U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: GUIDELINES FOR THE OPERATIONAL USE OF LORAN-C NAVIGATION SYSTEMS OUTSIDE THE U.S. NATIONAL AIRSPACE SYSTEM (NAS)

Date: 2/5/93
Initiated by: AFS-430
AC No: 90-92

1. PURPOSE. This advisory circular (AC) contains guidance to be used by pilots for the operational **use** of Loran-C navigation systems under visual flight rules (VFR) and instrument flight rules (IFR) while operating **outside** the U.S. NAS and beyond the coverage of standard International Civil Aviation Organization (ICAO) navigation aids (NAVAID's). These NAVAID's include very high frequency omnidirectional range stations (VOR's), with or without distance measuring equipment (DME), and nondirectional beacons (NDB's). This AC also contains guidance which is applicable for use while over the Gulf of Mexico and other coastal waters.

2. DEFINITIONS. Since this AC contains a number of technical terms which may not be familiar to the new Loran-C user, a list of definitions can be found in the Glossary, appendix 2. A list of frequently used acronyms may be found in appendix 3.

3. RELATED READING MATERIAL. The guidelines within this AC complement the following documents:

a. AC's and Operations Manuals. Copies of the following AC's and operations manuals may be obtained from the U.S. Department of Transportation (DOT), General Services Section, M-443.2, Washington, D.C. 20590.

(1) AC 20-121, "Airworthiness Approval of Airborne Loran-C Navigation Systems for Use in the U.S. National Airspace System (NAS)," current edition.

(2) AC 90-79, "Recommended Practices and Procedures for the Use of Electronic Long-Range Navigation Equipment," current edition.

(3) AC 91-49, "General Aviation Procedures for Flight in North Atlantic Minimum Navigation Performance Specifications Airspace," current edition.

(4) "North Atlantic MNPS Airspace Operations Manual," 5th edition, reprinted 1991. (Requires a self-addressed mailing label.)

b. Federal Aviation Administration (FAA) Orders and Operations Manuals. Copies of the following FAA orders may be obtained from the Government Printing Office (GPO). Please have stock number and credit card available when placing an order by phone.

(1) FAA Order 8300.10, "Airworthiness Inspector's Handbook," S/N 050-007-0922-4.

(2) FAA Order 8400.10, "Air Transportation Operations Inspector's Handbook," S/N 050-007-00923-2.

(3) FAA Order 8700.1, "General Aviation Operations Inspector's Handbook," S/N 050-007-00921-6.

(4) "North Atlantic International General Aviation Operations Manual," 1st edition, October 1990, FAA/DOT, Washington, D.C., S/N 050-007-00886-4.

c. ICAO Publications. Copies of the following ICAO publications may be obtained by contacting ICAO. Orders for ICAO publications should be sent to the following address together with the appropriate remittance (by check or postal money order) in U.S. dollars:

Document Sales Unit
International Civil Aviation Organization (ICAO)
1000 Sherbrooke Street West, Suite 400
Montreal, Quebec
Canada H3A 2R2
(Telephone: (514) 285-8219)

(1) ICAO Annex 2, "Rules of the Air."

(2) ICAO Annex 6, "Operation of Aircraft."

(3) ICAO Document 7030, "Regional Supplementary Procedures."

4. COMMENTS INVITED. Comments regarding this publication should be directed to the following address:

Federal Aviation Administration
Flight Standards National Field Office, AFS-500
Advisory Circular Staff
P.O. Box 20034, Gateway Building
Dulles International Airport
Washington, D.C. 20041-2034

Comments may not be deemed to require a direct acknowledgement to the commenter; however, they will be considered in the development of upcoming revisions to AC's or other related technical material.

Thomas C. Accardi
Director, Flight Standards Service

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1. SYSTEM DESCRIPTION.

a. Loran-C is a low frequency 100 kilohertz hyperbolic radio navigation system. A Loran-C chain consists of a master station (identified as "M") and two or more secondary stations identified as "V," "W," "X," "Y," and "Z." A prescribed signal-to-noise ratio (SNR) level and geometric dilution of precision (GDOP) accuracy define the geographical coverage of a Loran-C chain. The receiver computes lines of position (LOP's) based on the difference between the arrival times of signals from two time-synchronized transmitting stations of a chain. Normally, two LOP's are required to obtain a position fix. Loran-C chains are identified by the group repetition interval (GRI) used to time-synchronize the signal (see figure 1 for a list of the worldwide Loran-C chains).

NOTE: Loran-C accuracy is severely degraded (to nonexistent) along a baseline extension, such as the extension of a line connecting two or more Loran-C stations (see figure 9 in appendix 2).

b. Loran-C equipment may be designed to provide one (or more) of **three** basic operational modes:

(1) VFR use only (not certified for IFR operations)

(2) IFR en route and terminal

(3) IFR approach

c. Loran-C units may be portable, installed, single-sensor units (for example, Loran-C only), or contained as part of a multisensor (for example, Loran-C and global positioning system (GPS)) flight management system (FMS). Portable, hand-held Loran-C units are **not** currently FAA approved. "Strap-down" portable units with external antenna systems are generally considered to be portable electronic devices that do **not** require FAA approval; however, some antenna installations may constitute a major alteration to the airframe. All permanently installed equipment must be FAA approved. For any permanently installed unit, specific limitations and operating instructions **must** be accessible by the flightcrew during normal operations.

d. Only properly installed and FAA-approved Loran-C units are authorized for use in IFR navigation. Hand-held, portable units and non-FAA-approved "strap-down" units **should not** be used for IFR navigation. Also, potential users of Loran-C units should not be misled and assume that a technical standard order (TSO) means that a particular Loran-C unit is approved for IFR use.

FIGURE 1

TABLE OF LORAN-C CHAINS

Geographic presentation order begins on the U.S./Canada west coast border and continues in an easterly direction around the world. (see also figure 3)

CHAIN NAME	GRI #	STATION IDENTIFIER	APPENDIX 1 Page
Canadian West Coast	5990	M, X, Y, Z	1
U.S. West Coast	9940	M, W, X, Y	2
North Central U.S.	8290	M, W, X, Y	3
South Central U.S.	9610	M, V, W, X, Y, Z	4
U.S. Great Lakes	8970	M, W, X, Y, Z	5
Southeast U.S.	7980	M, W, X, Y, Z	6
Northeast U.S.	9960	M, W, X, Y, Z	7
Canadian East Coast	5930	M, X, Y, Z	8
Labrador Sea	7930	M, W, X	9
Icelandic	9980	M, W, X	10
Norwegian Sea	7970	M, W, X, Y, Z	11
Mediterranean Sea	7990	M, X, Y, Z	12
Saudi Arabia (North)	8990	M, V, W, X, Y, Z	13
Saudi Arabia (South)	7170	M, W, X, Y, Z	14
East Asia	5970	M, W, X, Y	15
Northwest Pacific	9970	M, W, X, Y, Z	16
Alaska - North Pacific	9990	M, X, Y, Z	17
Alaska - Gulf of Alaska	7960	M, X, Y, Z	18

2. SYSTEM CHARACTERISTICS. The following are Loran-C system characteristics:

a. Predictable Accuracy

FIGURE 2

PREDICTABLE ACCURACY TABLE

OPERATIONAL SEGMENT	TYPE NAV FIX	ACCURACY (NM)	COMMENTS
Oceanic IFR	Any fix	5.8	At this time, there are no published accuracy standards (including oceanic operations) for VFR Loran-C equipment. This level of accuracy requires that the Loran-C unit be operated within the coverage limits as specified by the manufacturer (see figure 8).
En route IFR - - airway only, NAS, and Gulf of Mexico	Any fix on or off airway (given suitable obstacle clearance)	2.8	This level of accuracy requires that the Loran-C unit be operated within the coverage limits as specified by the manufacturer.
Terminal IFR - - NAS, and Gulf of Mexico	Any SID/STAR waypoint plus IAF's; also from MAP holding fix	1.7	
Approach IFR - - for published Loran-C approaches in the NAS and Gulf of Mexico	From IAF to FAF, then to MAP	0.3	This 0.3 nm level of accuracy applies to only those instrument approaches that have been FAA approved.

b. Repeatable Accuracy: 60-300 feet (18.3-91.4 meters)

c. Relative Accuracy: 60-300 feet (18.3-91.4 meters)

d. Operational Availability: Greater than 95 percent

NOTE: Operational availability determines what percentage of the time the pilot can expect the Loran-C signal to be usable. Signal coverage, reliability, and system capacity parameters each contribute to availability, but are only part of the equation. Antenna location, flight control bonding, precipitation, electrostatic discharge wick availability and condition, precipitation static, and atmospheric conditions also affect total operational availability. A high-powered surface transmitter can attenuate a Loran-C signal if the pilot is operating near a high-powered antenna.

e. Reliability (Triad): 99.7 percent

f. Capacity: Unlimited

g. Fix Dimension: "2D"

h. Fix Rate: 60 per minute

i. Ambiguity Potential: Low (for example, positions are easily resolved)

3. OCEANIC AIRSPACE COVERAGE. Figure 3 depicts worldwide Loran-C coverage. Figure 4 depicts Loran-C coverage over the United States (excluding Canadian chains) and surrounding oceanic areas, including the Gulf of Mexico and the Caribbean. Detailed coverage charts are found in appendix 1.

CAUTION! Individual Loran-C units may **not** be certified for use everywhere; therefore, pilots should consult their airplane flight manual (AFM)/pilot's operating handbook (POH) or aircraft operating manual (ACOM).

a. Loran-C Chain Closures or Transfers. All overseas Loran-C chains operated by and for the U.S. Government will either be turned over to foreign governments or closed by December 31, 1994. Specific closure or transfer dates have yet to be established. This includes the following Loran-C chains:

European area

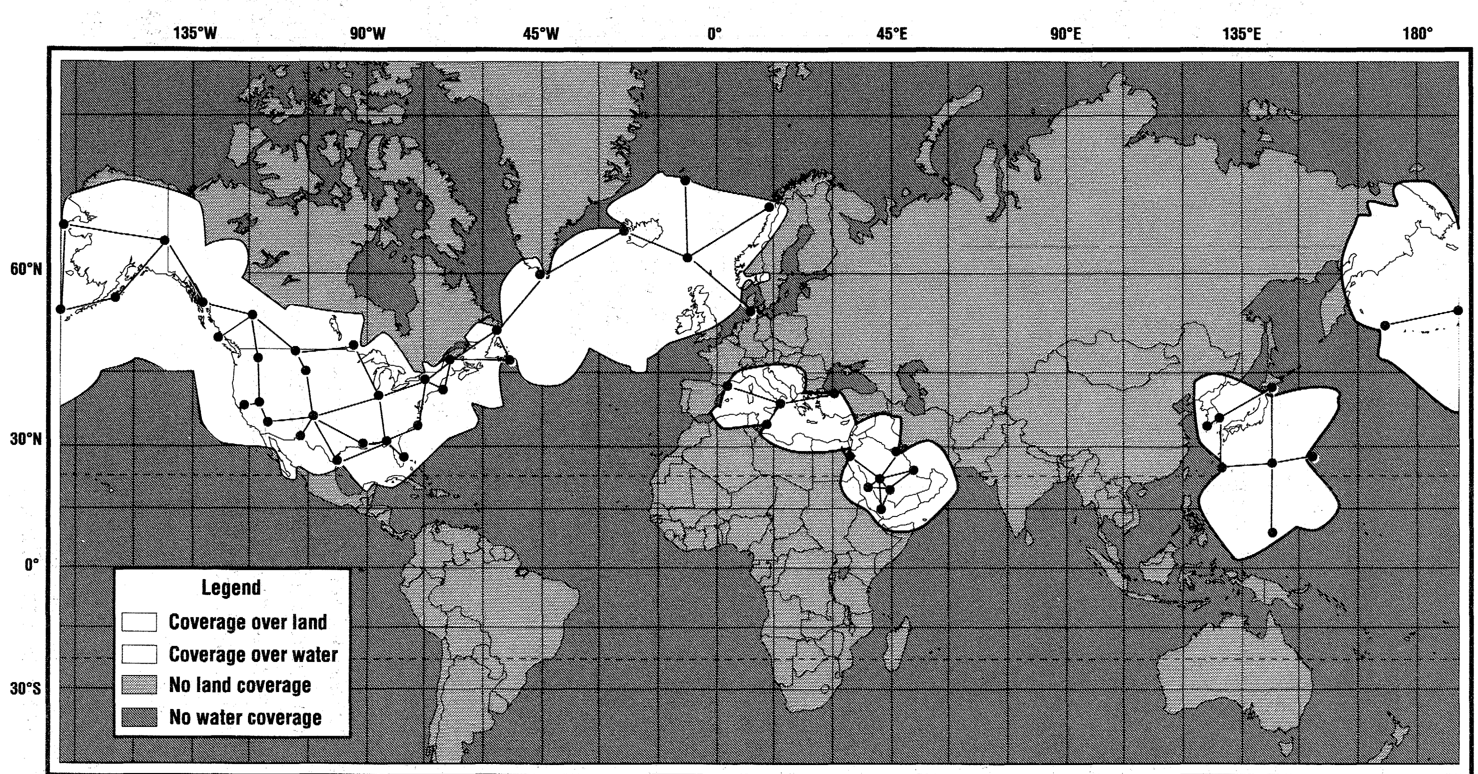
- Icelandic Sea Chain
- Norwegian Sea Chain
- Mediterranean Sea Chain

Asian-Pacific area

- Northwest Pacific Chain

FIGURE 3

WORLDWIDE LORAN-C COVERAGE



Contours represent the range limits in which the signal-to-noise ratio (SNR) falls to 1:3 (or -10 db SNR) and the accuracy limits in which the GDOP falls to 7,700 ft/μs.

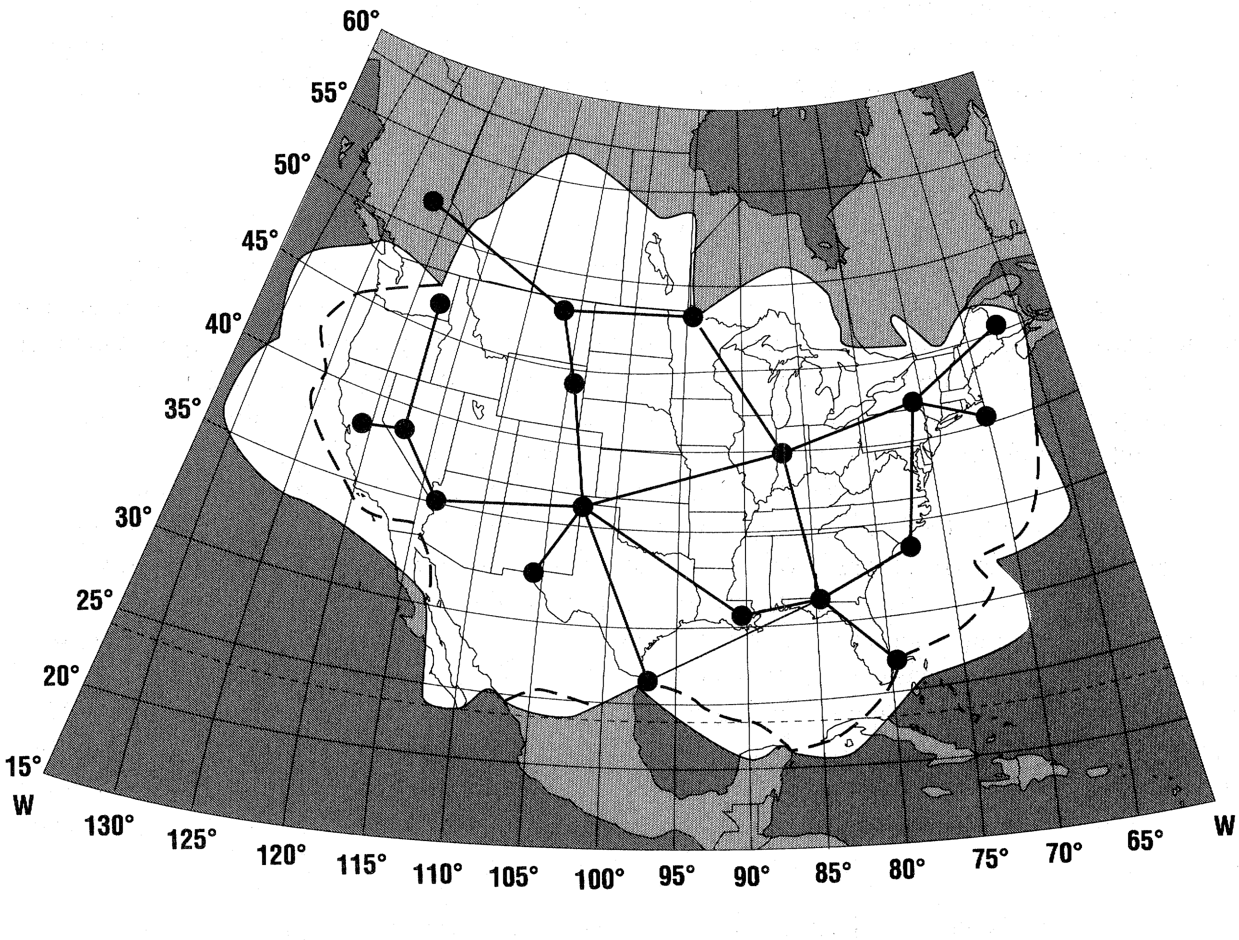
FIGURE 4

LORAN-C NAS COVERAGE DIAGRAM

United States and Surrounding Oceanic Areas

Parameters

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs;
- NAS GDOP 4,200 ft/µs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 64 db
- Surface to FL 600
- Flight Verified



b. Use Caution! Pilots are cautioned that foreign-operated Loran-C chains may not provide adequate signal coverage when required for air navigation. Pilots are further advised to use extreme caution before committing themselves to an extended ocean crossing. They should also ensure that adequate signal coverage is available throughout the route and be fully prepared to navigate by dead reckoning (DR) or other means in the event of signal loss.

