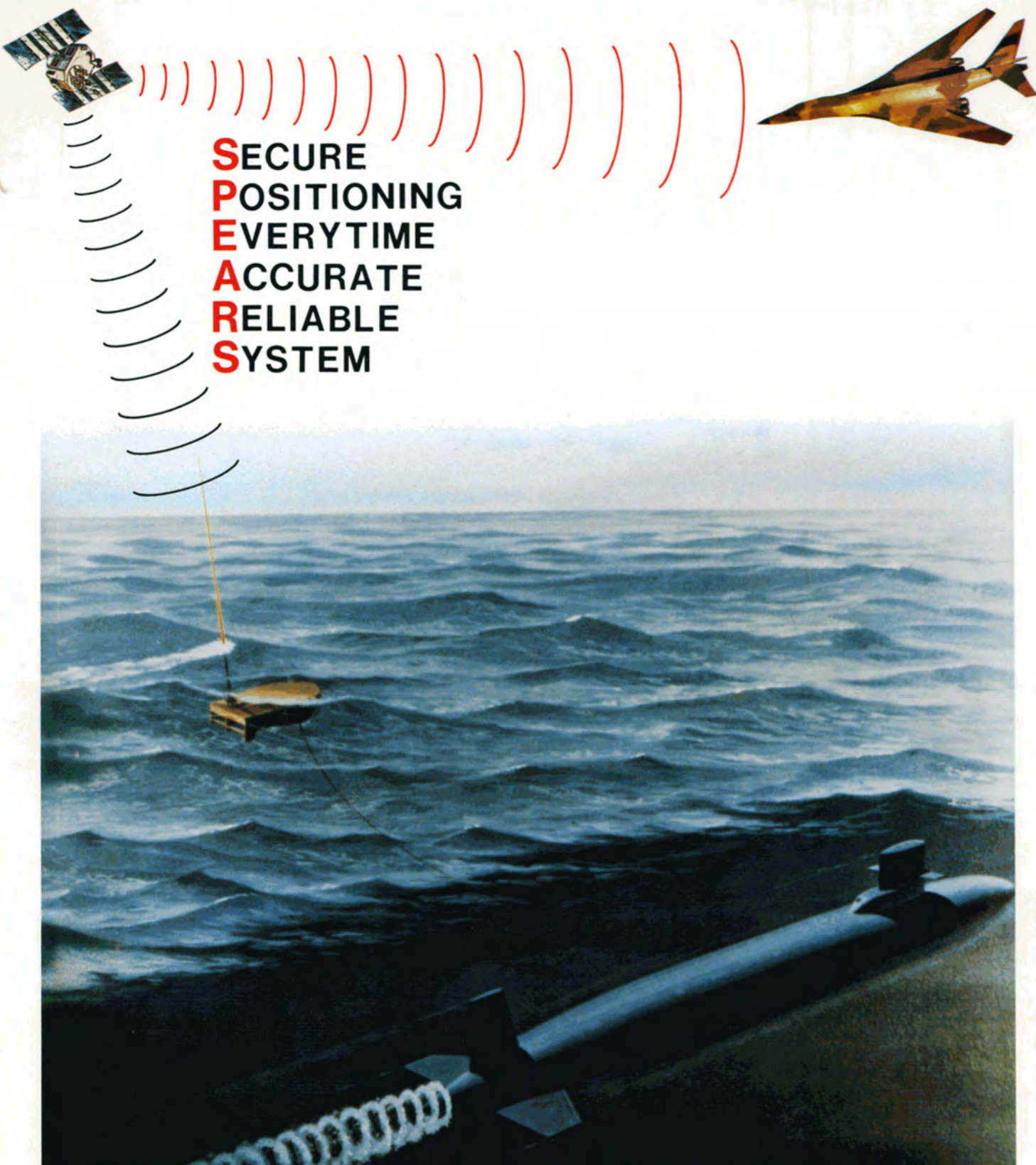
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