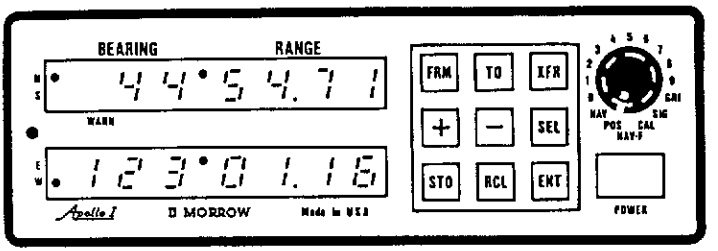
OPERATION MANUAL

APOLLO LORAN C RECEIVER



 II Morrow Inc. 1983

P.O.Box 13549 Salem, OR 97309

(503) 581-8101

0583 560-0010

A message to our customers:

This manual is intended to supply you with information to help you obtain the most from your II Morrow Loran C receiver. By following the instructions contained in this manual, you will be able to take advantage of the Loran C Navigation System.

As a pilot, I have found the Loran C system to be a valuable tool for direct point-to-point navigation in the prime coverage areas. However, you need to consider that it is never safe to rely solely on any single aid of navigation.

II Morrow is committed to the design and production of quality navigation equipment. I wish to personally thank you for purchasing a II Morrow Loran C receiver.

Ray E. Morrow Jr., President
II Morrow Incorporated

TABLE OF CONTENTS

SECTION A

SPECIFICATIONS AND FEATURES A-1

FRONT PANEL CONTROLS AND DISPLAYS A-3
MODE SWITCH A-4
PUSH BUTTON CONTROLS A-7
DISPLAYS AND INDICATORS A-16

INTRODUCTION A-17

DESCRIPTION OF OPERATION A-18

SELECTING THE GRI AND SECONDARIES A-19
ENTERING THE GRI AND SECONDARIES A-21
NEW SECONDARY SELECTION A-24

SIGNAL QUALIFIER MODE A-28

SNR VALUES A-29
ECD VALUES A-30
TO ADJUST ECD VALUES A-31
SIGNAL STRENGTH DISPLAY A-33

POS MODE A-36

DISPLAYING CURRENT LAT/LONG POSITIONS A-36
DISPLAYING CURRENT LOP POSITIONS A-38
STORE AND RECALL A-39

(continued)

CAL MODE A-40

MAGNETIC VARIATION FACTOR A-40
LAT/LONG POSITION CALIBRATION A-42
LAT/LONG CALIBRATION ENROUTE A-44
LAT/LONG CALIBRATION USING KNOWN FACTORS A-47
CROSS TRACK ERROR RESOLUTION A-49

WAYPOINT MODE A-50

WAYPOINT GROUPS A-51
SELECTING A WAYPOINT NUMBER A-52

WAYPOINT ENTRY A-54

ENTERING CURRENT POSITION AS A WAYPOINT A-54
ENTERING NEW COORDINATES AS A WAYPOINT A-55
ENTERING STORED COORDINATES AS A WAYPOINT A-57

DEFINING A COURSE A-59

POINT-TO-POINT BEARING AND RANGE A-59

NAV AND NAV-F MODE A-61

NAV DISPLAYS A-62
CROSS TRACK ERROR DISPLAYS A-64
WAYPOINT ARRIVAL A-66

ADVANCED OPERATING ROUTINES A-67

CYCLE SLIP A-67

MANUAL TRACK MODE A-68

CORRECTING THE LORAN TD'S A-69

PRIMARY/EXTENDED LAT/LONG SOLUTIONS A-73

PROGRAMMING THE APOLLO WITHOUT SIGNAL INPUT A-76

OPERATOR TROUBLESHOOTING A-77

OSCILLATOR OFFSET AND TEMPERATURE DISPLAYS A-79

DISPLAYING THE DATE CODE A-79

HISTORY OF REVISIONS

SECTION A P/N 560-0010

Revision 0	April 1983	(0483)
Revision 1	December 1983	(1283)

Revision 1

A-19	Changed LORAN-C chains
Revision Page	Add

SPECIFICATIONS AND FEATURES

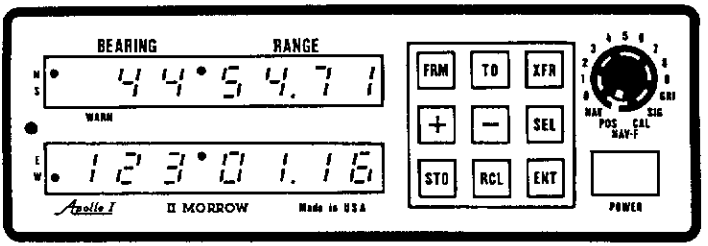
APOLLO LORAN C RECEIVER

Power Requirements		: 6.5 to 48 VDC, negative ground, 10.5 Watts nominal
Size	Receiver	: H - 2" W - 6.25" D - 11.2" (5.0cm) (15.9cm) (28.45cm)
	Preamp	: H - 0.75" W - 1.6" D -4.5" (1.95cm) (4.0cm) (11.4cm)
Weight	Receiver	: 3.68 lbs (1.67kg)
	Preamp	: 0.172 lbs (0.078kg)
Operating Temperature	Receiver	: -15°C to +55°C
	Preamp	: -55°C to +70°C
Operating Humidity		: 95% at 50°C
Operating ALT	Receiver	: 20,000 ft
	Preamp	: 50,000 ft
Track Speed		: 650 knots in prime coverage areas
Time to Track		: 2 minutes nominal
Update Rate of Current Position		: 0.5 seconds nominal
Position Repeatability		: 0.01nm typical in primary Loran C coverage
Range Resolution		: 0.1nm (600 ft)
Cross Track Error Resolution		: 0.01nm (60 ft)
CDI Display Resolution		: Selectable 0.1, 0.05, 0.02, 0.01nm
Memory		: Continuous, supplied by internal battery (nominal lifecycle:5yrs.)
Waypoints		: 200 LAT/LONG Coordinates
Notch Filters		: 8 Internal
Displays		: Easy to read, high intensity LEDs with automatic brightness control

Vibration	:	Receiver is designed to meet categories P, K, and S of DO-160A Preamp is designed to meet categories Y, J, L, and M of DO-160A
Environmental Specs.	:	Receiver DO-160A category A1B1/A/PKS/XXX/Z/BZ/B/Z/Z Preamp DO-160A category A1C2D1/A/YJLM/XXX/Z

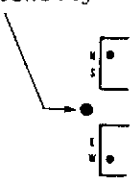
FRONT PANEL CONTROLS AND DISPLAYS

This section is intended to familiarize you with the APOLLO controls and displays. Use this section as a reference when performing basic operating routines or refresh your memory on the control functions.

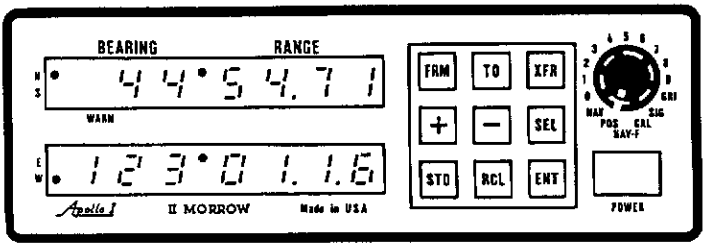


ON-OFF Control.
Press the switch in to turn the unit on, press again to turn the unit off.

Automatic Display Intensity

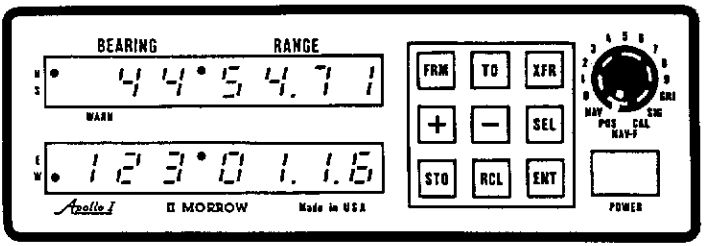


The APOLLO incorporates a photo-sensitive device on the front panel which senses the ambient light and controls the display intensity accordingly.

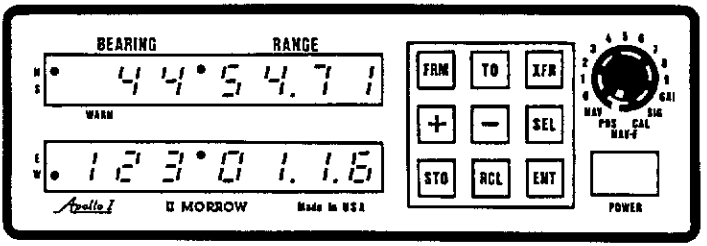


MODE SWITCH

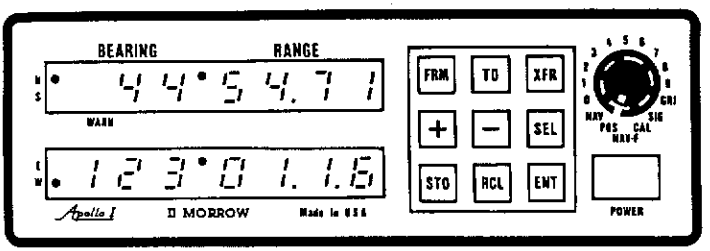
MODE POSITION		DESCRIPTION
GRI (Group Repetition Interval)	Used to:	1) Display GRI and selected secondaries. 2) To select new chain or secondaries.
SIG (Signal Qualifier)	Used to:	1) Display SNR (signal to noise) values on the upper display. 2) Display ECD (envelope to cycle difference) on the lower display. 3) Display actual signal strength.
CAL (Calibrate)	Used to:	1) Enter magnetic variations. 2) Calibrate LAT/LONG displays. 3) Select cross track error resolution factor. 4) Manually correct LOP values or enter manual track.



MODE POSITION		DESCRIPTION
NAV-F (Nav-From) 	Used to:	1) Display Bearing and Range to the From or the origin waypoint. 2) Display Ground track angle (GTA) which is your aircraft's actual heading. 3) Display ground speed (GS) in knots. 4) Display cross track error (CDI) distance. 5) Display time in minutes (ETE) to destination. 6) Display point-to-point Bearing and Range between any two pre-defined way-points.
POS (Current Position) 	Used to:	1) Display present position coordinates in Latitude and Longitude. 2) Select primary or extend-ed LAT/LONG solution. 3) Display Loran LOP Position. 4) Display previously stored coordinates.

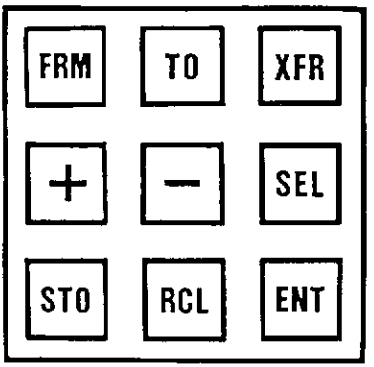


MODE POSITION		DESCRIPTION
NAV (Nav To)	Used to:	1) Display Range and Bearing to the destination waypoint. 2) Display Ground track Angle (GTA) to the destination waypoint. 3) Display Ground Speed (GS). 4) Display Cross track error (CDI). 5) Display time in minutes (ETE) to destination. 6) Display point-to-point Range and Bearing between any two pre-defined waypoints.
0-9 (Waypoints)	Used to:	1) Display waypoint number from 0 to 199. 2) Enter up to 200 waypoints in LAT/LONG coordinates. 3) Set From and To waypoints.

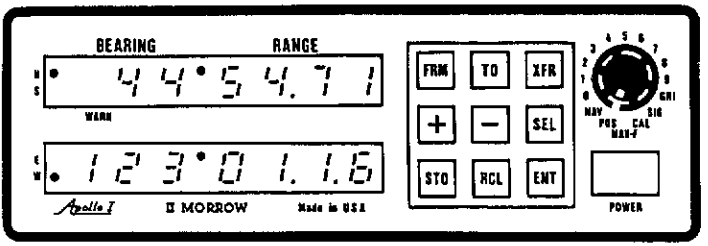


PUSH BUTTON CONTROLS

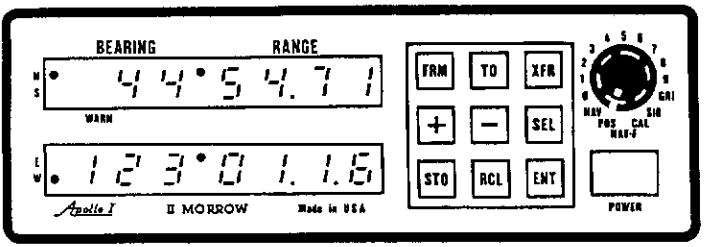
There are nine push button controls on the front panel of the APOLLO. These controls perform a specific function in accordance with the Mode Switch. We have listed the function of each push button control according to the position of the Mode Switch.



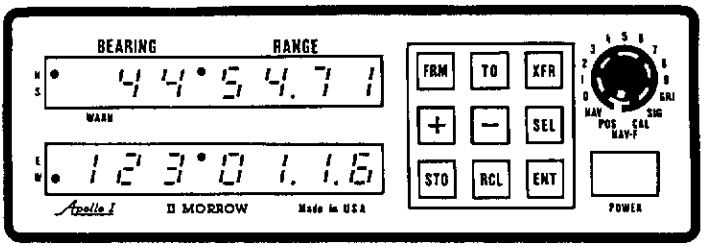
PRESS	MODE SWITCH	OPERATION
FRM	POS	1) Sets present position as the point of origin for the Course to steer.



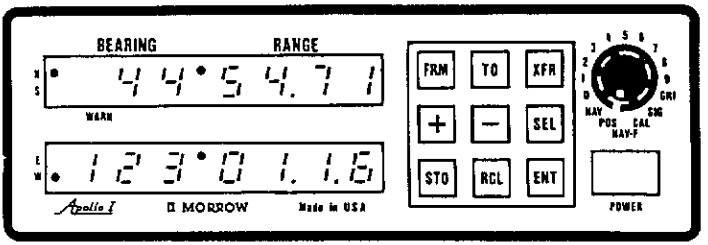
PRESS	MODE SWITCH	OPERATION
FRM	0-9	1) Sets the waypoint as the point of origin for the course to steer.
TO	0-9	1) Sets the To destination waypoint for the Course to Steer or the destination waypoint for point-to-point Range and Bearing.
+ −	GRI	1) To change the Loran Chain and/or secondaries.
+ −	SIG	1) To change the ECD bias to a good value when signals become distorted.
+ −	CAL	1) To slew in magnetic variations. 2) To slew in LAT/LONG calibration factors. 3) To slew in desired cross track error resolution factor.



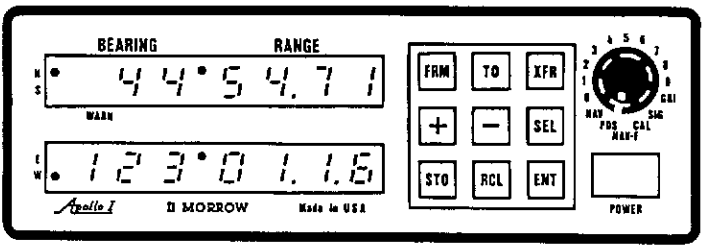
PRESS	MODE SWITCH	OPERATION
[+] [−]	CAL	1) To manually correct Loran TD's in 10 microsecond increments.
[+]	POS	1) To display primary LAT/LONG solution.
[−]	POS	1) To display extended LAT/LONG solution.
[+] [−]	C-9	1) To select and display the desired waypoint number from 0 thru 199. 2) To slew LAT display to the desired waypoint coordinate. 3) To slew LONG display to the desired waypoint coordinate.
[STO]	All Positions	1) To store present position coordinates in memory. (The previous entry is erased).



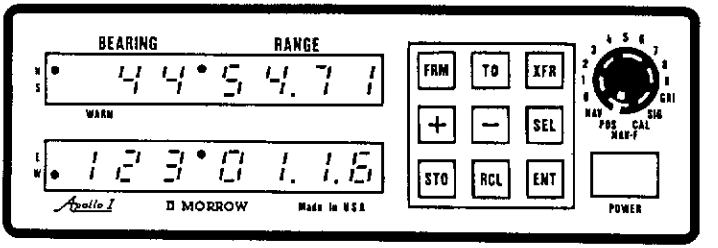
PRESS	MODE SWITCH	OPERATION
RCL	POS	1) To recall stored coordinates. (Display will flash on and off). 2) To return to present position display.
RCL	NAV	1) To display point-to-point Bearing and Range and the From and To waypoints.
RCL	NAV-F	1) To display point-to-point Bearing and Range and the From and To waypoints.
XFR	SIG	1) To change the display of SNR and ECD to signal strength values. 2) To display the ECD bias value. 3) To display the oscillator values. 4) To display the crystal temperature in degrees centigrade. 5) To display the date code revision.



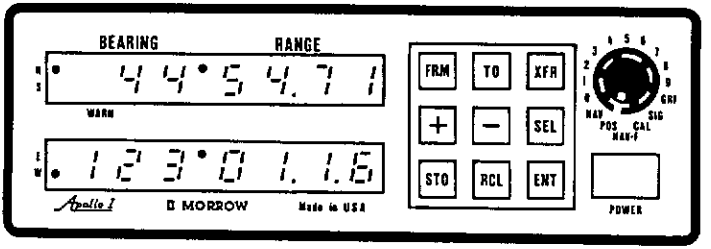
PRESS	MODE SWITCH	OPERATION
XFR	SIG	6) To display the SNR and ECD values.
XFR	CAL	1) To change the calibration factors to the present position LAT/LONG coordinates. 2) To display the Loran TD's for manual LOP corrections. 3) To display the calibration factors.
XFR	NAV-F	1) To change the lower display of ground track angle (GTA) to ground speed (GS). 2) To display cross track error (CDI). 3) To display estimated time enroute (ETE). 4) To display ground track angle (GTA).



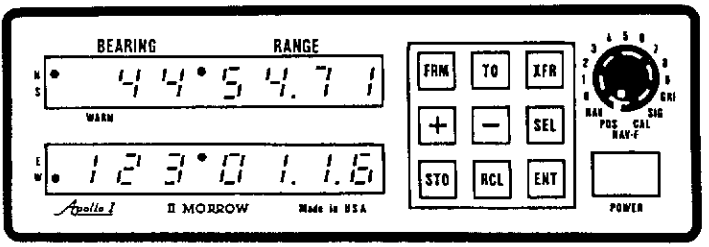
PRESS	MODE SWITCH	OPERATION
XFR	POS	1) To change the display of present position LAT/LONG to the Loran TD values.
XFR	NAV	1) To change the lower display of ground track angle (GTA) to ground speed (GS). 2) To display cross track error (CDI). 3) To display estimated time enroute (ETE). 4) To display ground track angle (GTA).
XFR	0-9	1) To display waypoint number. 2) To display LAT/LONG coordinates.
SEL	GRI	1) To enable new GRI (Chain) selection.



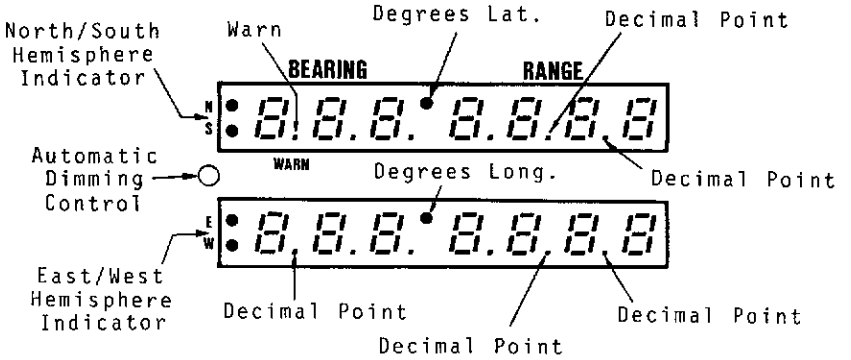
PRESS	MODE SWITCH	OPERATION
SEL	GRI	2) To enable new secondary selection on the upper display. 3) To enable new secondary selection on the lower display.
SEL	CAL	1) To enable magnetic variation entry. 2) To enable latitude offset calibration. 3) To enable longitude offset calibration. 4) To enable cross track error (CDI) resolution distance.
SEL	CAL (Press XFR before SEL)	1) To enable latitude coordinate calibration. 2) To enable longitude coordinate calibration.



PRESS	MODE SWITCH	OPERATION
SEL	CAL (Press XFR before SEL)	1) To enable master 10 μsec LOP corrections. 2) To enable upper secondary LOP corrections. 3) To enable lower secondary LOP corrections.
SEL	0-9 (with LAT/LONG displayed)	1) To enable latitude coordinate slewing. 2) To enable longitude coordinate slewing.
ENT	GRI	1) To enter selected GRI (Chain) in memory. 2) To enter selected secondaries in memory.
ENT	CAL (Press XFR before ENT)	1) To enter present position LAT/LONG coordinates for calibration.
ENT	CAL (Press RCL before ENT)	2) To enter the manual track mode and enable manual 10 μsec LOP corrections.



PRESS	MODE SWITCH	OPERATION
ENT	NAV or NAV-F	1) To reset ground track angle (GTA) and ground speed (GS) average.
ENT	0-9	1) To enter present position as a waypoint or reference to slew from.



DISPLAYS AND INDICATORS

The display consists of 14 high intensity LED digits, 6 LEDs used as hemisphere and degree indicators and a photo-sensitive automatic dimming device controlling the display intensity.

The two rows of 7 digit LEDS are used to display a variety of information:

1) The GRI and each secondary within the chain.
2) SNR and ECD values along with signal strength values.
3) Calibration offsets for magnetic variation in degrees, latitude and longitude, and cross track error resolution distance.
4) Bearing in degrees true or magnetic and Range in nautical miles to the destination waypoint or from the point of origin.
5) Point-to-point Bearing and Range between any two pre-defined waypoints.
6) Ground track Angle (GTA) in degrees.
7) Ground Speed (GS) in knots.
8) Estimated Time Enroute (ETE) in minutes.
9) Cross track Error (CDI).
10) Waypoint Number from 0 to 199.
11) Loran LOP coordinates.
12) Minus Symbol for LAT/LONG extended solution.
13) Warn indicator alerting operator of low SNR, master and secondary cycle status, station blink and track mode.

INTRODUCTION

The Loran-C system is intended to be used as a radio navigational aid. The APOLLO receives the transmitted signals and computes the users location. Because of the low frequency of the Loran-C transmitters, the coverage is very good over all types of terrain and is not limited to line of sight.

The APOLLO has, in addition to present position coordinates, the ability to provide a variety of basic navigation data. This information is displayed to the user on the front panel.

All NAV displays are based on great circle navigation providing the pilot with direct enroute information including Bearing and Range, Ground Track Angle, Ground Speed, Estimated Time Enroute, Cross Track Error, to the destination, or from the point of origin.

A total of 200 waypoints can be retained in a non-volatile memory, with point to point Range and Bearing available between any two pre-defined waypoints.

The APOLLO includes many advanced features by incorporating reliable microprocessor technology.

This manual is intended to instruct you on the operation of the APOLLO Loran receiver in a simplified easy to understand manner.

DESCRIPTION OF OPERATION

This section of the manual explains in detail the operation of the APOLLO Loran receiver. It is recommended that you read the Loran C theory section of this text before operating the APOLLO, to obtain a basic understanding of the Loran C System.

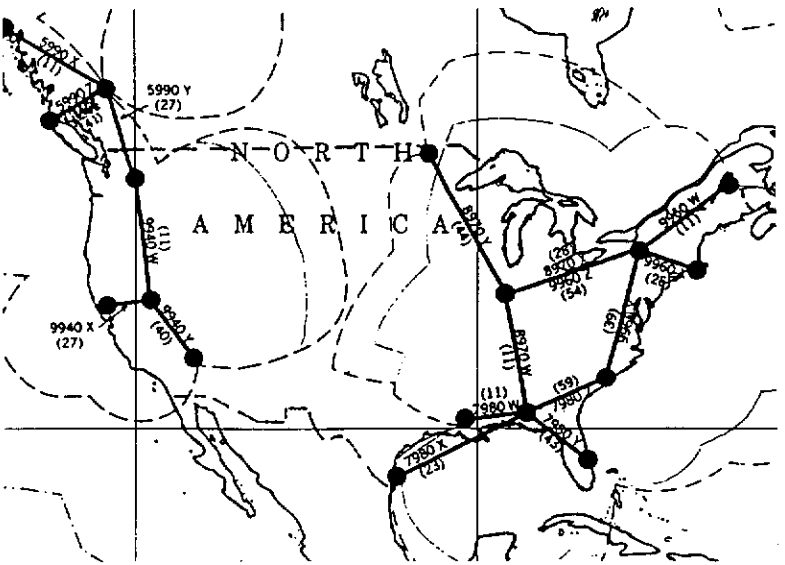
Below is the outline of the recommended operating sequence of the APOLLO. Turn the unit on and:

1) Enter the GRI and secondaries for the desired Chain. (GRI Mode)
2) Check the SIG mode for signal strength and distortion. (SIG Mode)
3) Check your present position LAT/LONG coordinates for accuracy.(POS Mode)
4) Calibrate the LAT/LONG display to the actual known position. (CAL Mode)
5) Enter and slew in desired waypoint coordinates. (0-9 Mode)
6) Select POS as the From waypoint and another waypoint 0-9 as the To waypoint to check the NAV and NAV-F functions.

SELECTING THE GRI AND SECONDARIES

Before operating the APOLLO I receiver, refer to the LORAN-C section in the manual to determine the Chain for your area.

LORAN-C Chain Coverage of the Continental United States



AVAILABLE LORAN-C CHAINS

GRI	CHAIN	GRI	CHAIN
4990	Central Pacific	7990	U.S. Southeast
5930	Canadian East Coast	8970	Great Lakes
5990	Canadian West Coast	9940	U.S. West Coast
7930	Labrador Sea	9960	U.S. Northeast
7960	Gulf of Alaska	9970	Northwest Pacific
7970	Norwegian Sea	9980	Icelandic
7980	U.S. Southeast	9990	North Pacific

The information for each Chain is printed as follows in the Loran C section.

U.S. WEST COAST LORAN-C CHAIN - GRI 9940 (old rate SS6)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Fallon, NV	Master	39 33 06.6 N 118 49 56.4 W		400	Two pulse comms installed.
George, WA	Whiskey	47 03 48.0 N 119 44 39.5 W	11000/ 2796.90	1600	Two pulse comms installed. Dual-rated to West Coast Canada Chain.
Middletown, CA	Xray	38 46 57.0 N 122 29 44.5 W	27000/ 1094.50	400	Exercises operational control of chain. Control for W, X, and Y. Two pulse comms installed.
Searchlight, NV	Yankee	35 19 18.2 N 114 48 17.4 W	40000/ 1967.30	540	
North Bend, OR	Monsite	43 24 36.2 N 124 14 27.9 W			Unmanned receiver site.
Pt. Pinos, CA	Monsite	36 37 59.0 N 121 56 05.6 W			Unmanned receiver site.

The Loran C Chain is selected by the first three digits of the GRI.....9940.

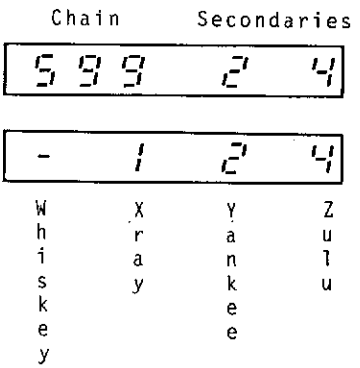
The secondaries are selected by the first digit of the coding delay....

1) George, Wa. Whiskey 11,000
2) Middleton, Ca. Xray 27,000
3) Searchlight, Nv. Yankee 40,000

DISPLAYING THE GRI AND SECONDARIES

1) Turn the APOLLO on and set the mode switch to GRI.

2) When the unit is turned on the previously entered Chain and Secondaries are displayed on the upper display. The lower display indicates all availabile secondaries by the first digit of their respective coding delays.



In this example the previously selected GRI, 599 and secondaries 2 and 4 are displayed on the upper readout.

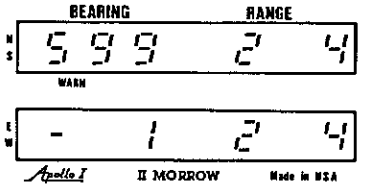
The lower readout displays all available secondaries within the Chain by the first digit of their coding delays. They are displayed from left to right as Whiskey, Xray, Yankee and Zulu.

When selecting a Chain with less than 4 secondary stations, as in the previous example, the missing secondary is displayed with a dash.

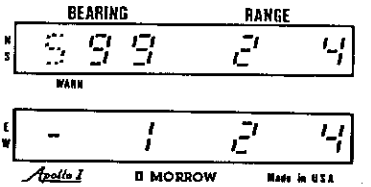
ENTERING A NEW GRI AND SECONDARIES

In the example we will change from the 5990 Canadian West Coast Chain to the 9940 U.S. West Coast Chain using secondaries Whiskey (1) and Xray (2).

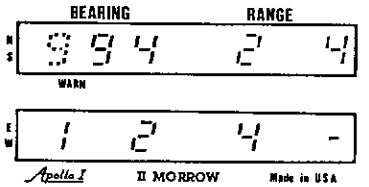
1) Set the mode switch to GRI. (Display shows previously entered Chain & Secondaries)



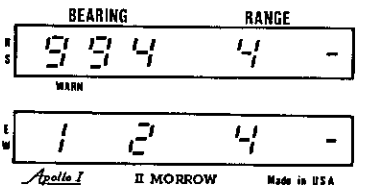
2) Press SEL to enable new GRI selection. The first digit of the GRI will flash.



3) Press + or - to slew thru the pre-programmed GRI rates, until the desired Chain is displayed.



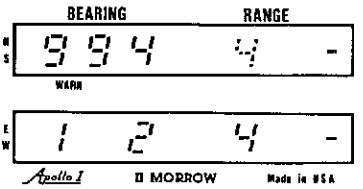
4) Press ENT to enter the desired Chain in memory.



5) Secondary selection is automatically enabled, the first digit will flash.

SEL

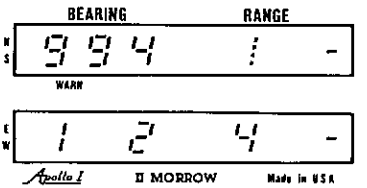
SEL



6) Press + or - to slew in the desired secondary (Whiskey).

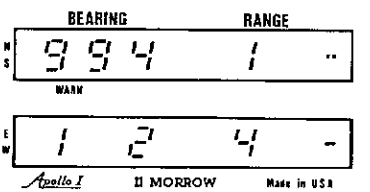
+

−

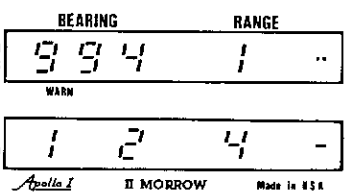


7) Press ENT to enter the secondary in memory.

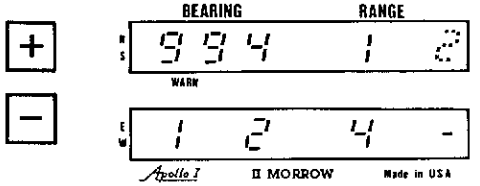
ENT



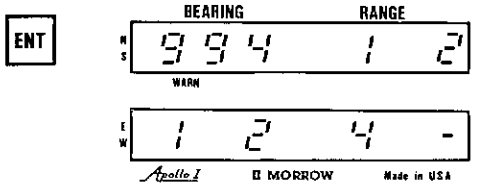
8) The other secondary is automatically enabled, the digit will flash.



9) Press + or - to slew in the desired secondary (Xray).



10) Press ENT to enter the secondary in memory.



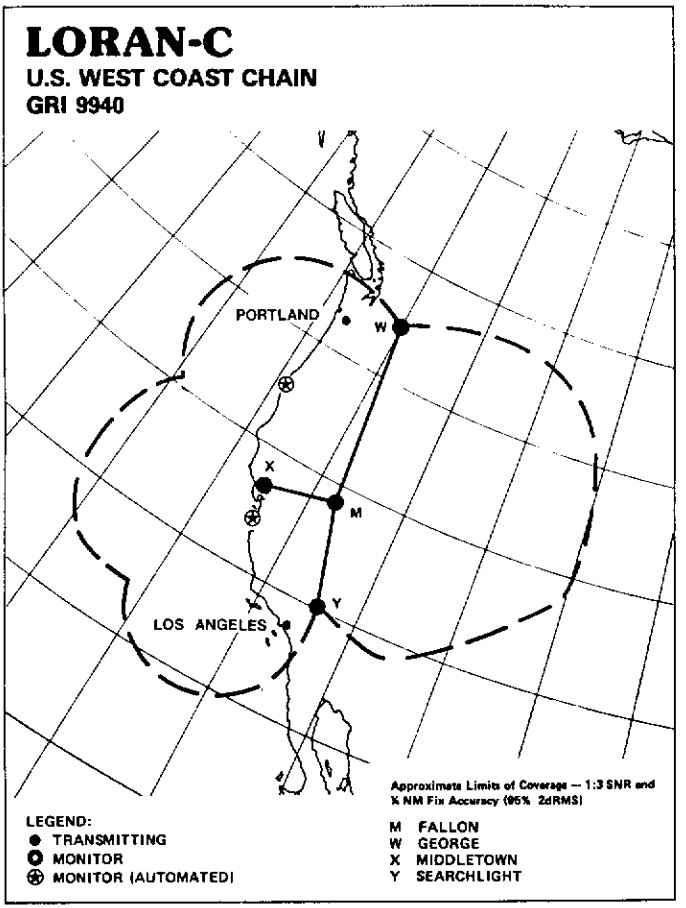
The GRI and secondaries will be retained in memory. Each time the APOLLO is turned on, automatic search and acquisition of the entered stations will begin.

NEW SECONDARY SELECTION

All available secondaries within the Chain are acquired and tracked by the APOLLO. Since it only takes the master and two secondaries (forming a triad) to display a LAT/LONG position, the operator selects the appropriate secondaries.

Each Loran C Chain covers a large geographic area. If you refer to the following coverage map of the U.S. West Coast Chain you can see that a large portion of the Western U.S. is covered by this Chain.

In making a trip from Portland, OR, to Los Angeles, CA, a new secondary selection would be required enroute.

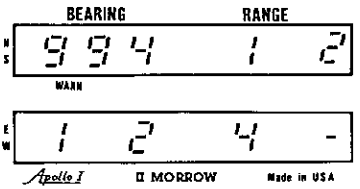


At the point of origin, Portland, you would operate on 994 W and X. Just south of San Francisco you would need to select the Y secondary. Thus, tracking 994 X and Y.

TO ENTER NEW SECONDARIES

New secondaries can be entered enroute without turning the power off.

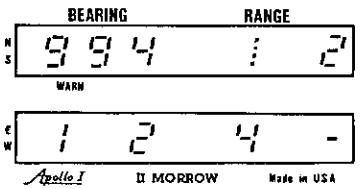
1) Set the mode switch to GRI.



2) Press SEL repeatedly until the desired secondary(s) is enabled. The first digit will flash.

SEL

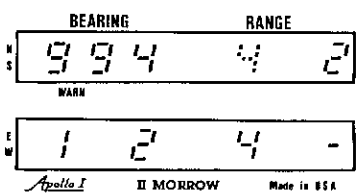
SEL



3) Press + or - to slew in the desired secondary (Yankee).

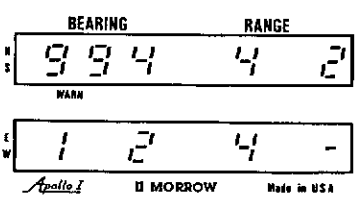
+

−



4) Press ENT to enter the secondary in memory.

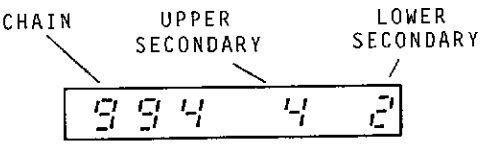
ENT



NOTE: The secondaries may be entered in any order on the upper display.

In this text, the secondaries entered on the upper readout of the GRI MODE will be referred to as the Upper Secondary and Lower Secondary.

FOR EXAMPLE:



The time differences (TD's) for the entered secondaries can be displayed in the POS MODE. In this mode, the upper secondary is displayed on the top readout and the lower secondary on the bottom readout.

Upper Secondary: Is the first secondary entered which is displayed in the middle of the upper readout.

Lower Secondary: Is the second secondary entered which is displayed on the far right of the upper display.

When selecting secondaries you can typically select the two secondaries that provide the best coverage for your area. This is usually determined by your distance from the transmitters. However, there are several other considerations such as.....

1) Baseline Extensions
2) LOP crossing angles
3) Signal strengths
4) Primary and extended LAT/LONG solutions

These conditions are discussed and illustrated in the Loran C theory section.

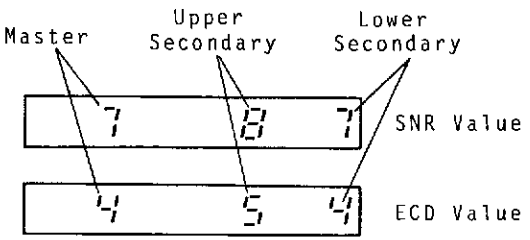
SIGNAL QUALIFIER MODE

The SIG MODE is an important feature for the operator. You can monitor both signal strength and signal distortion. We recommend a periodic check of SIG MODE to determine the quality of the signal the APOLLO Loran is tracking.

To check the signal quality of the selected stations, turn the mode switch to SIG. The APOLLO will display two sets of numbers.

The top row of numbers represents the Signal-to-Noise Ratio (SNR).

The bottom row of numbers represents the Envelope-to-Cycle Difference (ECD).



SNR VALUES

Signal-to-Noise Ratio (SNR) values are displayed as numbers from 0 to 9. The higher the value displayed the stronger the signal and the less noise present. For most applications a 5 value or higher will represent good signal conditions and tracking ability.

Below is a reference to help you evaluate SNR values.

9 - Excellent
8 - Excellent
7 - Excellent
6 - Good
5 - Good
4 - Good
3 - Fair
2 - Fair
1 - Poor
0 - No signal

If the SNR values drop to 2 or below the WARN indicator will turn on with the Mode Switch in all positions.

Low SNR values can be caused by one or more of the following factors.

1) Approaching or in a fringe coverage area.
2) Improper installation of antenna, grounding, or power cables.
3) Any atmospheric interference caused by electrical storms, lightning, sunspots, etc.
4) Military installation transmissions.
5) Operating the APOLLO in a hangar or shed.
6) Interference generated by other electrical equipment such as compressors, etc.

ECD VALUES

Envelope-to-Cycle Difference (ECD) values on the lower display in the SIG mode represent the tracking point of the Loran signal for the master and secondary stations. The ECD can be used to monitor the distortion of the Loran signal.

The ECD values are displayed as numbers from 0 thru 9. ECD values of 4's and 5's represent the ideal tracking point of the Loran signal.

Below is a reference to help you evaluate ECD values.