4. APPLICABILITY. Pilots may use Loran-C equipment as a primary means of navigation over certain areas of the Atlantic Ocean, the Caribbean Sea, the Pacific Ocean, and certain other areas, **provided** that the equipment and software are installed, maintained, and operated in accordance with the prescribed limitations. The following operational guidelines apply:

a. U.S.-Registered Civil Aircraft. Federal Aviation Regulations (FAR), Part 91, Subpart H, governs the operation of U.S.-registered civil aircraft **outside** the United States. This subsection requires all such aircraft to comply with ICAO Annex 2 and with FAR §§ 91.117(c), 91.130, and 91.131 when operating over the high seas. In addition, FAR Part 91, Subpart F, and FAR Parts 121, 125, and 135 establish requirements for radio and navigation equipment during over-water or extended over-water operations.

b. VFR Operations.

(1) Equipment Requirements. ICAO Annex 2 (to the Convention on International Civil Aviation) entitled, "Rules of the Air," and ICAO Annex 6 entitled, "Operation of Aircraft," require all VFR aircraft to be equipped with the navigation equipment that will enable them to proceed in accordance with their flight plans and the requirements of the various air traffic control (ATC) services. While ICAO Annexes 2 and 6 do not specifically define the kinds of equipment or accuracies required for VFR flight over the oceans and beyond the operational coverage area of conventional land-based VOR, VOR/DME, or NDB NAVAID's, prudence and good pilot judgment both suggest that Loran-C units used as the sole means of VFR oceanic navigation be capable of providing **continuous** and **reliable** coverage over the entire route. If Loran-C coverage capability cannot be guaranteed or is unknown, then an alternative means of navigation should be available (see coverage diagrams in appendix 1). DR is an acceptable means; pilotage is **not** an acceptable means of navigation over large bodies of water because of the absence of prominent landmarks (with the exception of the Gulf of Mexico where there are over 2,000 landmarks offshore). In all cases, Loran-C equipment should be backed up with a DR flight plan progress log or other means so that the pilot knows, at all times, where the aircraft is, since atmospheric phenomena can render a Loran-C receiver useless with almost no advance warning.

(2) Altitude Limitations. ICAO Document 7030, "Regional Supplementary Procedures," also specifies the **maximum** altitudes that can be flown VFR in specific oceanic areas. For example, all pilots must file an **IFR flight plan** when intending to fly in North Atlantic (NAT) airspace at flight level (FL) 60 (6,000 feet mean sea level (MSL)) and above in New York, Gander, Shanwick, Santa Maria, and Reykjavik Oceanic Control Area/Flight Information Regions (CTA/FIR's), at FL 60 and above in the Bodø Oceanic CTA/FIR beyond 100 nautical miles (nm) seaward from shoreline, and at FL 200 and above in the Søndrestrom CTA/FIR. Since it is extremely unlikely that a NAT crossing can be conducted entirely in visual meteorological conditions (VMC), VFR operations are strongly discouraged.

NOTE: ICAO Annex 6 requires a **redundancy** of navigation equipment for VFR aircraft operations. For FAR Part 91 VFR operations, this redundancy of equipment may be met by means other than a duplication of navigation equipment. For example, one VOR or NDB (supplemented by DR) and one Loran-C would meet the requirement.

c. IFR Operations.

(1) IFR Operations Outside Minimum Navigation Performance Specifications (MNPS) Airspace. ICAO Annex 2 states, in part, that aircraft operating IFR over the high seas "shall be equipped with suitable instruments and with navigation equipment appropriate to the route to be flown."

(i) Redundancy of IFR Equipment. Annex 6 also requires a redundancy of equipment for IFR operations. FAR Part 91, "General Operating and Flight Rules," is silent on the need for long-range navigation units for operations of small aircraft certificated under FAR Part 23. FAR Part 125 and Subpart F of FAR Part 91, which govern the operation of large and of turbine-powered, multiengine airplanes, require **two independent** electronic navigation systems. Backup equipment is not required to be identical (such as duplicate independent systems). For example, one Loran-C and one Omega system combination is acceptable. Dual temporarily installed long-range navigation (LRN) systems are acceptable for ferry flights, provided that their installation is properly documented and approved.

(ii) FAR Part 121, FAR Part 135, and FAA Order 8400.10, "Air Transportation Operations Inspector's Handbook," contain specific guidance regarding navigational system requirements for air carrier operations. Specific authorization for equipment and routes is contained in the operations specifications (OpSpecs) for each carrier, as amended by the aircraft's minimum equipment list (MEL).

(iii) Offshore Helicopter Operations in the Gulf of Mexico.

(A) IFR offshore helicopter operations are conducted within Houston Center airspace at 7,000 feet MSL and below.

(B) Loran-C equipment may be used for both primary course guidance and approved Loran-C instrument approaches. Use of Loran-C for **all** IFR offshore helicopter operations in the Gulf of Mexico must be specifically approved by the FAA through issuance of a letter of authorization (LOA). Pilots should refer to FAA Order 8400.10 for further guidance.

(2) IFR Operations Within MNPS Airspace. Navigation equipment used in NAT MNPS airspace must meet ICAO accuracy standards as stated in FAR Part 91, appendix C, and be **specifically** approved by the FAA. In addition, an endorsement must be contained in the "Operating Limitations Section" of the AFM/POH, and each operator and aircraft must have **written** FAA approval to operate in MNPS airspace. Operational capability should be maintained through recurrent training, periodic equipment inspection, and reliability checks. At present, MNPS airspace is designated over virtually all of the NAT between FL 275 and FL 400 and over certain areas and altitudes over Northern Canada (see figures 5 and 6). ICAO Annex 6 specifically requires all navigation equipment used in MNPS airspace to continuously provide an indication to the flightcrew under all weather conditions of adherence to assigned tracks, within the accuracy required for navigation along that track. For further information on MNPS airspace requirements, pilots should refer to the "North Atlantic MNPS Airspace Operations Manual," and ICAO Document 7030, "Regional Supplementary Procedures."

FIGURE 5

NORTH ATLANTIC (NAT) MNPS AIRSPACE

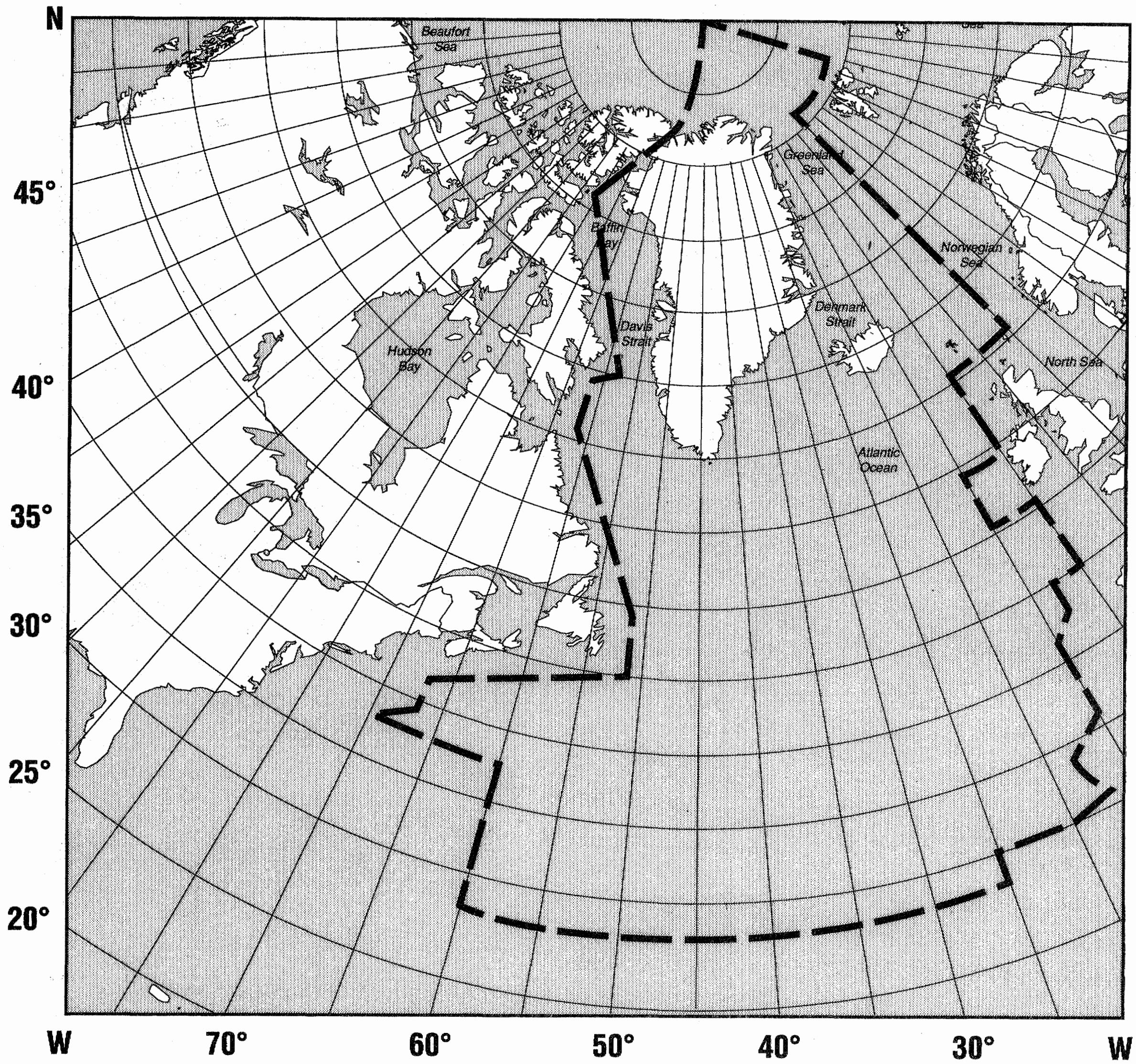
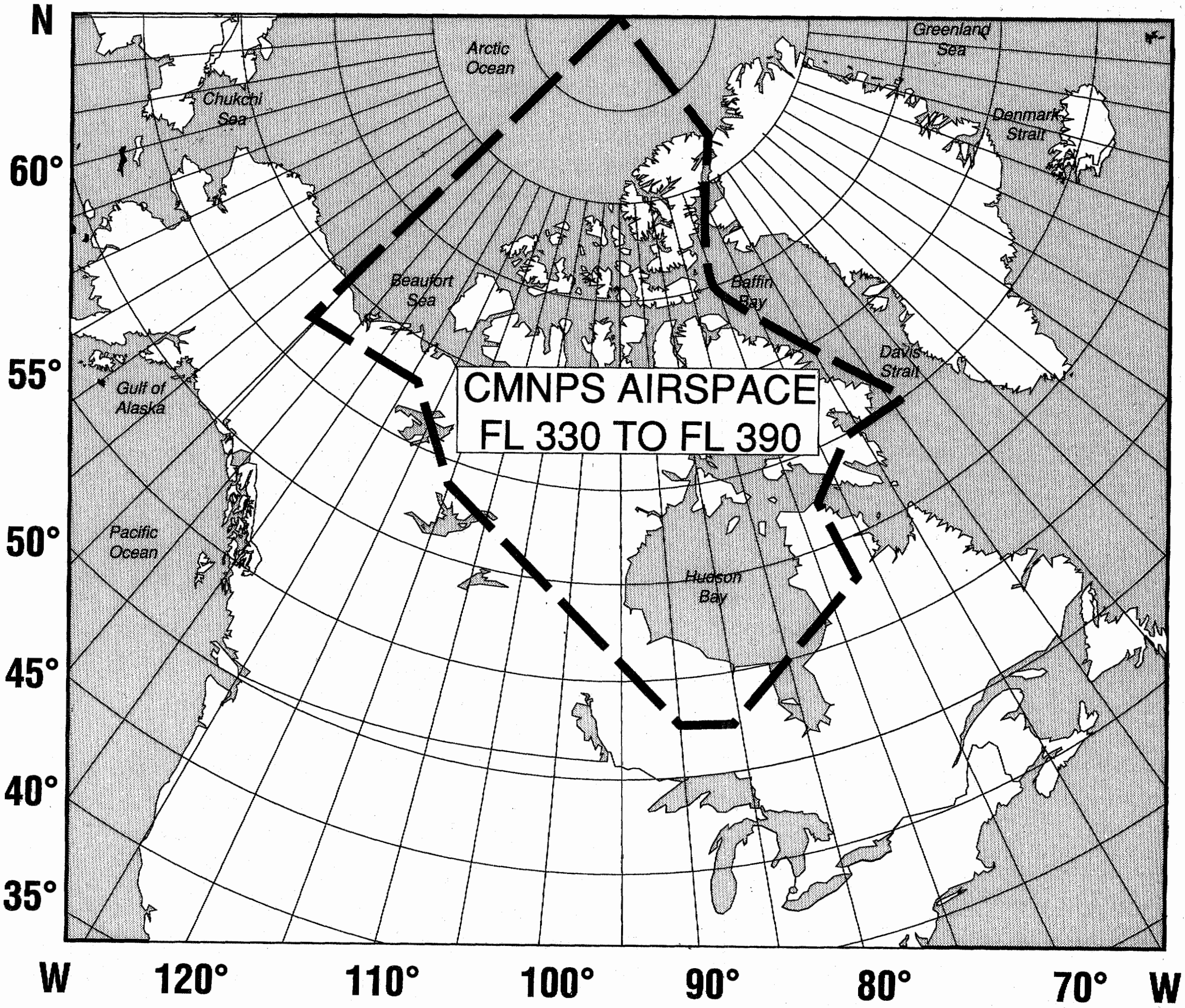


FIGURE 6

CANADIAN MNPS AIRSPACE



5. INSTALLATION AND OPERATIONAL GUIDANCE FOR THE USE OF LORAN-C IN OCEANIC OPERATIONS.

a. Installation Guidance. Loran-C navigation equipment used in oceanic operations should be installed in accordance with AC 20-121, "Airworthiness Approval of Airborne Loran-C Navigation Systems for Use in the U.S. National Airspace System (NAS)," current edition. Loran-C units must be installed under the Type Certificate (TC), a Supplemental Type Certificate (STC) or field approved using an FAA Form 337, "Major Repair and Alteration (Airframe, Powerplant, Propeller or Appliance)." Loran-C units may be susceptible to signal attenuation due to improperly installed antennas. Any temporarily installed Loran-C unit should be connected to an external antenna approved for use by the manufacturer. Pilots should be aware that limited single-chain operation or inappropriate (or obsolete) signal processing software, or a "noisy" antenna system, can all cause loss of navigable signal information with all types of Loran-C units. All temporarily installed or portable Loran-C units must be operated pursuant to FAR § 91.21, "Portable Electronic Devices." This section states, in part, that no person may operate a portable electronic device on a U.S.-registered civil aircraft operated by a holder of an air carrier operating certificate or an operating certificate, or on **any** aircraft operating IFR. However, the regulations allow for such operations if it has been determined that the portable unit, when operated, will not interfere with either the navigation or communication equipment installed on **that** aircraft.

b. Oceanic Use. Loran-C navigation equipment for oceanic use should be capable of multiple chain operation and be capable of using any chain necessary for the intended flight. The unit must also be capable of inputting into memory any latitude/longitude coordinates required for the flight. The manufacturer's most recent software version should be installed, and the appropriate software documentation should be available.

c. Preflight Activities. Pilots should carefully **review** Loran-C operating limitations and instructions contained in either the AFM or POH (see figure 7 for an example). Pilots should make themselves aware of **specific** documentation which authorizes the use of this equipment for oceanic navigation and what restrictions and/or limitations, if any, may be placed upon its operational use. An example of a limitation follows: "IFR area navigation of [brand & model name] is **limited** to the continental United States." Pilots should also review the scope of data within the memory of the Loran-C. For example, are all airport locations stored in memory or are only selected airports stored in memory?

d. Preflight and Continued Airworthiness. During preflight, it is extremely important for pilots to ensure that all flight-control-to-airframe bonding straps (loosely woven metal braid) are secured. In addition, pilots should check each P-static wick for general condition and ensure that adequate bonding exists so that electrostatic discharge does not impede the SNR of the Loran-C. Either of these two conditions could "detune" the Loran-C without warning.

e. Backup Plans and Equipment. Judgment and plain common sense suggest that it is risky for pilots to attempt a flight over the cold waters of the NAT while relying only on one means of navigation. Pilots should **be prudent** and always have an alternate plan. They should also have backup navigation equipment available and an up-to-date flight progress log just in case they have to put aside all of their equipment and use DR to their destination.