9 - Unreliable
8 - Poor
7 - Fair
6 - Good
5 - Good
4 - Good
3 - Good
2 - Fair
1 - Poor
0 - Unreliable

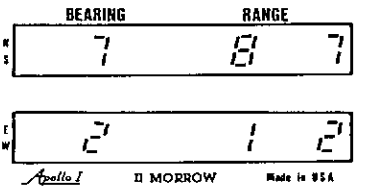
The APOLLO allows the operator to compensate for distorted values and adjust the ECD to the proper value. The total adjustment of ECD values or ECD bias is from 0 to ±4.

ECD BIAS RANGE

-4 -3 -2 -1 0 +1 +2 +3 +4

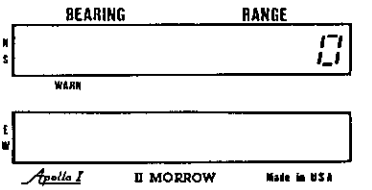
TO ADJUST ECD VALUES

1) Set the mode switch to SIG. The SNR and ECD values are displayed.

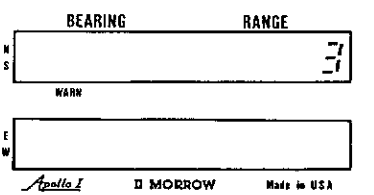


In this display the ECD values are reading a little low and should be adjusted up to values of 4 and 5.

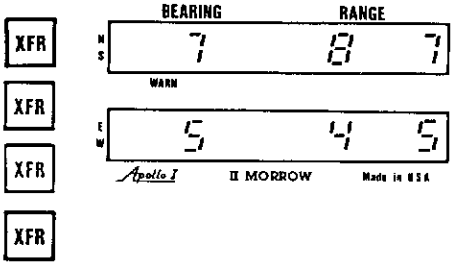
2) Press the XFR switch twice to display the compensated or ECD bias number on the upper display. The ECD bias adjust is factory set to 0.



3) Press the + switch 3 times to display an ECD bias number of 3.



4) Press XFR 4 times to display the SNR and ECD values.



The same procedure can be used to adjust high ECD values down by using the - switch when the ECD bias number is displayed.

The distance your position is from the transmitting stations will have a direct effect on the ECD values. The closer you are to a station the higher the ECD value, the farther away from the station the lower. This condition is caused by the wave propagation of the Loran signal. If you are close to a station or if the SNR values are reading 7's or higher, do not be alarmed with high ECD values. The ECD should read fairly constant with an SNR reading of 7 or higher.

ECD bias adjustments will be retained in memory when the APOLLO is turned off.

FLASHING ECD VALUES

The ECD values will flash during the cycle select process. When the APOLLO is first turned on a setting time of approximately 2 minutes is required. During this time the APOLLO is performing a cycle select function to determine the proper tracking point. The ECD values will flash on and off during this time until cycle selection is complete.

The WARN indicator is also turned on while an ECD value flashes. If the WARN indicator is turned on while enroute, check the SIG MODE for the SNR and ECD status. You may

have to change to a new Loran Chain or secondary station or simply make an ECD bias adjustment.

SIGNAL STRENGTH DISPLAY

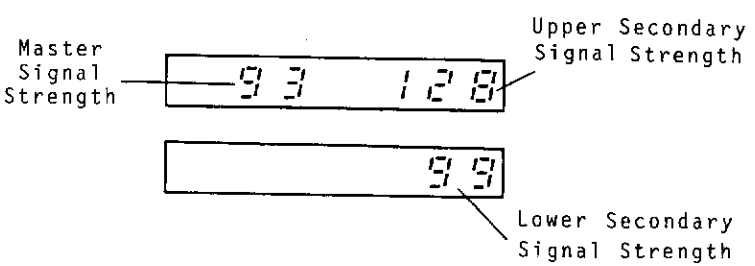
The APOLLO will also display signal strength values for the selected stations. The signal strength display can assist in determining the ideal location for securing the antenna to the aircraft.

The signal strength has a 100db range and will display values from 0 to 255.

SIGNAL STRENGTH DISPLAY

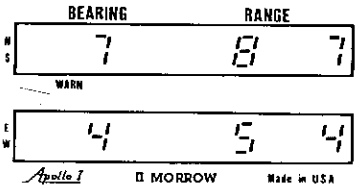
To display the signal strength for the selected stations:

1) Set the function selector to SIG and press XFR.



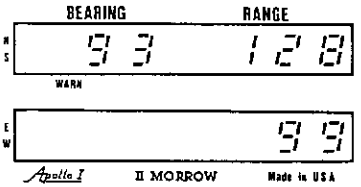
There is a total of six different displays in the SIG MODE. These displays are called up in the following sequence with the XFR switch.

1) SNR and ECD



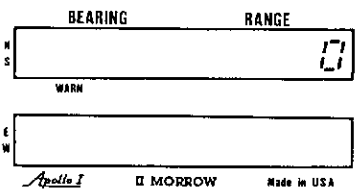
XFR

2) Signal Strength



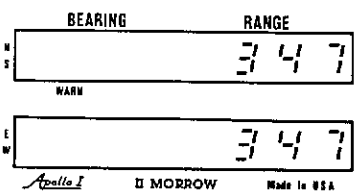
XFR

3) ECD Bias



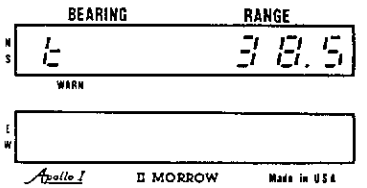
XFR

4) Oscillator Values



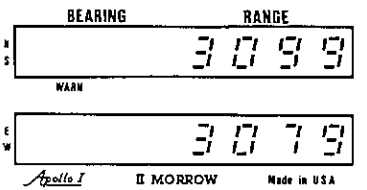
XFR

5) Crystal Temperature, °C



XFR

6) Software Date Code Revision



Press the XFR button again to return to ECD & SNR values (Step 1)

The Oscillator Values, the Crystal temperature in degrees Centigrade, and the Date Code displays are explained in detail in the Operator Troubleshooting section.

POS MODE

The POS MODE is used to display:

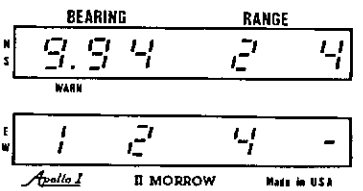
1) Current LAT/LONG Positions
2) Current LOP coordinates
3) Previously stored coordinates
4) Primary/Extended LAT/LONG coordinates

When the desired Chain and secondaries are selected in the GRI MODE the APOLLO will automatically search and acquire the Loran signals. To display current LAT/LONG positions turn the mode switch to POS.

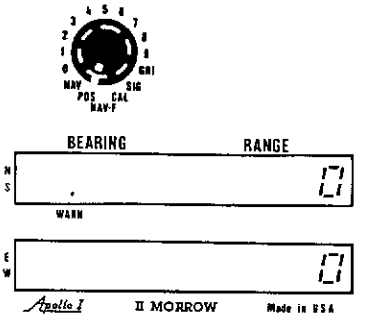
DISPLAYING CURRENT LAT/LONG POSITIONS

If the unit is turned on in the POS MODE you will observe the following sequence on the displays:

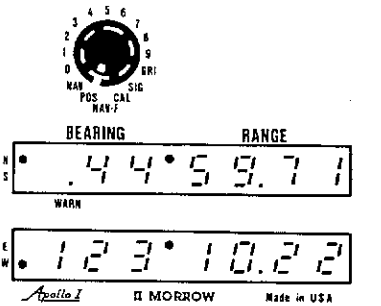
1) The chain and previously entered secondaries are displayed on the upper readout. The lower readout will indicate all available secondaries in the chain.



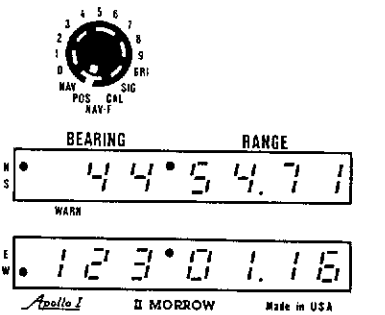
2) When the Master signal is acquired one zero will be displayed on each readout.



3) When both secondaries are acquired the APOLLO will begin to calculate the LAT/LONG position.



4) The cycle select process takes approximately 2 minutes and when completed the WARN indicator will turn off. The calculated LAT/LONG for the current position is displayed.



NOTE 1: If operating in a fringe coverage or weak signal area, the WARN indicator may stay on. Check the displayed values in the SIG MODE to determine the signal conditions.

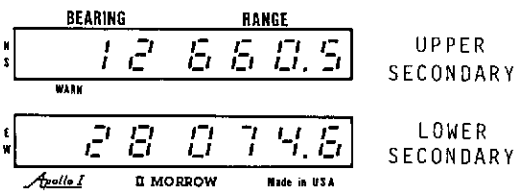
NOTE 2: If the calculated LAT/LONG position is not correct you will have to correct the displays due to signal propagation errors. This procedure is defined in the CAL MODE section. If the LAT/LONG display of current position is a few hundred miles away from your actual position refer to the Primary/Extended LAT/LONG solution.

DISPLAYING CURRENT LOP POSITIONS

The actual Loran time difference (TD) measurements used to calculate the current LAT/LONG position may also be displayed in the POS Mode.

To display the Loran TD's:

1) Set the function selector to POS and press XFR.



The Loran TD's are displayed in microseconds, with 5 digits to the left of the decimal point and one digit to the right of the decimal point representing tenths of microseconds. These TD's can be referenced to a Loran C Chart. The time differences on the Loran C Chart are represented by curved or hyperbolic lines.

These lines are referred to as LOP's (line of position) and your current position is at the point of intersection of these two LOP's.

Loran C Charts with LOP grids printed overland are available. Contact your II Morrow dealer or the II Morrow factory for additional information.

STORE AND RECALL

Your current position coordinates can be stored in memory by pressing the STO switch, with the mode switch in any position. The stored coordinates can be recalled anytime by turning the mode switch to POS and pressing RCL. The stored coordinates will flash.

The Store and Recall feature can be useful when a location needs to be immediately recorded. The STO switch has only one function which is to store current position coordinates. Each time the STO switch is pressed, the current position is stored in memory erasing the previous entry.

CAL MODE

The CAL MODE is used to:

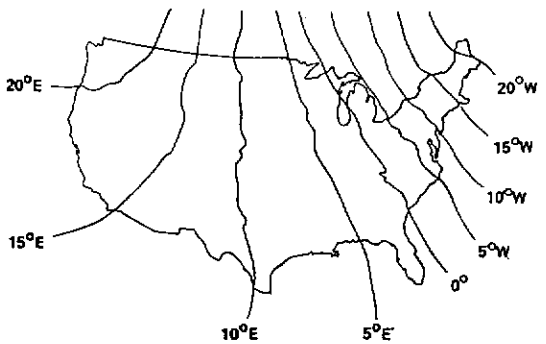
1) Enter magnetic variation factors
2) Calibrate the LAT/LONG coordinates due to wave propagation.
   a. From known LAT/LONG offsets
   b. From a known LAT/LONG position on the ground or enroute.
3) To select the desired cross track error (CDI) distance.
4) Manually correct the Loran TD values.

For accurate NAV displays correction factors must be entered.

MAGNETIC VARIATION

In order for the APOLLO's Bearing and GTA displays to read magnetic bearings you will need to enter the magnetic variation factor for your area. The illustration below shows the magnetic variations for the Continental United States. You can also refer to the WAC Section Charts and Approach Plates to determine the magnetic variation for your area.

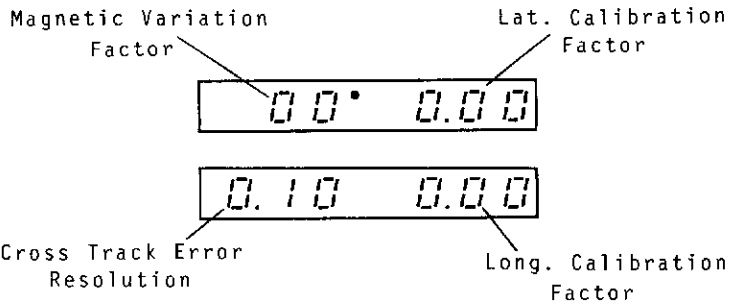
Magnetic variations can also be entered enroute and the Bearing and GTA displays will be corrected.



Easterly variations will require a negative adjustment.

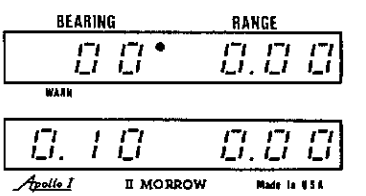
Westerly variations will require a positive adjustment.

To display the CAL values, turn the Mode switch to CAL.

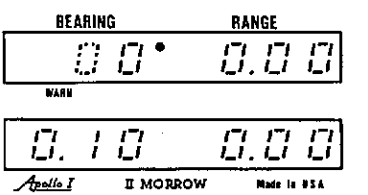


To enter magnetic variation factor:

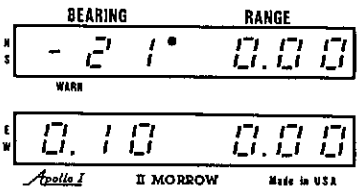
1) Set the mode switch to CAL.



2) Press SEL to enable magnetic variation entry. The first digit will flash.



3) Press + for westerly variation.
Press - for easterly variation.



LAT/LONG CALIBRATION

Slight errors in the LAT/LONG readout of your current position may be displayed due to the transmission of the Loran C signal. The speed or velocity of the transmitted signal can vary when it passes over different land masses including mountains and glaciers. Also, seasonal changes will have a direct effect on the Loran signals. These velocity changes can cause distortion in the Loran C grids and inaccuracies in LAT/LONG conversions.

For accurate LAT/LONG displays and navigation it is important to enter the LAT/LONG calibration factors.

There are three ways to calibrate the LAT/LONG displays:

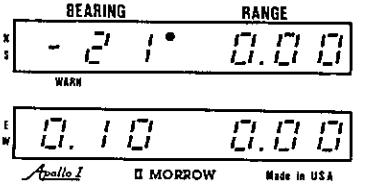
1) With a known position on the ground such as an airport reference point (ARP).
2) With a known position enroute such as VOR coordinates.
3) With known calibration factors.

LAT/LONG CALIBRATION USING A KNOWN POSITION

In this example the published LAT/LONG of Salem, OR, McNary Field is N 44.54.60 and W 123.00.10.

The current position LAT/LONG display in the POS MODE is reading N 44.55.05 and W 123.00.55.

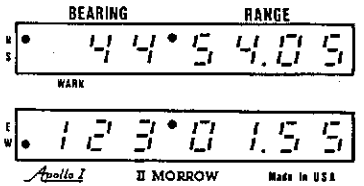
1) Turn the MODE switch to CAL.



2) Press XFR and then ENT to display the current LAT/LONG coordinates.

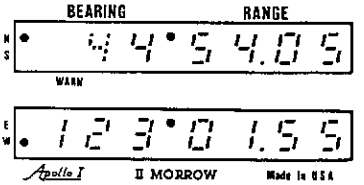
XFR

ENT



3) Press SEL to enable LAT coordinate calibration. The first digit will flash.

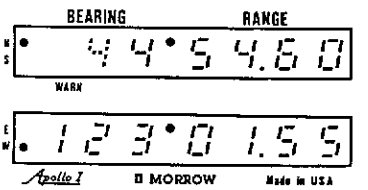
SEL



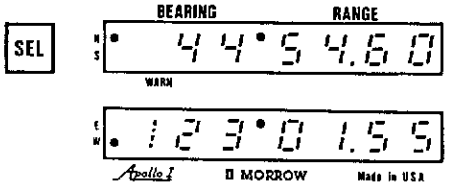
4) Press + or - to slew the LAT display to the known coordinate (44.54.60).

+

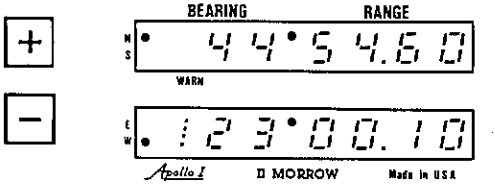
−



5) Press SEL to enable LONG coordinate calibration. The first digit will flash.



6) Press + or - to slew the LONG display to known coordinate.
(W 123° 00.10)



LAT/LONG CALIBRATION ENROUTE

Providing you operate on the same chain and secondaries the LAT/LONG calibration factors will be accurate for a radius of approximately 200 miles, from point of origin. If you change the chain or secondaries enroute you will need to change the LAT/LONG calibration factors for accurate navigation.
This procedure may be done if you fly over a known point with a published LAT/LONG coordinate such as a VOR.

In the example the point of origin was Vancouver, B.C. Canada, and the destination is Salem, OR.

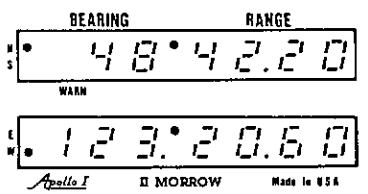
At the point of origin the Canadian West Coast Chain 599 was entered, along with secondaries Y(2) and Z(4).

Just north of Olympia, WA. the U.S. West Coast Chain 994 is entered along with secondaries W(1) and X(2). The Olympia WA. VOR coordinates N 46°58.30 and W 122°54.00 can be used to recalibrate the APOLLO enroute for accurate displays.

As you pass over the VOR:

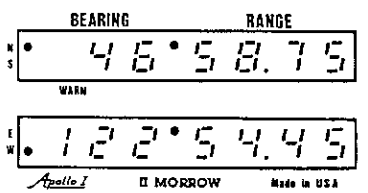
1) Set the MODE Switch to CAL.
2) Press XFR.
3) Press ENT to enter these coordinates in memory.
4) Then, perform the LAT/LONG calibration procedure using known coordinates.
5) These coordinates will be retained in memory and and can be calibrated at the operators convenience.

1) Turn the MODE switch to CAL and press XFR. The previously entered LAT/LONG is displayed.

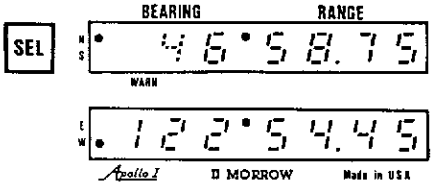


2) Press ENT to enter Olympia coordinates into memory. Slew these coordinates to the published LAT/LONG.

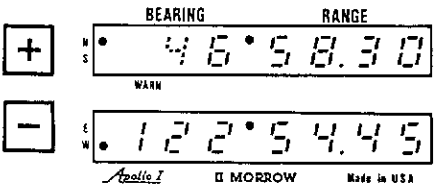
N 46°58.30
W122°54.00



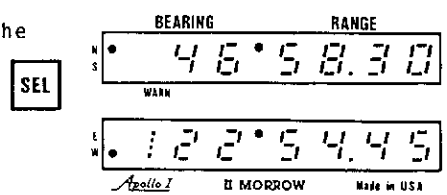
3) Press SEL to enable the LAT coordinate calibration. The first digit will flash.



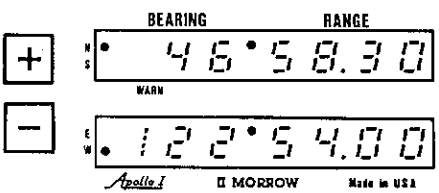
4) Press + or - to slew the LAT display to the published coordinates. (N 46°58.30)



5) Press SEL to enable the LONG coordinate calibration. The first digit will flash.



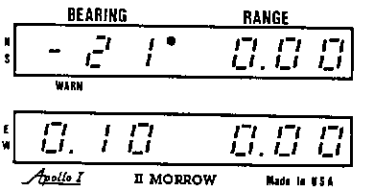
6) Press + or - to slew the LONG display to the published coordinate. (W 122°54.00)



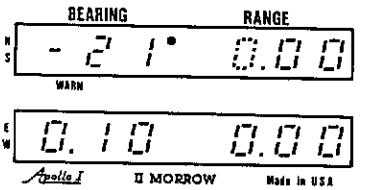
LAT/LONG CALIBRATION USING KNOWN CALIBRATION FACTORS

There are no published LAT/LONG corrections to assist in *LAT/LONG calibrations. However, the APOLLO* does display the actual LAT/LONG offset values. These values may be recorded in the supplied waypoint log. If these values are recorded along with destination coordinates, they can be entered to offset the LAT/LONG display for accurate navigation.

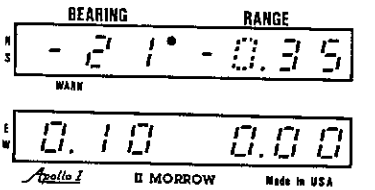
1) Turn the MODE switch to CAL.



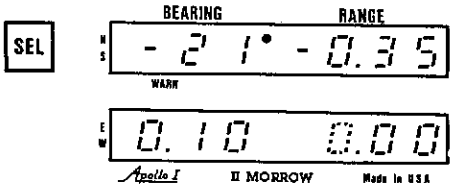
2) Press SEL twice to enable LAT calibration. The first digit will flash.



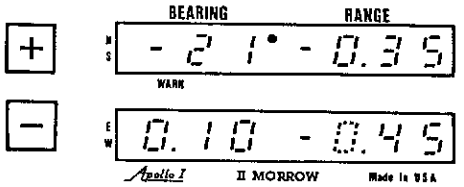
3) Press + or - to slew in the LAT calibration factor.



4) Press SEL to enable LONG calibration. The first digit will flash.



5) Press + or - to slew in the LONG calibration factor.

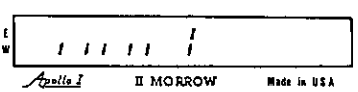


CROSS TRACK ERROR DISTANCE

The cross track error display in the NAV function is a visual indication of direction to steer to stay on course. The course being an imaginary line between the From and To waypoints.

Cross track error is displayed as either a numerical display of nautical miles off course or by a bar graph presentation as a distance off course.

When you are on course, the center full bar is displayed. The half bars indicate direction to steer to get on course. In order to make this receiver more useful to wider variety of users, the APOLLO allows the user to select the distance each half bar represents.



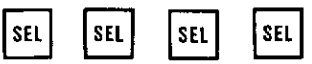
Typical cross track error as displayed the NAV MODES

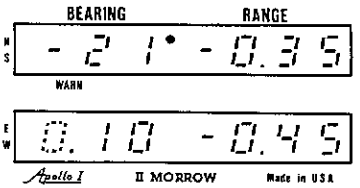
The selections available are .1, .05, .02, and .01 nautical miles per bar.

0.10 nautical mile = 608 feet per bar.
0.05 nautical mile = 304 feet per bar.
0.02 nautical mile = 122 feet per bar.
0.01 nautical mile - 61 feet per bar.

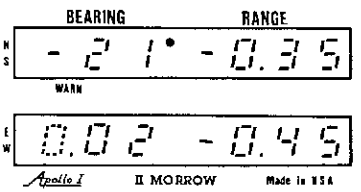
TO SELECT THE CROSS TRACK ERROR DISTANCE

1) Set the MODE switch to CAL. Press SEL four times until the cross track error distance is enabled. The first digit will flash.





2) Press + or - to select the desired distance. (0.02 nautical miles per bar is entered).



WAYPOINT MODE

The MODE switch positions 0 thru 9 can be used to enter up to 200 different waypoints. Waypoints are entered into memory as LAT/LONG coordinates. Each MODE position 0 thru 9 will accept 20 different waypoints. For example the 0 Mode switch position will display the following 20 waypoint numbers; 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190.

Waypoint numbers are increased or decreased by a factor of 10 with the + and - switches.

Waypoint numbers are increased or decreased by a factor of 1 with the MODE switch positions 0 thru 9.

Waypoints can be broken down into 20 groups or trips of 10 waypoints. This is shown on the following page.

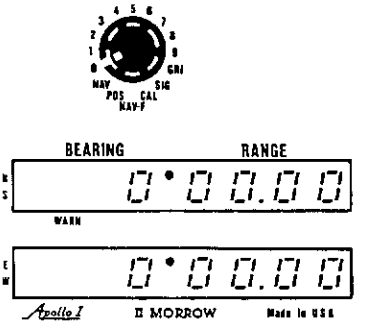
WAYPOINT GROUPS

GROUP (Selected with + and - switch)	MODE SWITCH POSITION	WAYPOINT NUMBER DISPLAYS
0	0-9	0 thru 9
1	0-9	10 thru 19
2	0-9	20 thru 29
3	0-9	30 thru 39
4	0-9	40 thru 49
5	0-9	50 thru 59
6	0-9	60 thru 69
7	0-9	70 thru 79
8	0-9	80 thru 89
9	0-9	90 thru 99
10	0-9	100 thru 109
11	0-9	110 thru 119
12	0-9	120 thru 129
13	0-9	130 thru 139
14	0-9	140 thru 149
15	0-9	150 thru 159
16	0-9	160 thru 169
17	0-9	170 thru 179
18	0-9	180 thru 189
19	0-9	190 thru 199

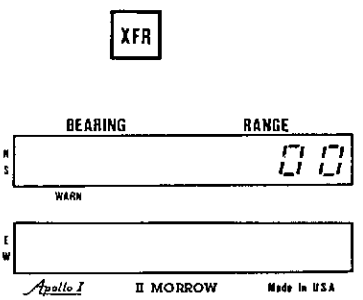
The following pages describe how to select a waypoint number. To assist you in selecting waypoints the explanation shows how to display all available waypoints consecutively from 0 to 199. However waypoints may be displayed in any method convenient to the user.

SELECTING A WAYPOINT NUMBER

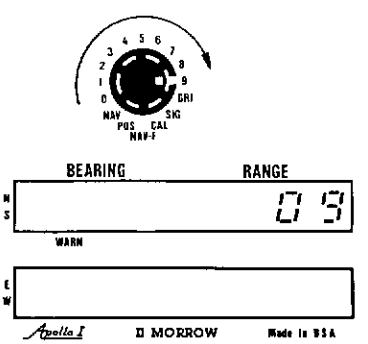
1) Turn the MODE switch to 0. Either zeroes or previously entered LAT/LONG coordinates will be displayed. (Zeroes indicate an unused waypoint).



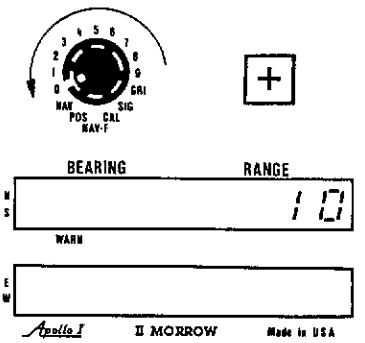
2) Press XFR to display the waypoint number on the upper readout. If the display is not 00, press the - switch until 00 is displayed.



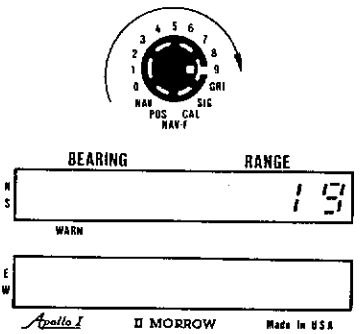
3) Rotate the MODE switch from 0 thru 9. The upper readout will display waypoint numbers 00 thru 09.



4) Turn the MODE switch back to 0 and press the + switch. The upper readout will display waypoint number 10.



5) Rotate the MODE switch from 0 to 9. The upper readout will display waypoint numbers 10 thru 19.



You can repeat steps 4 and 5 until all waypoint numbers from 0 to 199 are displayed.

To display the LAT/LONG coordinates for any waypoint number press XFR.

WAYPOINT ENTRY

There are three methods of entering waypoints:

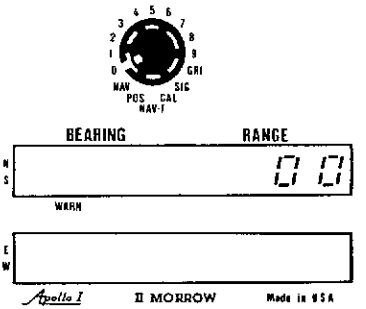
1) Entering current position coordinates as a waypoint.
2) Slewing in new LAT/LONG coordinates as a waypoint.
3) Entering previously stored coordinates as a waypoint.

METHOD 1 - TO ENTER THE CURRENT POSITION AS A WAYPOINT

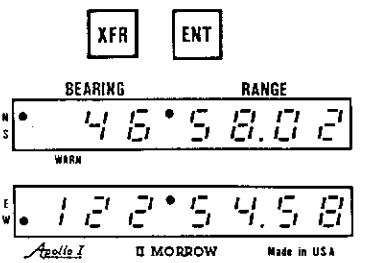
The APOLLO allows the operator to automatically enter the current position as a waypoint. Select the desired waypoint number and press ENT, the current position coordinates are entered as a waypoint.

To enter current position as a waypoint:

1) Select the desired waypoint number. Waypoint number 0 is shown.



2) Press XFR and ENT to enter current position LAT/LONG coordinates as a waypoint.



METHOD 2 - SLEWING IN NEW LAT/LONG COORDINATES AS A WAYPOINT

You may enter any LAT/LONG coordinates as a waypoint(s) on the APOLLO. The hemisphere indicators are automatically selected and displayed.

The waypoint coordinates in MODE 0 thru 9 are displayed to the hundredth of a minute. Most published references supply LAT/LONG coordinates to the tenth of a minute. When using these references slew the hundredth of a minute display on the APOLLO to zero.

Some published references list LAT/LONG coordinates in Degrees, Minutes, and Seconds. You will need to convert the Seconds to Hundredths of a Minute to enter these coordinates in the APOLLO.

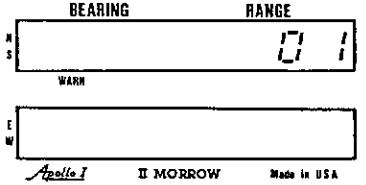
To convert Seconds to Hundredths of Minutes divide the Seconds by 60.
For example: N 27°31'43" = N 27°31.72'
43 ÷ 60 = 0.72

To slew in new LAT/LONG coordinates as a waypoint select the desired waypoint number. Enter the current position LAT/LONG coordinates (Method 1) as a reference to slew from. Enable the LAT display with the SEL switch and press + or - to slew the display to the desired coordinate. Enable the LONG display with the SEL switch and press + or - to slew the display to the desired coordinate. When the desired coordinates are displayed do not push ENT or STO. The displayed coordinates will be retained in memory.

In the following example the coordinates for Portland International will be entered in waypoint number 1. The published coordinates for Portland International are N 45-35.4 and W 122-35.6. The current position is Salem, Or. coordinates N 44-54.60 and W 123-00.10.

To slew in new LAT/LONG coordinates as a waypoint:

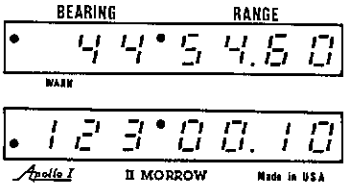
1) Select the desired waypoint number. Waypoint number 1 is shown.



2) Press XFR then ENT to enter current position coordinate as a reference to slew from. (LAT/LONG for Salem, Or, displayed).

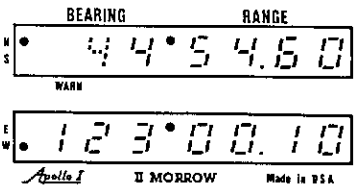
XFR

ENT



3) Press SEL to enable the LAT coordinate slewing. The first digit will flash.

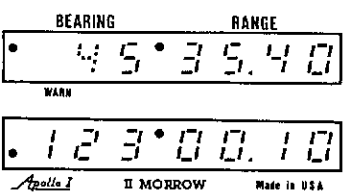
SEL



4) Press + or - to slew in the desired coordinate. The longer the switch is held the quicker the slew rate. (LAT for Portland International displayed).

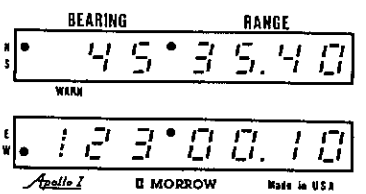
+

−

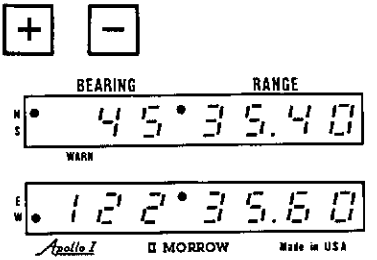


5) Press SEL again to enable LONG coordinate slewing. The first digit will flash.

SEL



6) Press + or - to slew in the desired coordinate. The longer the switch is held the quicker the slew rate. (LAT/LONG for Portland is displayed).



The LAT/LONG coordinates for Portland International are shown and will be retained in memory as waypoint number 1.

This same procedure can be repeated when entering any new LAT/LONG coordinates as waypoints.

METHOD 3-TO ENTER STORED COORDINATES AS A WAYPOINT

Stored coordinates are retained in memory any time the STO switch is pressed. To recall these coordinates turn the MODE switch to POS and press RCL. The stored coordinates will flash.

These stored coordinates can also be entered as a waypoint.

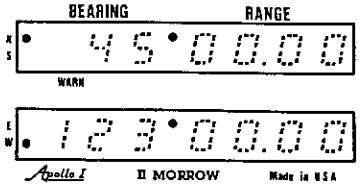
Anytime you want to store a location in memory and may not have the time to select a waypoint number and enter this location as a waypoint you can press the STO switch. The location can be recalled later and entered as a waypoint.

NOTE: The store function will only retain one location. Each time the STO switch is pressed the previous entry is erased and the new location is stored.

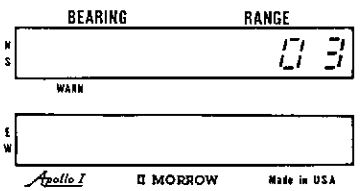
To enter stored coordinates as a waypoint:

1) Turn the MODE switch to POS and press RCL. The stored coordinates will flash.

RCL



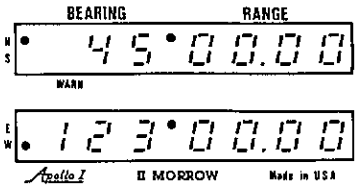
2) Select the desired waypoint number. Waypoint 3 is shown.



3) Press XFR and ENT to enter the stored location as a waypoint.

XFR

ENT



DEFINING A COURSE

The previously entered waypoints are used to define a course to steer. To define a course to steer, select POS or a waypoint as the point of origin and press FRM. Select the destination waypoint and press TO. Turn the MODE switc' to NAV. The Bearing and Range for the defined course will be displayed.

POINT-TO-POINT BEARING AND RANGE

The APOLLO can display Bearing and Range between any two pre-defined waypoints. You may select two waypoints other than your current location and check the Bearing and Range between the two locations. All NAV and NAV-F displays are based on great circle routes and can be displayed as true or magnetic bearings by entering the magnetic variation factor.

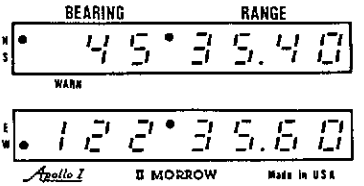
In the following example the Bearing and Range from Portland, Or. and Reno, Nv. will be displayed. Let's assume that the coordinates of Portland International are entered in waypoint number 5 and the coordinates for Reno, Nv. are entered in waypoint number 6. Select waypoint num' 5 and press FRM and select waypoint number 6 and press TO. Turn the function selector to NAV and press RCL. The Bearing and Range from waypoint 5 to waypoint 6 will be displayed. The Bearing in this example is displayed as a true bearing.

The point-to-point feature is used for calculating the Bearing and Range between the selected waypoints and for displaying the FROM and TO waypoints used to define the course. The displays in the point-to-point mode <u>will not update</u> with changes in your position.

DISPLAYING POINT-TO-POINT BEARING AND RANGE

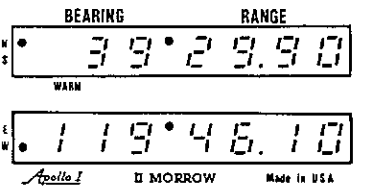
1) Select the desired waypoint and press FRM. (WP #5 Portland).

FRM



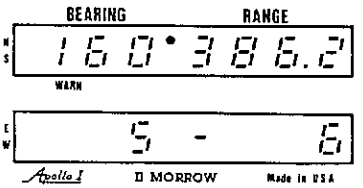
2) Select the destination waypoint and press TO.(WP #6 Reno).

TO



3) Turn the MODE switch to NAV and press RCL. The displays indicate Bearing and Range from waypoint 5 to waypoint 6.

RCL



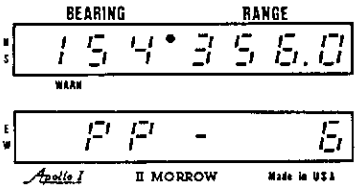
4) Press RCL to clear the point-to-point display.

RCL

The point to point Bearing and Range can be displayed in the NAV-F mode also.

To display the reciprocal Bearing reverse the FRM and TO waypoints.

If the current position (POS) is selected as the FROM waypoint and another waypoint as the destination, current position will be displayed as PP.



NAV AND NAV-F MODE

When a course is defined the NAV MODE displays the followin data to the destination:

1) Bearing in degrees.
2) Range in nautical miles up to 9,999.
3) Ground track angle (GTA) in degrees.
4) Ground speed (GS) in knots.
5) Estimated time enroute (ETE) in minutes.
6) Cross track error (CDI).

When a course is defined the NAV-F MODE displays the follov ing data to the FROM or point of origin waypoint.

1) Bearing in degrees.
2) Range in nautical miles
3) Ground track angle (GTA) in degrees.
4) Ground speed (GS) in knots.
5) Estimated time enroute (ETE) in minutes.
6) Cross track error (CDI).

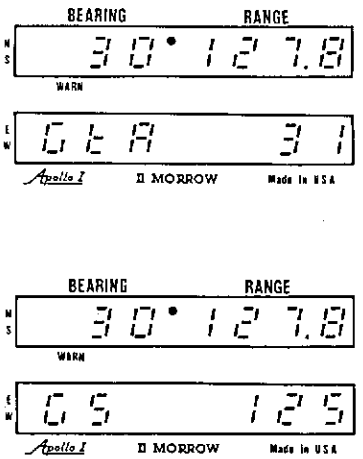
In the NAV-MODE the Bearing and Range to the destination waypoint is constantly displayed on the upper readout. The lower readout is specified by the operator with the XFR switch.

In the NAV-F MODE the Bearing and Range to the FROM or point of origin waypoint is constantly displayed on the upper readout. The lower readout is specified by the operator with the XFR switch.

You may display different navigation data in the NAV and NAV-F MODES. For example you can display cross track error (CDI) data in the NAV MODE and display ground speed (GS) in the NAV-F MODE. Both displays are available by turning the MODE switch to NAV and NAV-F.

NAV DISPLAYS

When in the NAV or NAV-F MODES, you may select the desired navigation display by pressing XFR.