NOTE: In addition to the need for good judgment and plain common sense, Canadian Air Regulations **require** specific kinds of backup equipment for aircraft operated over the NAT.

f. Acceptable Signals. If the navigation equipment incorporates a mode for extended range (such as one that uses sky waves), then this mode should **not** be used when flying in oceanic airspace. Only surface/ground wave signals should be used for oceanic navigation (see figure 10 in appendix 2).

g. MNPS Airspace Approval Documents. Loran-C equipped aircraft approved to fly IFR in NAT or Canadian MNPS airspace, or areas of known magnetic unreliability, should have the basis for each specific approval stated in the AFM or POH, whichever is appropriate. Figure 8 is an example of such an endorsement. In addition, each operator intending to fly an aircraft in MNPS airspace must have **separate** written authorization from a Flight Standards District Office (FSDO). This LOA should state the geographical or chain coverage limits while using Loran-C to navigate in MNPS airspace (if not explicitly stated in the flight manual supplement section).

h. Minimum Equipment List (MEL) Considerations. Even though a pilot has committed to an ocean crossing, the pilot is still bound to the aircraft's MEL requirements in the event of partial (or complete) failure of any navigation system. Pilots should consult the appropriate MEL for specific guidance.

FIGURE 7

SAMPLE "PAGE ONE" FROM AFM/POH SUPPLEMENT

Oakland, CA

FAA-APPROVED AIRPLANE FLIGHT MANUAL SUPPLEMENT
LORAN-C NAVIGATION SYSTEM

AIRCRAFT MAKE: Cessna

AIRCRAFT MODEL: T-210F

SERIAL NUMBER: T2100014

REGISTRATION NUMBER: N6114R

Note! ↦ **This document must be carried in the aircraft at all times.**

This document describes the operating procedures for the [make] Loran-C system when it has been installed in accordance with (manufacturer's installation manual) and FAA Form 337 dated ______.

For airplanes with a pilot's operating handbook and/or FAA-approved AFM, this document serves as the FAA-approved [make] Loran-C Flight Manual Supplement.

The information contained herein supplements or supersedes the basic AFM only in those areas listed herein. For limitations, procedures, and performance information not contained in this document, consult the basic AFM [if applicable.]

FAA APPROVED: ______________________________

[Inspector's name]
Aviation Safety Inspector [Avionics]
WP OAK FSDO #123
Federal Aviation Administration

FAA APPROVED

FIGURE 8

SAMPLE AFM/POH APPROVAL ENDORSEMENT TO OPERATE LORAN-C IN MNPS AIRSPACE

INSTALLATION CENTER/FAA REPAIR STATION #______
6114 Earhart Road
Oakland, CA 94614

FAA-APPROVED AIRPLANE FLIGHT MANUAL SUPPLEMENT
LORAN-C NAVIGATION SYSTEM

SECTION I

INTRODUCTION

A. **EQUIPMENT DESCRIPTION**
Provide a general description of the Loran-C Area Navigation System installed in the aircraft.

Information in this section defines what kinds of operational use is permitted, and any geographical limitations to its use. ↦

B. **GENERAL**
Provided that the [make] Loran-C navigation system is receiving adequate usable signals, it has been demonstrated capable of, and has been shown to meet the accuracy specifications of:

1. VFR/IFR en route, terminal, and approach [if applicable] operation within the conterminous United States and Alaska, in accordance with the criteria of AC 20-121A.

2. Flight in the NAT Minimum Navigation Performance Specifications (MNPS) airspace within the following coverage areas: ______________.

FAA APPROVED
DATE: ________

i. MNPS Performance Capability. MNPS capability is not solely dependent upon navigation equipment accuracy alone, but also includes the following:

(1) Crew knowledge of the system being used and crew skill at operating the specific navigation equipment. This includes knowledge of basic navigation principles, equipment operating procedures, and MNPS airspace emergency procedures.

(2) Adherence to equipment installation, maintenance and software update standards.

(3) Periodic position accuracy checks using other available NAVAID's along the route of flight.

j. Review Notices to Airmen (NOTAM's). Before attempting **any** oceanic flight using Loran-C for navigation, operators must review all appropriate Loran-C NOTAM's. While these are technically NOTAM (D's), they are grouped in a special file entitled, LRN NOTAM's, and listed by chain number. Domestic Loran-C NOTAM's may be accessed under this LRN NOTAM's file. International NOTAM's are issued under the "KNMH" series. NOTAM's for Omega, Loran-C, or GPS must be **specifically** requested even if the briefer has been informed that the aircraft is RNAV equipped and a standard briefing is being requested. Such a generic request alone is not sufficient to receive Loran-C NOTAM's. In addition, prerecorded telephone answering service messages for selected Loran-C stations are printed in the "Airman's Information Manual" (AIM).

NOTE: Different countries have different ways to disseminate Loran-C NOTAM's. It is the responsibility of the pilot in command (PIC) to obtain all NOTAM's that may affect safety of flight.

Examples: LRN 00/000 LRN CHAIN 9960 OTS
Explanation: The entire Northeast U.S. chain is out of service.

LRN 00/000 LRN CHAIN 9960 STN Y OTS
Explanation: Station Y of the Northeast U.S. chain is out of service.

k. Preprogram Waypoints. The best way to minimize the chances of misprogramming a Loran-C unit is for the pilot to carefully program the various waypoints into the equipment memory **before** beginning a flight. During this process, it is best to have another person doublecheck waypoint entries to ensure that the unit is properly programmed. The use of oceanic (such as over-water) plotting charts is a **must** for effective flight planning and flight management when airborne. While it may not be possible for a pilot to use a plotting chart in a small helicopter, alternate position recordkeeping is still a fundamental way for the pilot to stay "position oriented" and on the assigned route/track.

l. Cross-Check Positions. Once airborne and before proceeding beyond the range of standard NAVAID's, flightcrews should cross-check their Loran-C position with ground- or space-based NAVAID's to ensure that all navigation equipment is performing correctly. The flightcrew may use the following methods, as appropriate, to accomplish this:

(1) Flying directly to and over a "gateway" fix and comparing the displayed position data with that derived from the Loran-C equipment;

(2) Navigating precisely to any fix using VOR/NDB bearing and DME or GPS-derived data, then comparing these data with Loran-C derived position data;

(3) Comparing the range and bearing information provided by conventional NAVAID equipment (such as VOR/DME) or GPS-provided data with that obtained from the Loran-C unit;

(4) Plotting a radial/DME fix on a chart and then plotting the Loran-C position for comparison; or

(5) Using any other equivalent procedure that ensures an adequate comparison between standard NAVAID's information and Loran-C derived position information. An example of an equivalent procedure is cross-checking with ground-based ATC radar.

m. Beware of Fatigue! Once committed to an oceanic flight, crewmembers should exercise extreme care to ensure that all waypoints are carefully cross-checked (ideally by another crewmember) to ensure accuracy. Beware of fatigue as a physiological stressor. Long, oceanic night flights can be tiring. Waypoint insertion errors or the misreading of a clearance are more likely to occur when crewmembers are fatigued.

n. Keep a Waypoint Notebook or DR Flight Progress Log. It is good practice for the pilot or the appropriate crewmember to make written notations of the time each waypoint passage occurs. The aircraft position should then be plotted to ensure that the flight is progressing normally and that the next waypoint has been entered correctly. **Routine use of oceanic plotting charts is the most effective way to minimize the chances of performing a gross navigational error.** The calculated time to the next fix or checkpoint should be validated. After passing each waypoint, it is good practice for the pilot or the selected crewmember to cross-check the actual outbound heading with the plotted course to ensure that the aircraft is headed in the proper direction, considering the known or forecast winds and temperatures aloft. Also, if the displayed "distance to go" readout conflicts with where the pilot thinks the actual location is, the pilot should recheck the aircraft's position with another onboard navigation system.

NOTE: The pilot should make sure that navigation is consistent. The actual (and plotted) headings may vary, depending on whether the pilot is navigating along a "rhumb line" or a "great circle" route. A "rhumb line" course appears as a straight line only on Mercator projection charts which are not readily available to the flying community (see Glossary, appendix 2). In any event, the pilot should make sure that the readings on the aircraft's compass system agree with the heading information on the computer-generated flightplan, DR flight log, or plotting charts.

o. Adopt Minimum Standards. Operators and pilots should review and adopt the practices and procedures published in AC 90-79, "Recommended Practices and Procedures for the Use of Electronic Long-Range Navigation Equipment," as their **minimum** standards. This AC provides guidance for the disciplined and systematic cross-checking of navigation information during all phases of flight.

p. Safeguard Against Signal Loss. Potential interference or loss of Loran-C signal reception is always a possibility. In-flight weather conditions, such as moderate to heavy precipitation and various types of electromagnetic interference, may adversely affect Loran-C signal reception. Such disturbances are unpredictable and could put flightcrews at risk of getting lost over the high seas. Inoperative static wicks or poor antenna bonding may also contribute to loss of signal. If the route takes the aircraft along an extended baseline or outside the Loran-C manufacturer's coverage envelope (see appendix 1 for details), the Loran-C signal may be lost for extended periods. Flight crewmembers should also consider the possibility that the chain transmitter itself may be temporarily out of service or go off the air during an ocean crossing. Under any of the above conditions, a judicious pilot should have an alternate plan of action **readily available** and be prepared to navigate by other means. If a course is properly plotted and navigation logs are kept up-to-date, a quick conversion to a DR mode will be easier and result in more accurate navigation. If a loss of signal does occur, the pilot flying VFR should be prepared to rely on other available electronic means. Pilots flying IFR in aircraft equipped with multiple, independent navigation sensors may only need to manually switch to their alternate navigation system or DR.

q. Critical Triangle Method. Many professional pilots rely on the critical triangle method to stay out of trouble when flying over the high seas. To minimize risk, experienced pilots rely on three **independent** navigation systems (as opposed to one or even three Loran-C triads). If one system fails or provides inaccurate position data, the pilot can cross-check the navigation data with the other two units to determine which one of the three units is in error. **Two independent systems alone will not work.** Some examples of this concept follow:

(1) Loran-C/VOR/VOR

(2) Loran-C/Weather radar (in map mode)/automatic direction finder (ADF)

(3) VOR/Loran-C/Omega

(4) Three separate inertial navigation system (INS) units

(5) Inertial/Loran-C/VOR

(6) Inertial/Loran-C/GPS

(7) Loran-C/VFR Pilotage/VOR

(8) Loran-C/Ground-based radar/GPS

r. R_x for Automation. Here are some suggestions for pilots on how to work effectively with either of the following labor-saving equipment: old style electromechanical displays or the new age glass cockpit.

(1) Learn the operating requirements and limitations of aircraft equipment -- before flight. This is sound advice for both sophisticated computer systems and the basic systems of any aircraft.

(2) Avoid over-reliance on **any** equipment, whether it is a flight management computer, RNAV, altitude alerter, or autopilot. Pilots should remember that advanced technology equipment is an aid to, not a replacement for, proper cockpit management.

(3) While using navigation devices, pilots should maintain position awareness at all times. They should back up FMS's with raw data wherever possible, and they should avoid letting the equipment take command.

(4) Use aeronautical charts. A common theme in track deviations involving advanced technology aircraft is, "We were cleared to a point not on the FMS route of flight, and it took several minutes to get the charts out and program the new waypoints." Pilots should keep all relevant charts handy and use them to track the flight's progress.

(5) Plan programming chores for times of relatively low workload. Pilots should make waypoint and other data entries only when there are no pressing demands of general cockpit management.

(6) Avoid spending a lot of time trying to "force" data into a computer. If things do not work correctly, pilots should revert to basic modes of control.

(7) Determine what equipment can do before using it. If equipment fails to operate within expected parameters or performs in an unexpected manner, pilots should be prepared to take manual control of the aircraft.

APPENDIX 1. LORAN-C OCEANIC AND NAS COVERAGE DIAGRAMS

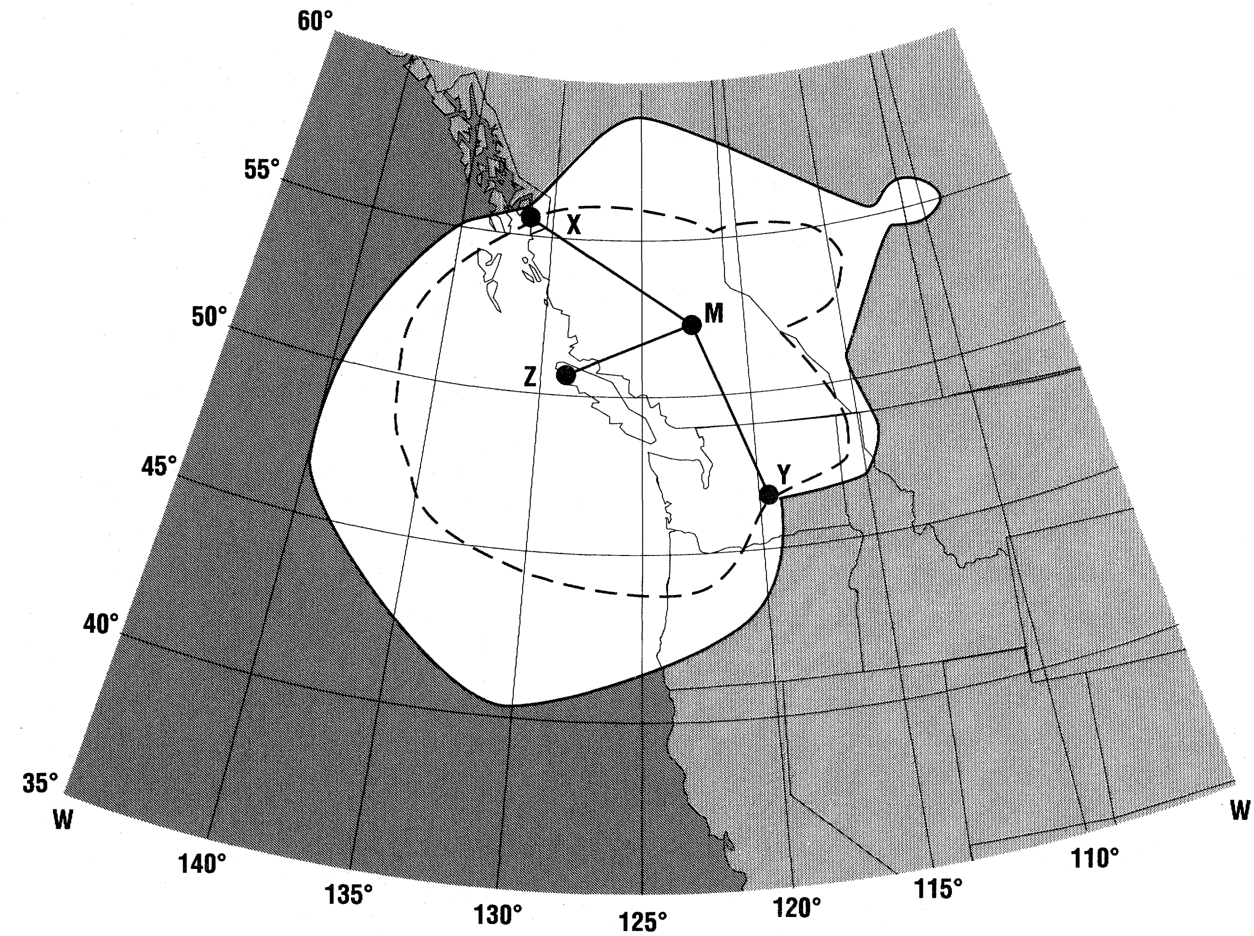
LORAN-C NAS COVERAGE DIAGRAM

Canadian West Coast Chain - 5990

ID	TRANSMITTER	POWER (KW)
M	Williams Lake	400
X	Shoal Cove	560
Y	George	1400
Z	Port Hardy	335

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/μs
- NAS GDOP 4,200 ft/μs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 64 db
- Surface to FL 600
- Flight Verified



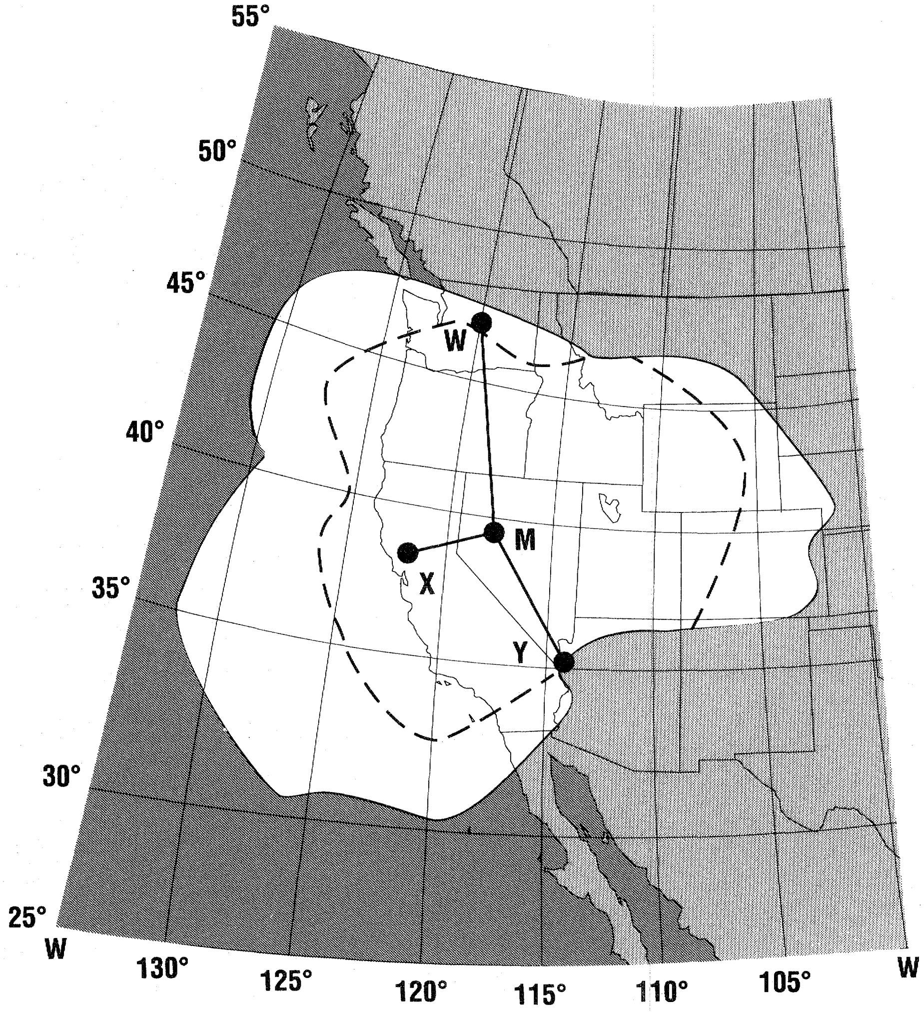
LORAN-C NAS COVERAGE DIAGRAM

United States West Coast Chain - 9940

ID	TRANSMITTER	POWER (KW)
M	Fallon	400
W	George	1400
X	Middleton	400
Y	Searchlight	560