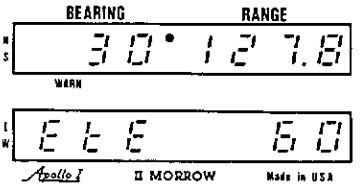
Bearing and Range

Ground Track Angle

Bearing and Range

Ground Speed

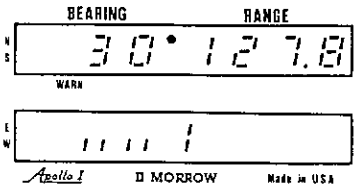
XFR



Bearing and Range

Estimated Time Enroute

XFR



Bearing and Range

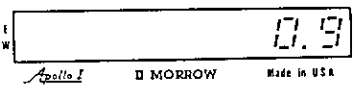
Cross Track Error(CDI)

CROSS TRACK ERROR

When a course is defined as FROM and TO the APOLLO internally draws the course line between these two points. The Cross Track Error display in the NAV MODES presents a visual indication of direction to steer.

The Cross Track Error display is a bar graph presentation representing the off course error. When the aircraft is on course a center full bar is displayed. If you drift from the intended flight path half bars will turn on indicating direction to steer. Six half bars to the right or left of the center bar can be displayed. If you drift further off course the next display will be a numeric indication of nautical miles off course. The maximum off course distance is 9.9 miles. This display will flash until the error is less than 9.9 miles.

CROSS TRACK ERROR DISPLAYS



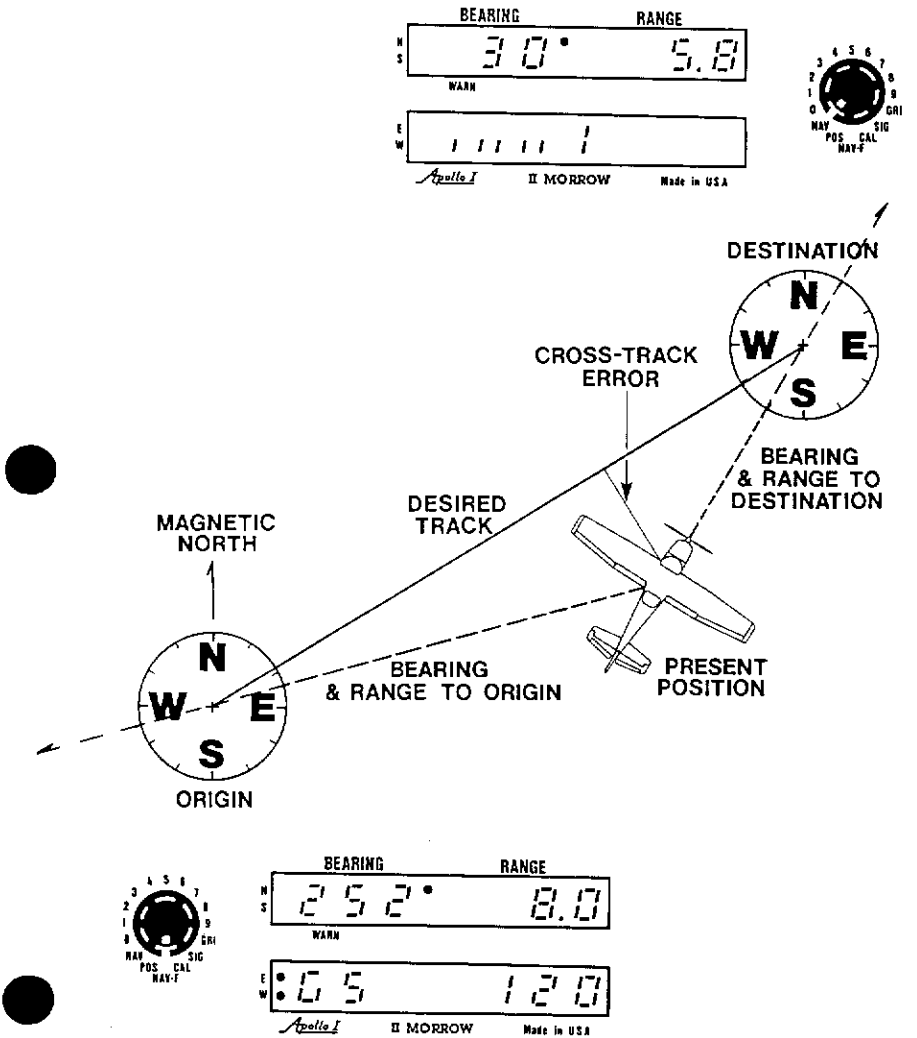
Numeric display indicates you are 0.9 miles off course. Steer right.

Numeric display indicates you are 1.2 miles off course. Steer left.

Half bars indicate steer left.

Center bar only indicates you are on course.

The following figure illustrates some of the navigation data available on a defined course.



ADVANCED OPERATING ROUTINES

This section deals with APOLLO operating functions that are not required for normal operation in prime Loran C coverage areas, or to displays that are used to provide performance and service checks.

CYCLE SLIP

In most Loran C coverage areas, the APOLLO will automatically track and update positions. But in some areas of high noise or fringe coverage areas you may need to prevent cycle slip and position errors by placing the receiver in the MANUAL TRACK MODE.

Cycle slip can be detected in the SIG MODE. If the ECD values are flashing and won't remain constant after the unit has been on at least two minutes a cycle slip problem exists.

Cycle slip may also be detected in the POS MODE when the LAT/LONG coordinates or TD values won't settle and uncorrectable position errors occur.

In both of these cases the WARN indicator will be turned on.

Cycle slip may be controlled by:

1) Making an ECD bias adjustment as explained in SIG MODE section, or
2) Placing the unit in the MANUAL TRACK MODE.

MANUAL TRACK MODE

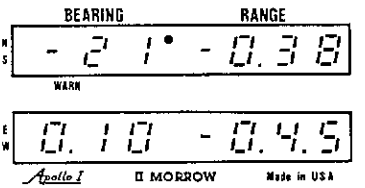
The Manual Track Mode can be useful when operating in a high noise or fringe coverage area when these conditions affect tracking.

You may also want to select the Manual Track Mode if your flight originates in a good coverage area and the destination is in a fringe area or the mid continent gap. The Manual Track Mode locks the receiver on the signal and prevents any automatic cycle corrections.

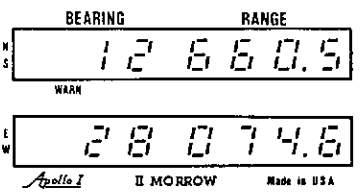
The Manual Track Mode can in some cases extend the tracking ability into fringe or weak signal areas. Before selecting the Manual Track Mode reference your known position with the displayed position in the POS MODE.

TO SELECT THE MANUAL TRACK MODE

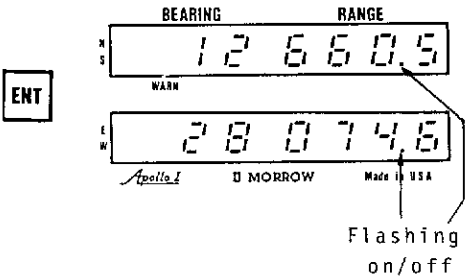
1) Turn the MODE switch to CAL. Cal values are displayed.



2) Press XFR twice to display the Loran TD's.

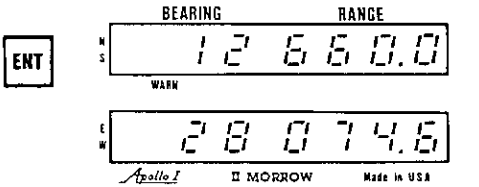


3) Press ENT to select and enter the Manual Track Mode. The TD decimal indicators will flash.



When the receiver is placed in the Manual Track Mode, positions will be updated along with all NAV displays.

4) To clear the Manual Track Mode, press ENT again.



CORRECTING TD VALUES

If the Loran signal becomes distorted by strong interfering noise, weak signal, or if the ground wave becomes contaminated with skywave, the receiver can slip cycle and cause erroneous positions to be displayed. These errors occur in 10 microsecond increments. The actual time measurement between the 100 KHz Loran cycles is 10 microseconds. These potential 10 microsecond errors are inherent in the Loran C system and usually occur only in fringe coverage areas.

You should record the actual TD's displayed for your airport or location. These TD's can be used as a reference to correct for position errors caused by cycle slip.

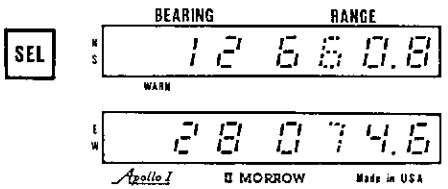
If both TD's are reading higher or lower than normal, the master signal will have to be corrected.

If one of the TD's is reading higher or lower than normal, the master signal will have to be corrected.

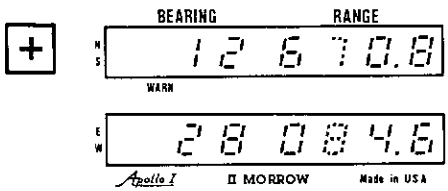
TD CORRECTION PROCEDURE

Before the TD displays can be corrected, select the Manual Track Mode. Turn the MODE switch to CAL and press XFR twice to display the TD values, Press ENT to select and enter the Manual Track Mode.

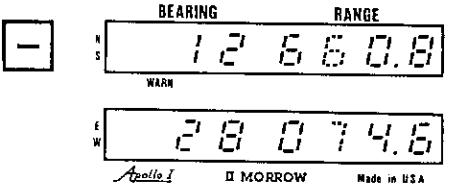
1) Press SEL to enable Master 10 microsecond corrections. Both 10 microsecond digits will flash.



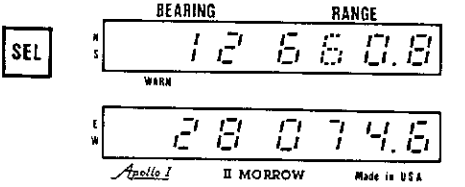
2) Press + once for each +10 microsecond correction of both displays.



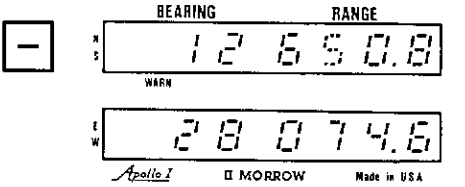
3) Press - once for each -10 microsecond correction of both displays.



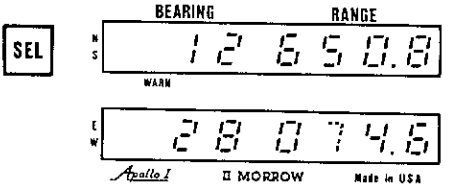
4) To correct the upper TD value press SEL again. The 10 microsecond digit for the upper display will flash.



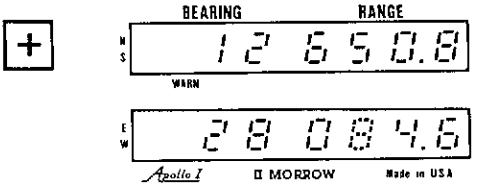
5) Press + or - to increase or decrease the display by 10 microseconds. (Minus shown)



6) To correct the lower TD value press SEL again. The 10 microsecond digit for the lower display will flash.



7) Press + or - to increase or decrease the display by 10 microseconds. (Plus shown)



PRIMARY AND EXTENDED LAT/LONG SOLUTIONS

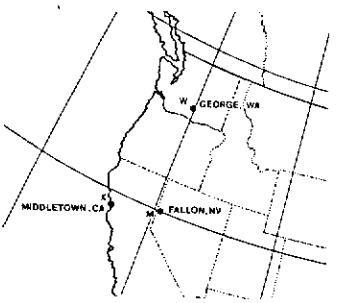
Due to the positioning and geometry of the Loran transmitters, PRIMARY and EXTENDED LAT/LONG solutions are available when the Loran receiver converts Loran TD's to LAT/LONG.

The PRIMARY solution is automatically calculated and displayed on the APOLLO in the POS MODE. In most cases you will be navigating in PRIMARY areas. However, if you are operating near a baseline extension or in an extended area you may need to display the EXTENDED solution.

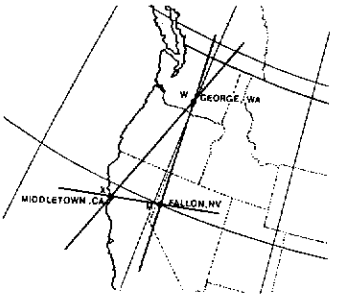
The position difference between the PRIMARY and EXTENDED solution can be several hundred miles. Usually it is obvious which LAT/LONG solution to use for navigating. The only area that may be confusing is when you are navigating near a baseline extension, which is clearly marked on the coverage maps in the Loran C theory section of this manual.

The EXTENDED areas are also shown in the Loran C theory section. To help you understand PRIMARY and EXTENDED areas, follow this procedure:

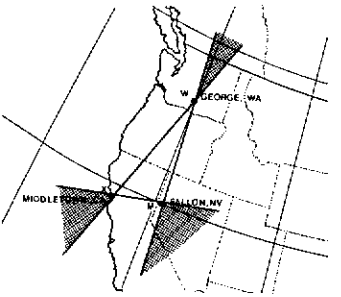
1) Using an actual map or chart, place the Master and 2 secondary stations in their geographic location.



2) Connect the transmitters by the baseline and EXTEND the lines through each transmitter as shown.

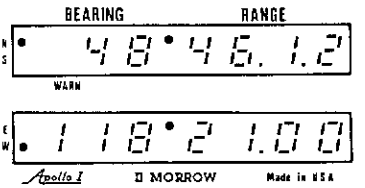


3) Shade in the area between the extensions to determine the EXTENDED areas. Non-shaded areas are PRIMARY.

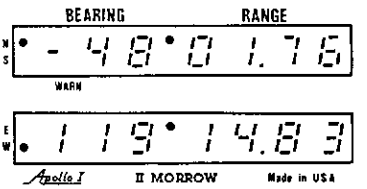


To display the EXTENDED solution:

1) Turn the function selector to POS. The PRIMARY LAT/LONG solution is displayed.



2) Press the - switch to display the EXTENDED solution.



When the EXTENDED solution is calculated a (-) minus symbol is displayed to the left of the latitude coordinate.

To restore the PRIMARY solution, press the + switch.

PROGRAMMING THE APOLLO WITHOUT SIGNAL INPUT

The user can enter waypoints and display point-to-point Bearing and Range without signal input from the preamplifier and the antenna.

The last LAT/LONG coordinates displayed on the APOLLO before the power was turned off are maintained in memory. These coordinates may be used to enter new LAT/LONG locations as waypoints. Refer to Method 2 in the WAYPOINT ENTRY section of this manual.

You may also select a From and To waypoint and display the Bearing and Range between the locations. Refer to DEFINING THE COURSE and POINT-TO-POINT BEARING AND RANGE sections in this manual.

Without signal input the GRI, SIG, CAL, and POS MODES will only display the previously entered chain and secondaries.

The NAV and NAV-F can be accessed for point-to-point Bearing and Range with the RCL switch.

OPERATOR TROUBLESHOOTING

This section deals with a few isolated problems which may be corrected by the operator.

CHAIN AND SECONDARY DISPLAY ONLY IN THE POS MODE

1) Check for the correct GRI and secondary selection by turning the MODE switch to GRI. Select and enter the proper Loran Chain for your area.

2) Antenna must be located outside of any sheds, hangars, buildings, etc.

3) Verify transmission of Loran signals with other operators or your local II Morrow dealer.

ZEROES DISPLAYED IN THE POS MODE

1) Turn the MODE switch to GRI and enter the proper secondaries for your area.

2) Check the SIG MODE for SNR and signal strength displays.

ERROR IN LAT/LONG DISPLAY OF CURRENT POSITION

1) Check calibration values in the CAL MODE and adjust LAT/LONG for an accurate display.

2) Check for improper selection of PRIMARY and EXTENDED LAT/LONG solutions.

3) Check the Loran TD display in the POS MODE. Make a manual TD correction.

LAT/LONG DISPLAYED BUT NOT UPDATING POSITIONS

1) Check the SIG MODE for proper SNR values. Re-acquire the Loran Chain. Power off, power on.

2) Check your position to see if you are navigating along a baseline extension.

3) Make sure the function selector is set to POS and not a waypoint position (0-9).

ERROR IN NAVIGATION DISPLAYS

1) Check the calibration values in the CAL MODE for correct entry.

2) Check for improper selection of PRIMARY and EXTENDED LAT/LONG solution.

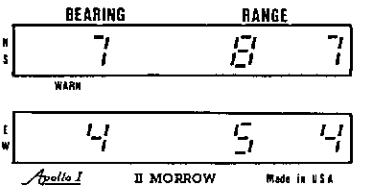
3) Check waypoints used for FROM and TO. Re-enter waypoints.

SERVICE DISPLAYS

The APOLLO displays service information to aid the dealer in isolating problems should the need arise. These displays appear in the SIG MODE and can be displayed by the operator.

OSCILLATOR OFFSET AND TEMPERATURE DISPLAYS

1) Turn the MODE switch to SIG. SNR and ECD values will be displayed.

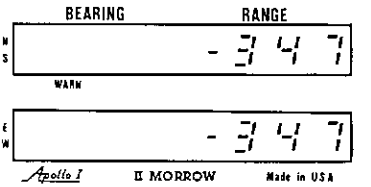


2) Press XFR three times to display the oscillator offset values.

XFR

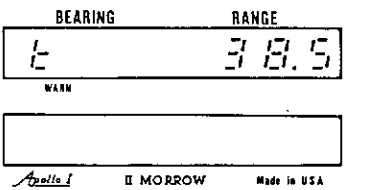
XFR

XFR



3) Press XFR again to display the internal Crystal Temperature in degrees C.

XFR

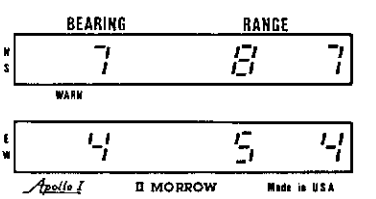


DISPLAYING THE DATE CODE

The APOLLO will also display the software date code. When contacting the factory or your dealer regarding APOLLO performance or operation, provide the date code.

TO DISPLAY THE DATE CODE

1) Turn the MODE switch to SIG. The SNR and ECD values will be displayed.



2) Press XFR five times to display the date code. A four digit number will appear in both displays.

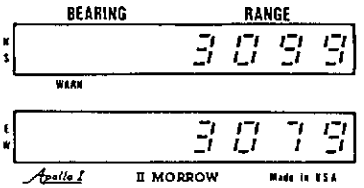
XFR

XFR

XFR

XFR

XFR



SECTION B
APOLLO INSTALLATION, MAINTENANCE, WARRANTY

INSTALLATION	B-1
RECEIVER LOCATION	B-1
ANTENNA LOCATION	B-1
ANTENNA PREAMPLIFIER	B-1
RECEIVER ACCESS	B-4
INSTALLATION WIRING DIAGRAM	B-5
CDI INTERFACE	B-5
MAINTENANCE	B-6
WARRANTY	B-7

P.O.Box 13549
Salem, OR 97309
(503) 581-8101

INSTALLATION

RECEIVER LOCATION:

The APOLLO is designed to be panel mounted with the enclosed accessories. The unit should be located in a position providing a clear view of the displays during routine instrument scans.

ANTENNA LOCATION:

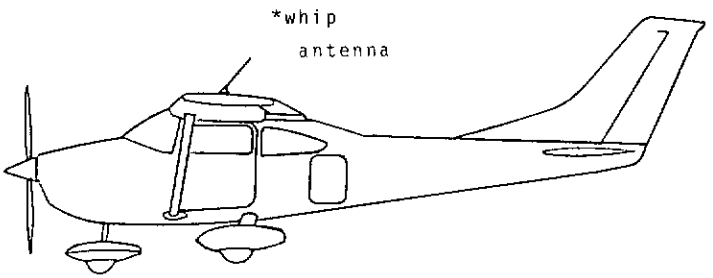
The APOLLO is designed to operate on a non-loaded antenna. The antenna should be mounted on the top side of the aircraft. Recommended antennas are the CI-121 SP which is a 19" Comant Antenna manufactured for II Morrow Loran receivers, or a long wire ADF sense antenna.

ANTENNA PREAMPLIFIER:

The A-6 antenna preamplifier must be located within 6 inches of the antenna. The supplied coax cables must be used.

The following pages illustrate recommended antenna locations.

WHIP ANTENNA

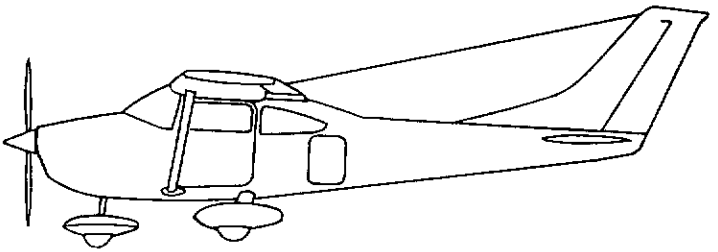


*The Comm whip antenna must be a wire only with NO loading capacitors or matching devices. Whip antenna length 18" to 22" long.

The supplied coax cable which connects between the preamp and the antenna is 6" long and must not be lengthened.

The supplied coax cable which connects between the Loran receiver and the preamp may be changed in length.

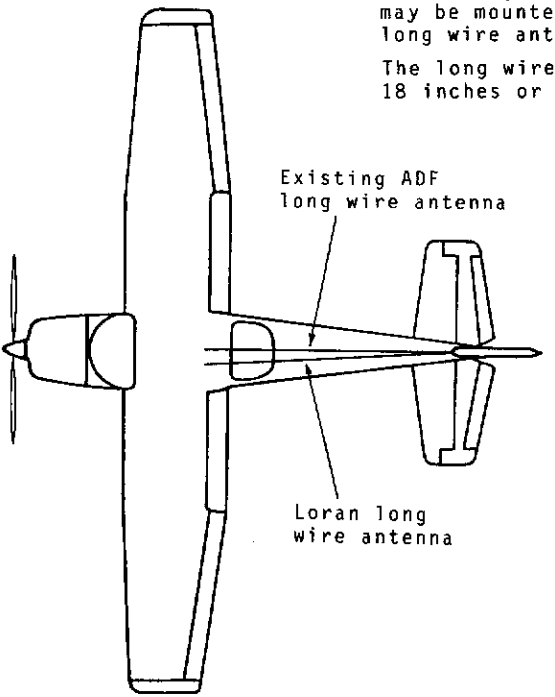
LONG WIRE ANTENNA



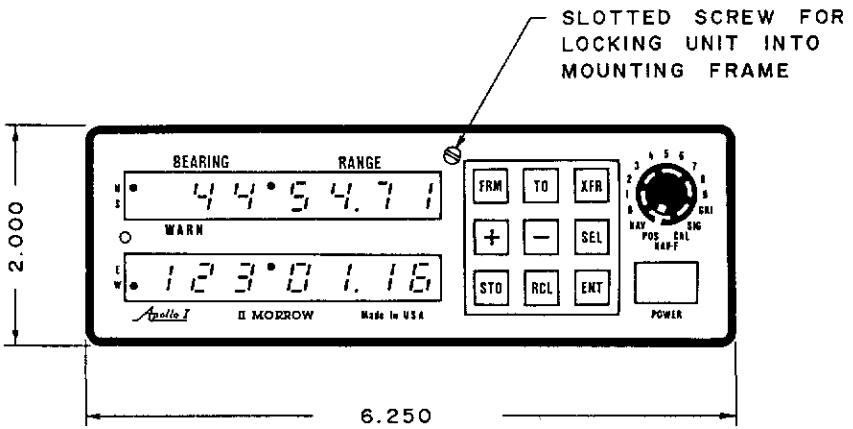
Use Antenna Specialists AV 545 long wire or equivalent.

Loran long wire antenna may be mounted next to ADF long wire antenna.

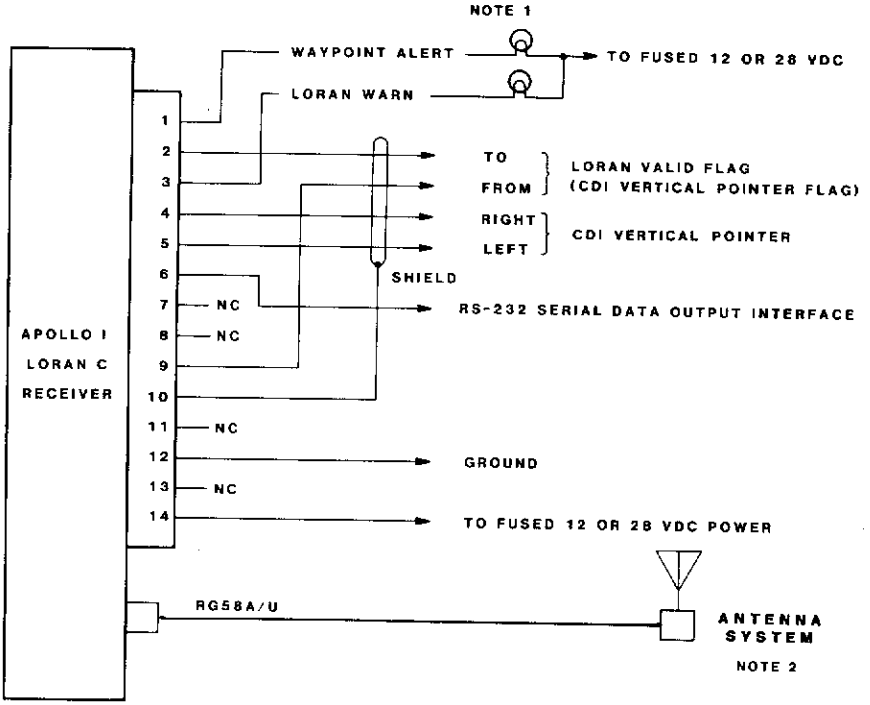
The long wire may be 18 inches or longer.



The APOLLO is secured to the mounting frame by tightening the slotted screw on the front panel. The screw protrudes through the rear panel of the APOLLO and will fasten to the mounting frame. The APOLLO may be easily removed by loosening the screw.



INSTALLATION WIRING DIAGRAM
for the
Apollo I



CDI INTERFACE

The APOLLO II will interface with low power (±150 uA) CDI meters. The wiring diagram shown above indicates the pins to be connected.

The APOLLO II CDI interface will not operate with units that have internal CDI or HSI conversions.

NOTE 1: Use 12 or 28 Volt indicator lamps depending on the supply voltage. Lamps MUST NOT draw more than 150 mA.

NOTE 2: Antennas other than the A-16 require the use of the A-6 Antenna Preamplifier.

MAINTENANCE AND WARRANTY

MAINTENANCE:

There are no routine maintenance procedures to be performed by the user. To clean any dust collection from the front panel use a clean soft cloth and furniture polish. Do not use chemical cleaning agents or solvents to clean the front panel.

BATTERY REPLACEMENT:

The APOLLO memory is maintained by a Lithium battery. The expected service life of this battery is five years. This battery must be replaced by your II Morrow dealer.

26 MONTH LIMITED WARRANTY

II MORROW INC. warrants the APOLLO LORAN-C receiver for 26 months and the antenna/preamplifier for one year from the date of original retail purchase in the United States to be free of any manufacturing and material defects.

PARTS

Parts will be replaced in exchange for defective parts for 26 months after the original retail purchase at no charge to the customer.

LABOR

Repairs performed by II Morrow, or an authorized dealer, will be done at no charge to the customer for 26 months after the original retail purchase for the APOLLO LORAN-C receiver and 12 months for the antenna/preamplifier.

WARRANTY SERVICE

Warranty service may be obtained by shipping the product to the II Morrow factory, II Morrow's East Coast Service Center, or an authorized dealer.

EXCLUSIONS

This warranty covers normal customer use and does not cover damage which occurs in shipment or failures which result from alteration, accident, misuse, abuse, installation, improper maintenance, or failures caused by undue exposure to corrosive environments. Some states do not allow for exclusion of incidental or consequential damages. This warranty gives you specific legal rights. You may also have other rights which vary from state to state.

THE WARRANTY IS VOID IF THE UNIT IS NOT INSTALLED BY AN AUTHORIZED II MORROW DEALER.

SECTION C
LORAN C THEORY

THE LORAN-C SYSTEM C-1

DEFINITION C-1

LORAN-C TRANSMITTING STATIONS C-1

HOW LORAN-C WORKS C-3

THE LORAN-C RECEIVER C-3

LORAN-C CHAIN CONFIGURATIONS

4990	CENTRAL PACIFIC	C-5
5930	CANADIAN EAST COAST	C-8
5990	CANADIAN WEST COAST	C-11
7930	LABRADOR SEA	C-16
7960	GULF OF ALASKA	C-21
7970	NORWEGIAN SEA	C-24
7980	SOUTHEAST U.S.	C-32
7990	MEDITERRANEAN	C-40
8970	GREAT LAKES	C-45
9940	U.S. WEST COAST	C-50
9960	NORTHEAST U.S.	C-55
9970	NORTHWEST PACIFIC	C-63
9990	NORTH PACIFIC	C-71
9980	ICELAND	C-76

P.O. BOX 13549
SALEM, OR 97309
U.S.A.

503-581-8101

HISTORY OF REVISIONS

SECTION C P/N 560-0015

Revision 0	April 1983	(0483)
Revision 1	December 1983	(1283)
Revision 2	August 1985	(0885)

Revision 1

Revision Page	Add
Table of Contents	Reflect changes in LORAN-C chains
C-7	Change data
C-8	Reconfigure map
C-9	Reconfigure map
C-9a	Reconfigure map
C-9b	Reconfigure map
C-15	Change data
C-16	Reconfigure map
C-17	Reconfigure map
C-18	Delete
C-19	Delete
C-75	Add
C-76	Add
C-77	Add

Revision 2

C-8	Add coverage area
C-16	Add coverage area
C-24	Add coverage area
C-76	Add coverage area

THE LORAN C SYSTEM

DEFINITION

Loran C is an acronym for Long Range Navigation. The system consists of fixed land-based stations transmitting in the low frequency band (LF) at a frequency of 100 KHz. This low frequency follows the earth's surface providing long range coverage and is not limited to line of sight or altitude. Coverage is determined by the power transmitted from each station, the distance between the stations and their geographical orientation to each other.

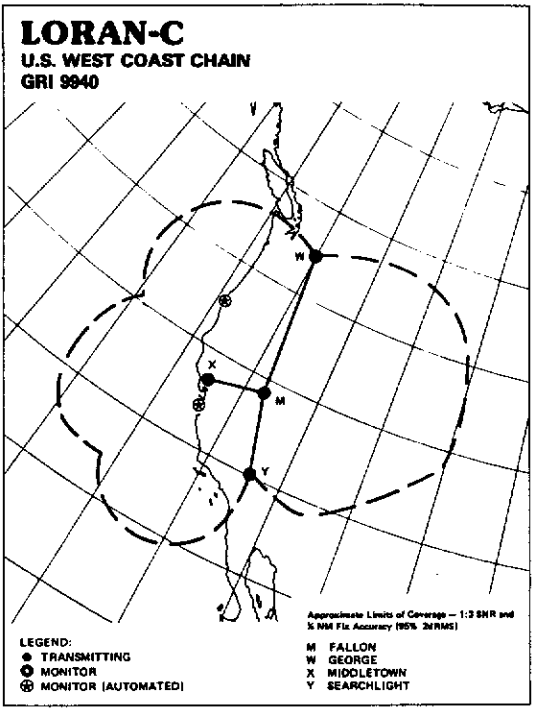
LORAN C TRANSMITTING STATIONS

A chain of three to five land-based transmitting stations separated by several hundred miles is established. Each chain consists of one master station(M) and up to four secondary stations, designated as Whiskey(W), Xray(X), Yankee(Y) and Zulu(Z).

Each station within the chain transmitts synchronized pulses at precise time intervals referred to as the GRI or Group Repetition Interval.

The master station transmitts a group of coded pulses first and then each secondary will transmit a group of coded pulses after a pre-determined coding delay.

On the following page an illustration of the U.S. West Coast Chain GRI 9940 is shown. Included are the locations, functions, power and coding delays.



U.S. WEST COAST LORAN-C CHAIN - GRI 9940 (old rate SS6)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Fallon, NV	Master	39 33 06.6 N 118 49 56.4 W		400	Two pulse comms installed.
George, WA	Whiskey	47 03 48.0 N 119 44 39.5 W	11000/ 2796.90	1600	Two pulse comms installed. Dual-rated to West Coast Canada Chain.
Middletown, CA	Xray	38 46 57.0 N 122 29 44.5 W	27000/ 1094.50	400	Exercises operational control of chain. Control for W, X, and Y. Two pulse comms installed.
Searchlight, NV	Yankee	35 19 18.2 N 114 48 17.4 W	40000/ 1967.30	540	
North Bend, OR	Monsite	43 24 36.2 N 124 14 27.9 W			Unmanned receiver site.
Pt. Pinos, CA	Monsite	36 37 59.0 N 121 56 05.6 W			Unmanned receiver site.

HOW LORAN C WORKS

Loran C is a synchronized radio navigation system based on time of arrival measurements. The time measurements correspond to the distance a Loran receiver is from the transmitting stations. These time measurements are referred to as a time difference (TD). Each time difference is measured in microseconds, or millionths of a second, and can be plotted on a curved line between the two stations called a hyperbola. The hyperbolic lines are referred to as a line of position (LOP).

The master and a secondary station form one line of position. To obtain a position fix, another time measurement is necessary from the master to another secondary station. This forms a crossing line of position. Where these two LOP's intersect determines the actual geographic position and can be referenced on a Loran C Chart.

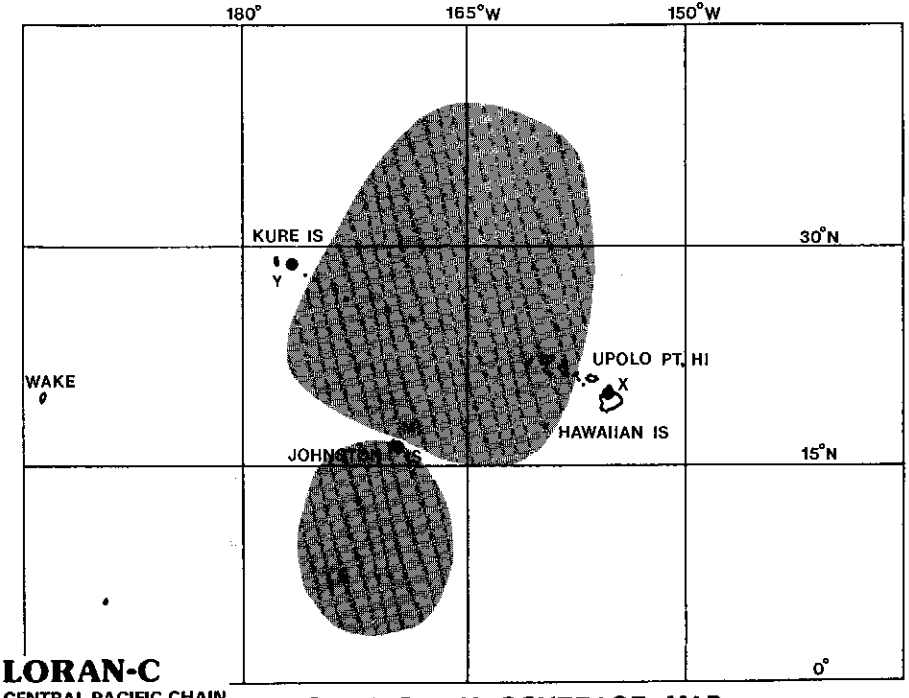
THE LORAN RECEIVER

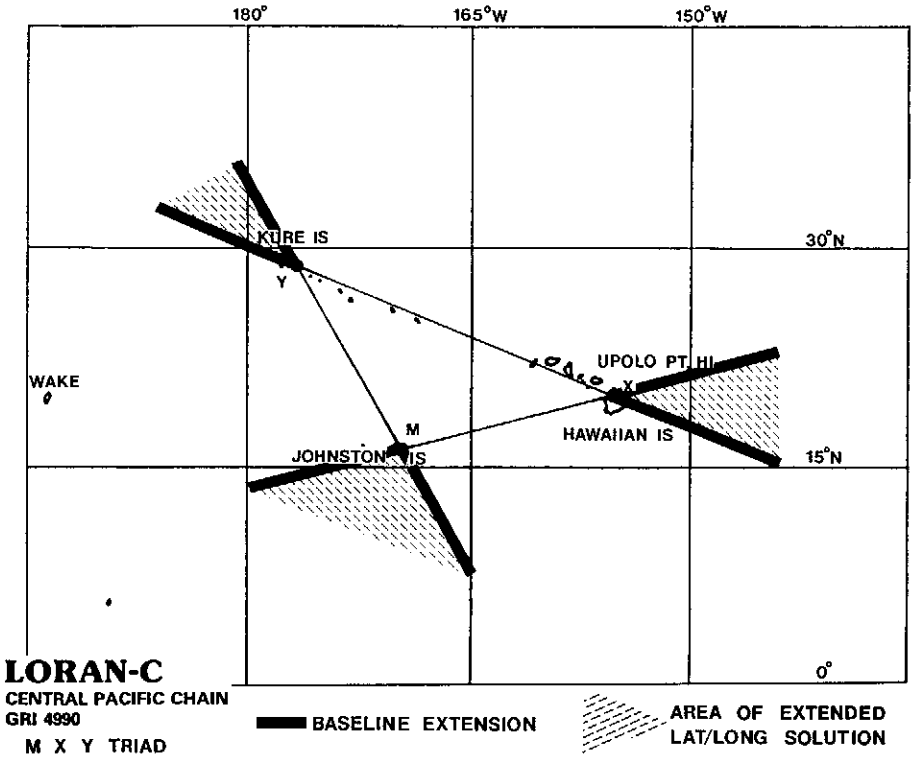
The APOLLO tracks all available secondaries within the selected Chain. By selecting two secondaries the APOLLO will automatically convert the time differences to Latitude and Longitude eliminating the need for special Loran C Charts.

To assist you in determining which chain and secondaries to use for a given area of operation the next few pages are devoted to coverage and secondary selection for all operating Loran C chains.

CENTRAL PACIFIC LORAN-C CHAIN - GRI 4990 (old rate S1)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Johnston Is, HI	Master	16 44 44.0 N 169 30 31.0 W		275	
Upolu Pt, HI	Xray	20 14 49.2 N 155 53 09.7 W	11000/ 4972.23	275	Time service monitor.
Kure Is, HI	Yankee	28 23 41.8 N 178 17 30.2 W	29000/ 5253.17	275	
Lormonsite Johnston Is, HI	Monitor	16 43 19.5 N 169 32 36.8 W			
Lormonsta Honolulu, HI	Control				Controls X and Y.


180°
165°W
150°W
30°N
15°N
0°
KURE IS
Y
WAKE
UPOLO PT, HI
X
HAWAIIAN IS
JOHNSTON I.
LORAN-C
CENTRAL PACIFIC CHAIN
GRI 4990
LORAN CHAIN COVERAGE MAP


180°
165°W
150°W
30°N
15°N
0°
KURE IS
Y
WAKE
UPOLO PT. HI
X
HAWAIIAN IS
M
JOHNSTON IS
LORAN-C
CENTRAL PACIFIC CHAIN
GRI 4990
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

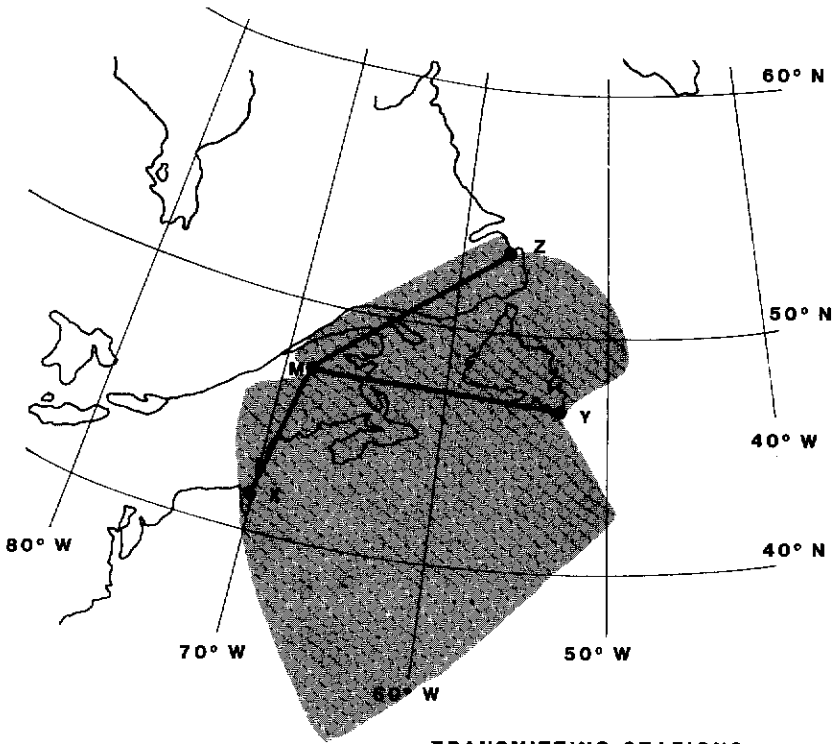
CANADIAN EAST COAST LORAN-C CHAIN - GRI 5930

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Caribou, ME	Master	46°48'27.2"N 67°55'37.7"W		350	Dual-Rated to North-east U.S. Chain.
Nantucket, MA	Xray	41°15'11.9"N 69°58'39.1"W	11000/ 2131.88	275	Dual-Rated to North-east U.S. Chain.
Cape Race, NFLD	Yankee	46°46'32.2"N 53°10'28.2"W	25000/ 3755.02	1500	Dual-Rated to Labrador Sea Chain.
Fox Harbour, Labrador	Zulu	52°22'35.2"N 55°42'28.4"W	38000/ 3594.58	800	Dual-Rated to Lab-rador Sea Chain.
Cape Elizabeth, ME	Monitor	43°33'54.8"N 70°11'58.5"W			Unmanned Receiver Site.
Montague, P.E.I.	Monitor	46°11'40.0"N 62°39'37.0"W			Unmanned Receiver Site.
St. Anthony, NFLD	Monitor/ Control	51°21'37.0"N 55°37'28.0"W			Exercises Operational Control of the Chain.

Rev. 1 1283

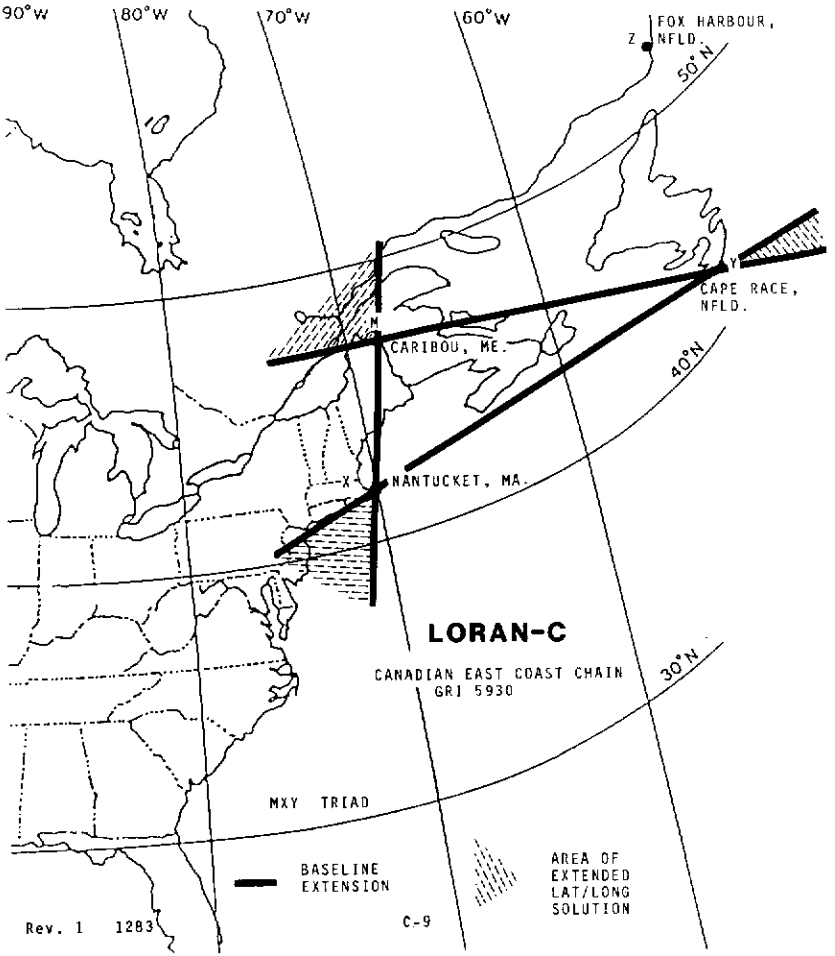
LORAN-C

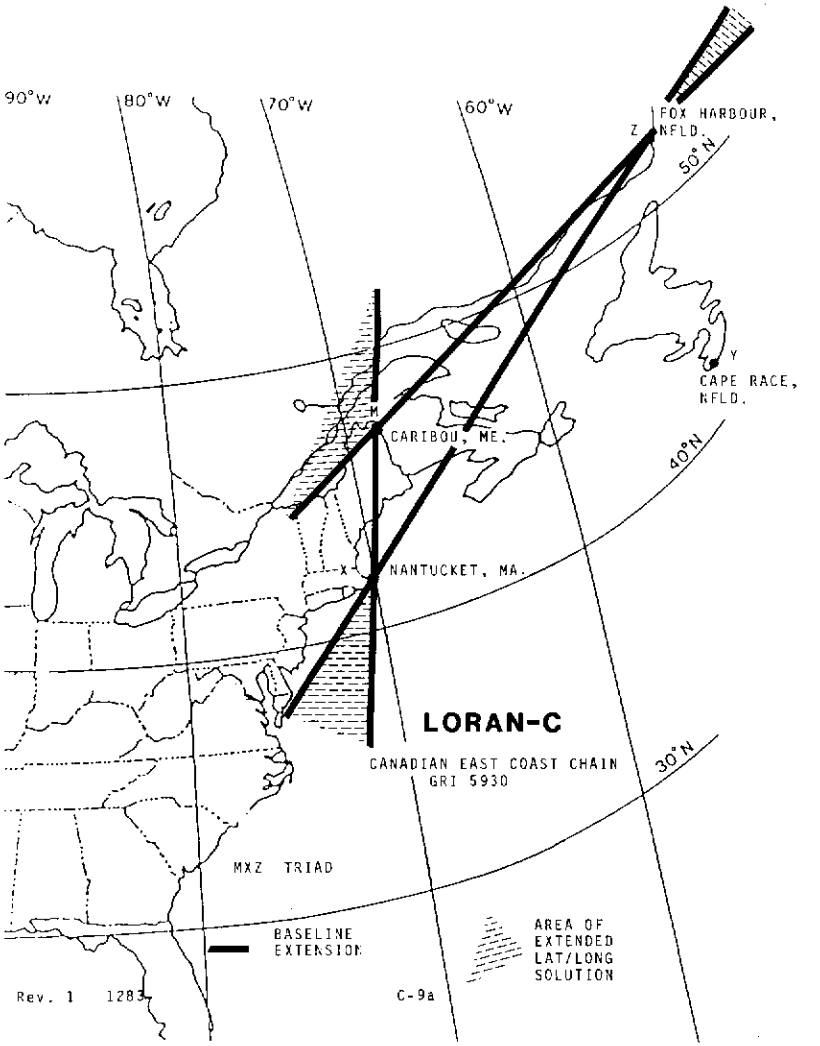
CANADIAN EAST COAST CHAIN
GRI 5930

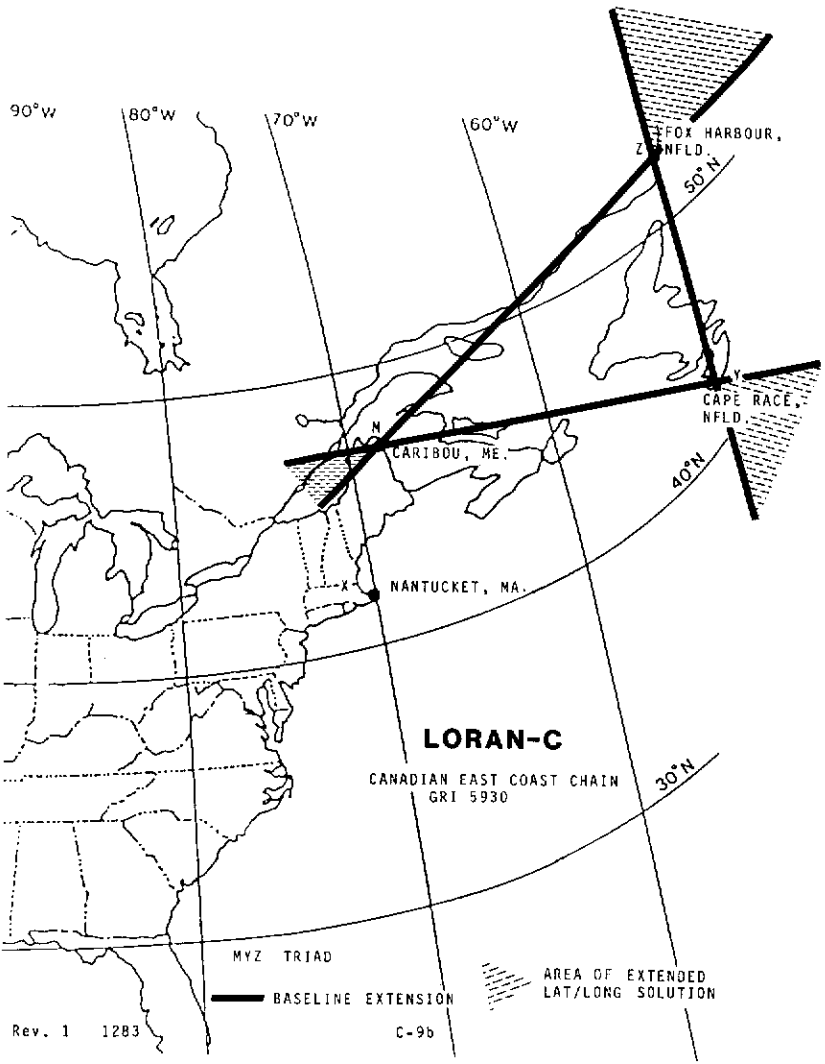


TRANSMITTING STATIONS

M CARIBOU
X NANTUCKET
Y CAPE RACE
Z FOX HARBOUR


90°W
80°W
70°W
60°W
FOX HARBOUR, NFLD.
Z
50°N
CAPE RACE, NFLD.
Y
M
CARIBOU, ME.
40°N
X
NANTUCKET, MA.
LORAN-C
CANADIAN EAST COAST CHAIN
GRI 5930
30°N
MXY TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION
Rev. 1 1283
C-9

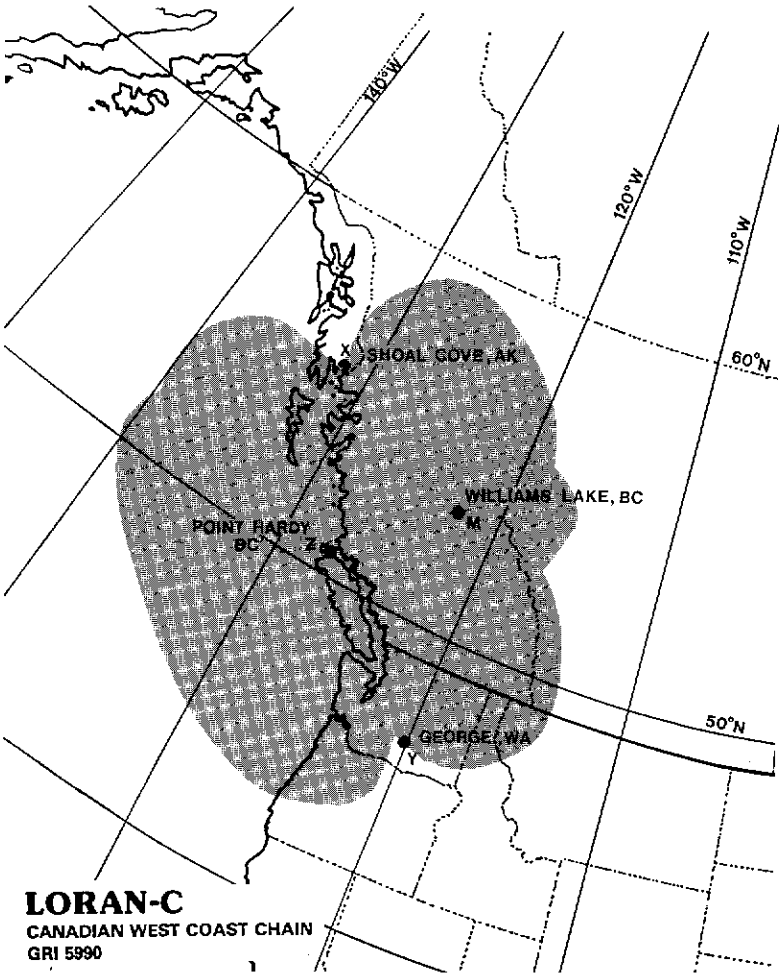

90°W
80°W
70°W
60°W
50°N
40°N
30°N
FOX HARBOUR, NFLD.
Z
Y
CAPE RACE, NFLD.
M
CARIBOU, ME.
X
NANTUCKET, MA.
LORAN-C
CANADIAN EAST COAST CHAIN
GRI 5930
MXZ TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION
Rev. 1 1283
C-9a


90°W
80°W
70°W
60°W
50°N
40°N
30°N
FOX HARBOUR, NFLD.
CAPE RACE, NFLD.
CARIBOU, ME.
NANTUCKET, MA.
N
X
Y
Z
LORAN-C
CANADIAN EAST COAST CHAIN
GRI 5930
MYZ TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

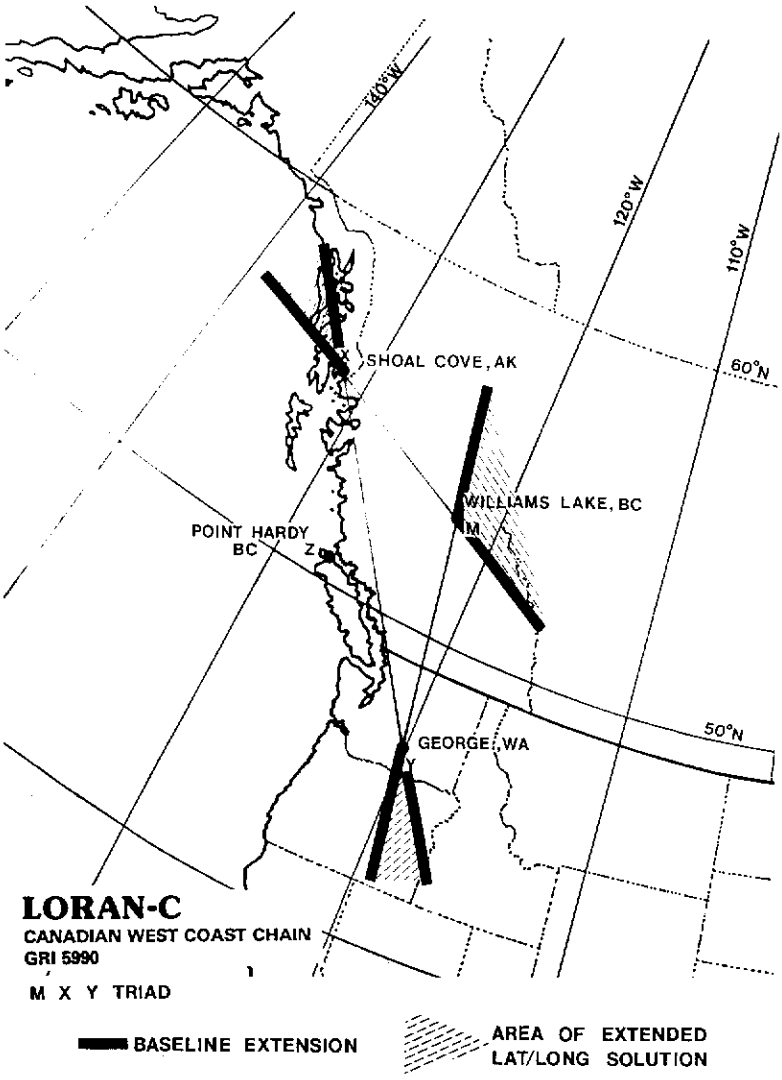
Rev. 1 1283

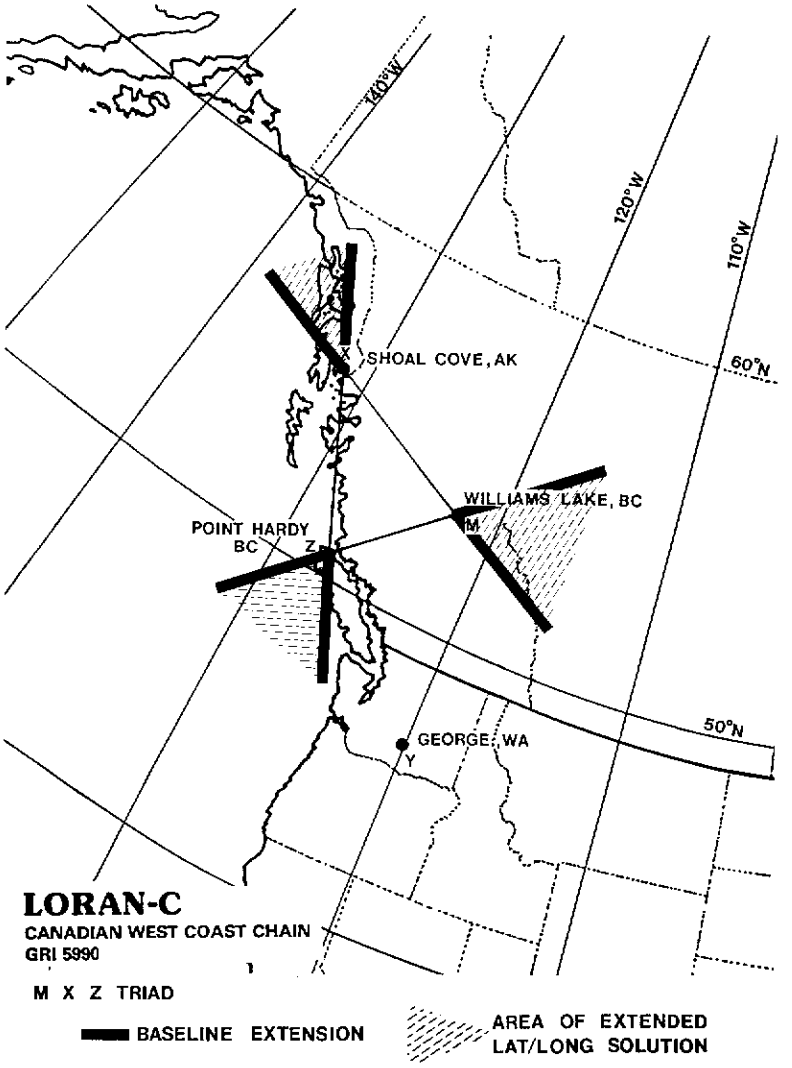
CANADIAN WEST COAST LORAN-C CHAIN - GRI 5990 (old rate SH1)

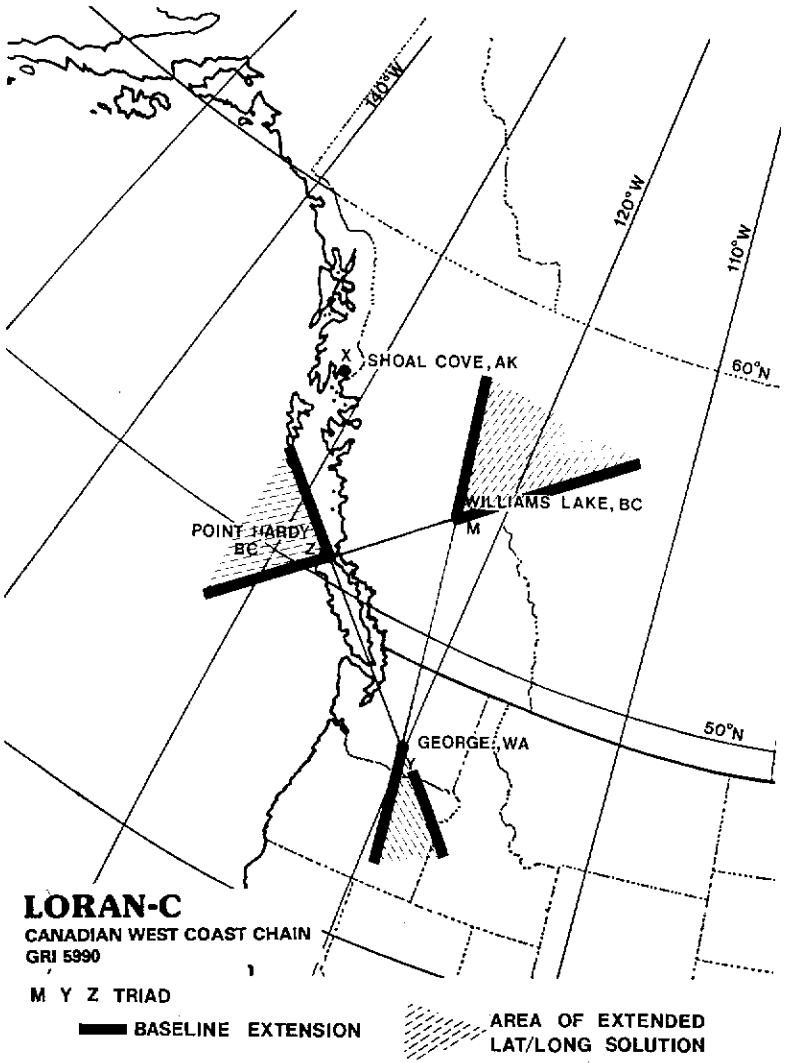
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Williams Lake, BC, Canada	Master	51 57 58.8 N 122 22 02.2 W		400	Control for X and Y. Two pulse comms installed.
Shoal Cove, AK	Xray	55 26 20.9 N 131 15 19.7 W	11000/ 2343.60	540	Two pulse comms installed. Dual-rated to Gulf of Alaska Chain.
George, WA	Yankee	47 03 48.0 N 119 44 39.5 W	27000/ 1927.36	1600	Two pulse comms installed. Dual-rated to U.S. West Coast Chain.
Port Hardy, BC, Canada	Zulu	50 36 29.7 N 127 21 29.4 W	41000/ 1266.63	400	Scheduled to be operational June 1980.
Alert Bay, Canada	Monitor	50 35 01 N 126 54 39 W			Unmanned receiver site.
Whidbey Is, WA	Monitor	48 17 39 N 124 33 55 W			Unmanned receiver site.



LORAN CHAIN COVERAGE MAP


140°W
120°W
110°W
60°N
50°N
SHOAL COVE, AK
X
WILLIAMS LAKE, BC
M
POINT HARDY
BC
Z
GEORGE, WA
Y
LORAN-C
CANADIAN WEST COAST CHAIN
GRI 5990
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


140°W
120°W
110°W
60°N
50°N
SHOAL COVE, AK
X
WILLIAMS LAKE, BC
M
POINT HARDY
BC
Z
GEORGE, WA
Y
LORAN-C
CANADIAN WEST COAST CHAIN
GRI 5990
M X Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

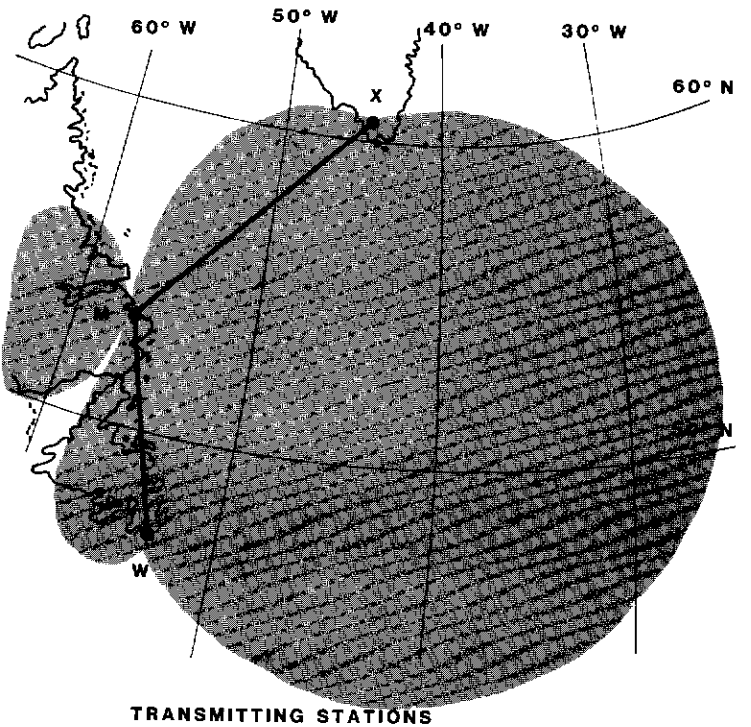

140°W
120°W
110°W
60°N
50°N
SHOAL COVE, AK
X
WILLIAMS LAKE, BC
M
POINT HARDY
BC
Z
GEORGE, WA
Y
LORAN-C
CANADIAN WEST COAST CHAIN
GRI 5990
M Y Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

LABRADOR SEA LORAN-C CHAIN - GRI 7930

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Fox Harbour, Labrador	Master	52°22'35.2"N 55°42'28.4"W		800	Dual-Rated to Canadian East Coast Chain.
Cape Race, NFLD	Whiskey	46°46'32.2"N 53°10'28.2"W	11000/ 2167.30	1500	Dual-Rated to Canadian East Coast Chain.
Angissoq, Greenland	Xray	59°59'17.3"N 45°10'27.5"W	26000/ 3565.38	760	Dual-Rated to Icelandic Chain.
St. Anthony, NFLD	Monitor	51°21'37.0"N 55°37'28.0"W			

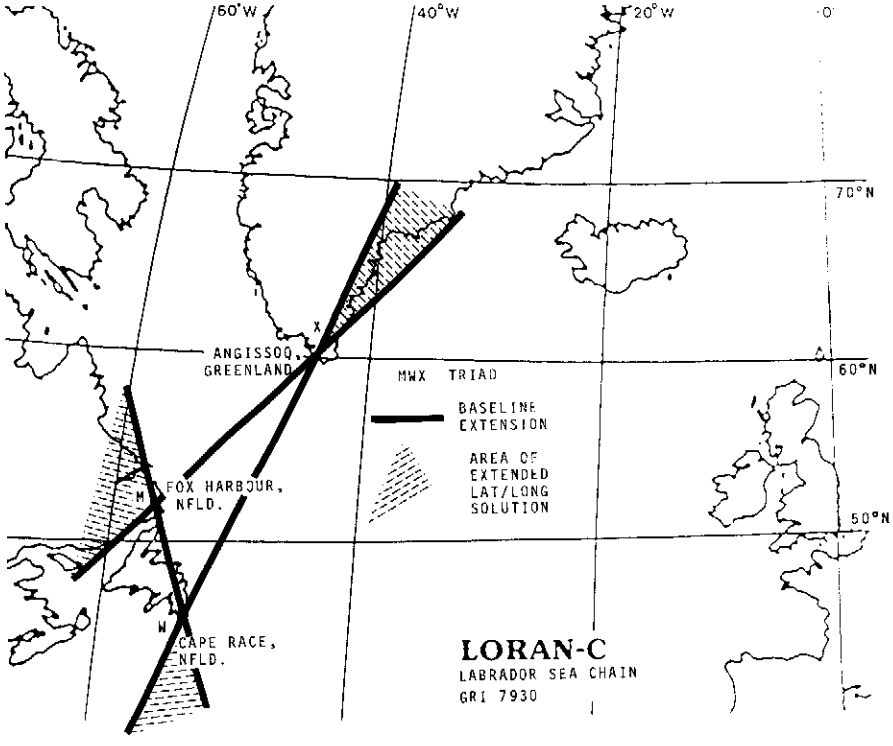
LORAN-C

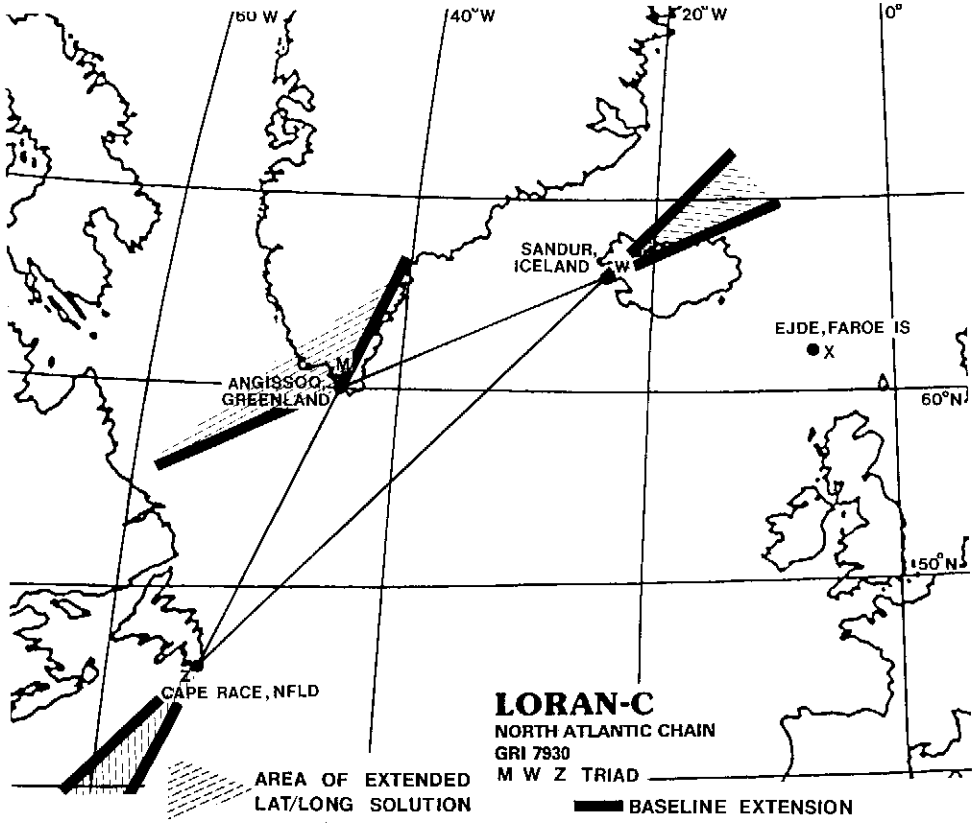
LABRADOR SEA CHAIN
GRI 7930

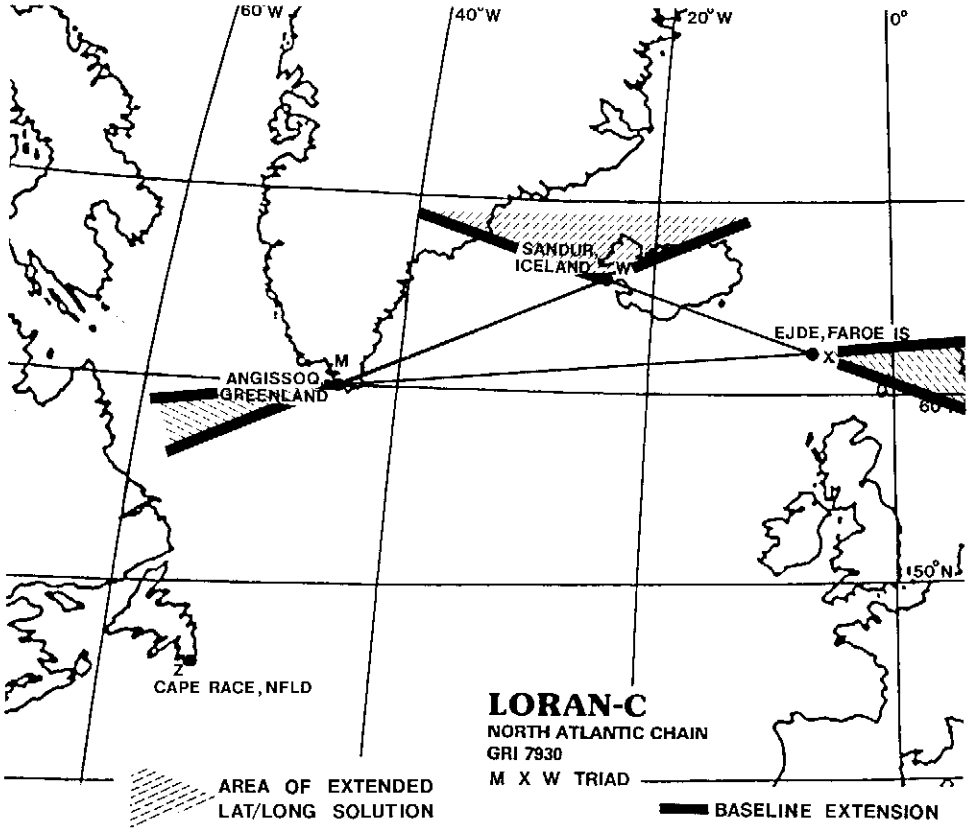


TRANSMITTING STATIONS

M FOX HARBOUR
W CAPE RACE
X ANGISSOQ

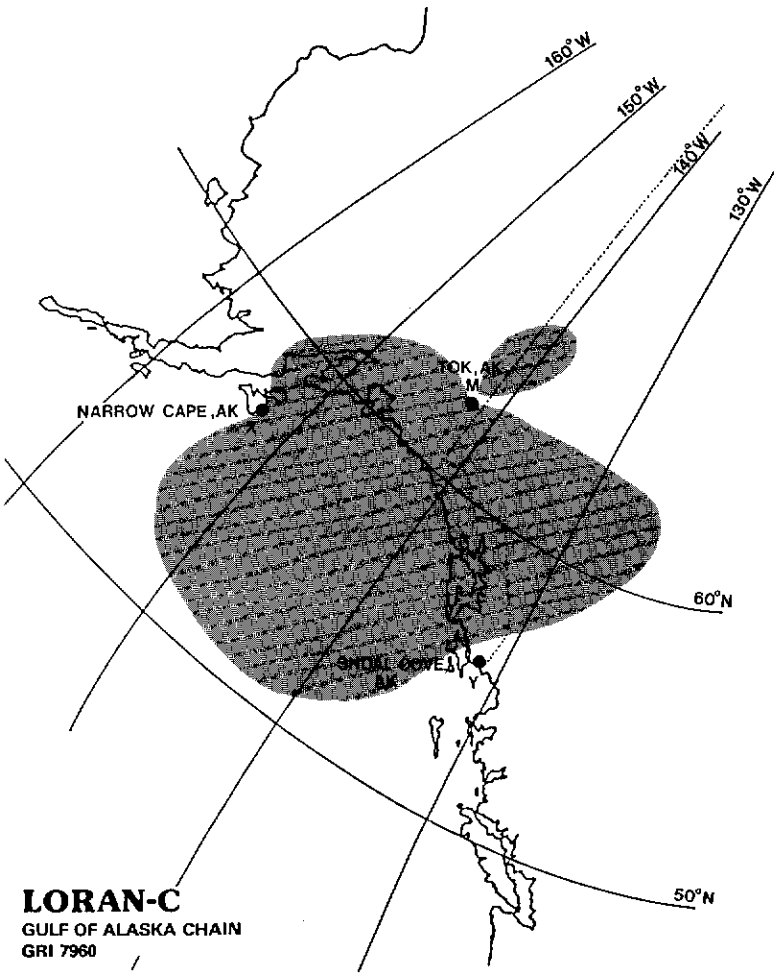

60°W
40°W
20°W
0°
70°N
60°N
50°N
ANGISSOQ, GREENLAND
FOX HARBOUR, NFLD.
CAPE RACE, NFLD.
MWX TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION
LORAN-C
LABRADOR SEA CHAIN
GRI 7930


60°W
40°W
20°W
0°
SANDUR, ICELAND
W
EJDE, FAROE IS
X
ANGISSOQ, GREENLAND
M
60°N
50°N
CAPE RACE, NFLD
Z
LORAN-C
NORTH ATLANTIC CHAIN
GRI 7930
M W Z TRIAD
AREA OF EXTENDED LAT/LONG SOLUTION
BASELINE EXTENSION

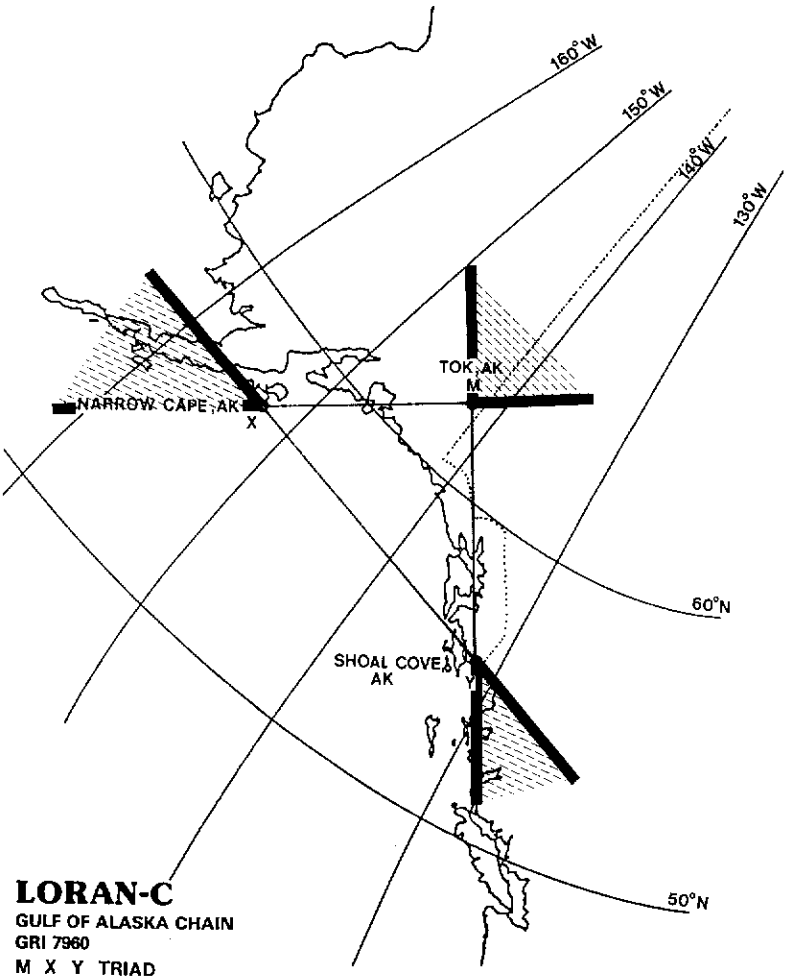

60°W
40°W
20°W
0°
SANDUR, ICELAND
W
EJDE, FAROE IS
X
ANGISSOQ, GREENLAND
M
60°N
50°N
CAPE RACE, NFLD
Z
LORAN-C
NORTH ATLANTIC CHAIN
GRI 7930
M X W TRIAD
AREA OF EXTENDED LAT/LONG SOLUTION
BASELINE EXTENSION

GULF OF ALASKA LORAN-C CHAIN - GRI 7960 (old rate SL4)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Tok, AK	Master	63 19 42.8 N 142 48 31.9 W		540	Two pulse comms installed.
Harrow Cape, Kodiak Is, AK	Xray	57 26 20.2 N 152 22 11.3 W	11000/ 2804.45	400	Two pulse comms installed. Dual-rated to North Pacific chain
Shoal Cove, AK	Yankee	55 26 20.9 N 131 15 19.7 W	26000/ 3651.14	540	Two pulse comms installed. Dual-rated to Canadian West Coast Chain.
Kodiak, AK	Monitor/ Control	57 44 00.7 N 152 30 20.4 W			Exercises operational control of chain, control for X and Y.
Juneau, AK	Monitor	58 17 54.8 N 134 24 45.4 W			Unmanned receiver site.