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs
- NAS GDOP 4,200 ft/µs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



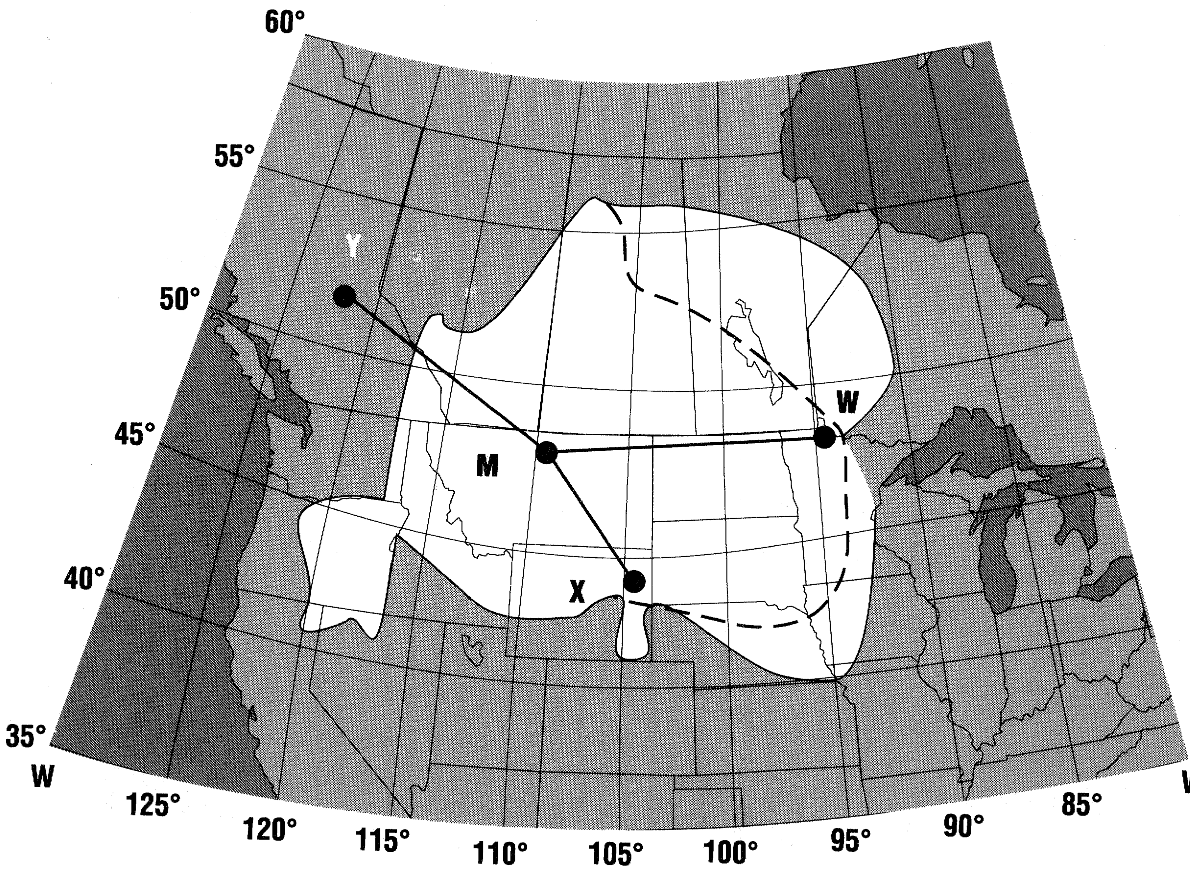
LORAN-C NAS COVERAGE DIAGRAM

North Central United States Chain - 8290

ID	TRANSMITTER	POWER (KW)
M	Havre	540
W	Baudette	800
X	Gillette	540
Y	Williams Lake	400

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs
- NAS GDOP 4,200 ft/µs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



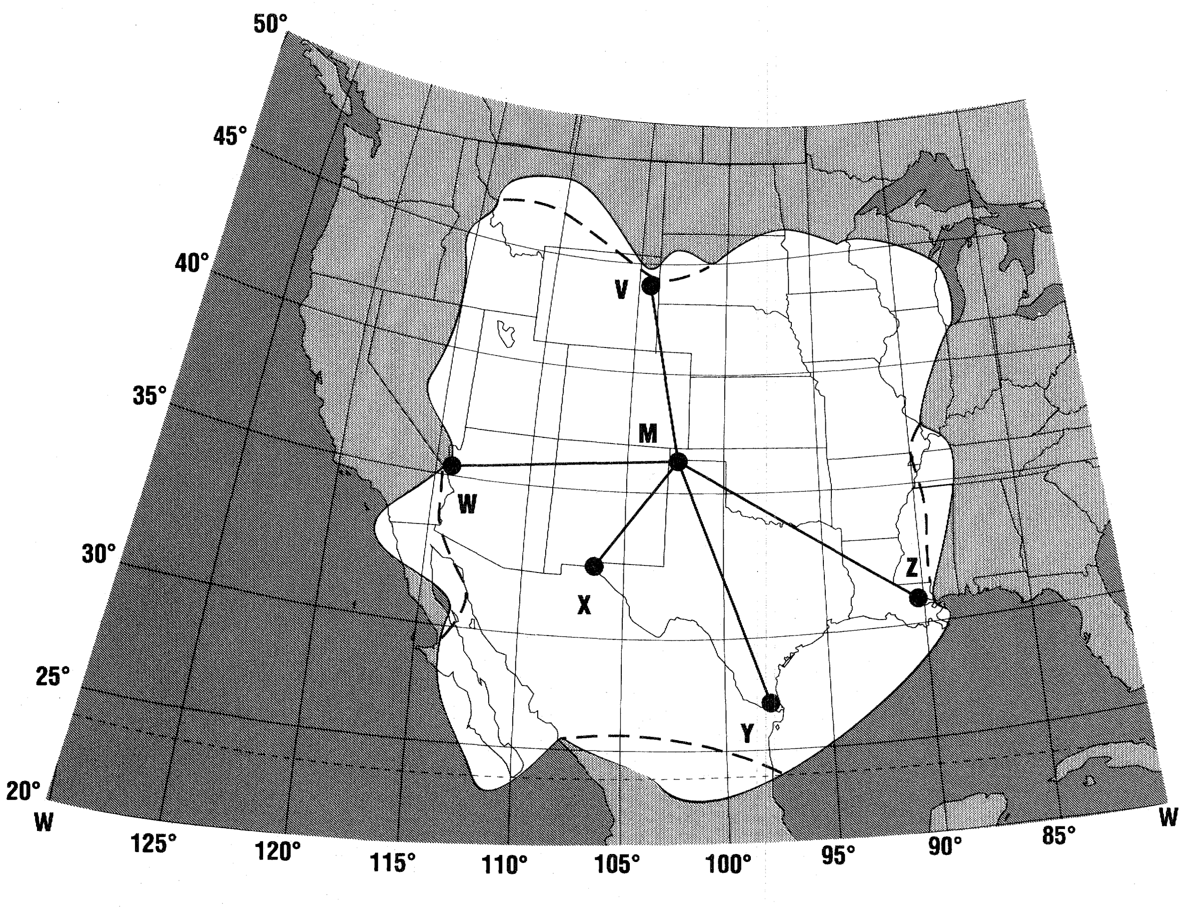
LORAN-C NAS COVERAGE DIAGRAM

South Central United States Chain - 9610

ID	TRANSMITTER	POWER (KW)
M	Boise City	900
V	Gillette	540
W	Searchlight	560
X	Las Cruces	540
Y	Raymondville	540
Z	Grangeville	800

PARAMETERS

· Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs
· NAS GDOP 4,200 ft/µs
· NAS Contour Symbology: — — —
· Average Atmospheric Noise: 61 db
· Surface to FL 600
· Flight Verified



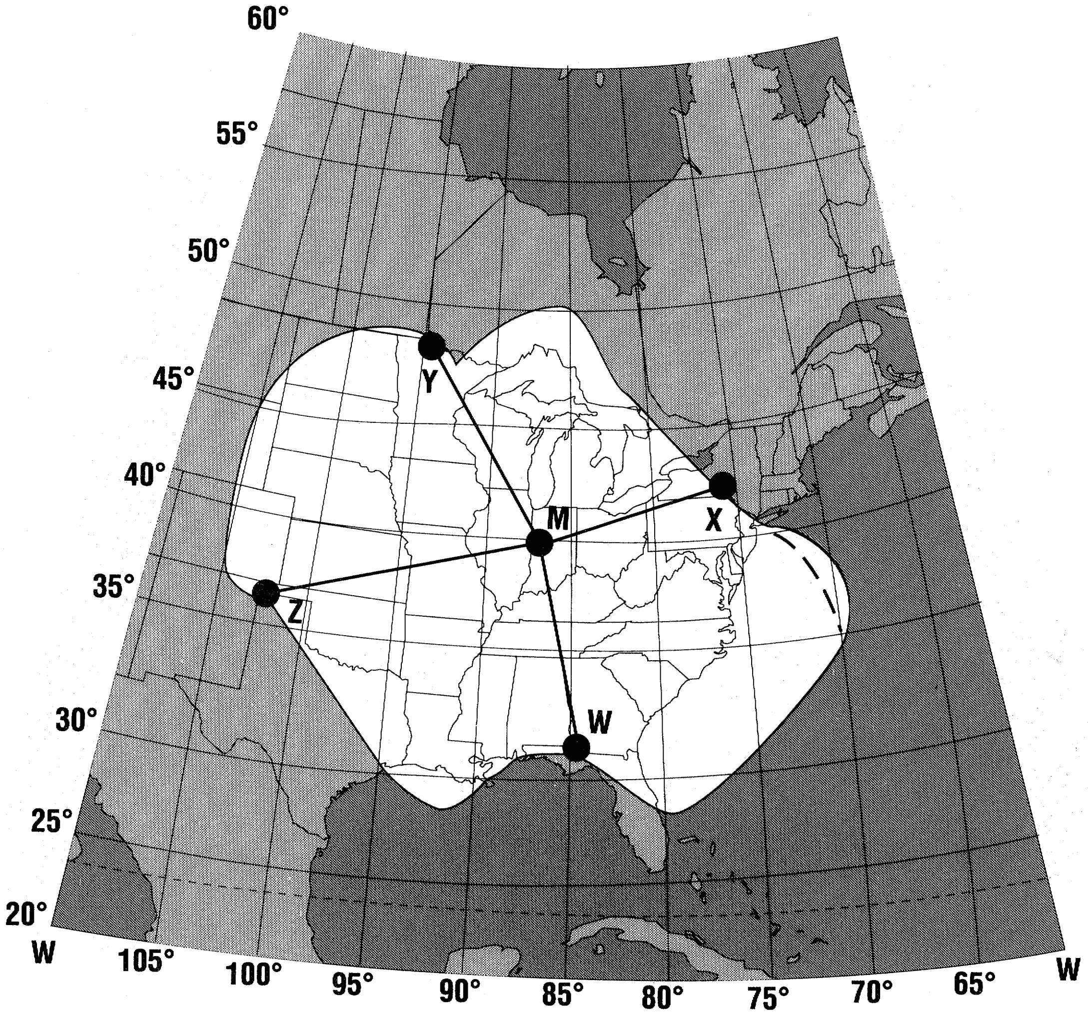
LORAN-C NAS COVERAGE DIAGRAM

United States Great Lakes Chain - 8970

ID	TRANSMITTER	POWER (KW)
M	Dana	400
W	Malone	800
X	Seneca	800
Y	Baudette	800
Z	Boise City	800

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs
- NAS GDOP 4,200 ft/µs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



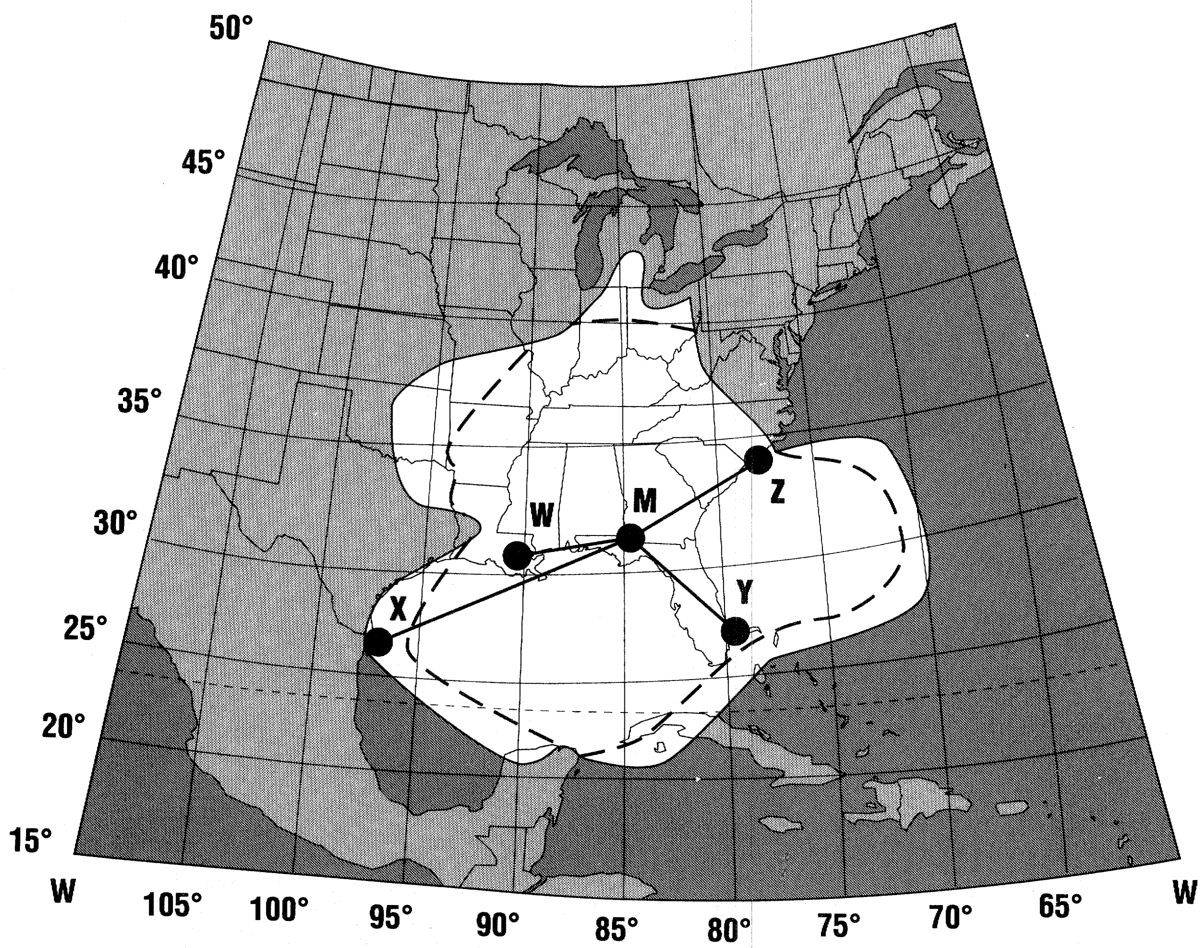
LORAN-C NAS COVERAGE DIAGRAM

Southeast United States Chain - 7980

ID	TRANSMITTER	POWER (KW)
M	Malone	800
W	Grangeville	800
X	Raymondville	540
Y	Jupiter	350
Z	Carolina Beach	600

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/µs
- NAS GDOP 4,200 ft/µs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