LORAN CHAIN COVERAGE MAP



LORAN-C
GULF OF ALASKA CHAIN
GRI 7960
M X Y TRIAD

BASELINE EXTENSION

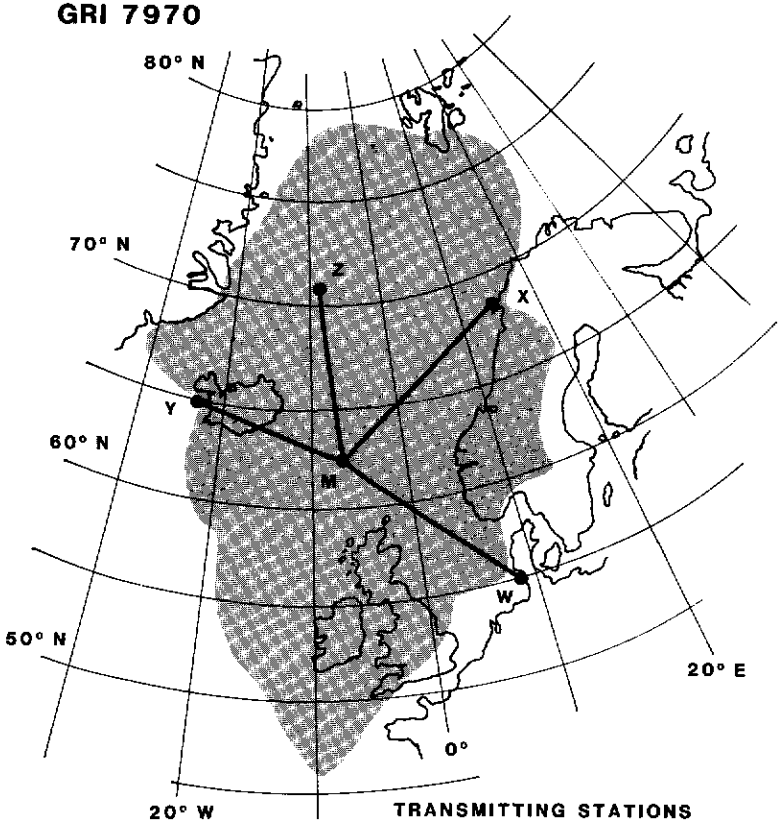
AREA OF EXTENDED LAT/LONG SOLUTION

NORWEGIAN SEA LORAN-C CHAIN - GRI 7970 (old rate SL3)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Ejde, Faeroe Is. Denmark	Master	62 17 59.7 N 07 04 26.7 W		325	Host Nation Manned, Dual-rated to North Atlantic Chain.
BØ, Norway	Xray	68 38 06.2 N 14 27 47.0 E	11000/ 4048.10	165	Host Nation Manned.
Sylt, Germany	Whiskey	54 48 29.8 N 08 17 36.3 E	26000/ 4065.64	325	
Sandur, Iceland	Yankee	64 54 26.6 N 23 55 21.8 W	46000/ 2944.53	1500	Host Nation Manned, dual-rated to North Atlantic Chain.
Jan Mayen, Norway	Zulu	70 54 52.6 N 08 43 58.7 W	60000/ 3216.30	165	Host Nation Manned.
Shetland Is., U.K.	Monitor/ Control	60 26 25.3 N 01 18 05.7 W			Control For X, W, Y, and Z

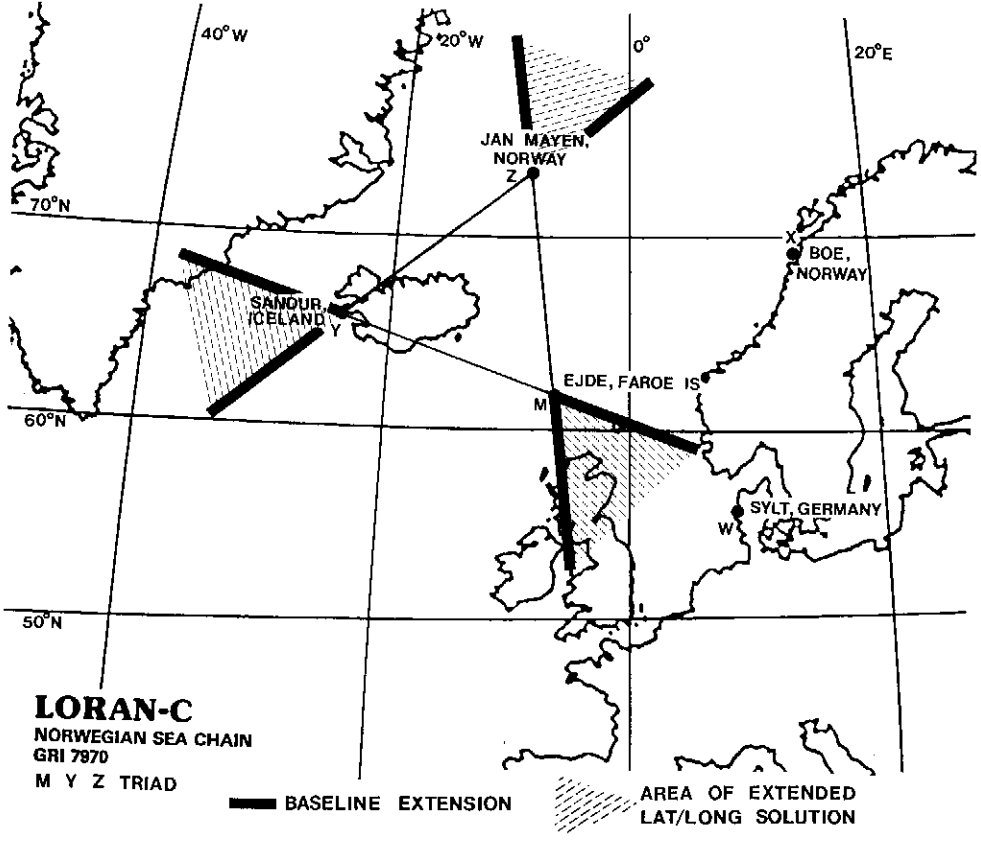
LORAN-C

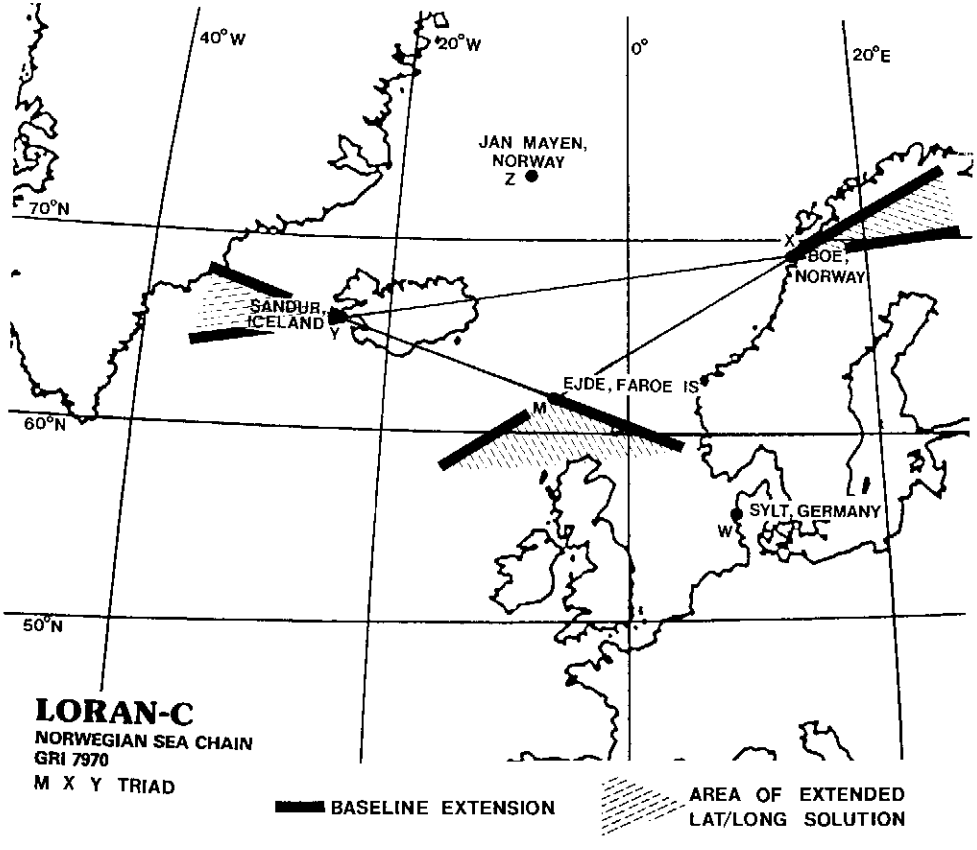
NORWEGIAN SEA CHAIN
GRI 7970

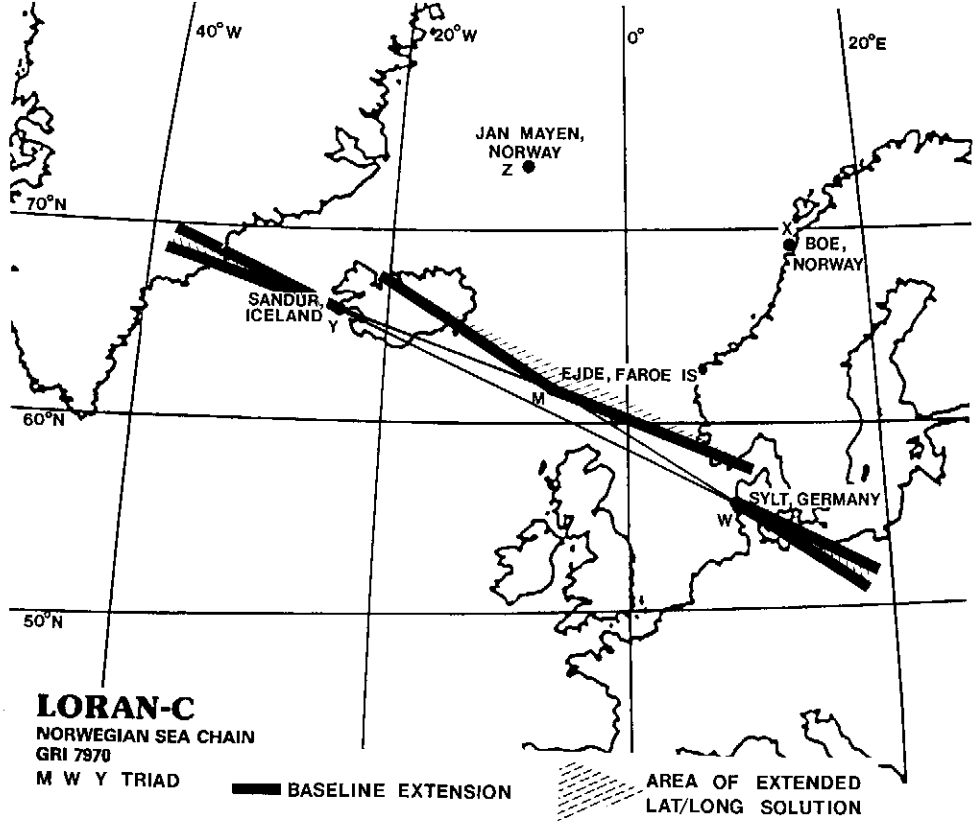


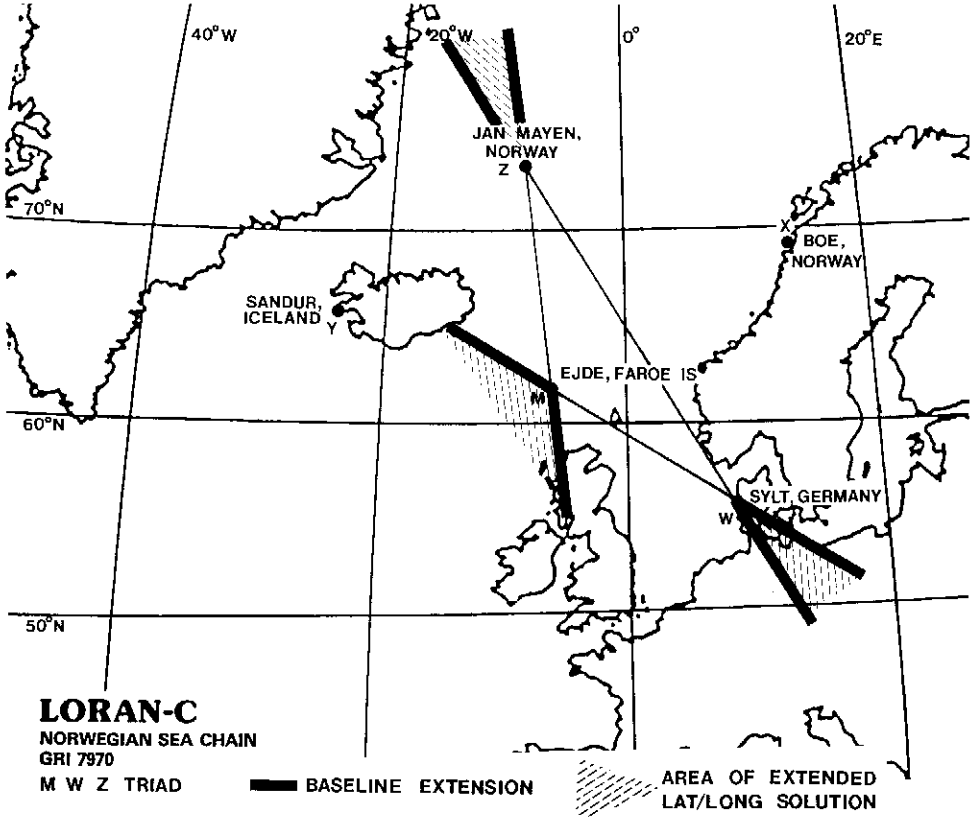
TRANSMITTING STATIONS

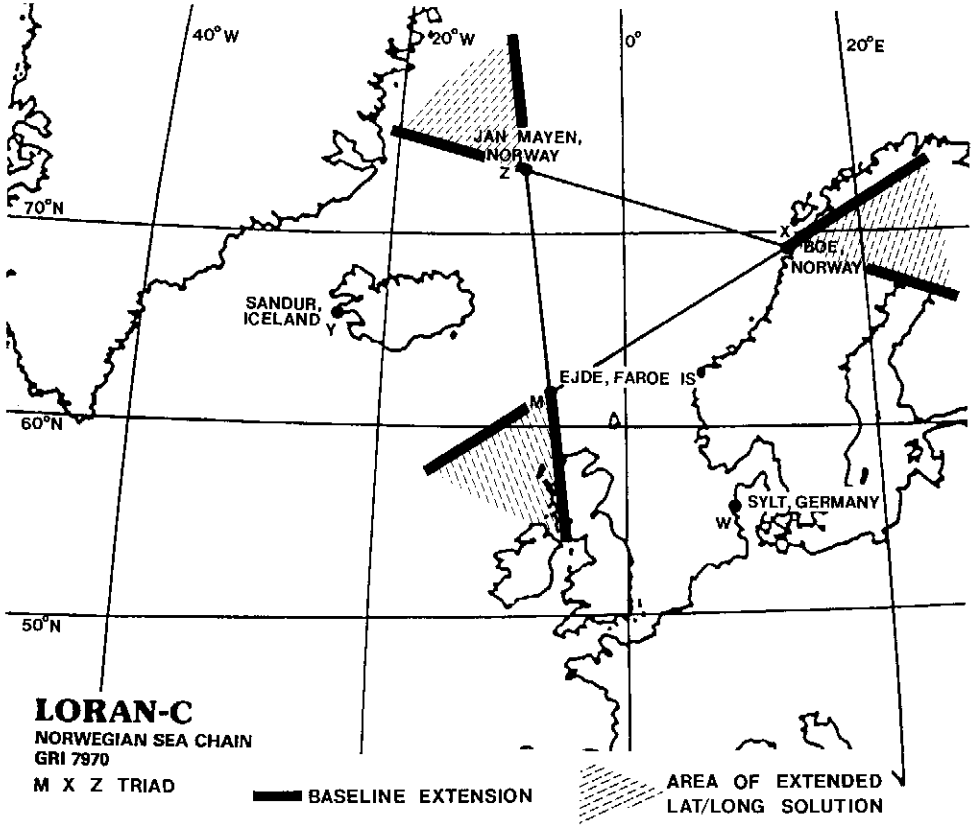
- M EJDE
- W SYLT
- X BØ
- Y SANDUR
- Z JAN MAYEN

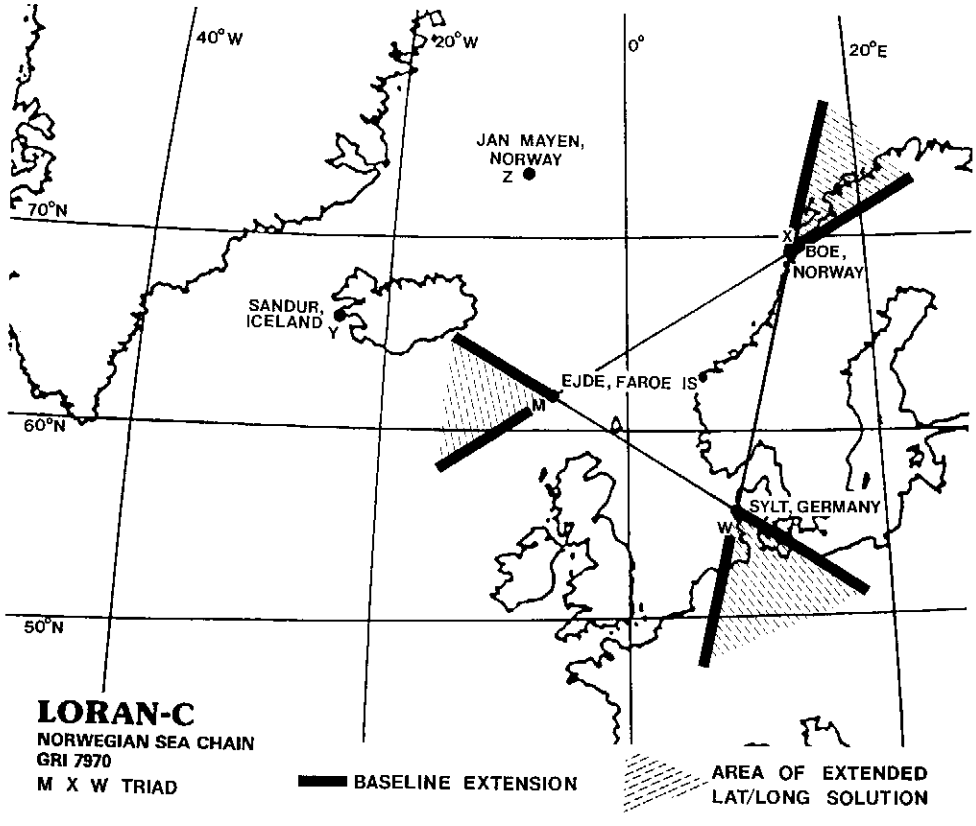

40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
SANDUR, ICELAND
Y
BOE, NORWAY
X
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M Y Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
SANDUR, ICELAND
Y
BOE, NORWAY
X
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
X
BOE, NORWAY
SANDUR, ICELAND
Y
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M W Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

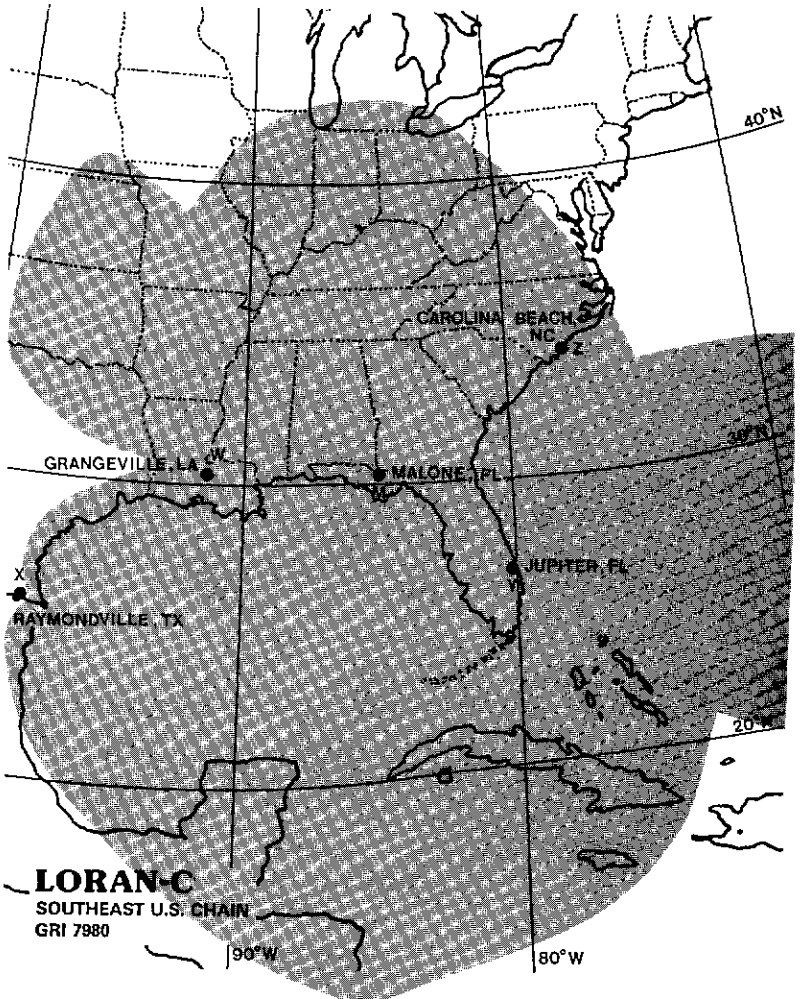

40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
X
BOE, NORWAY
SANDUR, ICELAND
Y
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M W Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
SANDUR, ICELAND
Y
BOE, NORWAY
X
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M X Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

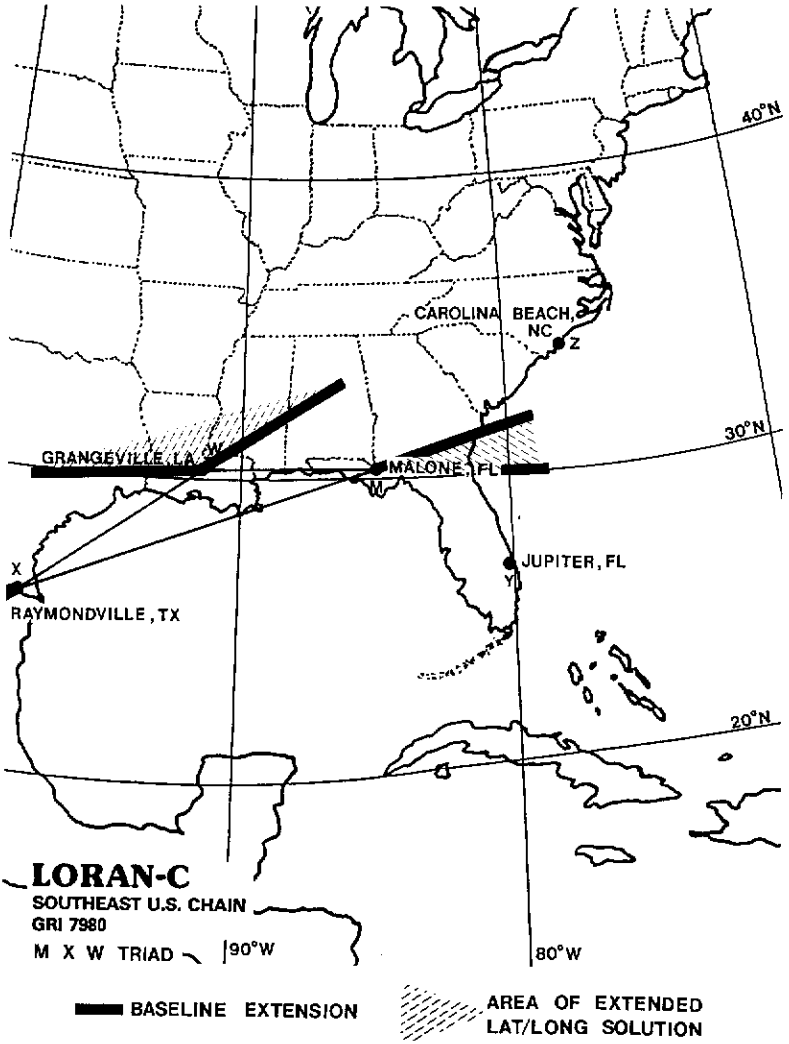

40°W
20°W
0°
20°E
70°N
60°N
50°N
JAN MAYEN, NORWAY
Z
SANDUR, ICELAND
Y
BOE, NORWAY
X
EJDE, FAROE IS
M
SYLT, GERMANY
W
LORAN-C
NORWEGIAN SEA CHAIN
GRI 7970
M X W TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

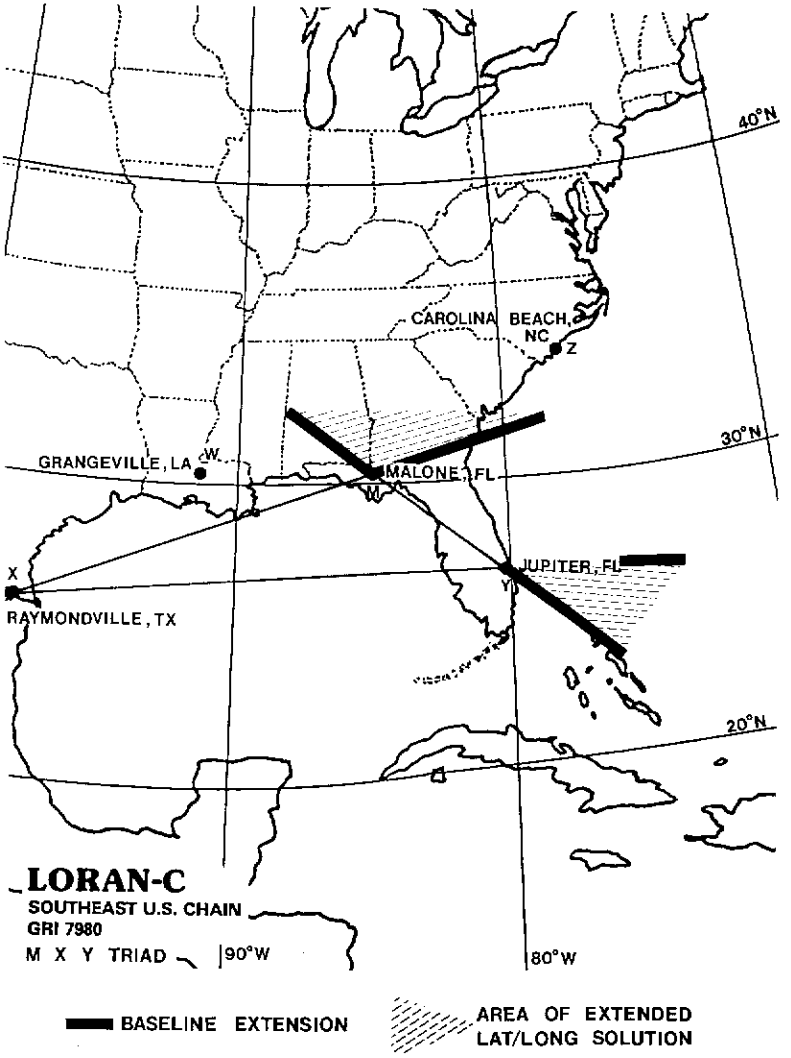
SOUTHEAST U.S. LORAN-C CHAIN - GRI 7980 (old rate SL2)

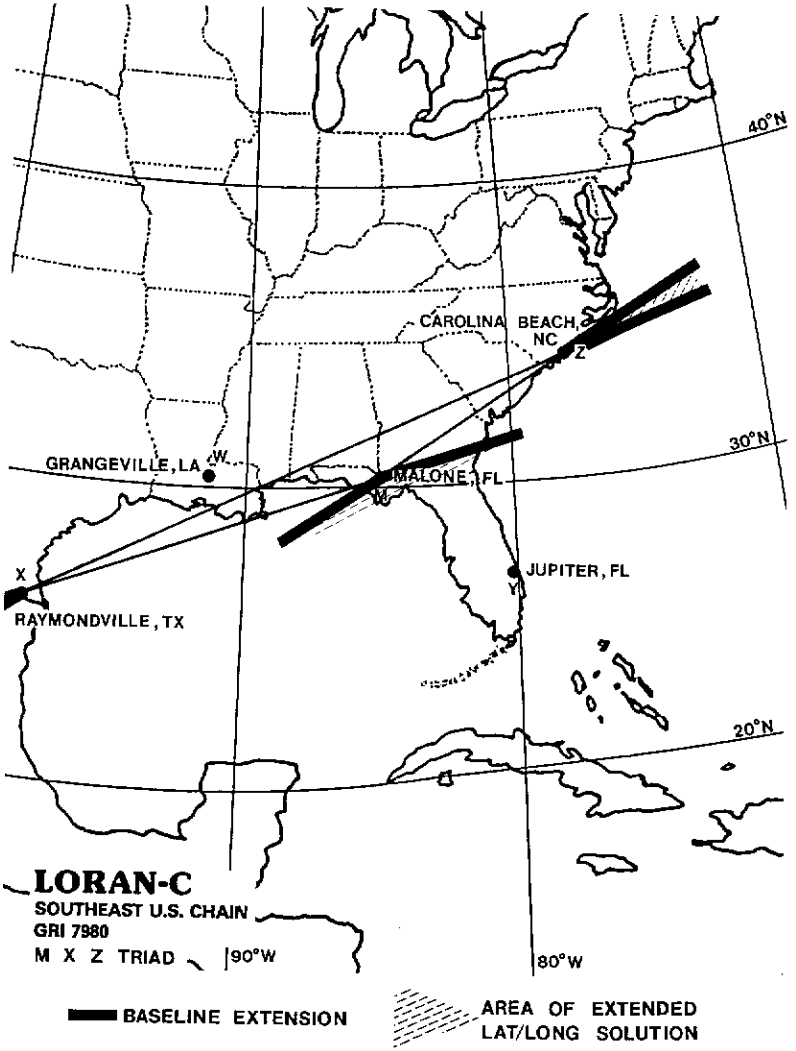
STATION	FUNCTION	COORDINATES	CODING DELAY-BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Malone, FL	Master	30 59 38.7 N 85 10 09.3 W		800	Control for W, X, Y, and Z. Dual-rated to Great Lakes Chain.
Grangeville, LA	Whiskey	30 43 33.0 N 90 49 43.6 W	11000/ 1809.54	800	
Raymondville, TX	Xray	26 31 55.0 N 97 50 00.1 W	23000/ 4443.38	400	
Jupiter, FL	Yankee	27 01 58.5 N 80 06 53.5 W	43000/ 2201.88	275	
Carolina Beach, NC	Zulu	34 03 46.0 N 77 54 46.8 W	59000/ 2542.72	550	
Mayport, FL	Monitor	30 22 58.9 N 81 25 13.1 W			Unmanned receiver site.
Eglin, FL	Monitor	30 35 05.3 N 86 36 54.4 W			Unmanned reciever site.
New Orleans, LA	Monitor	29 49 17.5 N 90 01 44.2 W			Unmanned receiver site.

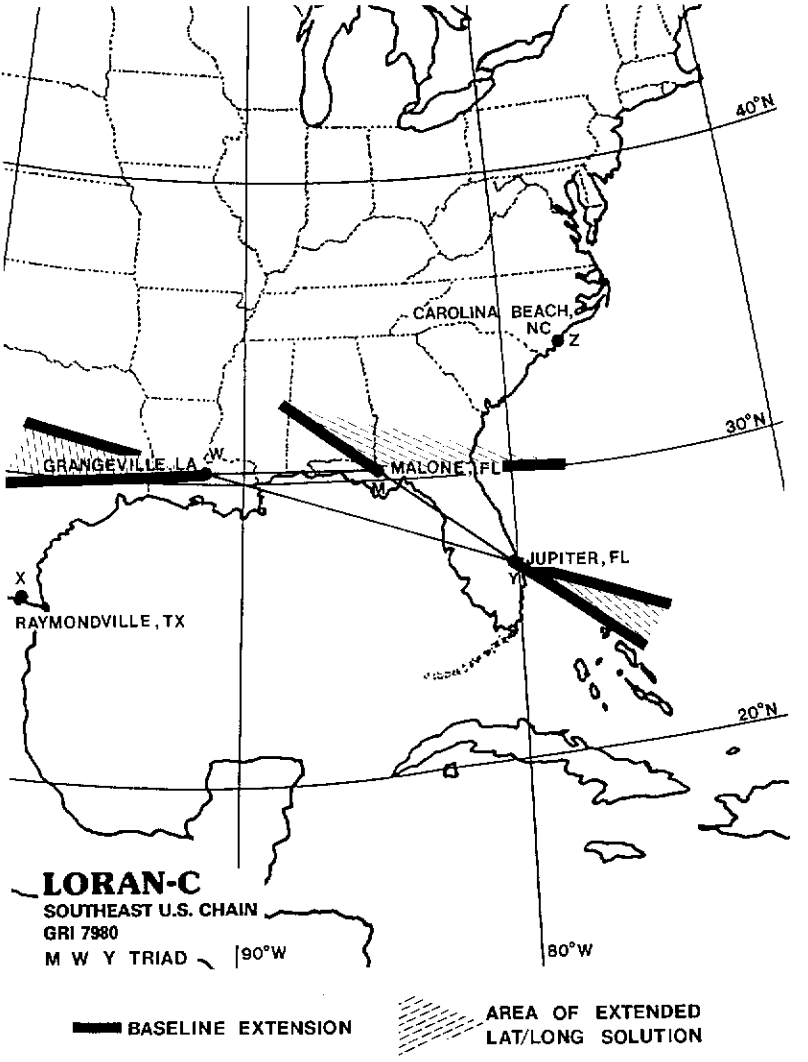


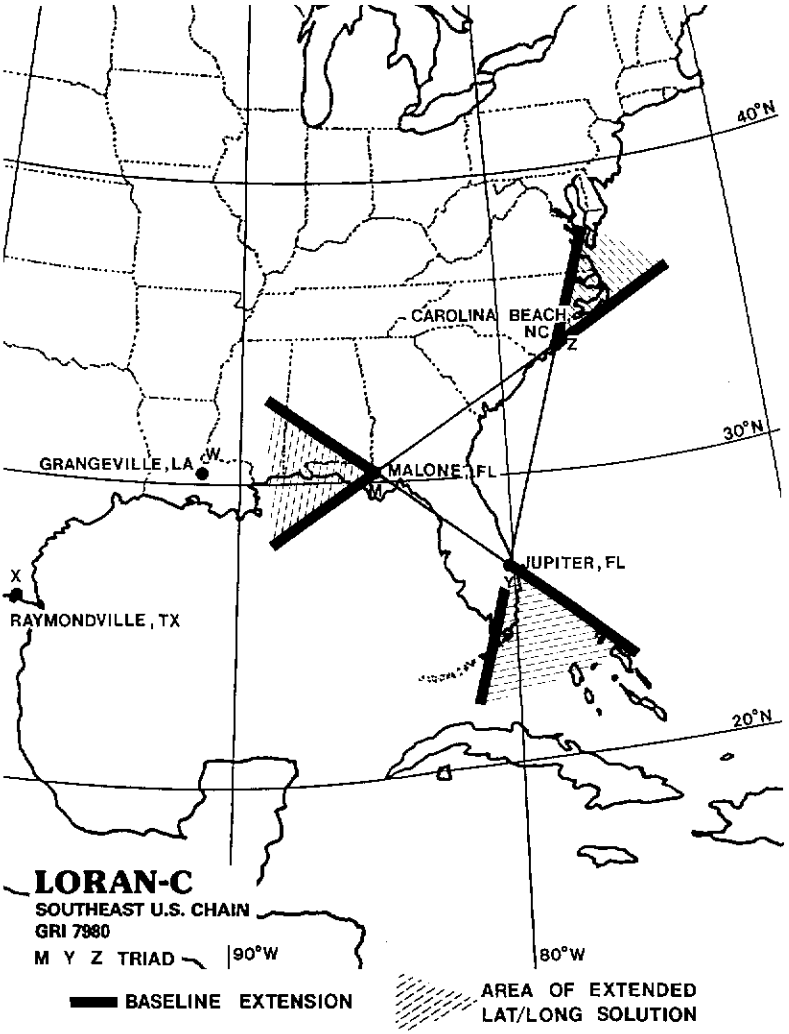
LORAN CHAIN COVERAGE MAP

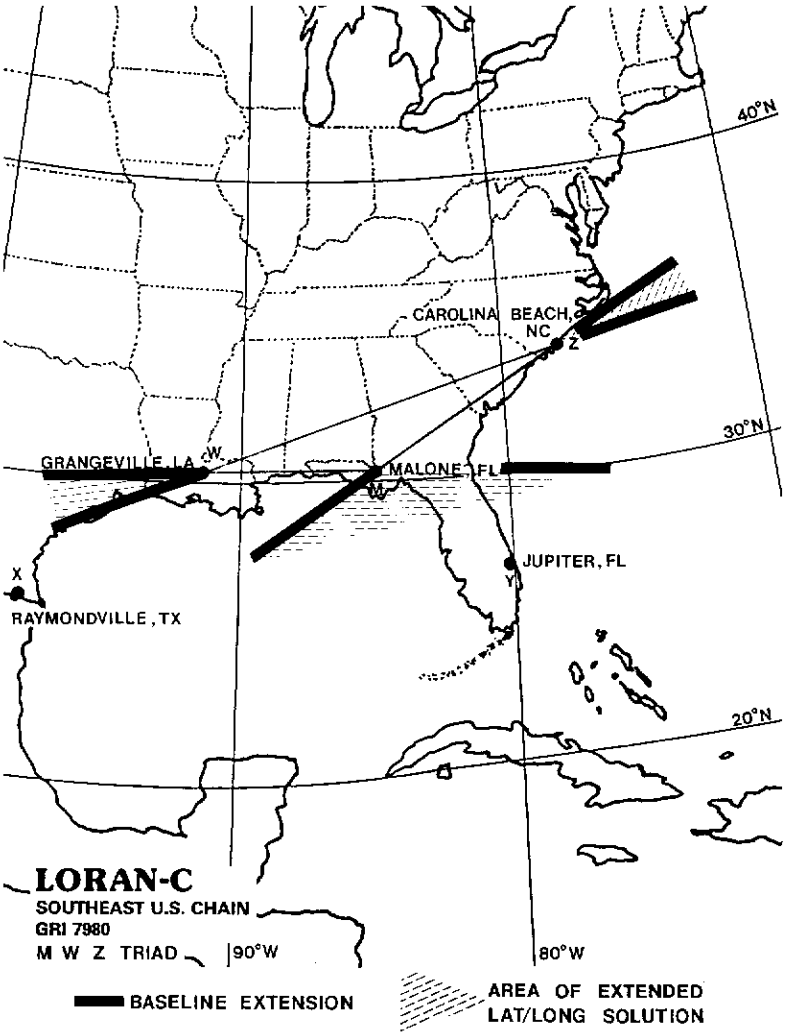

40°N
CAROLINA BEACH, NC
Z
30°N
GRANGEVILLE, LA
MALONE, FL
M
X
RAYMONDVILLE, TX
JUPITER, FL
Y
20°N
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M X W TRIAD
90°W
80°W
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

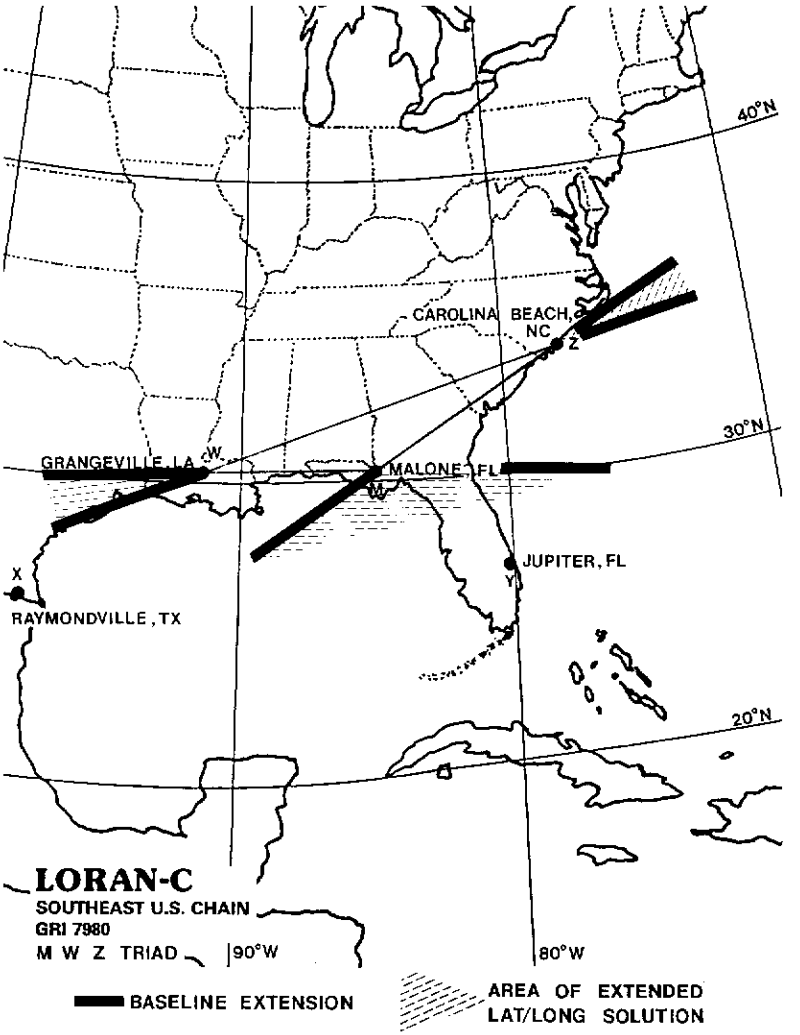

40°N
30°N
20°N
90°W
80°W
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°N
30°N
20°N
90°W
80°W
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M X Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°N
30°N
20°N
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M W Y TRIAD
90°W
80°W
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

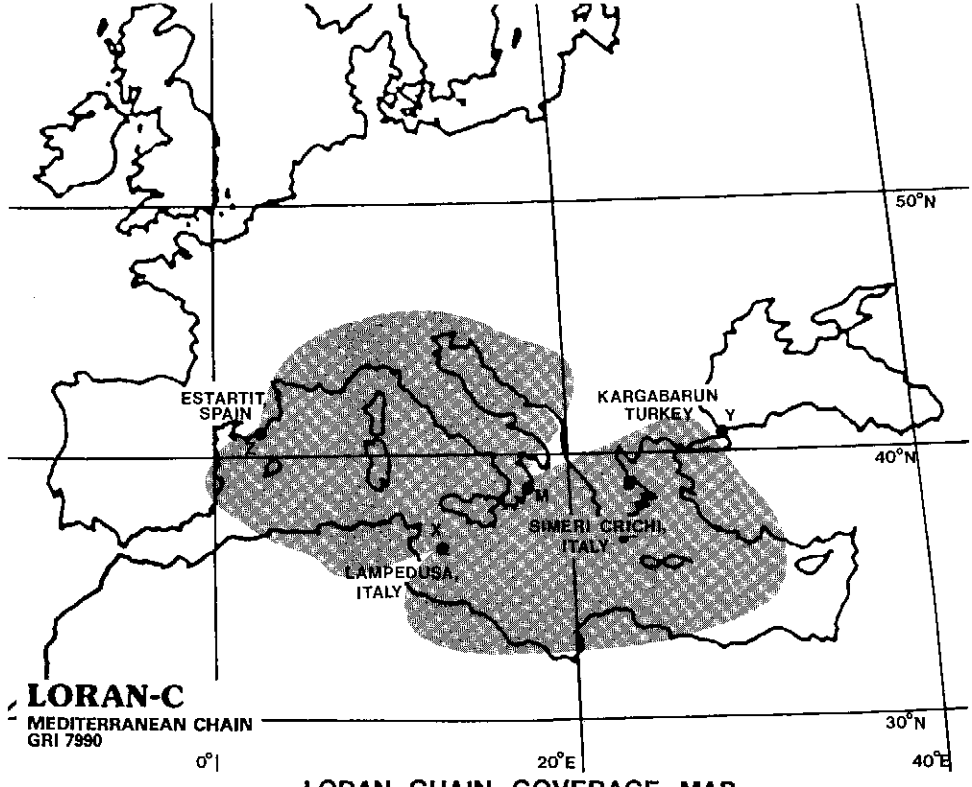

40°N
30°N
20°N
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M Y Z TRIAD
90°W
80°W
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


40°N
30°N
20°N
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M W Z TRIAD
90°W
80°W
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

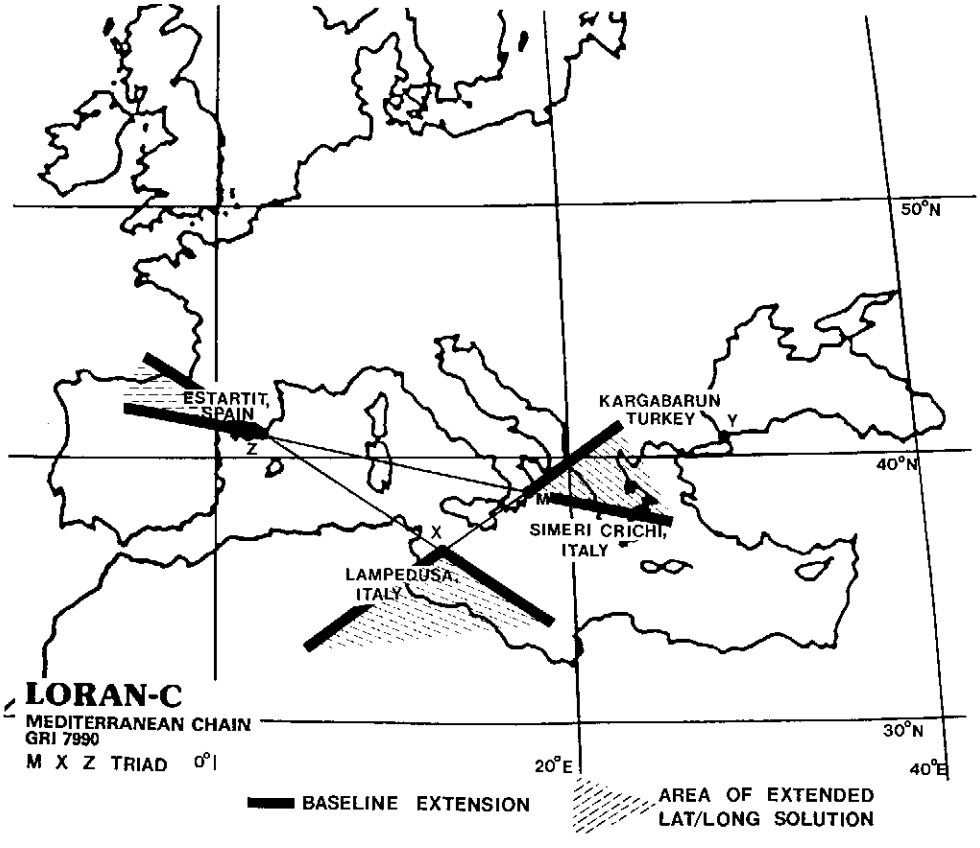

40°N
30°N
20°N
CAROLINA BEACH, NC
Z
GRANGEVILLE, LA
W
MALONE, FL
M
JUPITER, FL
Y
X
RAYMONDVILLE, TX
LORAN-C
SOUTHEAST U.S. CHAIN
GRI 7980
M W Z TRIAD
90°W
80°W
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

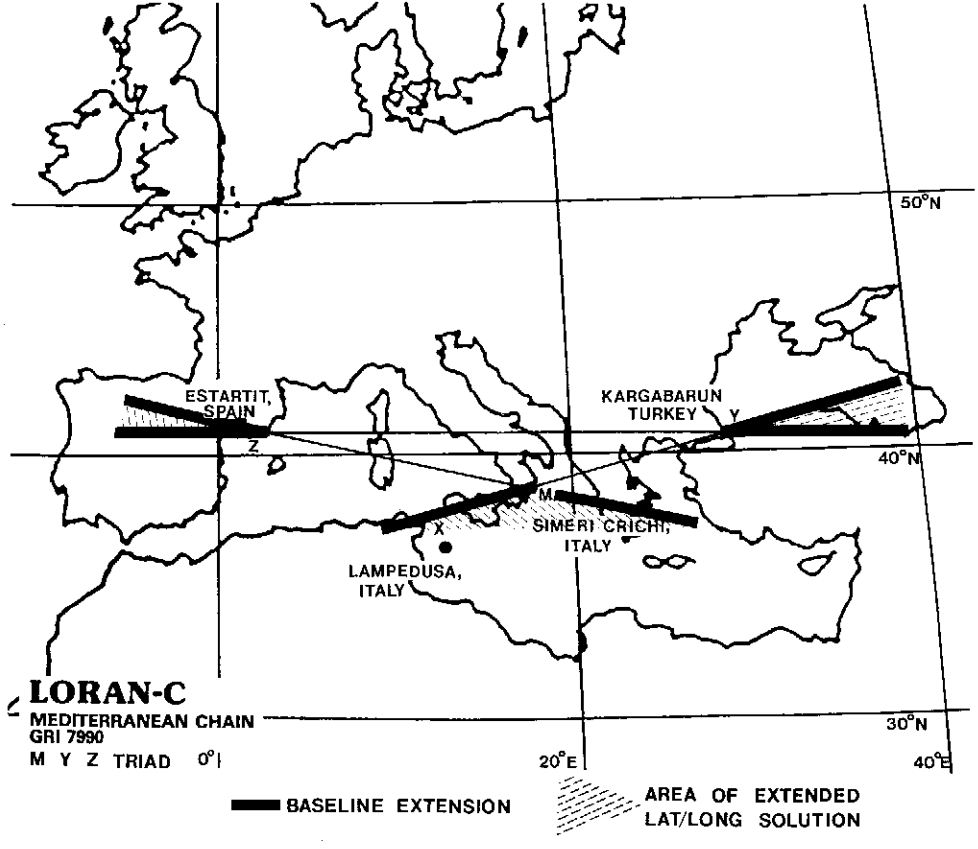
MEDITERREAN SEA LORAN-C CHAIN - GRI 7990 (old rate SL1)

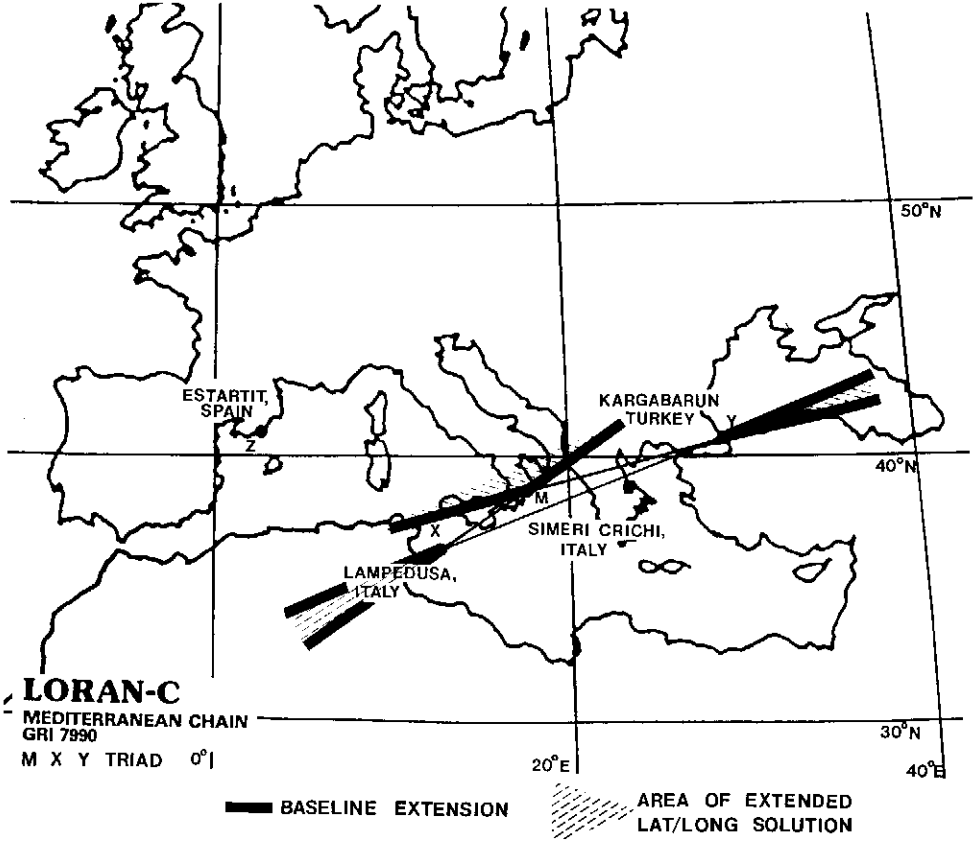
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Sellia Marina, Italy	Master	38 52 20.6 N 16 43 06.2 E		165	Exercises operational control of chain.
Lampedusa, Italy	Xray	35 31 20.8 N 12 31 30.2 E	11000/ 1755.98	325	Atis station.
Kargabarun, Turkey	Yankee	40 58 21.0 N 27 52 01.5 E	29000/ 3273.29	165	
Estartit, Spain	Zulu	42 03 36.5 N 03 12 15.9 E	47000/ 3999.71	165	



LORAN CHAIN COVERAGE MAP

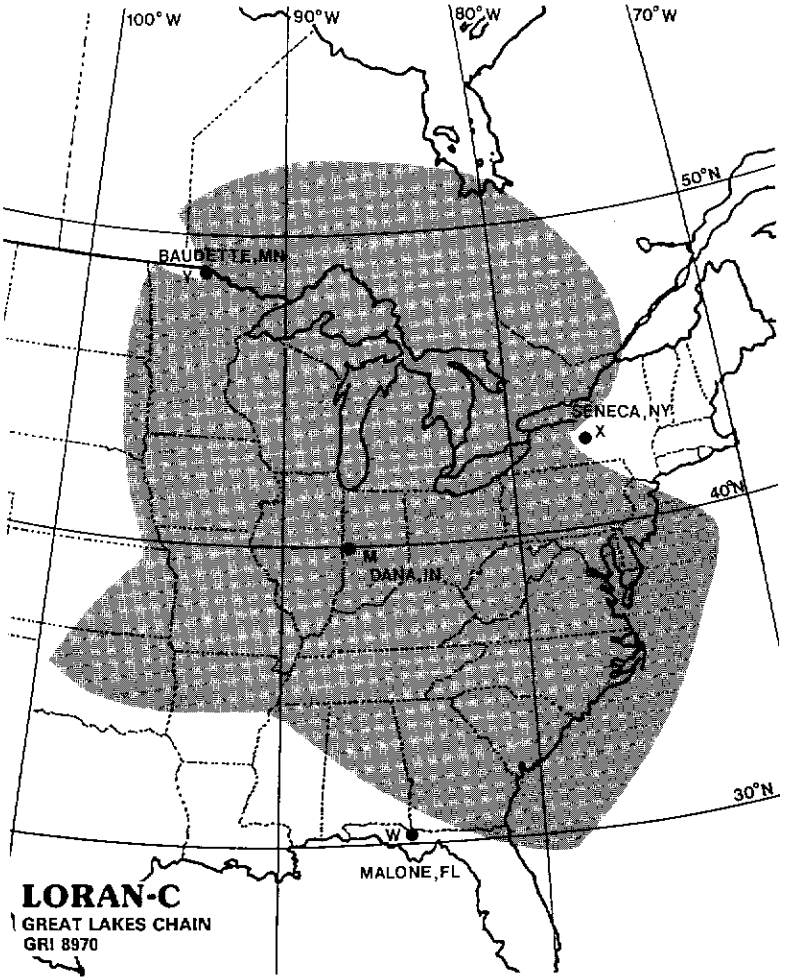

50°N
40°N
30°N
20°E
40°E
ESTARTIT, SPAIN
Z
KARGABARUN TURKEY
Y
M
X
SIMERI CRICHI, ITALY
LAMPEDUSA, ITALY
LORAN-C
MEDITERRANEAN CHAIN
GRI 7990
M X Z TRIAD
0°
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


50°N
40°N
30°N
20°E
40°E
ESTARTIT, SPAIN
KARGABARUN TURKEY
Y
Z
M
X
SIMERI CRICHI, ITALY
LAMPEDUSA, ITALY
LORAN-C
MEDITERRANEAN CHAIN
GRI 7990
M Y Z TRIAD
0°
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

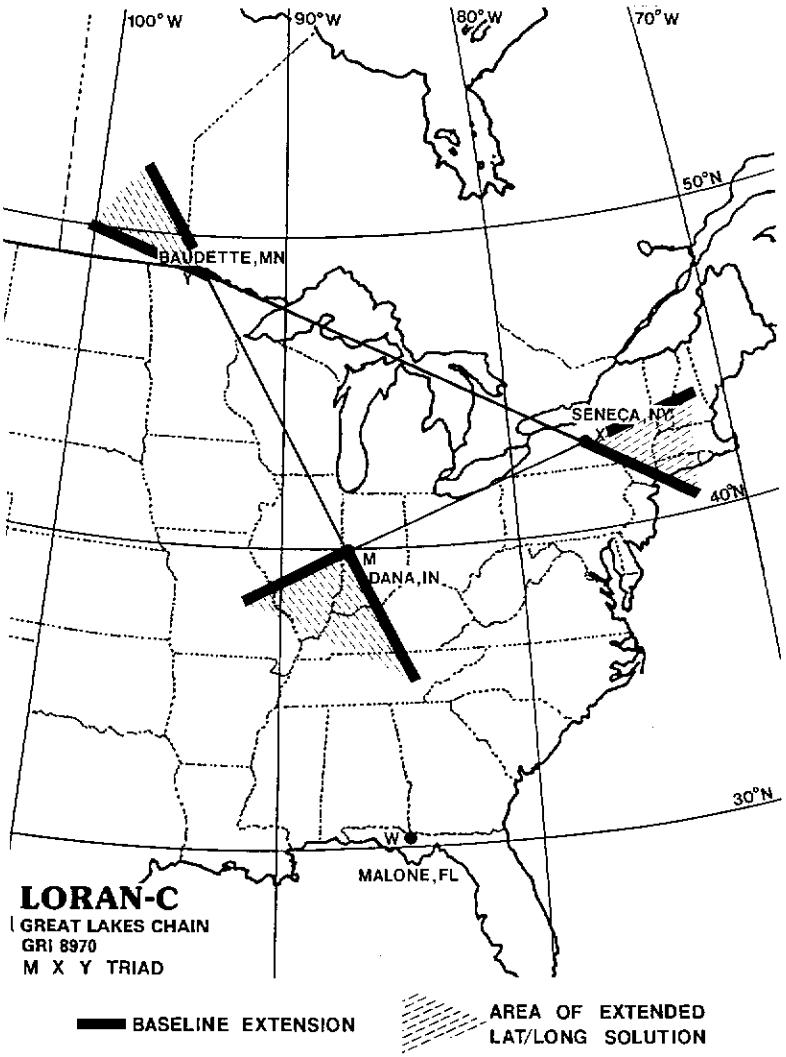

50°N
40°N
30°N
20°E
40°E
ESTARTIT, SPAIN
Z
KARGABARUN TURKEY
Y
M
X
SIMERI CRICHI, ITALY
LAMPEDUSA, ITALY
LORAN-C
MEDITERRANEAN CHAIN
GRI 7990
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

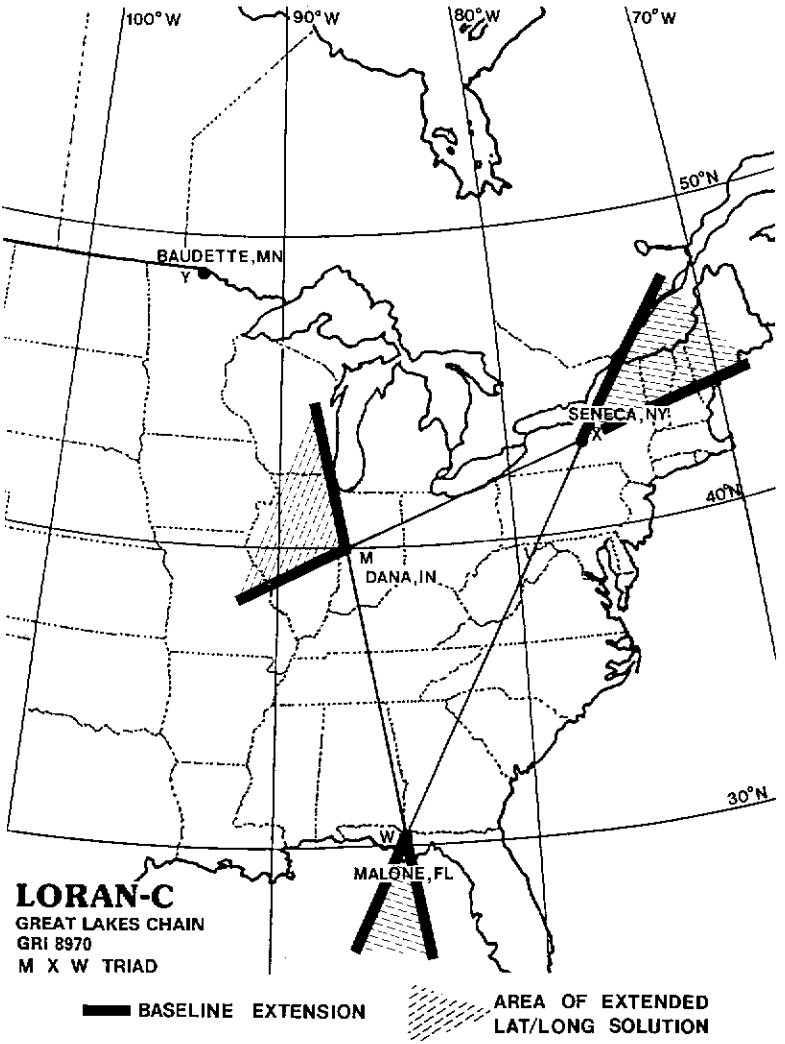
GREAT LAKES LORAN-C CHAIN - GRI 8970 (no old rate)

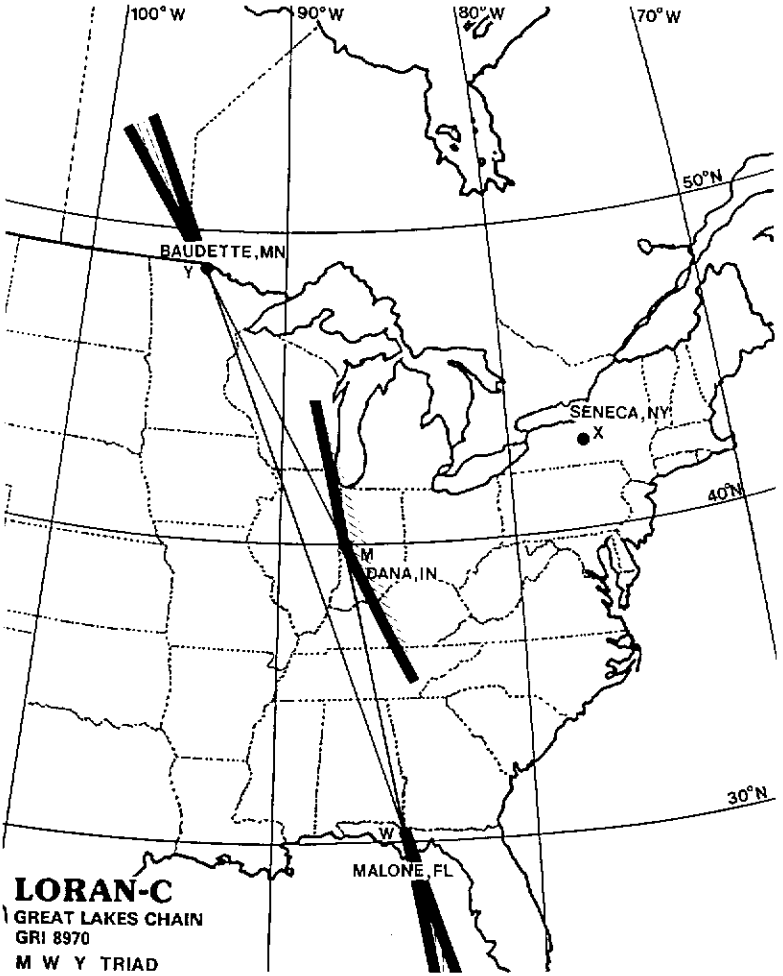
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Dana, IN	Master	39 51 07.5 N 87 29 12.1 W		400	Dual-rated to North-east U.S. Chain.
Malone, FL	Whiskey	30 59 38.7 N 85 10 09.3 W	11000/ 3355.11	800	Dual-rated to South east U.S. Chain.
Seneca, NY	Xray	42 42 50.6 N 76 49 33.9 W	28000/ 3162.06	800	Dual-rated to North-east U.S. Chain. Exercises operational control of chain.
Baudette, MN	Yankee	48 36 49.8 N 94 33 18.5 W	44000/ 3753.74	400	
Eecen Wildwood, NJ	Tango	38 56 58.2 N 74 52 01.6 W	72000/ 1617.92	Various	Experimental station, not to be used for navigation.
Claybanks, MI	Monitor	N W			
Plumbrook, OH	Monitor	44 22 47.0 N 82 39 38.5 W			Unmanned receiver site.
Eglin, FL	Monitor	30 35 05.3 N 86 36 54.4 W			Unmanned receiver site.
Mayport, FL	Monitor	30 22 58.9 N 81 25 13.1 W			Unmanned receiver site.



LORAN CHAIN COVERAGE MAP

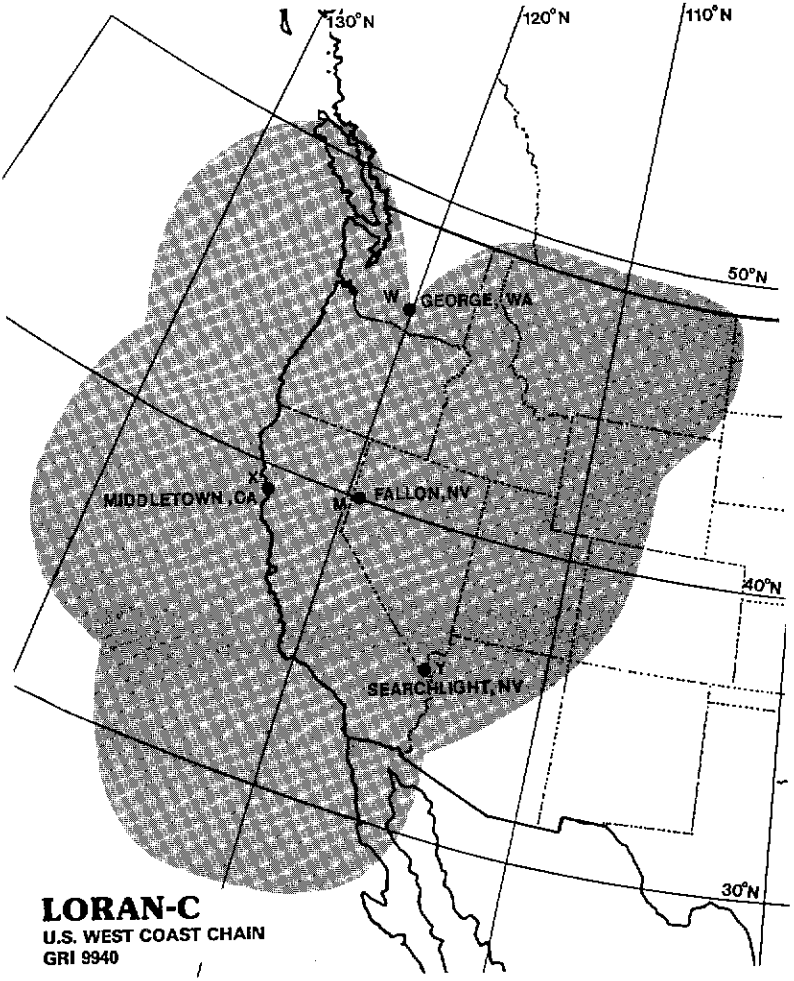

100°W
90°W
80°W
70°W
50°N
40°N
30°N
BAUDETTE, MN
SENECA, NY
M
DANA, IN
W
MALONE, FL
LORAN-C
GREAT LAKES CHAIN
GRI 8970
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


100° W
90° W
80° W
70° W
50° N
40° N
30° N
BAUDETTE, MN
Y
SENECA, NY
X
M
DANA, IN
W
MALONE, FL
LORAN-C
GREAT LAKES CHAIN
GRI 8970
M X W TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

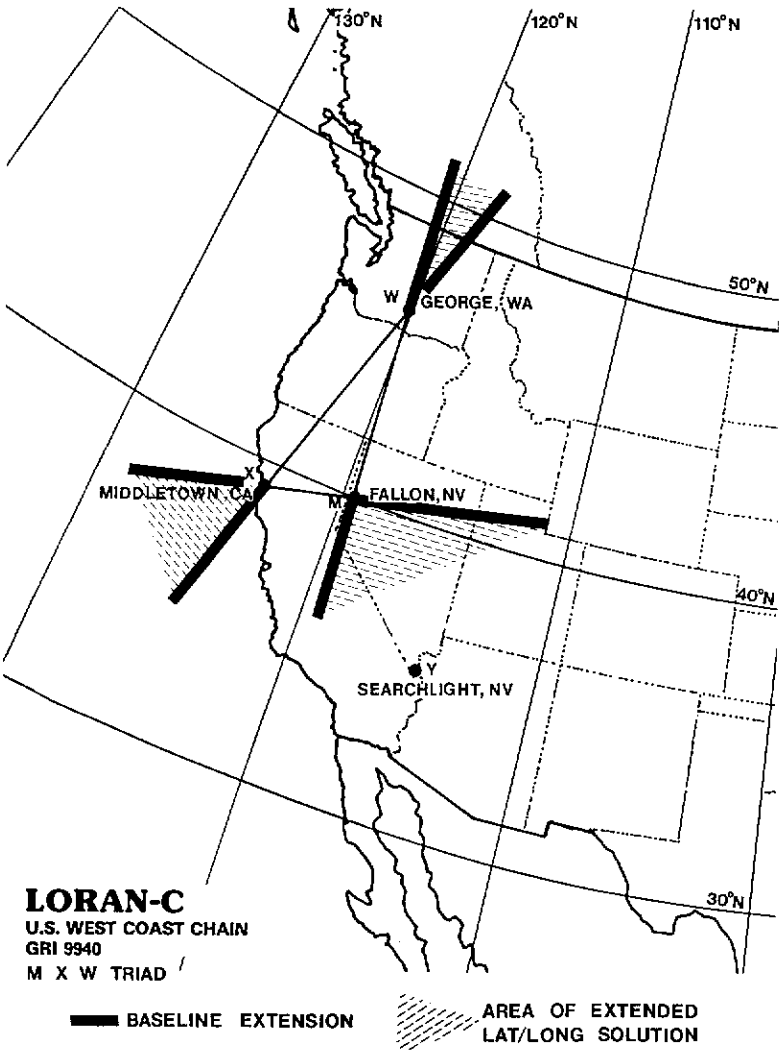

100° W
90° W
80° W
70° W
50° N
40° N
30° N
BAUDETTE, MN
Y
SENECA, NY
X
M
DANA, IN
W
MALONE, FL
LORAN-C
GREAT LAKES CHAIN
GRI 8970
M W Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

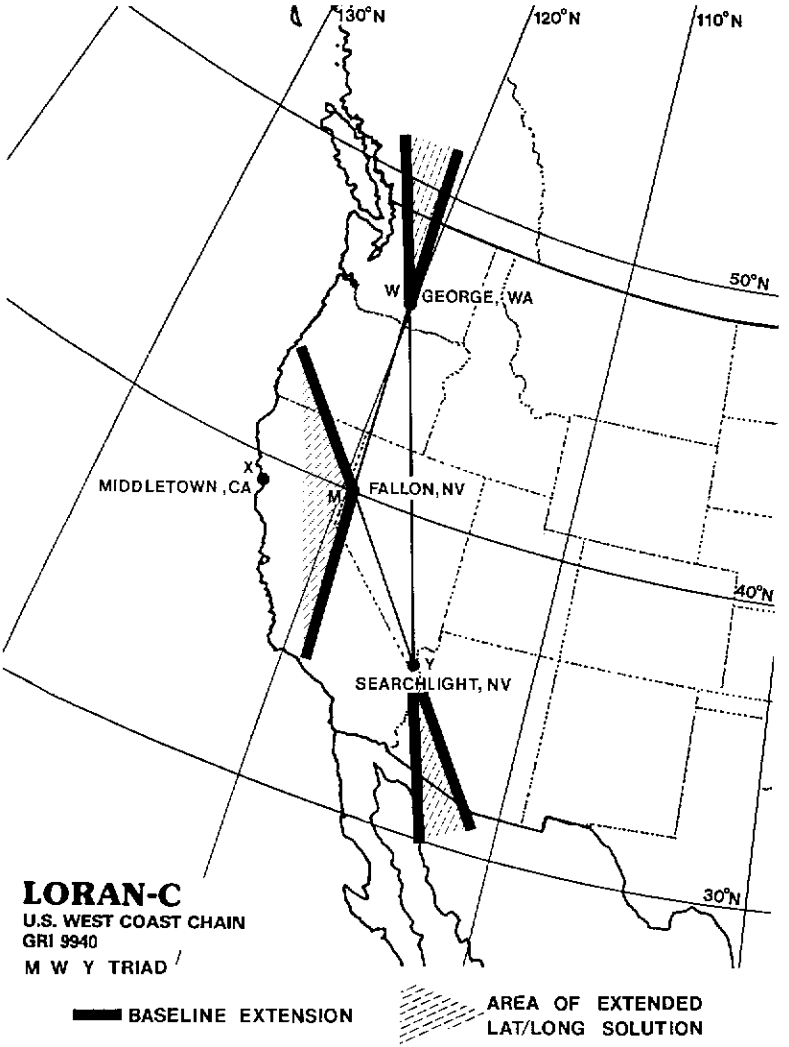
U.S. WEST COAST LORAN-C CHAIN - GRI 9940 (old rate SS6)

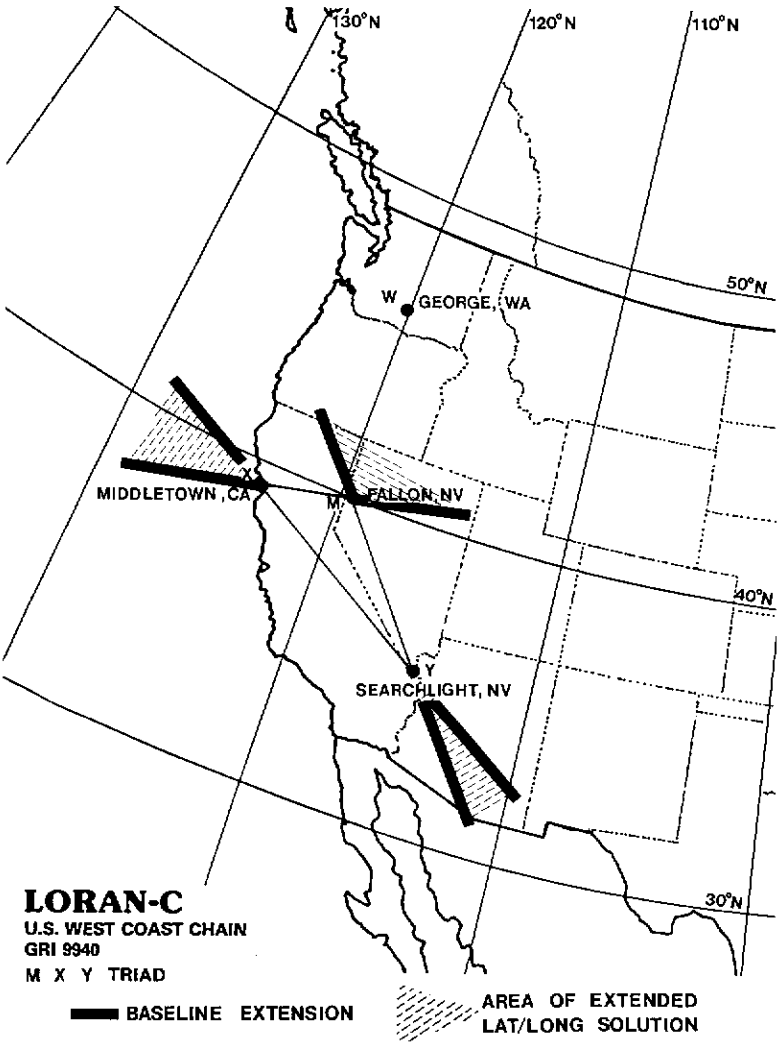
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Fallon, NV	Master	39 33 06.6 N 118 49 56.4 W		400	Two pulse comms installed.
George, WA	Whiskey	47 03 48.0 N 119 44 39.5 W	11000/ 2796.90	1600	Two pulse comms installed. Dual-rated to West Coast Canada Chain.
Middletown, CA	Xray	38 46 57.0 N 122 29 44.5 W	27000/ 1094.50	400	Exercises operational control of chain. Control for W, X, and Y. Two pulse comms installed.
Searchlight, NV	Yankee	35 19 18.2 N 114 48 17.4 W	40000/ 1967.30	540	
North Bend, OR	Monsite	43 24 36.2 N 124 14 27.9 W			Unmanned receiver site.
Pt. Pinos, CA	Monsite	36 37 59.0 N 121 56 05.6 W			Unmanned receiver site.