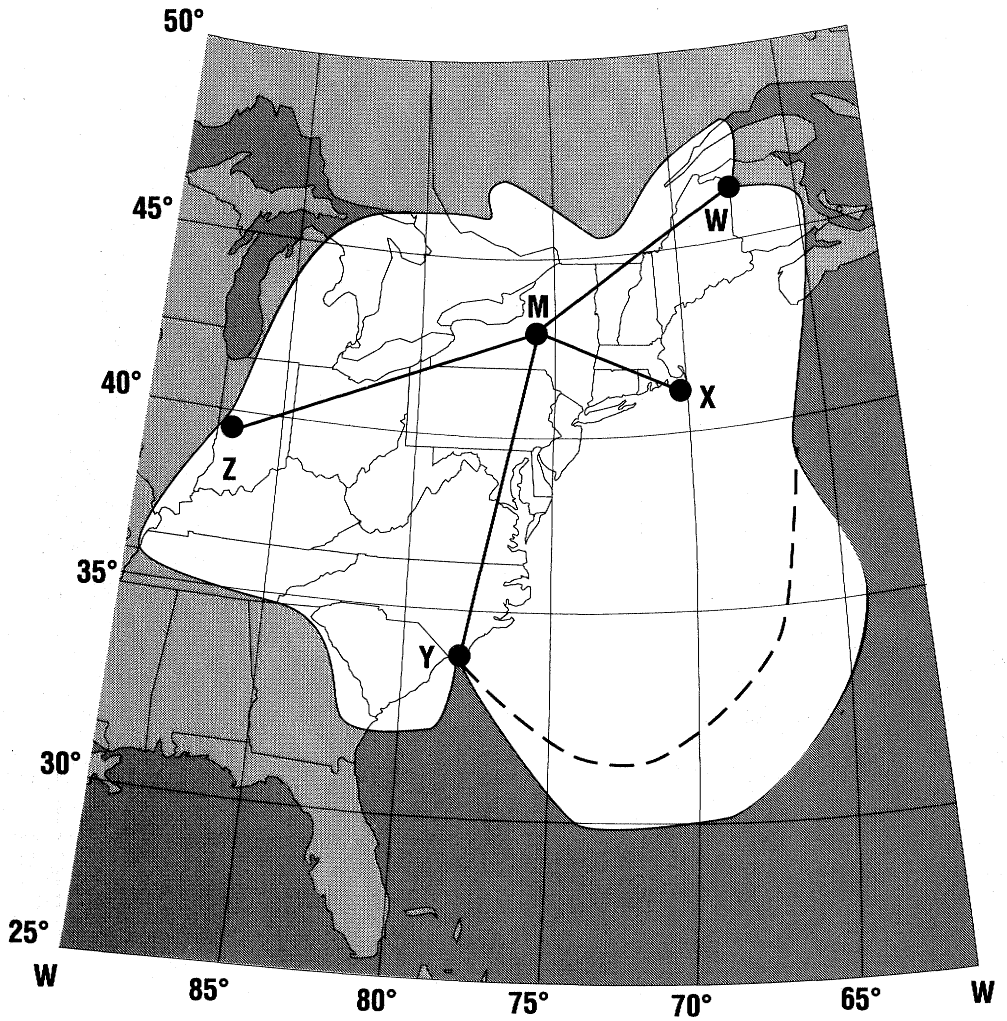
LORAN-C NAS COVERAGE DIAGRAM

Northeast United States Chain - 9960

ID	TRANSMITTER	POWER (KW)
M	Seneca	800
W	Caribou	790
X	Nantucket	350
Y	Carolina Beach	600
Z	Dana	400

PARAMETERS

- Contour: SNR -10 db; Oceanic GDOP 7,700 ft/μs
- NAS GDOP 4,200 ft/μs
- NAS Contour Symbology: — — —
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



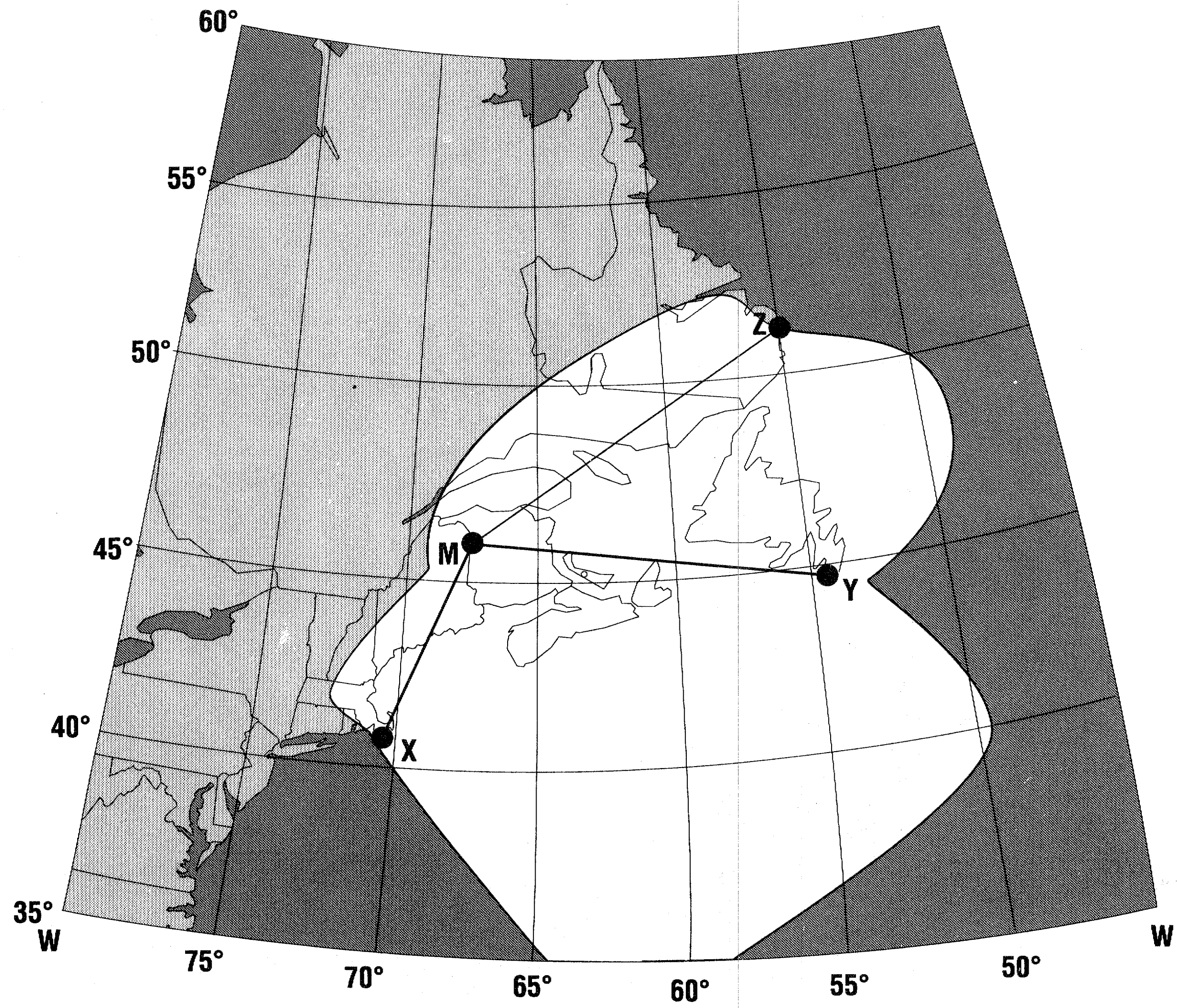
LORAN-C OCEANIC COVERAGE DIAGRAM

Canadian East Coast Chain - 5930

ID	TRANSMITTER	POWER (KW)
M	Caribou	790
X	Nantucket	400
Y	Cape Race	1030
Z	Fox Harbour	800

PARAMETERS

· Contour: SNR -10 db; Oceanic GDOP 7,700 ft/μs
· Average Atmospheric Noise: 61 db
· Surface to FL 600
· Flight Verified



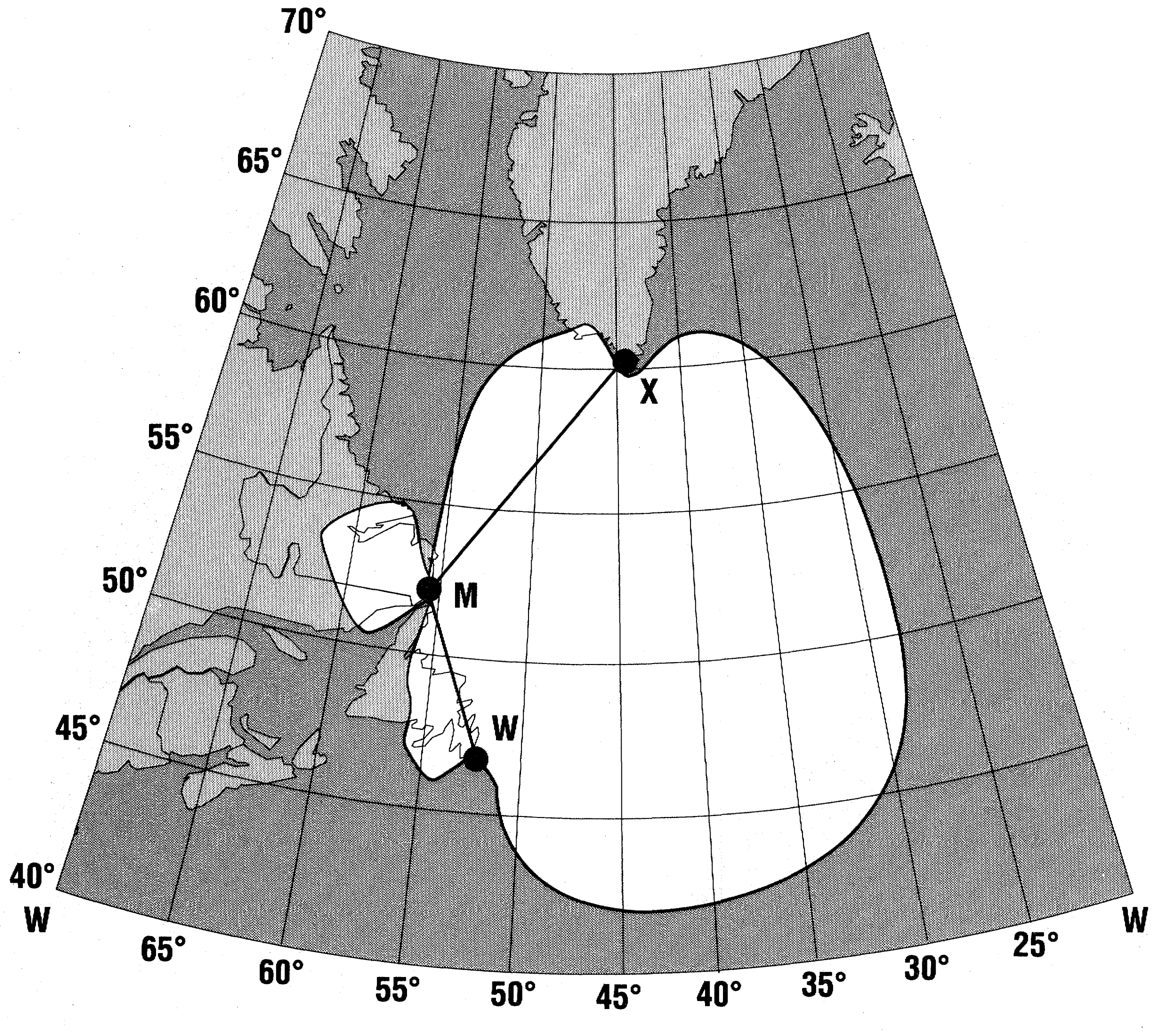
LORAN-C OCEANIC COVERAGE DIAGRAM

Labrador Sea Chain - 7930

ID	TRANSMITTER	POWER (KW)
M	Fox Harbour	800
W	Cape Race	1030
X	Angissoq	760

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/µs
- Average Atmospheric Noise: 47 db
- Surface to FL 600
- Flight Verified

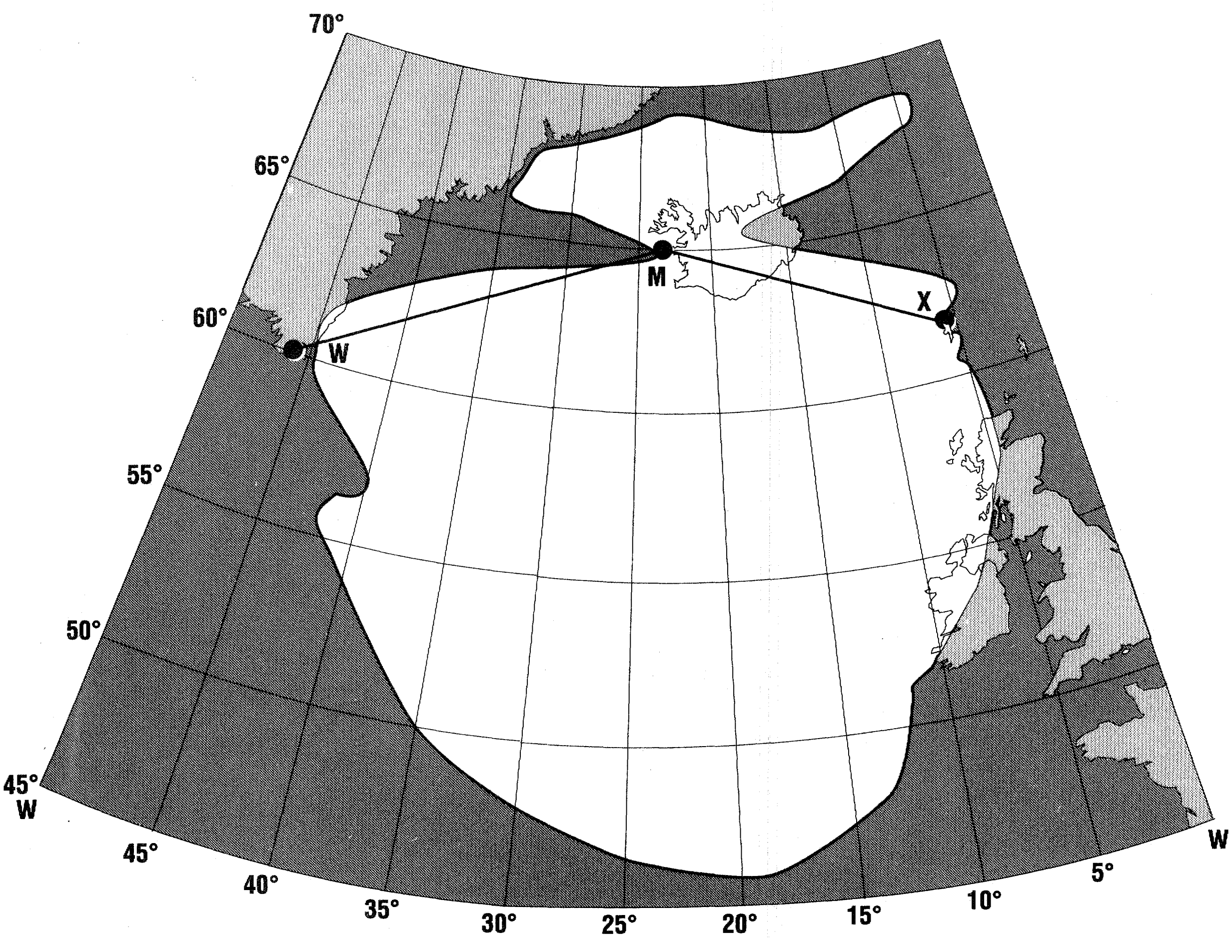


LORAN-C OCEANIC COVERAGE DIAGRAM

Icelandic Chain - 9980

ID	TRANSMITTER	POWER (KW)
M	Sandur	1500
W	Angissoq	760
X	Ejde	400

PARAMETERS
- Contour: SNR -10 db; GDOP 7,700 ft/µs
- Average Atmospheric Noise: 47 db
- Surface to FL 600
- Flight Verified



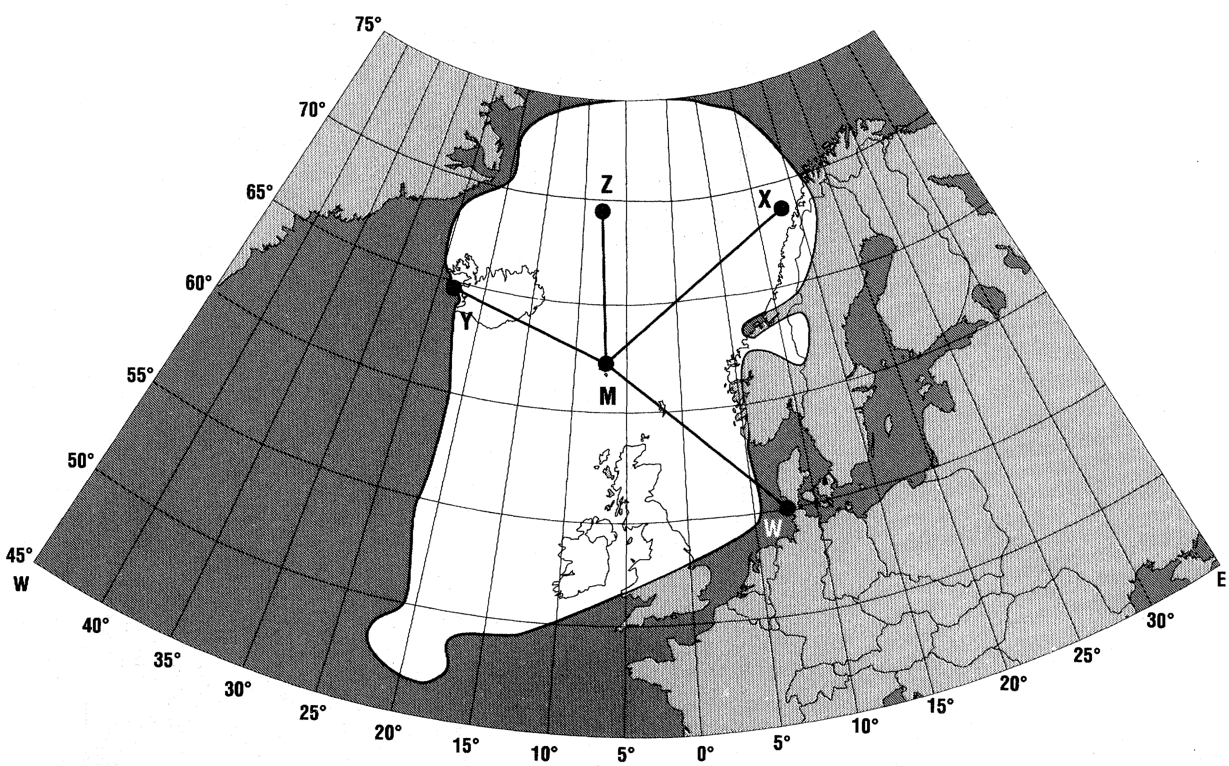
LORAN-C OCEANIC COVERAGE DIAGRAM

Norwegian Sea Chain - 7970

ID	TRANSMITTER	POWER (KW)
M	Ejde	400
W	Bø	165
X	Sylt	275
Y	Sandur	1500
Z	Jan Mayen	165