LORAN CHAIN COVERAGE MAP

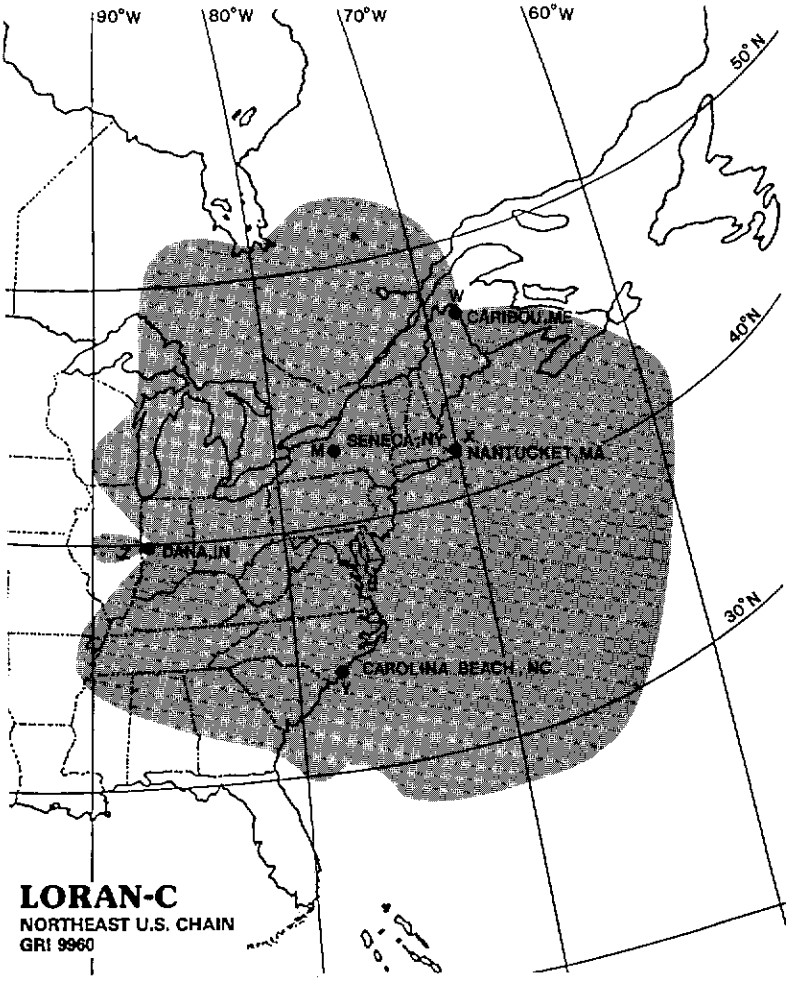

130°N
120°N
110°N
50°N
40°N
30°N
W
GEORGE, WA
X
MIDDLETOWN, CA
M
FALLON, NV
Y
SEARCHLIGHT, NV
LORAN-C
U.S. WEST COAST CHAIN
GRI 9940
M X W TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


130°N
120°N
110°N
50°N
W
GEORGE, WA
X
MIDDLETOWN, CA
M
FALLON, NV
40°N
Y
SEARCHLIGHT, NV
30°N
LORAN-C
U.S. WEST COAST CHAIN
GRI 9940
M W Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

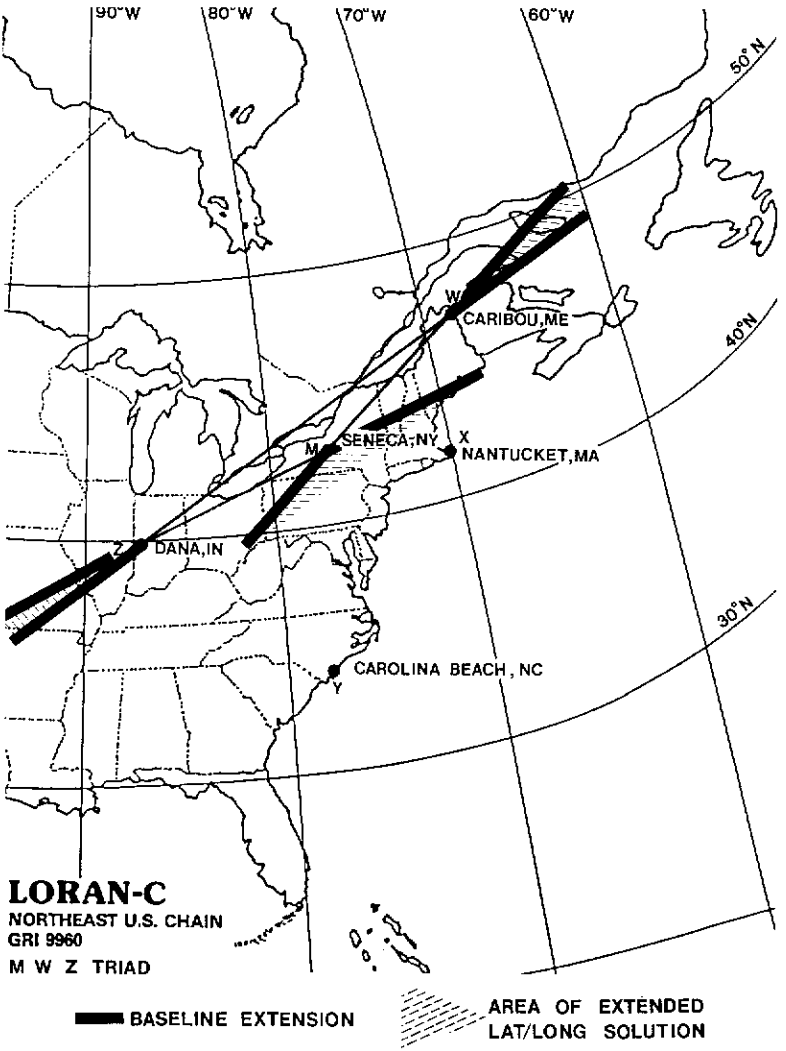

130°N
120°N
110°N
50°N
W
GEORGE, WA
MIDDLETOWN, CA
X
M
FALLON, NV
40°N
Y
SEARCHLIGHT, NV
30°N
LORAN-C
U.S. WEST COAST CHAIN
GRI 9940
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

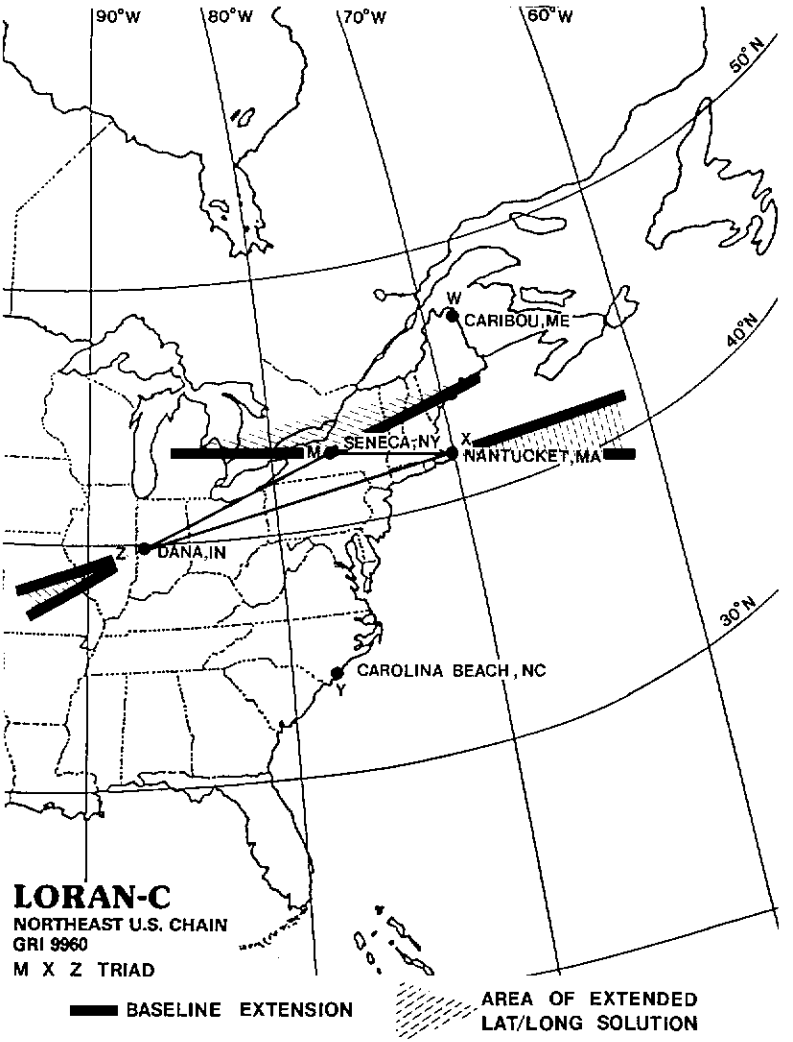
NORTHEAST U.S. LORAN-C CHAIN - GRI 9960 (old rate SS4)

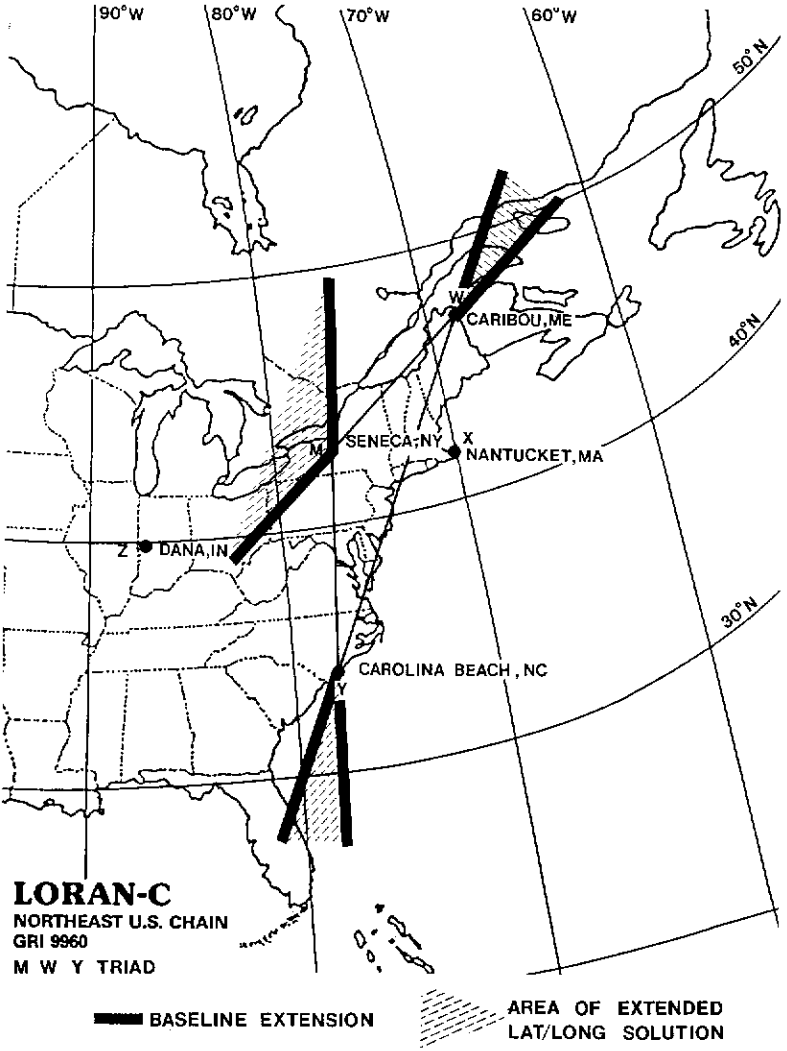
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Seneca, NY	Master	42 42 50.6 N 76 49 33.9 W		800	Control for W, X, Y, and Z. Exercises operational control of Chain.
Caribou, ME	Whiskey	46 48 27.2 N 67 55 37.7 W	11000/ 2797.20	350	
Nantucket, MA	Xray	41 15 11.9 N 69 58 39.1 W	25000/ 1969.93	275	
Carolina Beach, NC	Yankee	34 03 46.0 N 77 54 46.8 W	39000/ 3221.65	550	
Dana, IN	Zulu	39 51 07.5 N 87 29 12.1 W	54000/ 3162.06	400	
Eecen Wildwood, NJ	Tango	38 56 58.2 N 74 52 01.6 W	81500.49	Various	Experimental station, not to be used for navigation.
Cape Elizabeth, ME	Monitor	43 33 54.8 N 70 11 58.5 W			Unmanned receiver site.
Sandy Hook, NJ	Monitor	40 28 17.0 N 74 01 03.7 W			Unmanned receiver site.
Plumbrook, OH	Monitor	41 22 47.0 N 82 39 38.5 W			Unmanned reciever site.
Claybanks, MI	Monitor	43 31 48.0 N 86 29 01.0 W			Unmanned receiver site.

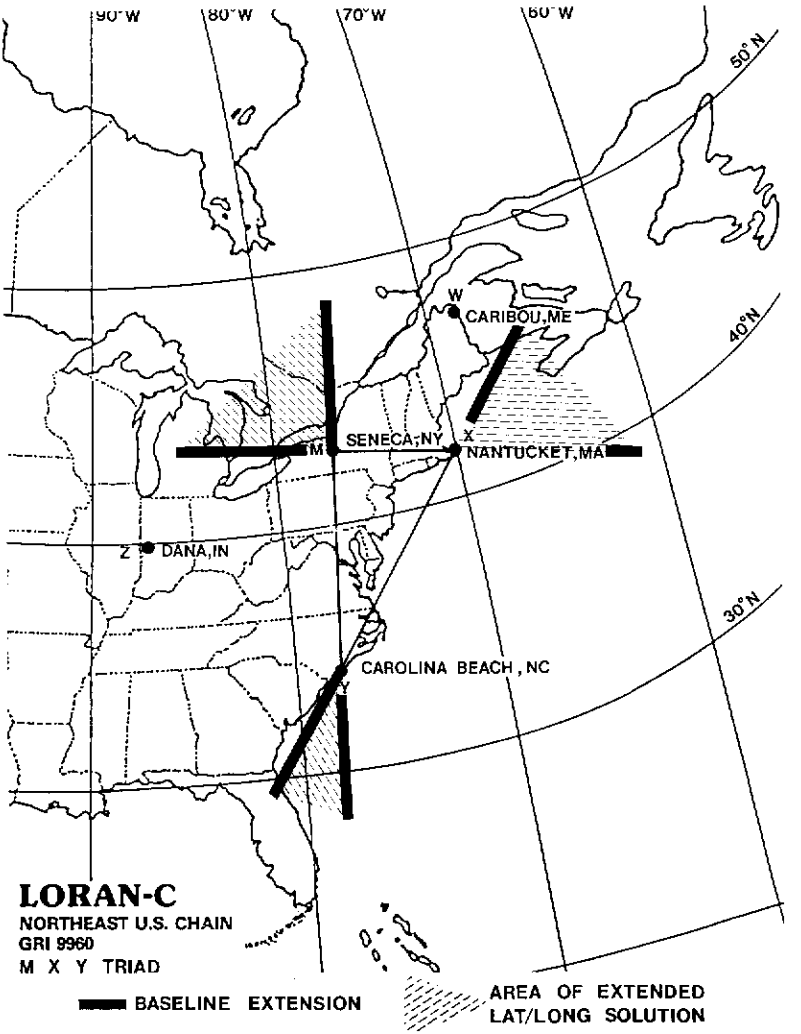


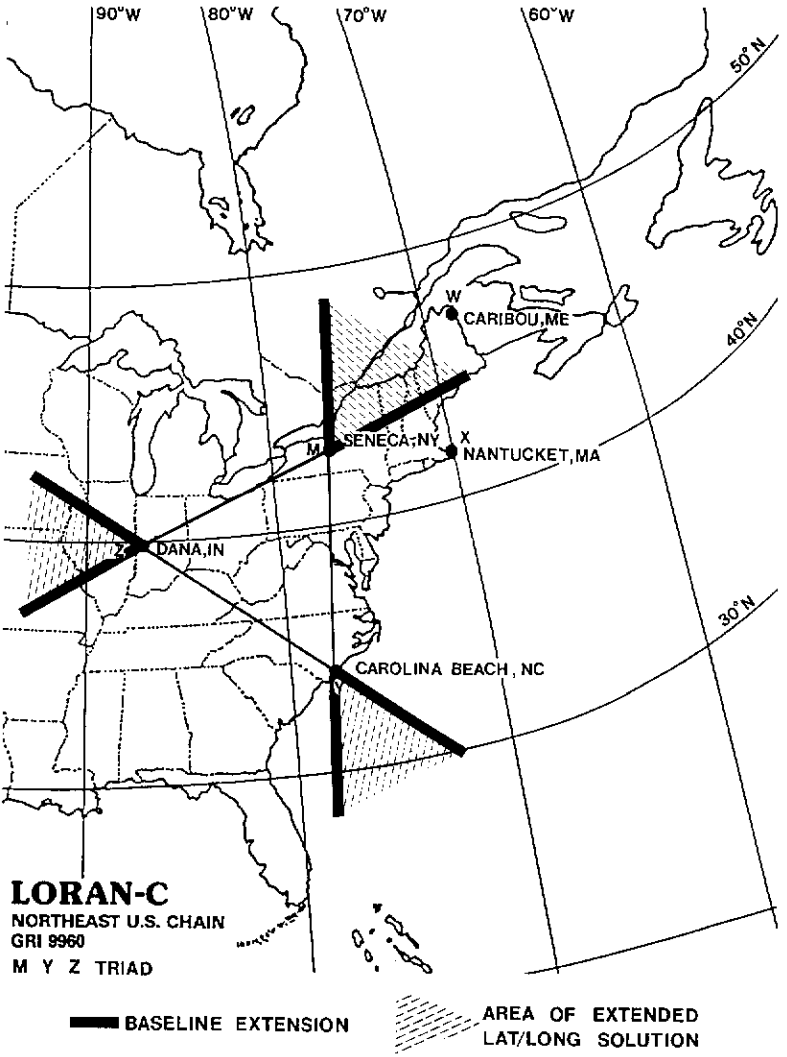
LORAN CHAIN COVERAGE MAP

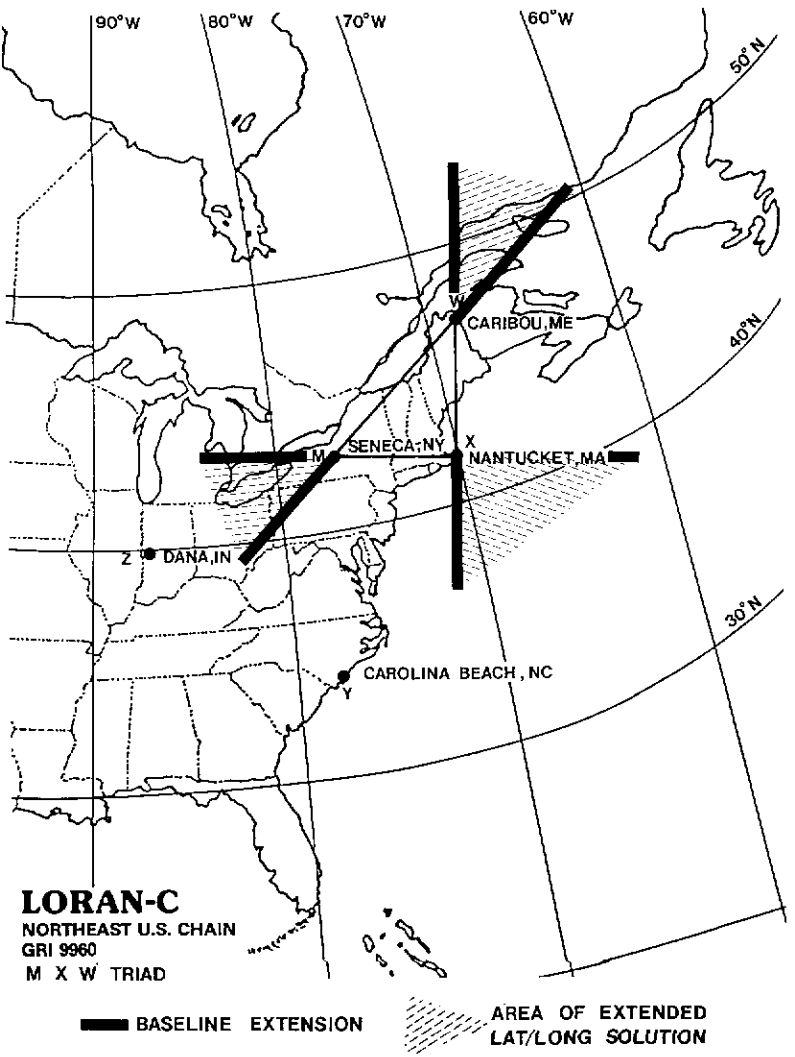

90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU,ME
M
SENECA,NY
X
NANTUCKET,MA
Z
DANA,IN
Y
CAROLINA BEACH, NC
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M W Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU,ME
M
SENECA,NY
X
NANTUCKET,MA
Z
DANA,IN
Y
CAROLINA BEACH, NC
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M X Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU, ME
M
SENECA, NY
X
NANTUCKET, MA
Z
DANA, IN
CAROLINA BEACH, NC
Y
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M W Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

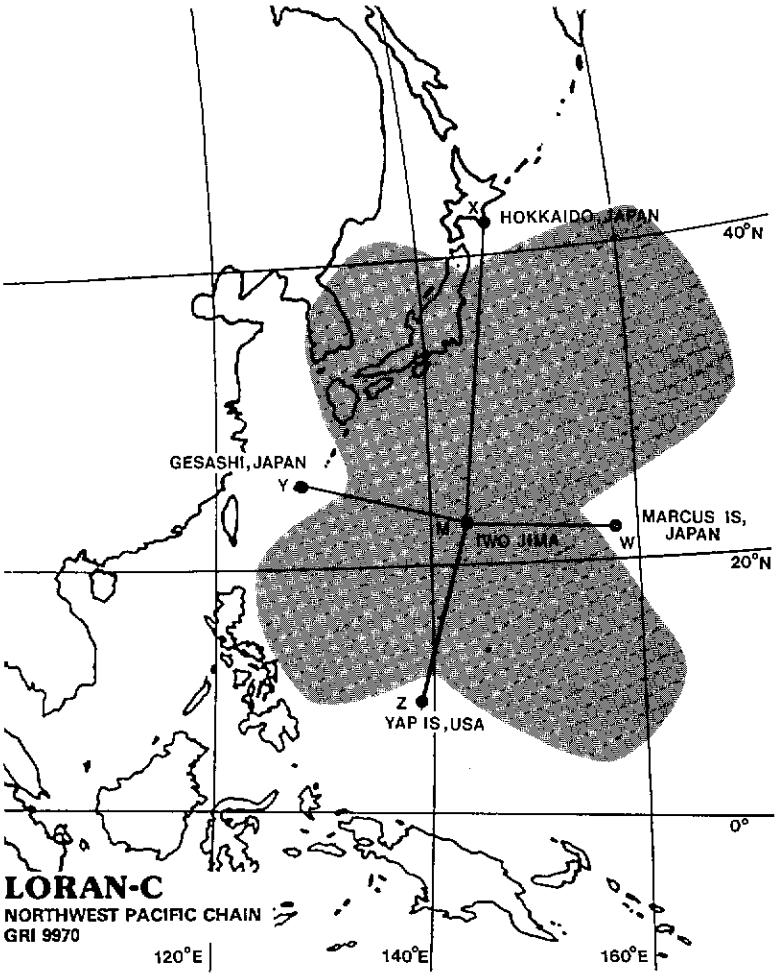

90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU,ME
M
SENECA,NY
X
NANTUCKET,MA
Z
DANA,IN
CAROLINA BEACH, NC
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU,ME
M
SENECA,NY
X
NANTUCKET,MA
Z
DANA,IN
CAROLINA BEACH, NC
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M Y Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

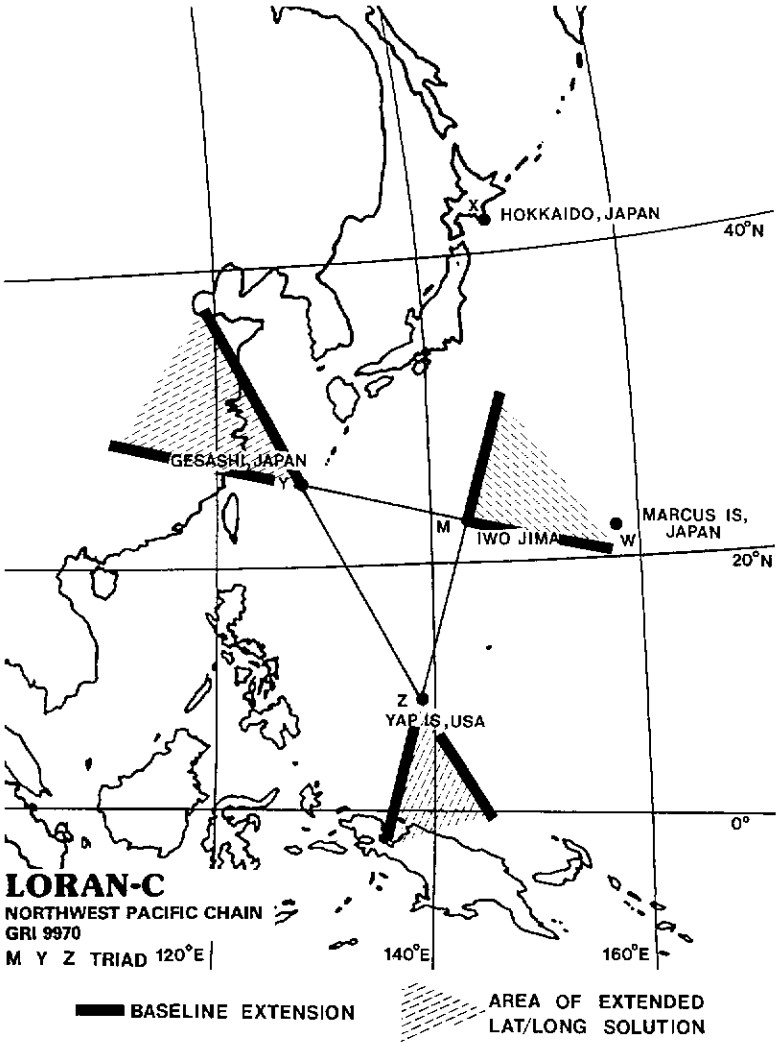

90°W
80°W
70°W
60°W
50°N
40°N
30°N
W
CARIBOU, ME
M
SENECA, NY
X
NANTUCKET, MA
Z
DANA, IN
Y
CAROLINA BEACH, NC
LORAN-C
NORTHEAST U.S. CHAIN
GRI 9960
M X W TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

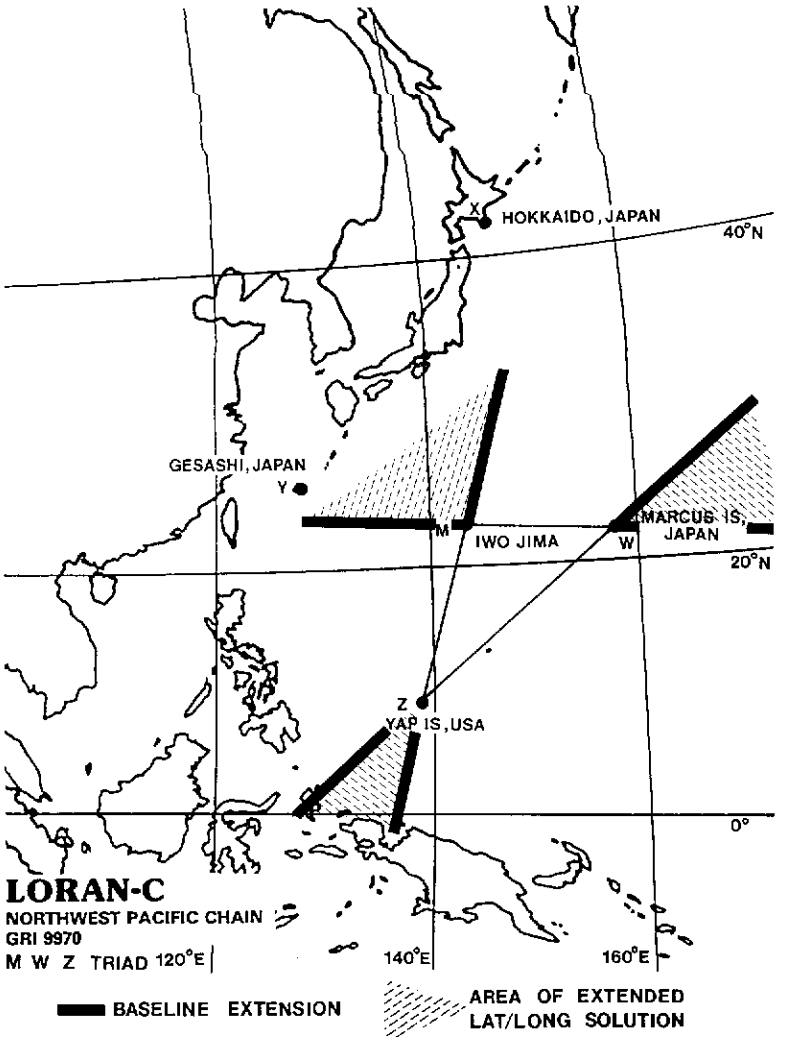
NORTHWEST PACIFIC LORAN-C CHAIN - GRI 9970 (old rate 553)

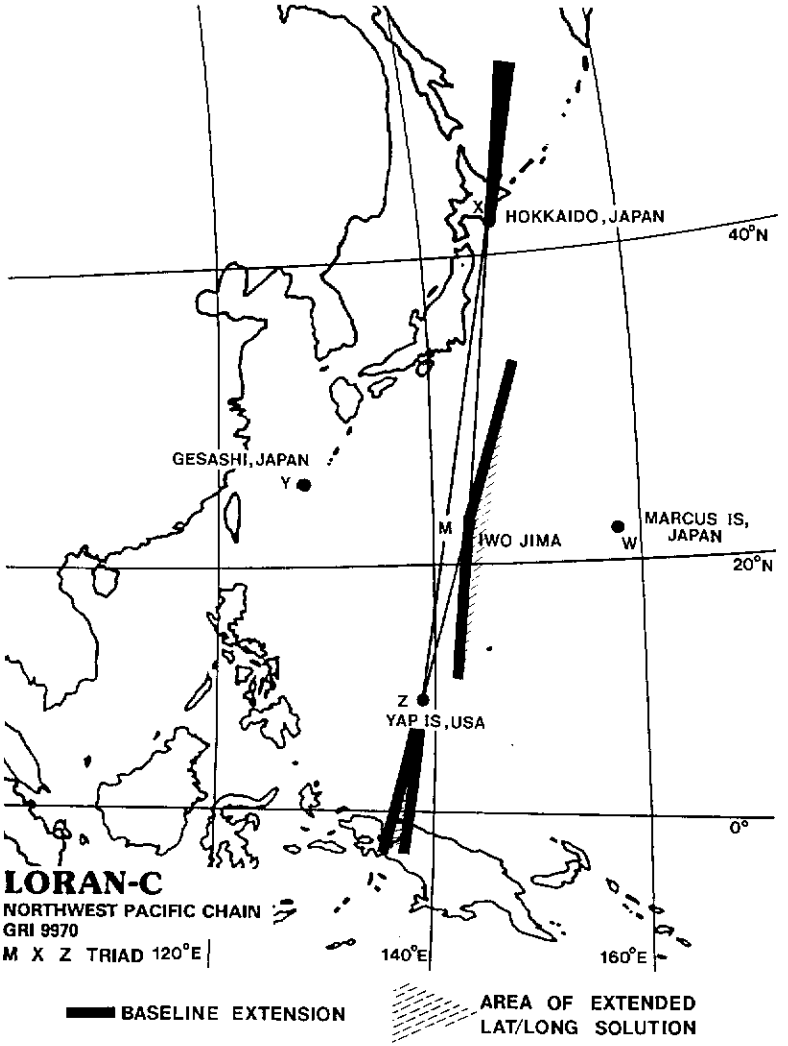
STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Iwo Jima, Japan	Master	24 48 03.6 N 141 19 30.3 E		1800	Clarinet pilgrim TTY2 installed.
Marcus Island, Japan	Whiskey	24 17 07.9 N 153 58 53.2 E	11000/ 4283.94	1800	Clarinet pilgrim TTY2 installed.
Hokkaido, Japan	Xray	42 44 37.1 N 143 43 09.2 E	30000/ 6685.12	1000	Clarinet pilgrim TTY2 installed.
Gesashi, Japan	Yankee	26 36 25.0 N 128 08 56.4 E	55000/ 4463.18	1000	Clarinet pilgrim TTY2 installed. Time service monitor.
Yap Island, U.S.A. Trust	Zulu	09 32 45.8 N 138 09 55.0 E	75000/ 5746.79	1000	Clarinet pilgrim and TTY2 installed.
Saipan, U.S.A. Trust	Monitor/ Control	15 07 46.8 N 145 41 38.6 E			Controls W and Z.
Yokota, Japan	Monitor/ Control	35 44 34.6 N 139 21 41.3 E			Controls X and Y.
Chansan, Korea	Monitor	35 11 26.0 N 128 08 48.0 E			