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/µs
- Average Atmospheric Noise: 61 db
- Surface to FL 600
- Flight Verified



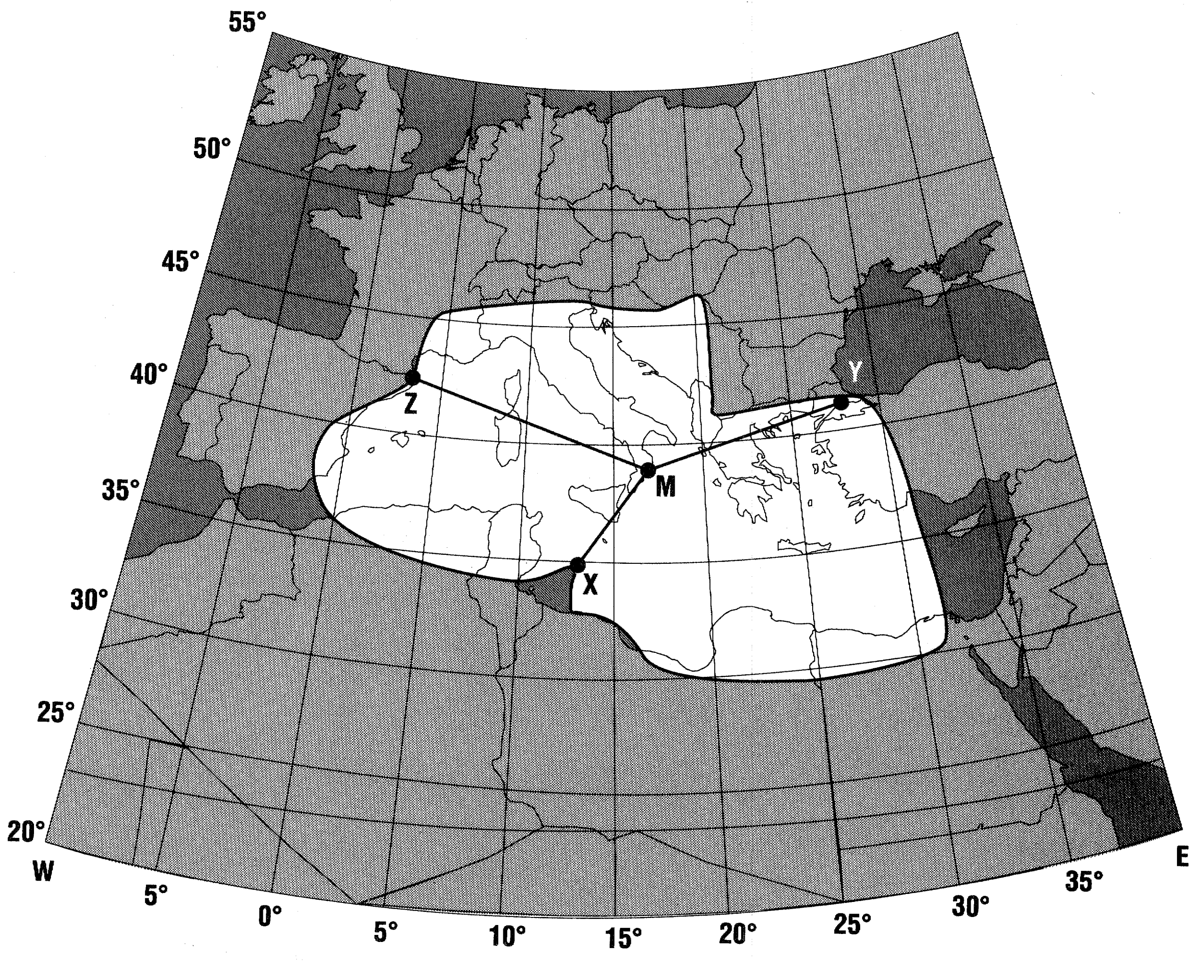
LORAN-C OCEANIC COVERAGE DIAGRAM

Mediterranean Sea Chain - 7990

ID	TRANSMITTER	POWER (KW)
M	Sella Marina	165
X	Lampedusa	400
Y	Kargabarun	165
Z	Estartit	165

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/µs
- Average Atmospheric Noise: 60 db
- Surface to FL 600
- Computer Generated



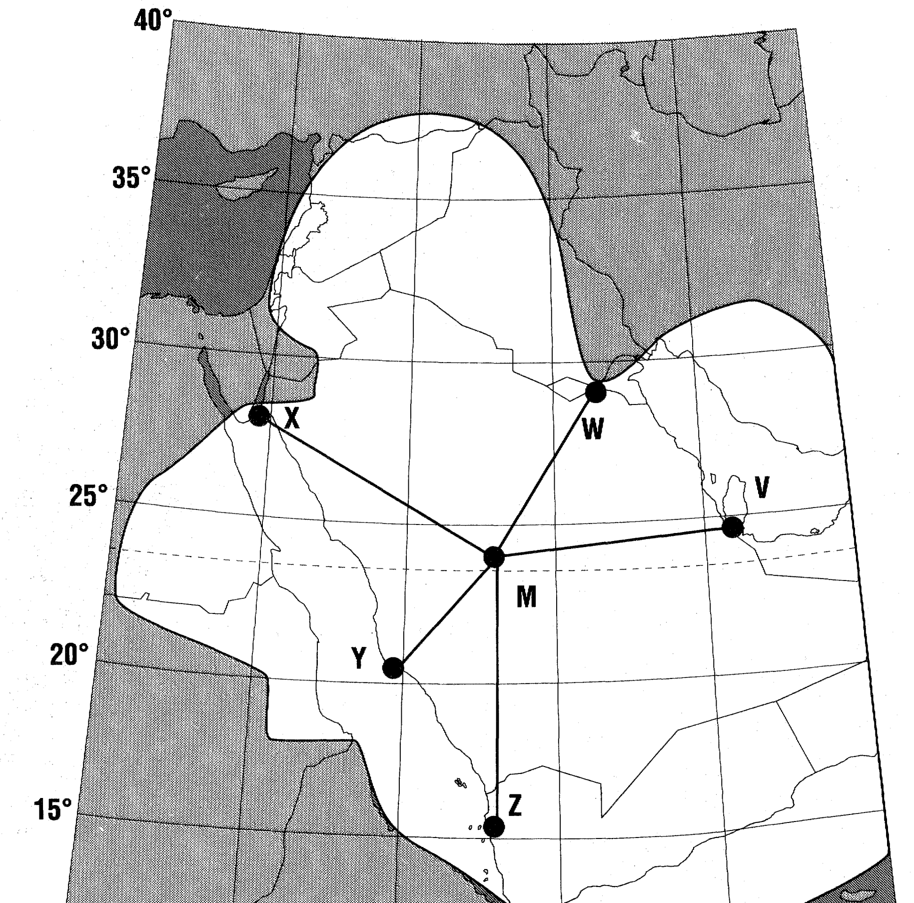
LORAN-C OCEANIC COVERAGE DIAGRAM

Saudi Arabia (North) Chain - 8990

ID	TRANSMITTER	POWER (KW)
M	Afif	800
V	Salwa	800
W	Ar Ruqi	200
X	Ash Shaykh Humayd	400
Y	Al Lith	200
Z	Al Muwassam	800

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/μs
- Average Atmospheric Noise: 65 db
- Surface to FL 600
- Computer Generated

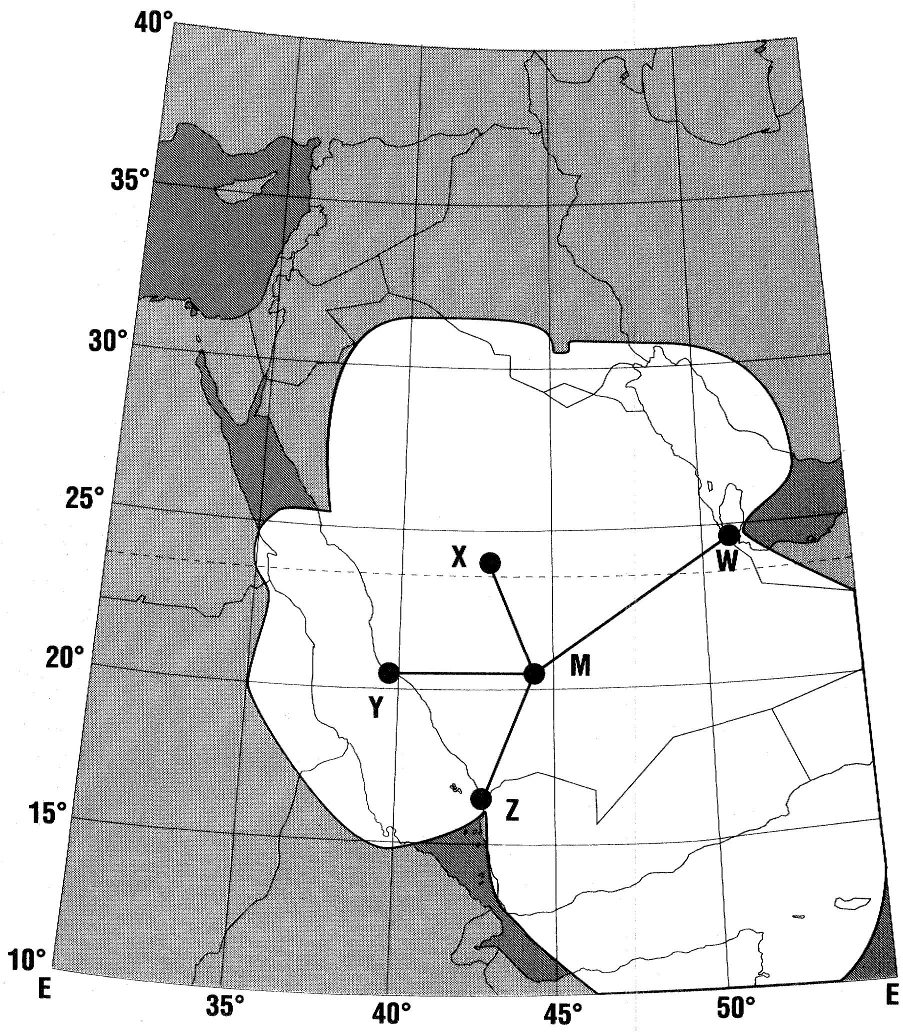


LORAN-C OCEANIC COVERAGE DIAGRAM

Saudi Arabia (South) Chain - 7170

ID	TRANSMITTER	POWER (KW)
M	Al Khamasin	800
W	Salwa	800
X	Afif	800
Y	Al Lith	200
Z	Al Muwassam	800

PARAMETERS
- Contour: SNR -10 db; GDOP 7,700 ft/µs
- Average Atmospheric Noise: 65 db
- Surface to FL 600
- Computer Generated



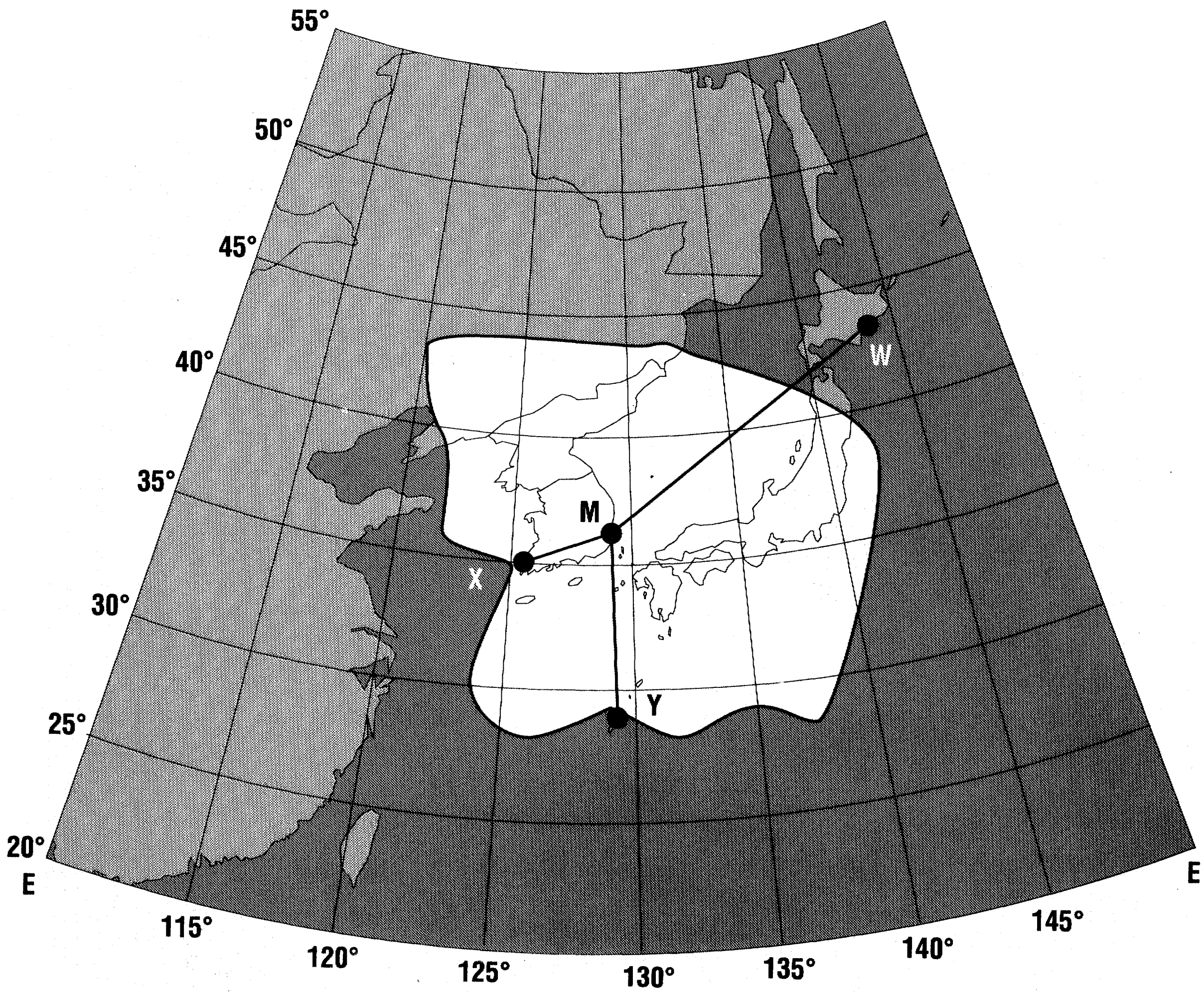
LORAN-C OCEANIC COVERAGE DIAGRAM

East Asia Chain - 5970

ID	TRANSMITTER	POWER (KW)
M	Pohang	35
W	Hokkaido	600
X	Hampyong	35
Y	Gesashi	600

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/μs
- Average Atmospheric Noise: 60 db
- Surface to FL 600
- Computer Generated



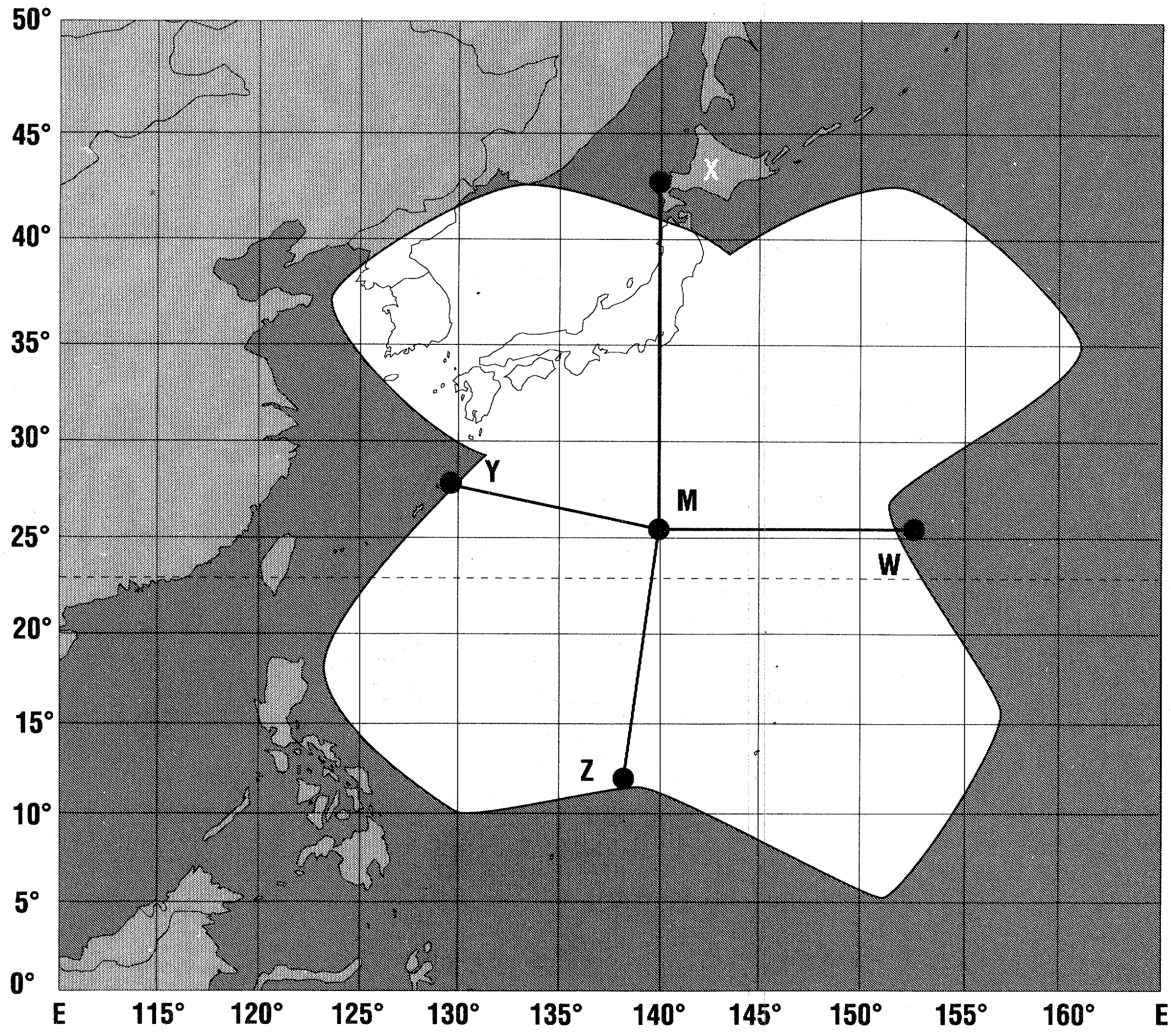
LORAN-C OCEANIC COVERAGE DIAGRAM

Northwest Pacific Chain - 9970

ID	TRANSMITTER	POWER (KW)
M	Iwo Jima	1815
W	Marcus Island	1050
X	Hokkaido	600
Y	Gesashi	600
Z	Barrigada	600

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/μs
- Average Atmospheric Noise: 60 db
- Surface to FL 600
- Computer Generated



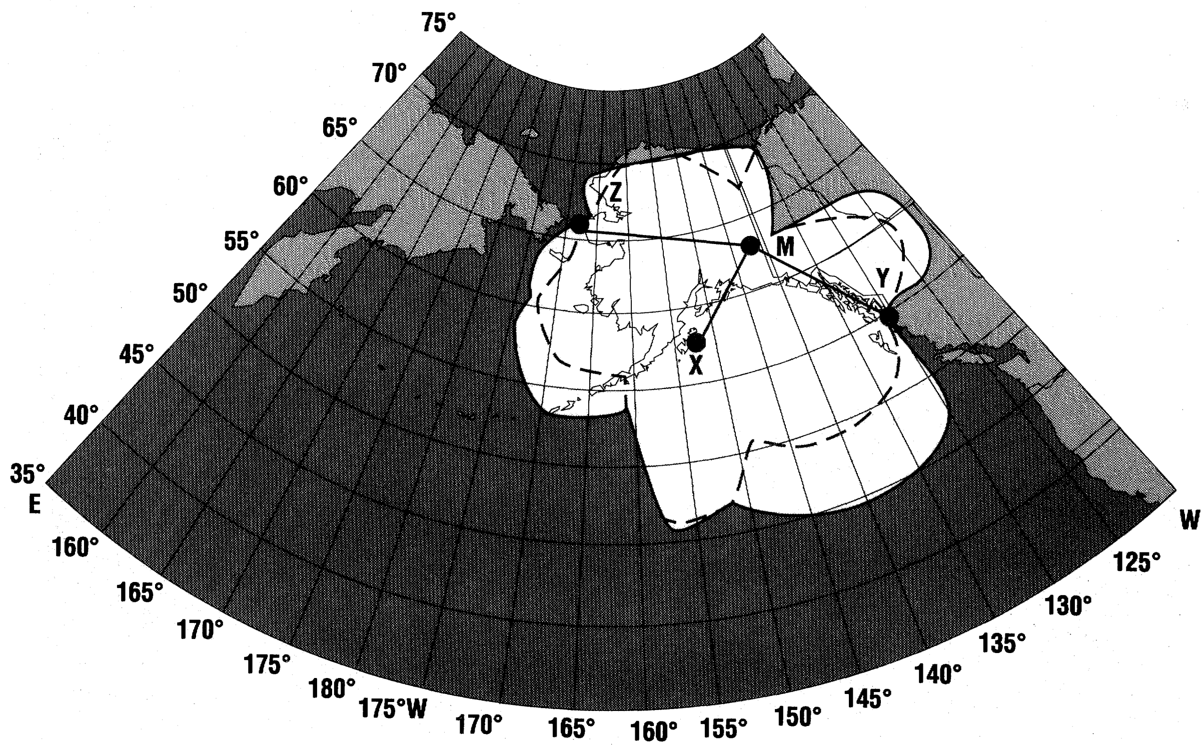
LORAN-C NAS COVERAGE DIAGRAM

Alaska - North Pacific Chain - 9990

ID	TRANSMITTER	POWER (KW)
M	Saint Paul	270
X	Attu Island	270
Y	Port Clarence	1000
Z	Narrow Cape	400

PARAMETERS

- Contour: SNR -10 db; GDOP 7,700 ft/µs
- NAS GDOP 4,200 ft/µs
- Average Atmospheric Noise: 53 db
- Surface to FL 600
- Flight Verified

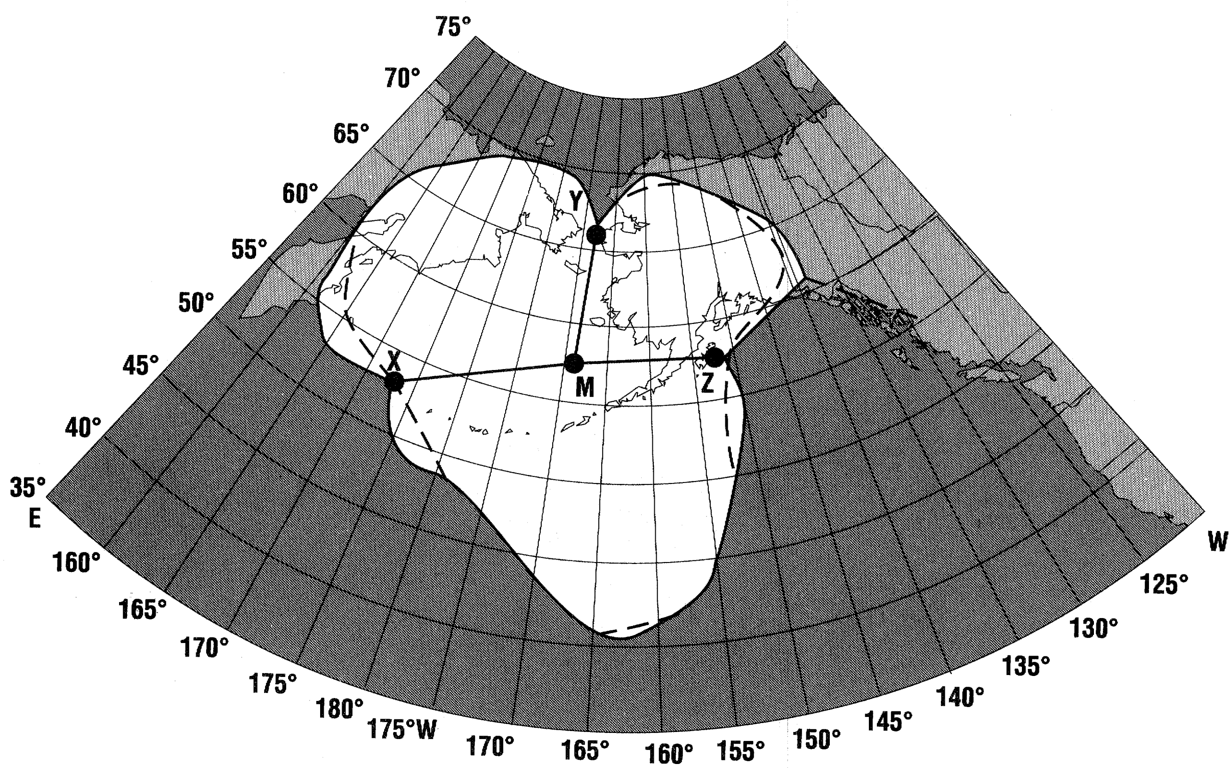


LORAN-C NAS COVERAGE DIAGRAM

Alaska - Gulf of Alaska Chain - 7960

ID	TRANSMITTER	POWER (KW)
M	TOK	540
X	Narrow Cape	400
Y	Shoal Cove	540
Z	Port Clarence	1000

PARAMETERS
· Contour: SNR -10 db; GDOP 7,700 ft/µs
· NAS GDOP 4,200 ft/µs
· Average Atmospheric Noise: 53 db
· Surface to FL 600
· Flight Verified



APPENDIX 2. GLOSSARY

Accuracy -- In navigation, the accuracy of an estimated or measured position of a craft (vehicle, aircraft, or vessel) at any given time is the degree of conformance of the measured position with the true position of the craft at that time. Since accuracy is a statistical measure of performance, a statement of the accuracy of a navigation system is meaningless unless it includes a statement of the applicable uncertainty in position (see **statistical measure of accuracy**).

Airplane Flight Manual (AFM) -- Means FAA-approved AFM. This **entire** document is FAA approved and must be carried on all aircraft certificated under FAR Part 25. The AFM contains flight manual supplements for operating specialized equipment installed in the aircraft, such as Loran-C, as well as operating procedures and **limitations** for the airplane. The AFM must be readily accessible to the flightcrew during all operations. Aircraft operating under FAR Part 121 may carry an aircraft operating manual (ACOM) in lieu of the AFM.

Air Traffic Service Route (ATSR) -- Many ATSR's are over the water and beyond the 12 nm limit. The term "ATS Route" by ICAO definition is used to mean at least the following: airway, advisory route, controlled or uncontrolled route. An ATSR is a designated route and may or may not have a published identifier. Part 121 and Part 135 operators should consult their operations specifications (OpSpecs) for specific route approval.

Ambiguity -- System ambiguity exists when the navigation system identifies two or more possible positions of the aircraft, with the same set of measurements, and no indication of which is the most accurate position. The pilot should be aware of potential system ambiguities and should be ready to identify and resolve the ambiguity within safe limits.

Appropriate Authority -- Regarding flight over the high seas, the relevant authority is the state of registry. Regarding flight over other than the high seas, the relevant authority is the state having sovereignty over the territory being overflown.

Appropriate NAVAID's -- Ground- or space-based NAVAID's that can be used along any given route. Standard, ground-based, ICAO NAVAID's include VOR, VOR/DME, and NDB's. Range is limited to their standard service volume or, if flight checked, to their extended service volume.

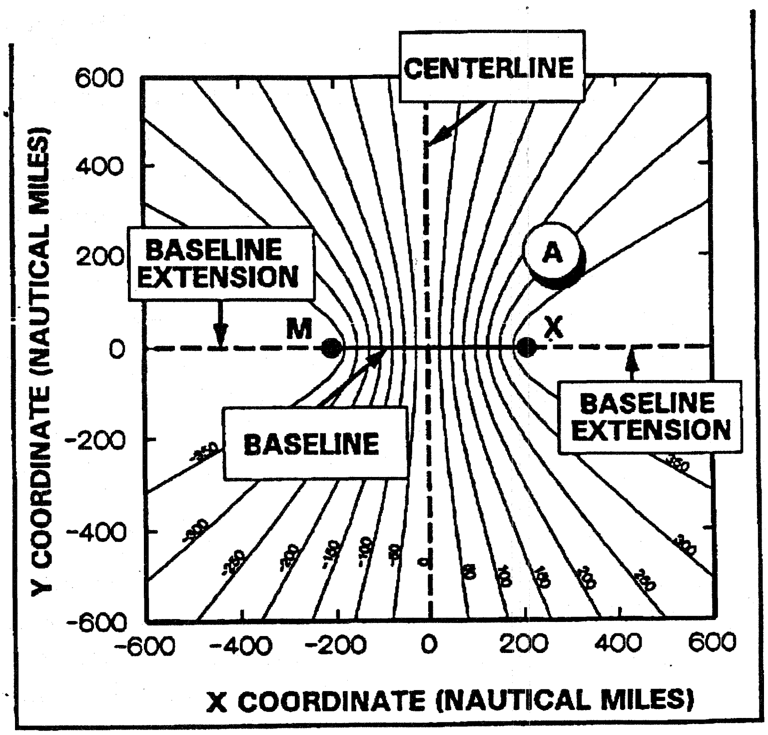
Area Navigation (RNAV) -- A method of navigation which allows pilots to establish and maintain a flight path on any chosen course within the coverage area of the type of navigation sources being used. RNAV utilizing capabilities in the horizontal plane only is called 2D (two dimensional) RNAV, while RNAV which also incorporates altitude positioning is called 3D. Time navigation (TNAV) may be added to either 2D or 3D systems. TNAV added to a 3D system is called 4D.

Availability -- The availability of a navigation system is the percentage of time that the pilot may use the services of the system within a specified coverage area. **Signal availability** is the percentage of time that navigation signals transmitted from external sources are available for use. **Operational availability** is a function of both the physical characteristics of the environment and the technical capabilities of the transmitter facilities.

Baseline Extension -- The extension of a line between two or more Loran-C stations. Loran-C accuracy is severely degraded (to non-existent) along a baseline extension (see figure 9).

FIGURE 9

BASELINE EXTENSION



Bonding -- Bonding, in Loran-C navigational installations, is the electrical connection of control surfaces to an airframe component. One example of bonding is the use of metal braid to connect and secure P-static wicks to a control surface.

Capacity -- The number of users that a system can accommodate simultaneously.

Class I Airspace -- Short-range navigation within the limits of the operational service volume of ground-based NAVAID's.

Class II Airspace -- Long-range navigation beyond the limits of the operational service volume of ground-based NAVAID's.

Coast-Out Fix -- A navigation aid or intersection, sometimes called a coastal fix or gateway fix, for aircraft transitions between the domestic and oceanic route structure, such as an Organized Track System (OTS) or air traffic service volume of ICAO standard NAVAID's.

Colored Airway -- An oceanic ATS route that is predicated on either low/medium frequency or VHF NAVAID's. For example, A646 is "Amber 646," B636 is "Blue 636," R540 is "Red 540," G528 is "Green 528." In some countries, the phonetic alphabet is used in lieu of colored airway designations such as Alpha (in lieu of Amber) and Bravo (in lieu of Blue). Some colored airways in the Gulf of Mexico are referred to as "Gulf Routes."

Coverage -- The coverage provided by a radio navigation system is that surface area or space volume in which the signals are adequate to permit the user to determine position to a specified level of accuracy. Coverage is influenced by system geometry, signal power levels, receiver sensitivity, atmospheric conditions, surface conductivity, and other factors affecting signal availability.

Critical Triangle Method -- The use of **three** independent navigation systems so that if any two systems are in disagreement with each other, then the third system can be used to determine which one of the two other units is in error.

Cross-Track Error -- The perpendicular deviation of the aircraft to the left or right of the desired track.

Dead Reckoning (DR) -- A method of estimating the position of an aircraft or radio aids, based upon a previous known position and an estimate of the course and distance travelled within a given time increment. An estimation of the winds and temperatures aloft is an integral part of the DR process. An alternative definition is that DR is navigation of an aircraft solely by means of computations based on true airspeed, course, heading, wind direction and speed, groundspeed, and elapsed time.

Decibel (db) -- A decibel is a unit of relative power, voltage, or current, plotted on a logarithmic scale. An increase (or decrease) of 3 db means that power is either double (or half) of the original value. Decibel is used to compare one relative value to another.

Domestic Airspace -- Airspace overlying the continental land mass of the United States, including Alaska, Hawaii, and U.S. possessions. Domestic airspace extends to 12 nm offshore.

En Route -- A phase of navigation covering operations between departure and arrival terminal phases.

Entry Point -- The point at which an aircraft transitions from an offshore control area to oceanic airspace.

Extended Over-Water -- FAR Part 1 defines "extended over-water operation" for aircraft as an operation over-water at a horizontal distance of more than 50 nm from the nearest shoreline; and for helicopters, as an operation over-water at a horizontal distance of more than 50 nm from the nearest shoreline or more than 50 nm from an offshore heliport structure. The term "extended over-water operations" is used in defining the kinds of radio equipment required for navigation for flight operations conducted under FAR Parts 121, 125, and 135 (see **over-water** for FAR Part 91 requirements).

Extended Service Volume -- Defines the reception limits of VOR/DME and NDB NAVAID's which are usable for unpublished route navigation **and** which are flight checked to confirm these limits of coverage. The extended service volume of NDB's used in oceanic navigation (such as beyond the 75 nm standard service volume) must be individually flight checked. There is no procedure readily available to pilots to help them determine whether or not a particular charted offshore route has an extended service volume. However, air traffic separation is based on DR beyond the extended service volume, so the pilot uses the NAVAID for as long as possible, establishes the wind drift rate, then uses LRN or DR.

Final Approach Fix (FAF) -- The point at which the last segment of an instrument approach commences. The final approach is the segment between the FAF (or point) and the runway, airport, or missed approach point (MAP).

Fix Dimensions -- This characteristic defines whether the navigation system provides a one-dimensional (linear), 2D, or 3D position fix. The ability of the system to derive a fourth dimension (time) from the navigational signals is also included.

Fix Rate -- The number of independent position fixes or data points available from the system per unit time.

Flight Level (FL) -- Flight level refers to the altitude when the aircraft's Kollsman altimeter window is set to 29.92 inches of mercury (or 1,015 millibars). It is also referred to as the "QNE" altimeter setting.

Flight Management System (FMS) -- An integrated airborne sensor, receiver, and computer (with both navigation and aircraft performance data bases) which provides optimum performance guidance to a display and automatic flight control system. FMS units may provide 2D, 3D, or 4D RNAV.

Flight Verified/Not Flight Verified -- Refers to Loran-C coverage diagrams, appendix 1. Flight-verified data involves the correlation of ground-based and airborne Loran-C data for Loran-C stations within the U.S., or correlation of airborne inertial guidance data and Loran-C data from specially configured aircraft operating over the North Atlantic (NAT). The computer-generated coverage model is then adjusted to agree with this empirical data.

Gateway Fix -- See **coast-out fix**.

Geometric Dilution of Precision (GDOP) -- This numerical parameter expresses the degrading of accuracy relative to a change in lines of position (LOP's) crossing angles. As the relative crossing angle decreases, the GDOP increases and the relative positional accuracy becomes less precise. GDOP can be expressed in either ft/μs or as a unitless measurement.

"Great Circle" Route -- The line of **shortest** distance between two points on the spherical earth. A "great circle" route is plotted as a straight line on aviation plotting charts.

Gross Navigational Error -- Pilots are expected to fly their aircraft along the centerline of their assigned route and to stay within the accuracy limits of their installed navigation systems. Navigational errors greater than 20 nm off course are investigated by the various countries that provide oceanic ATC service. If an aircraft is off course, it is usually for one of the following reasons: a communication error between the pilot and the controller, a pilot deviation due to weather without prior ATC approval or without declaring an emergency, an unintentionally entered waypoint not along the assigned route, or a navigational equipment error or failure.

NOTE: The accuracy tolerance limits for Loran-C equipment used in IFR oceanic navigation is 5.8 nm.

Ground Wave -- Ground wave signals emanate from a Loran-C transmitter and travel parallel to the surface of the earth. Loran-C receivers utilize this portion of the signal. The range of the usable ground wave signal is dependent upon the transmitter power and the surface conductivity of the earth (see also **sky wave** and figure 10).

Group Repetition Interval (GRI) -- Represents the length of time (in microseconds) between the start of one transmission from the master station in a Loran-C chain and the start of the next.

High Seas -- Any body of water **outside** the 12 nm limit. U.S. airspace within this 12 nm limit is governed by domestic FAA regulations, with some exceptions (see FAR 91.1, "Applicability," for further details).

Hyperbolic Radio Navigation System -- A system such as Loran-C or Omega that derives its position from measurement of differential distances to several stations.

IFR Navigation -- Oceanic IFR navigation techniques may include use of ICAO standard NAVAID's supplemented by DR, pilot-operated, electronic, long-range navigation equipment, or use of a flight navigator. Aircraft operating in controlled airspace with appropriate ATC clearance may enter instrument meteorological conditions (IMC).

Independent Fix -- A position fix that does not depend on a previous or following measurement.

Independent Receiver Function -- The function of any part of a receiver does **not** depend upon the functioning of any part of another unit. Today's receivers can be single-sensor, multi-sensor, or "embedded" as part of a multi-function flight management (and navigation) system (FMS). A combined communication-navigation system meets the requirement for an independent navigation receiver.

Initial Approach Fix (IAF) -- A transitional navigation fix between en route airspace and the initial approach segment of an instrument approach. The initial approach is the segment between the IAF and the intermediate fix or the point where the aircraft is established on the intermediate course or final approach course.

Integrity -- A system's ability to provide timely warnings to users when navigation information is unreliable.

<u>**Lines of Position (LOP's)**</u> -- For Loran-C, a hyperbolic line plotted on the surface of the earth representing a set of constant values of navigation information.

<u>**Minimum Navigation Performance Specification (MNPS)**</u> -- A specified set of minimum navigation performance standards which aircraft must meet in order to operate in MNPS-designated airspace. In addition, aircraft must be certified by their state of registry for MNPS operation.

<u>**Minimum Navigation Performance Specifications (MNPS) Airspace**</u> -- Designated airspace in which MNPS separation standards are applied between MNPS-equipped and certified aircraft. MNPS airspace is located over certain areas of the North Atlantic (NAT) and Northern Canada. NAT MNPS airspace, for example, is defined as the volume of airspace between FL 275 and FL 400 and bounded by certain geographical coordinates (see figure 5). To obtain MNPS authorization, operators must ensure that:

a. Each aircraft is suitably equipped and capable of meeting MNPS standards.

b. Operating procedures are established to ensure that MNPS standards are met.

c. Flightcrews are capable of operating with sufficient precision to consistently meet MNPS requirements and are aware of the emergency procedures specific to MNPS airspace.

<u>**Missed Approach Point (MAP)**</u> -- That point in a published instrument approach procedure from which a missed approach is initiated if the required visual reference cannot be identified. The missed approach is that segment between the MAP, or point of arrival at the decision height, and the missed approach fix while simultaneously at the prescribed altitude.

<u>**Multiple-Sensor Navigation System**</u> -- A navigation system that incorporates at least two different and physically separate navigation sensors, each sending position data to a single navigational display. Each sensor operates independently (not integrated). Such systems do not provide a blended position solution or a position integrity comparison. Each sensor must be manually selected by the flightcrew.

<u>**Multi-Sensor Navigation System**</u> -- A navigation system which uses a single sensor component or "black box" containing two (or more) navigation sensors that are physically integrated into a single unit. This type of system monitors the integrity of information by comparing the difference between the position computed using information from one sensor and the position computed from another approved sensor. The device automatically selects

and displays the best possible navigation data. It must also detect when sensors required for en route, terminal, or non-precision approach operations are not of the required accuracy or are not available for a specific phase of flight (such as en route, terminal, or approach). Under such conditions, a warning device, alerting the flightcrew that the system does not meet IFR requirements, is required. The pilot has the option of manually selecting or de-selecting data and displaying the output of a specific sensor.

National Airspace System (NAS) -- The common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

Nautical Mile (nm or NM) -- The distance equal to one arc minute of latitude. One nautical mile is equivalent to 6,076.1155 feet and is the fundamental measurement unit used in both sea and air navigation.

Navigation -- The means by which an aircraft is given guidance to fly from one known position to another known position. The process involves referencing the aircraft's **actual** position to its **desired** course.

Navigation Aid (NAVAID) -- A visual or electronic device which provides point-to-point guidance information or position data. Examples of standard ICAO NAVAID's include VHF omnidirectional range stations (VOR's), with or without distance measuring equipment (DME), and nondirectional, ground-based beacons (NDB's).

Navigation Guidance -- The calculation of steering commands to maintain the desired track from the aircraft's present position to desired position.

Navigation Information -- Aircraft parameters such as position, velocity vector and related data such as track angle, ground speed, and drift angle used for navigation guidance.

Not Flight Verified -- See **flight verified.**

Oceanic Airspace -- Airspace over the oceans of the world is considered international airspace where aircraft separation and air traffic procedures are standardized by ICAO. The responsibility for air traffic service in oceanic airspace is delegated to the various ICAO member states according to geographic proximity and availability of the required resources. Specific procedures are defined by ICAO Document 7030.

Oceanic Published Route -- A route established in international airspace and charted or described in flight information publications, such as route charts, DOD en route charts, chart supplements, NOTAM's, and track messages.

Oceanic Transition Route (OTR) -- An ATS route established for the purpose of transitioning aircraft to/from an organized track system.

Off Course -- An aircraft is off course when it reports a position fix (or is observed on radar) at a point not on the ATC-approved route of flight.

Offshore Airspace -- The airspace between the United States' 12 nm limit and the oceanic CTA/FIR boundary. Offshore airspace is normally within the limits of conventional land-based NAVAID's.

Organized Track System (OTS) -- A series of air traffic service routes (ATSR's) which may be fixed and charted or are flexible and are described by NOTAM's. For example, the North Atlantic (NAT) organized track system is a movable system of oceanic tracks that traverses the NAT between Europe and North America, the physical position of which is determined twice daily by taking the best advantage of the winds aloft. In comparison, the NOPAC, or North Pacific route system, is an organized charted route system between the Alaska West Coast and Japan. Likewise, the Central East Pacific (CEP) route system consists of charted routes between the U.S. West Coast and Hawaii.

Over-Water -- FAR 91.511 establishes the kinds of radio equipment required for navigation of large and of turbine-powered, multiengine aircraft operated under FAR Part 91 more than 30 minutes of flying time **or** 100 nm from the nearest shore. This differs from the "extended over-water" definition found in FAR Part 1 (see the definition for **extended over-water** in this appendix).

Parallel Offset Path -- A desired track specified in nm of offset distance parallel to and left or right of the "parent" track.

Pilotage -- Aerial navigation by means of visual reference to landmarks.

Pilot's Operating Handbook (POH) -- The POH is the result of a 1976 industry-developed specification for the operation of FAR Part 23 certificated aircraft. Only Sections I and II of the POH are FAA approved. These sections contain operating limitations for the airframe and engine combination. Section IX of the POH contains additional operating instructions and FAA-approved **limitations** for all supplemental installed equipment, including Loran-C.

Some type certificates issued for airplanes manufactured after 1977-1978 require that the POH be carried on the airplane (and therefore accessible to the pilot during flight) as a condition to meeting its type design.

Polar Track Structure (PTS) -- A system of organized routes between Iceland and Alaska which overlie Canadian MNPS Airspace.

Position Referenced Navigation -- Navigation referencing the aircraft's position in terms of latitude/longitude coordinates relative to the lat/long coordinates of the destination waypoint.

Primary Navigation System -- The active system which is being used for navigation.

P-Static (Precipitation Static) -- Static electricity caused by rain, hail, snow or dust storms in the vicinity of a receiving antenna, and measured at frequencies less than 10 mhz. Precipitation static is a significant source of interference with the Loran-C signal.

Random Route -- Any route that is not established, charted or published or is not otherwise available to all users.

Reliability -- The reliability of a navigation system is a function of the frequency of failures within the system. It is the probability that a system will perform its function within defined performance limits for a specified period of time under given operating conditions.

"Rhumb-Line" Course -- A track connecting the origin and destination points along a path that maintains a constant true course. The course crosses successive lines of longitude at a constant angle. A "rhumb-line" course appears as a straight line only on mercator projection charts which are not readily available to pilots for aviation use.

RNAV Equipment -- An airborne sensor, receiver or computer which allows the pilot to define waypoints anywhere desired to provide point-to-point navigation capability.

Route -- A defined path consisting of one or more courses in a horizontal plane, which aircraft traverse over the surface of the earth.

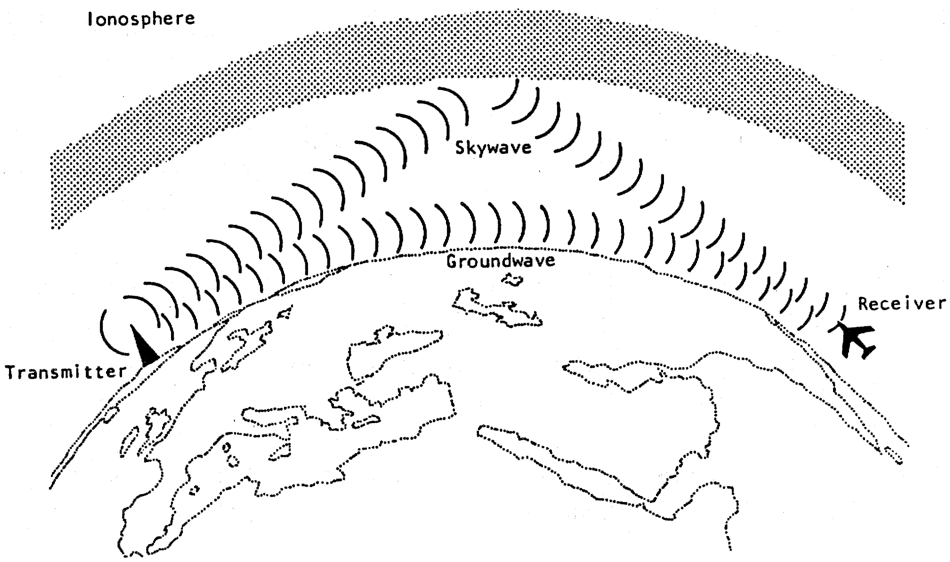
Self-Contained Navigation System -- A system which is not dependent on external navigation sources on a continuous basis to determine position or navigation track. Most self-contained navigation systems must be updated periodically with station-referenced or position-referenced fixes to maintain their accuracy.

Signal-to-Noise Ratio (SNR) -- SNR is a comparison of signal strength to electronic noise intensity and is stated in "db SNR." A signal of equal intensity and of equal noise is represented by "0 db." A positive db number represents a stronger signal than the existing noise, and a negative number indicates stronger noise.

Sky Wave -- This is the portion of the Loran-C signal which encounters the electrified layer of the atmosphere called the ionosphere and is reflected back towards the earth's surface. This sky wave signal is considered to be unusable for aircraft navigating by Loran-C because it is unstable and varies with the height of the ionosphere and other variable atmospheric conditions. Another definition -- "An indirect radio wave that reflects off the ionosphere, rather than taking a direct path from transmitter to receiver" (see figure 10).

FIGURE 10

LORAN-C SKY WAVE AND GROUND WAVE SIGNALS



The Loran-C sky wave signal (—) is reflected earthward from the ionosphere, requiring a longer time to reach the aircraft than the ground wave (- - -).

Sole-Means Navigation System -- An approved navigation system that can be used for specific phases of air navigation without the need for any other navigation system.

<u>Stand-Alone Navigation System</u> -- A navigation system that is physically independent of, and whose output is not combined with, another type of navigation system or sensor. Examples include VOR, Loran-C, Omega, and the Global Positioning System (GPS).

<u>Standard Service Volume</u> -- The reception limits of VOR/DME and NDB ground-based NAVAID's useable for random/unpublished route navigation. Standard service volume limitations do not apply to published IFR routes or procedures. Standard service volume is a **standard** value that has been flight checked. Coverage limits for restricted VOR/DME and NDB's are first published as NOTAM's, then in the "Airport Facility/Directory" (AF/D).

<u>Station-Referenced Navigation</u> -- Position determination referenced to a stationary NAVAID source, such as VOR's/NDB's.

<u>Statistical Measure of Accuracy</u> -- Specifications of radio navigation system accuracy generally refer to one or more of the following definitions:

(1) <u>Predictable accuracy</u>: The accuracy (in nm or feet) of a position with respect to geographic or geodetic coordinates; also known as **geodetic** or **absolute** accuracy.

(2) <u>Repeatable accuracy</u>: The accuracy (in feet) with which a user can return to a position whose coordinates have been measured at a previous time with the same navigation system.

(3) <u>Relative accuracy</u>: The accuracy (in feet) with which a user can measure position relative to that of another user of the same navigation system at the same time.

<u>"Strap-Down" Navigation Equipment</u> -- Navigation equipment that is temporarily installed in an aircraft, usually for the purpose of a ferry flight (not to be confused with a "strap-down" inertial navigation system). The installation must meet FAA requirements for "form, fit and function" for its intended use. Depending upon the specific installation, an FAA Form 337 may be required.

<u>Supplemental Air Navigation System</u> -- An approved navigation system that can be used in conjunction with a sole-means navigation system. It can be credited as an additional system to establish the required "redundancy" of navigation equipment for use in oceanic operations.

<u>System Capacity</u> -- The maximum number of users that a system can accommodate simultaneously.

VFR Navigation -- Navigation by pilotage, dead reckoning (DR) or electronic means in visual meteorological conditions (VMC) under visual flight rules (VFR). There are no published accuracy standards for either VFR oceanic (en route) navigation or Loran-C navigation equipment.

Visual Meteorological Conditions (VMC) -- Meteorological conditions which are expressed in terms of visibility, distance from clouds, and ceiling equal to or better than specified minimums. VFR differ when operating inside and outside (beyond the 12 nm limit) the NAS (see chapter 4 of ICAO Annex 2).

APPENDIX 3. ACRONYMS

This is a list of acronyms frequently used in this document.

AC	Advisory Circular
AFM	Airplane Flight Manual
ATSR	Air Traffic Service Route
CTA/FIR	Control Area/Flight Information Region
DME	Distance Measuring Equipment
DOT	Department of Transportation
DR	Dead Reckoning
FAR	Federal Aviation Regulations
FL	Flight Level (in 100's of feet)
FSDO	Flight Standards District Office
GDOP	Geometric Dilution of Precision
GPO	Government Printing Office
GPS	Global Positioning System
GRI	Group Repetition Interval
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LOP	Line of Position
Loran-C	Long-Range Navigation System
LRN	Long-Range Navigation
MAP	Missed Approach Point
MEL	Minimum Equipment List
MNPS	Minimum Navigation Performance Specifications
MSL	Mean Sea Level
NAS	National Airspace System
NAT	North Atlantic
NAVAID	Navigation Aid
NDB	Nondirectional Radio Beacon
nm (or NM)	Nautical Mile (6,076 feet)
NOTAM(S)	Notice(s) to Airmen
POH	Pilot's Operating Handbook
RNAV	Area Navigation
SNR	Signal-to-Noise Ratio
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range Station

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