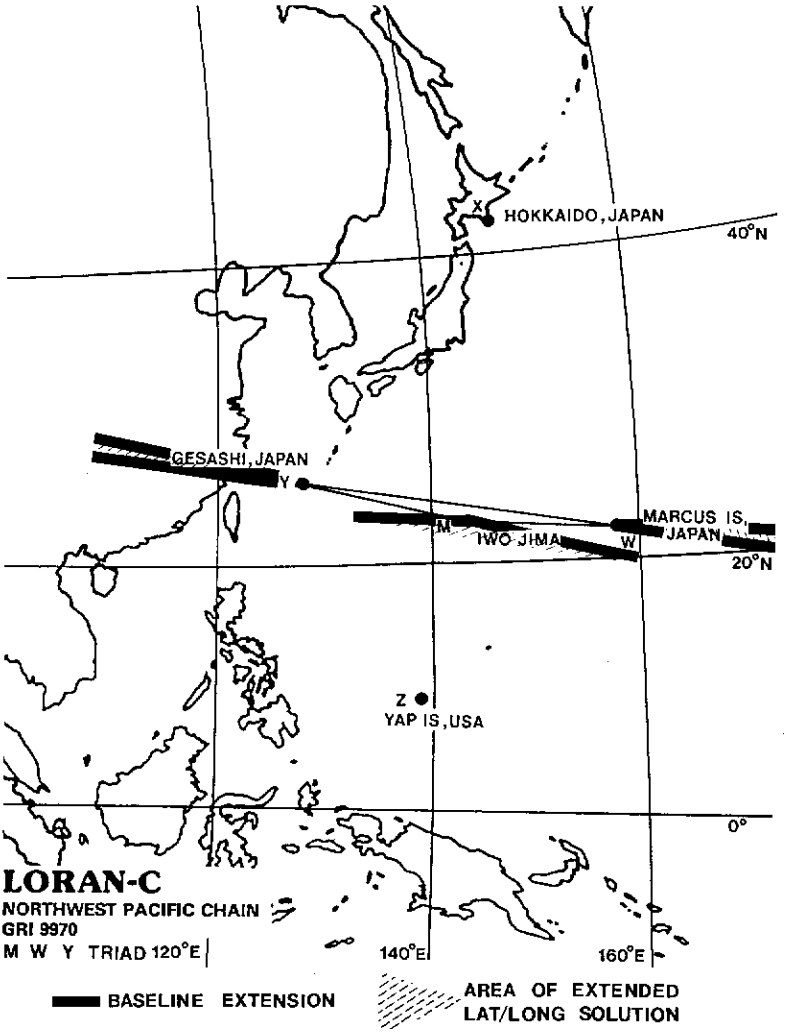


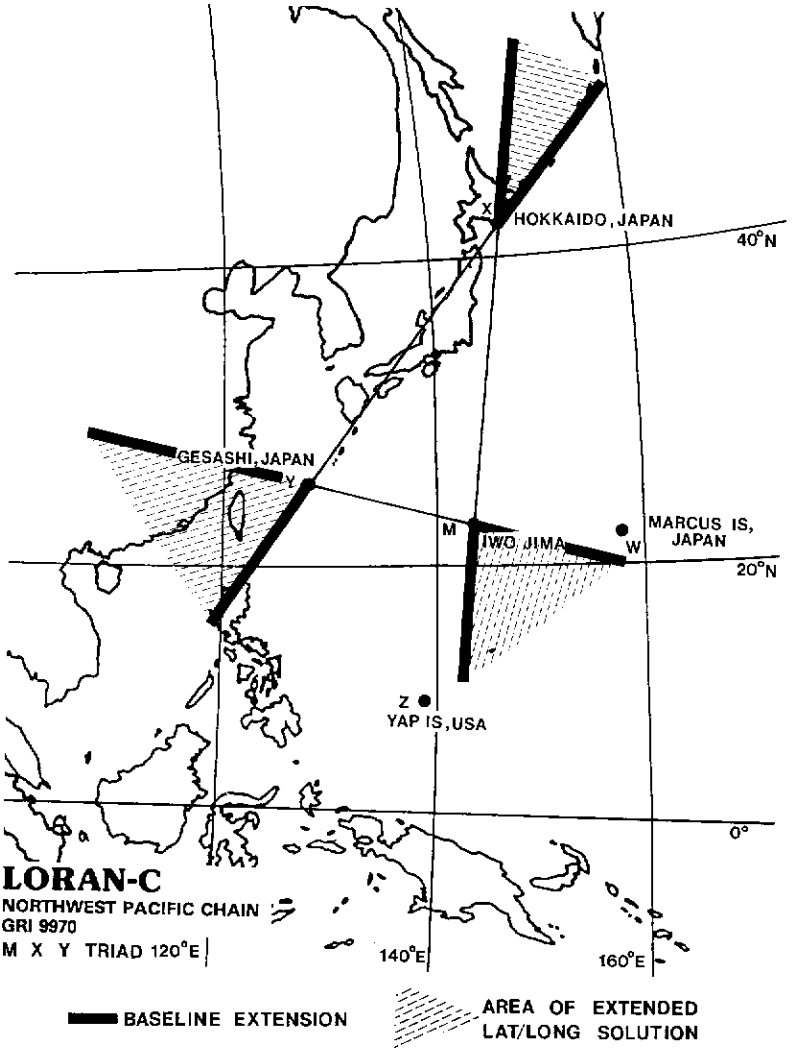
LORAN CHAIN COVERAGE MAP

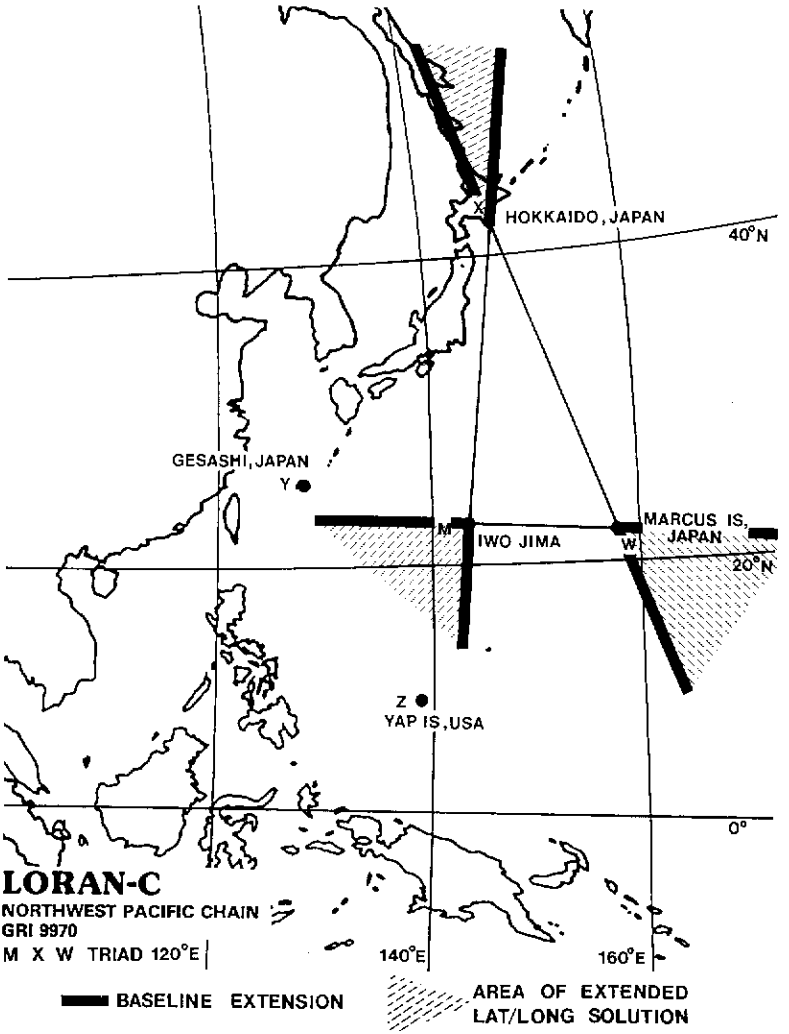

HOKKAIDO, JAPAN
X
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
W
MARCUS IS, JAPAN
20°N
Z
YAP IS, USA
0°
120°E
140°E
160°E
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M Y Z TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


HOKKAIDO, JAPAN
X
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
W
MARCUS IS, JAPAN
20°N
Z
YAP IS, USA
0°
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M W Z TRIAD
120°E
140°E
160°E
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION


HOKKAIDO, JAPAN
X
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
MARCUS IS, JAPAN
W
20°N
Z
YAP IS, USA
0°
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M X Z TRIAD
120°E
140°E
160°E
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

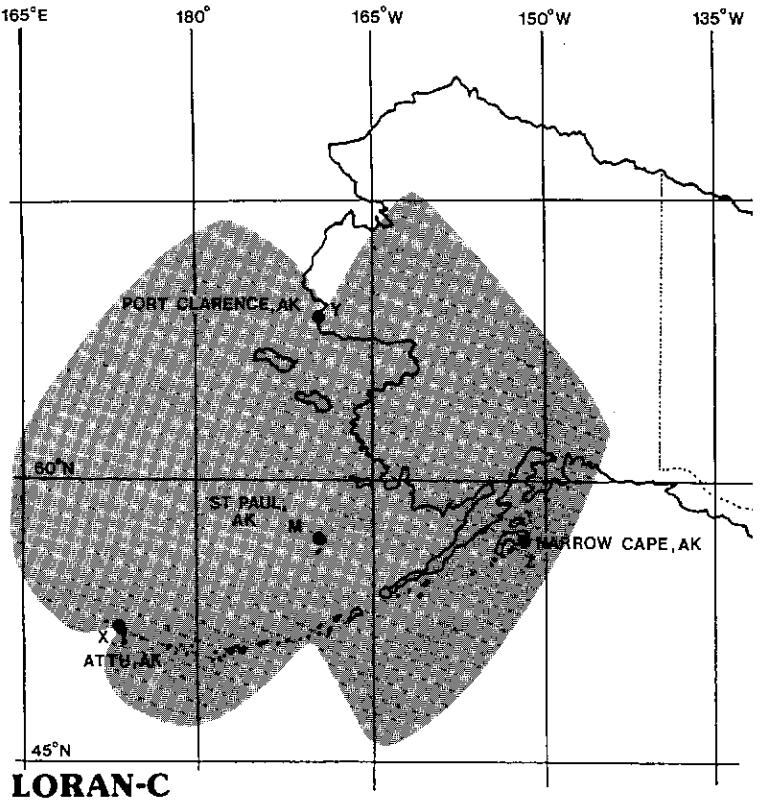

X
HOKKAIDO, JAPAN
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
W
MARCUS IS.
JAPAN
20°N
Z
YAP IS, USA
0°
140°E
160°E
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M W Y TRIAD 120°E
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION


HOKKAIDO, JAPAN
X
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
W
MARCUS IS, JAPAN
20°N
Z
YAP IS, USA
0°
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M X Y TRIAD 120°E
140°E
160°E
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION

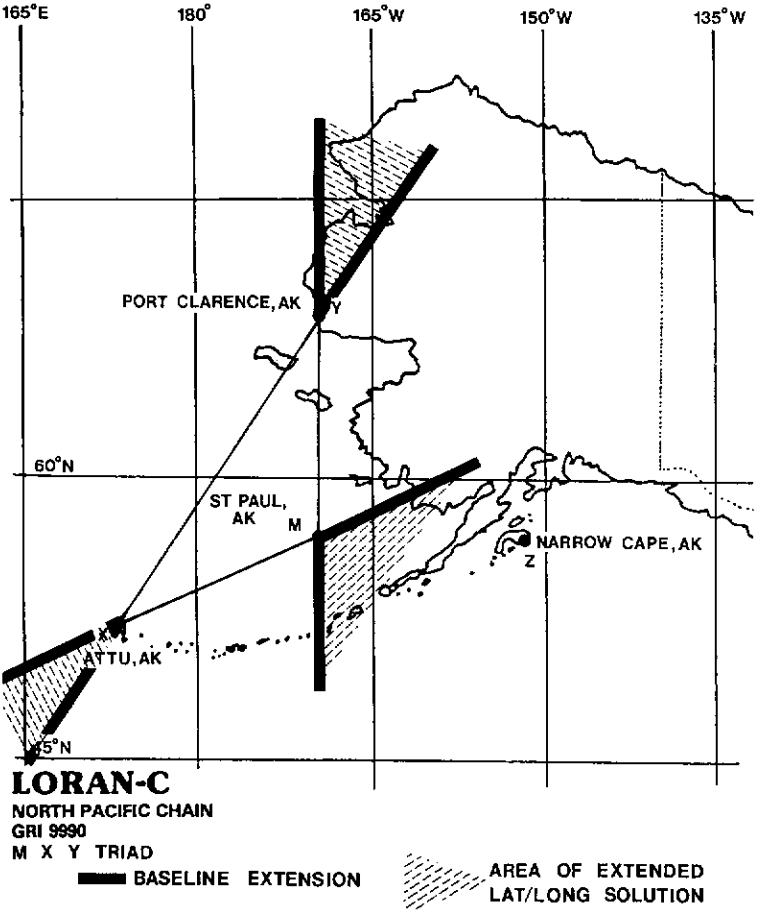

X
HOKKAIDO, JAPAN
40°N
GESASHI, JAPAN
Y
M
IWO JIMA
W
MARCUS IS.
JAPAN
20°N
Z
YAP IS, USA
0°
LORAN-C
NORTHWEST PACIFIC CHAIN
GRI 9970
M X W TRIAD 120°E
140°E
160°E
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

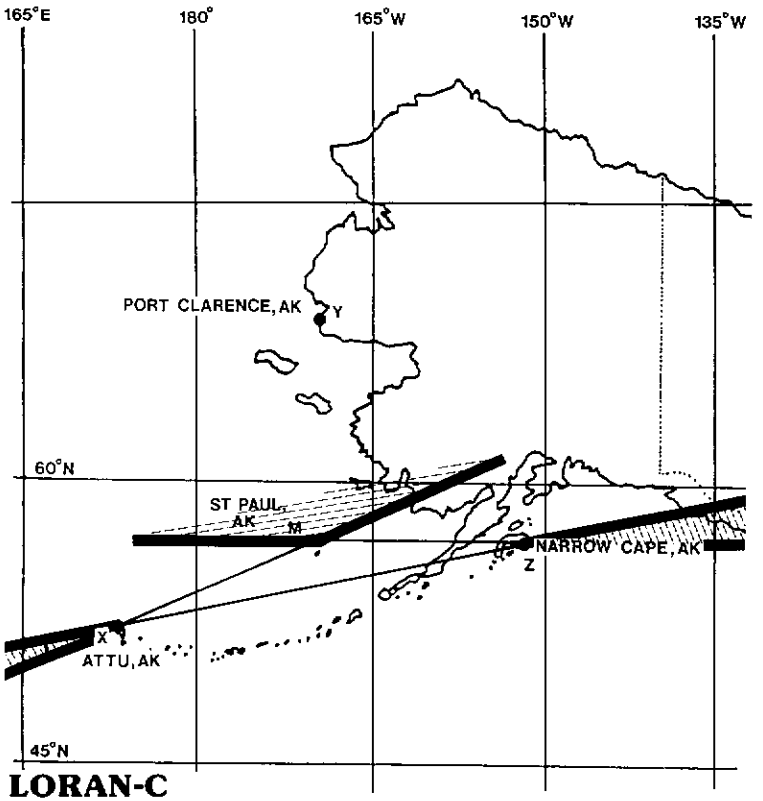
NORTH PACIFIC LORAN-C CHAIN - GRI 9990 (old rate SS1)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
St. Paul, AK	Master	57 09 12.3 N 170 15 06.8 W		275	Controls X and Y, exercises operational control of chain, two pulse comms installed.
Attu, AK	Xray	52 49 44.0 N 173 10 49.0 E	11000/ 3875.25	275	
Port Clarence, AK	Yankee	65 14 40.3 N 166 53 12.6 W	29000/ 3068.95	1000	
Narrow Cape, AK	Zulu	57 26 20.2 N 152 22 11.3 W	43000/ 3590.45	400	Two pulse comms installed. Dual-rated to Gulf of Alaska Chain.
Kodiak, AK	Monitor/ Control	57 44 00.7 N 152 30 20.4 W			Control for Z.



LORAN CHAIN COVERAGE MAP


165°E
180°
165°W
150°W
135°W
PORT CLARENCE, AK
Y
60°N
ST PAUL,
AK
M
NARROW CAPE, AK
Z
X
ATTU, AK
45°N
LORAN-C
NORTH PACIFIC CHAIN
GRI 9990
M X Y TRIAD
BASELINE EXTENSION
AREA OF EXTENDED
LAT/LONG SOLUTION

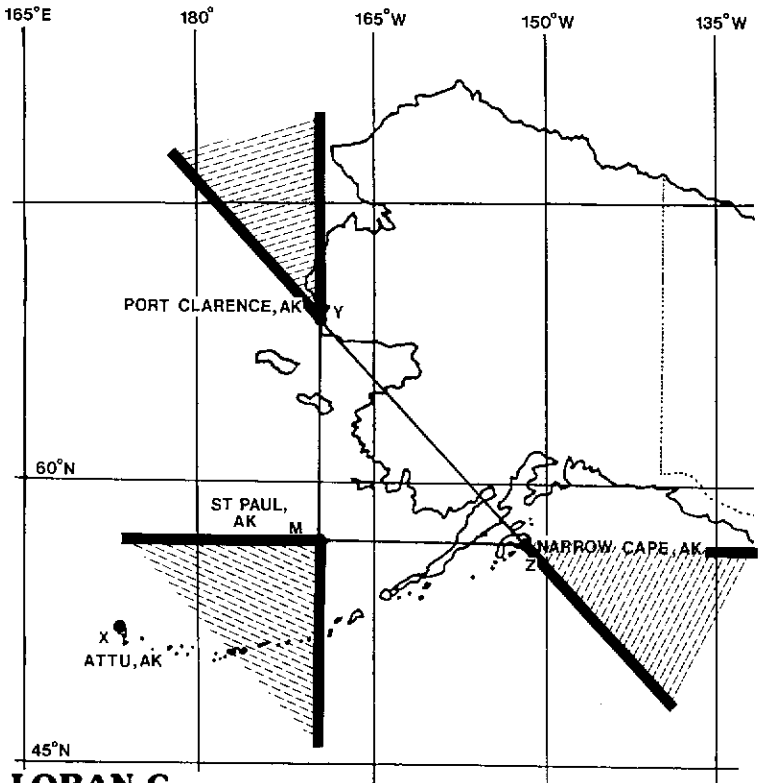


LORAN-C

NORTH PACIFIC CHAIN
GRI 9990
M X Z TRIAD

BASELINE EXTENSION

AREA OF EXTENDED LAT/LONG SOLUTION



LORAN-C

NORTH PACIFIC CHAIN
GRI 9990
M Y Z TRIAD

BASELINE EXTENSION

AREA OF EXTENDED LAT/LONG SOLUTION

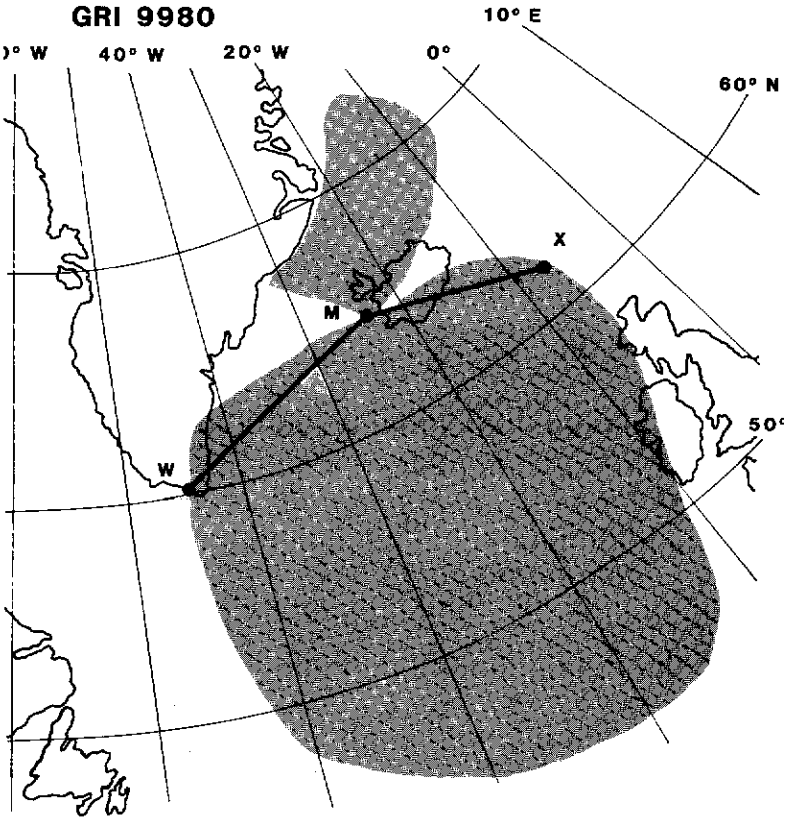
ICELANDIC LORAN-C CHAIN - GRI 9980

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(KW)	REMARKS
Sandur, Iceland	Master	64°54'26.6"N 23°55'21.8"W		1500	
Angissoq, Greenland	Whiskey	59°59'17.3"N 45°10'27.5"W	11000/ 4068.03	760	Dual-Rated to Labrador Sea Chain
Ejde, Faeroe Is., Denmark	Xray	62°17'59.6"N 07°04'26.5"W	30000/ 2944.54	325	Dual-Rated to Norwegian Sea Chain.
Keflavik, Iceland	Monitor	63°57'23.0"N 22°43'21.0"W			

LORAN-C

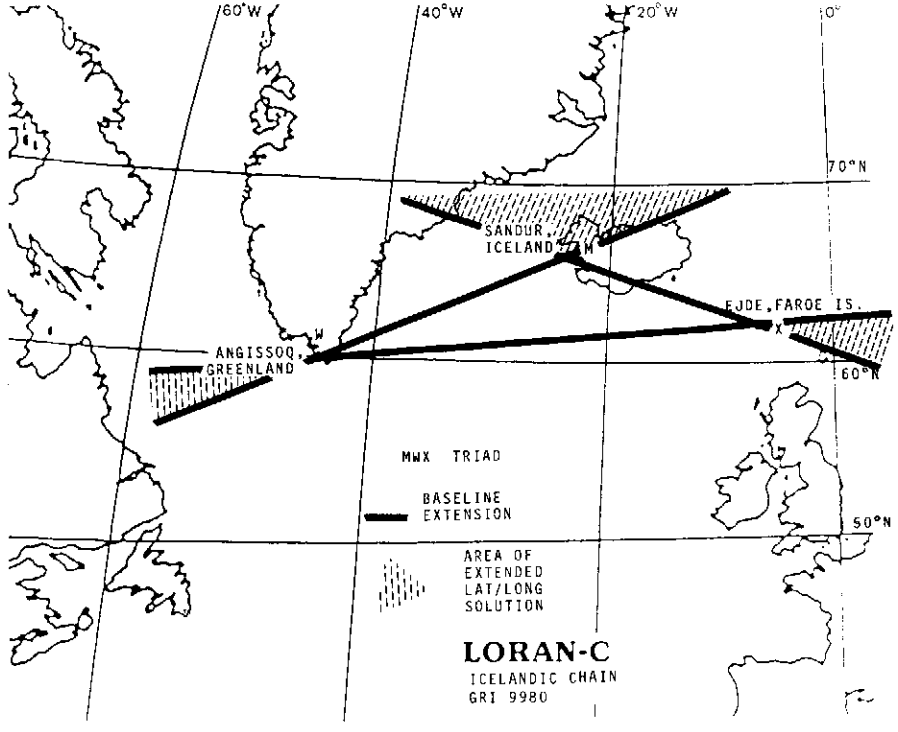
ICELANDIC CHAIN

GRI 9980



TRANSMITTING STATIONS

M SANDUR
W ANGISSOQ
X EJDE


60°W
40°W
20°W
0°
70°N
60°N
50°N
SANDUR, ICELAND
M
EJDE, FAROE IS.
X
W
ANGISSOQ, GREENLAND
MWX TRIAD
BASELINE EXTENSION
AREA OF EXTENDED LAT/LONG SOLUTION
LORAN-C
ICELANDIC CHAIN
GRI 9980

SECTION D
CONDENSED OPERATING INSTRUCTIONS

MODE SWITCH D-1

PUSH BUTTON SWITCHES D-2

ENTERING A NEW CHAIN AND SECONDARIES D-3

SIGNAL QUALIFIER D-5

TO ADJUST ECD DISPLAY D-6

POS MODE D-7

CALIBRATION FACTORS D-8

- MAGNETIC VARIATION ADJUSTMENT D-8
- LAT/LONG CALIBRATION D-9
- CROSS TRACK ERROR-RESOLUTION D-10

WAYPOINT MODE D-11

- SLEWING IN NEW LAT/LONG COORDINATES AS A WAYPOINT D-12

DEFINING A COURSE TO STEER D-13

NAV DISPLAYS D-14

NAV-F DISPLAYS D-15

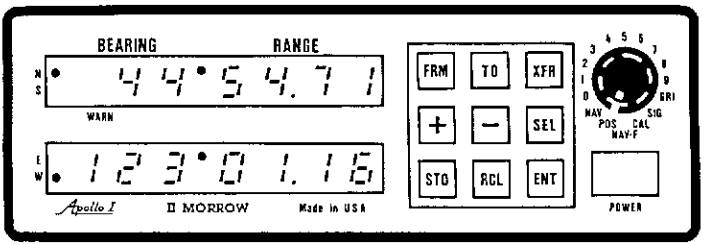
POINT-TO-POINT BEARING AND RANGE D-16

ABBREVIATIONS USED IN THIS MANUAL D-17

GLOSSARY OF TERMS D-19

P.O.Box 13549 Salem, OR 97309
(503) 581-8101

CONDENSED INSTRUCTIONS



MODE SWITCH

GRI: Used to display and enter chain and secondaries.

CAL: Used to display and enter calibration factors.

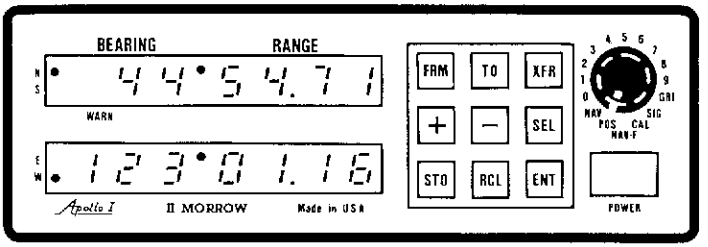
SIG: Used to display the SNR, ECD, and signal strength values.

NAV-F: Used to display Bearing and Range to the point of origin waypoint and select desired nav data on the lower readout.

POS: Used to display current position coordinates.

NAV: Used to display Bearing and Range to the destination waypoint and select desired nav data on the lower readout.

0 - 9: Used to enter up to 200 different waypoint locations.



PUSH BUTTON SWITCHES

FRM — Sets the origin waypoint.

TO — Sets the destination waypoint.

XFR — Transfers the readout displays in the SIG, CAL, NAV, NAV—F, and waypoint MODES.

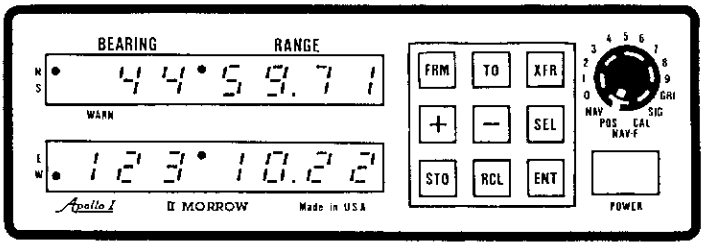
+ **−** — Slews (increases/decreases) the display.

SEL — Selects a display for slewing.

STO — Stores current position coordinates in memory.

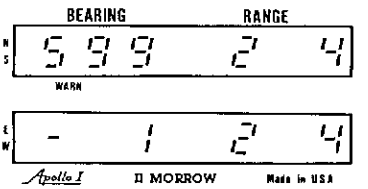
RCL — Recalls stored coordinates in the POS MODE. Displays or clears point-to-point in the NAV and NAV F MODES.

ENT — Enters the desired chain and secondaries in memory. Enters current position coordinates in the CAL MODE or 0 - 9 waypoint MODE.

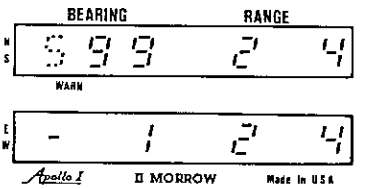


ENTERING A NEW GRI MODE AND SECONDARIES

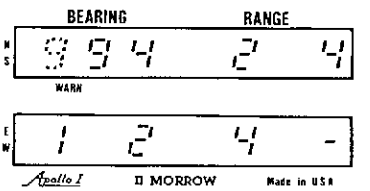
1) Turn the MODE switch to GRI. Previously entered chain and secondaries are displayed.



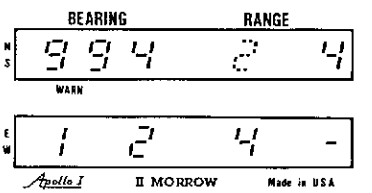
2) Press SEL to enable new GRI entry. The first digit will flash.

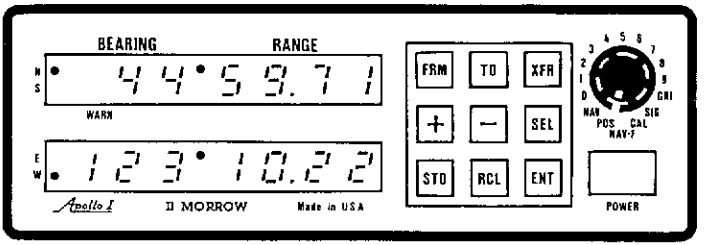


3) Press + or - to slew through the GRI menu until the desired CHAIN is displayed. Press ENT to enter the desired CHAIN into memory. (Plus shown)

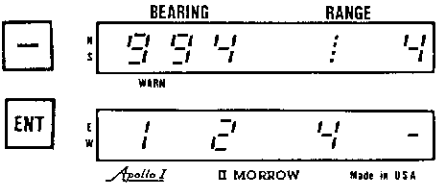


4) Secondary selection is automatically enabled. The first digit will flash.

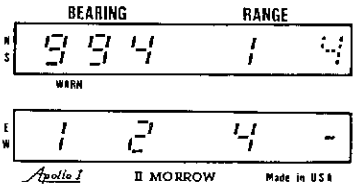




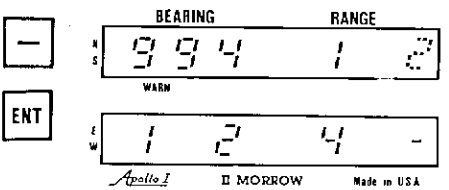
5) Press + or - to slew in the desired secondary. Press ENT to enter secondary into memory. (Minus shown)

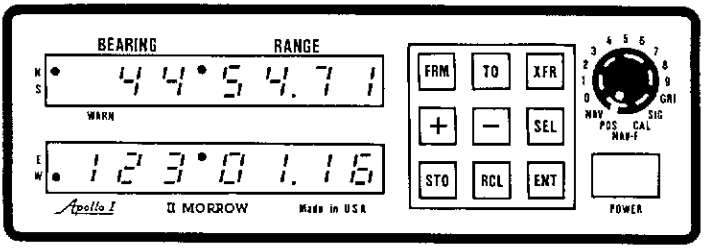


6) The other secondary is automatically enabled, with its digit flashing.



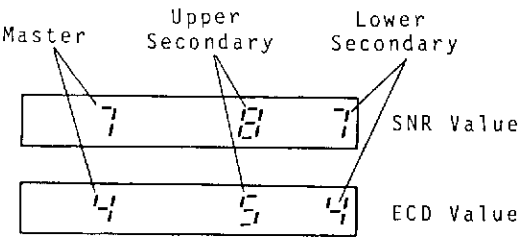
7) Press + or - to slew the desired secondary. Press ENT to enter secondary into memory. (Minus shown)



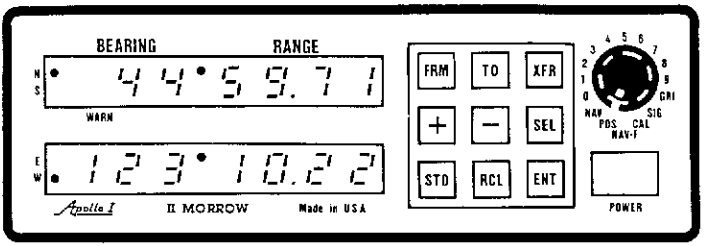


SIGNAL QUALIFIER MODE

1) Turn the MODE switch to SIG

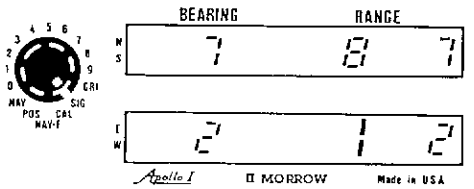


SNR DISPLAY	ECD DISPLAY
9 - Excellent	9 - Unreliable
8 - Excellent	8 - Poor
7 - Excellent	7 - Good
6 - Good	6 - Good
5 - Good	5 - Good
4 - Good	4 - Good
3 - Fair	3 - Good
2 - Fair	2 - Fair
1 - Poor	1 - Poor
0 - No signal	0 - Unreliable



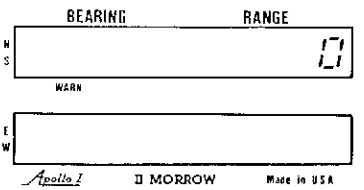
To Adjust ECD Display to a Good Value

1) Set the MODE switch to SIG.



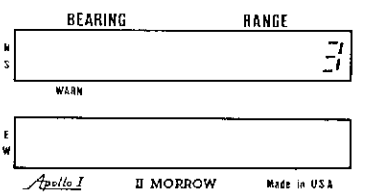
2) Press XFR twice to display the ECD bias number. The total adjustment is from 0 to ±4.

XFR XFR



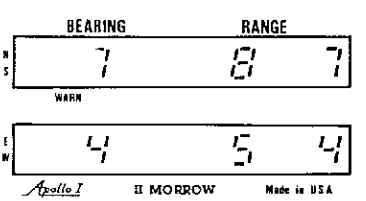
3) Press + or - switch to apply desired ECD bias. (Positive adjustment needed in this example)

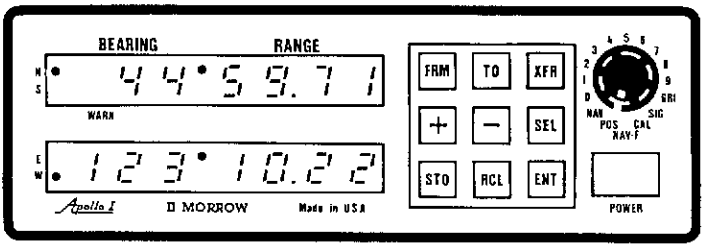
\+ \+ \+



4) Press XFR until SNR and ECD values are displayed.

XFR XFR XFR XFR

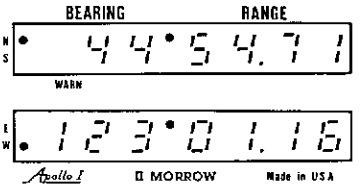




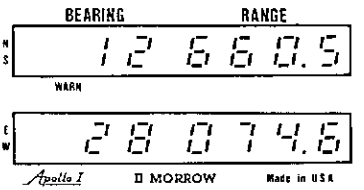
POS MODE

Displaying Current Position

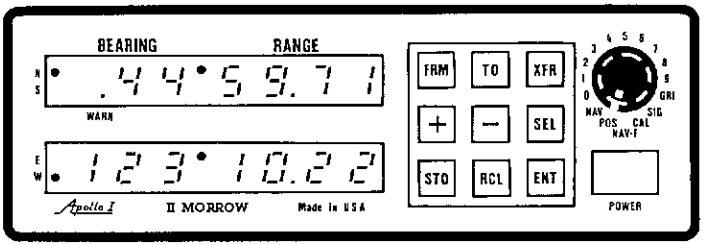
1) Turn the MODE switch to POS to display current LAT/LONG positions.



2) Press XFR to display the Loran TD's.



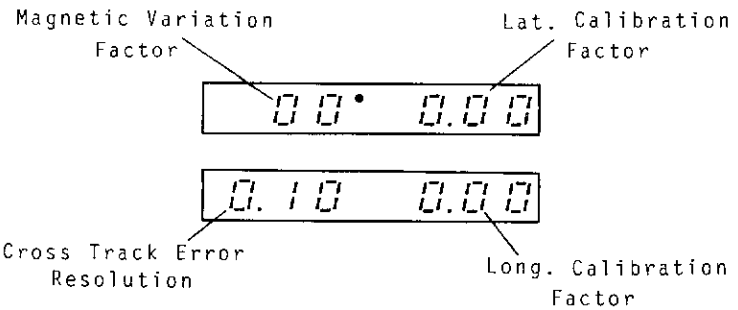
3) Press XFR to display LAT/LONG.



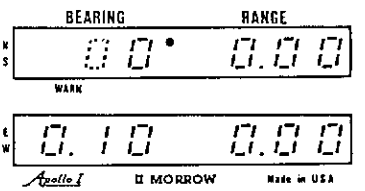
CALIBRATION MODE

Magnetic Variation Adjustment

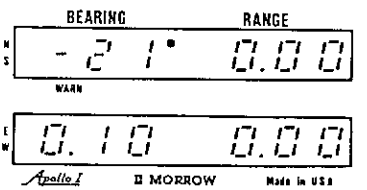
1) Turn the MODE switch to CAL.

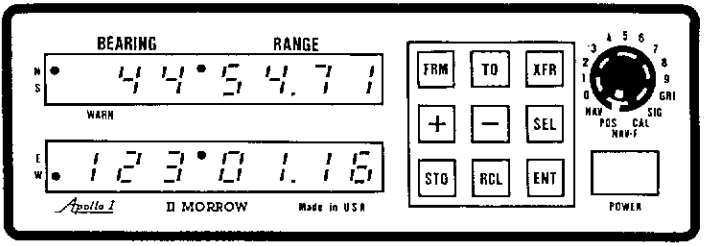


2) Press SEL to enable magnetic variation entry. First digit will flash.



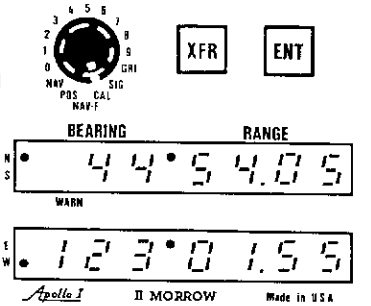
3) Press + for westerly variation. Press - for easterly variation. 21° easterly variation shown.



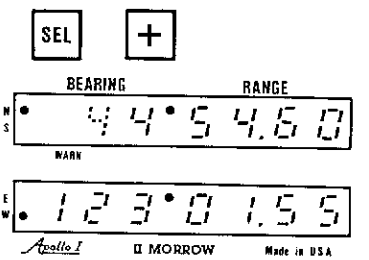


LAT/LONG Calibration Using a Known Position

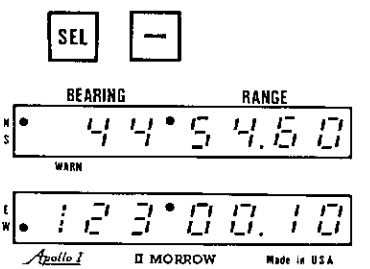
1) Turn the MODE switch to CAL. Press XFR and ENT to display calculated LAT/LONG position.

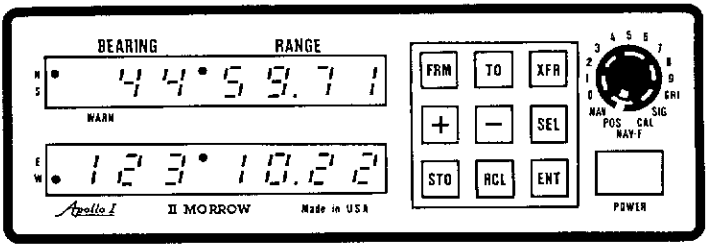


2) Press SEL to enable LAT calibration. First digit will flash. Press + or - to slew the LAT display to the known position. (Plus shown)



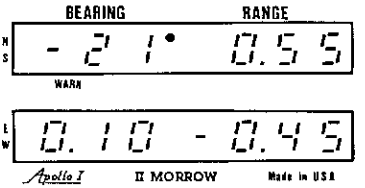
3) Press SEL to enable LONG calibration. First digit will flash. Press + or - to slew the LONG display to the known position. (Minus shown)



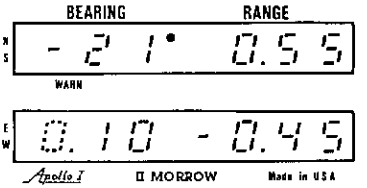


Cross Track Error Resolution

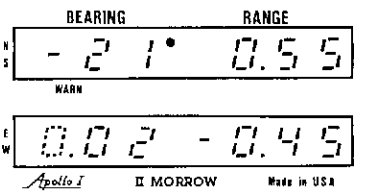
1) Turn the MODE switch to CAL.



2) Press SEL four times to enable resolution entry. The first digit will flash.

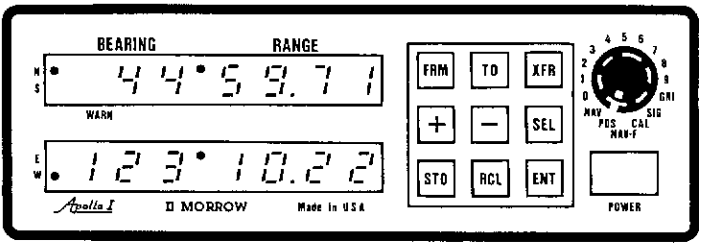


3) Press + or - to select the desired resolution. (Minus shown)



Resolution Selections

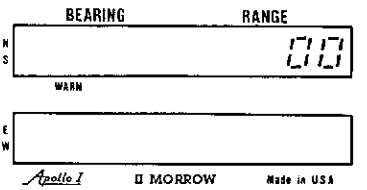
0.10 = 608'
0.05 = 304'
0.02 = 122'
0.01 = 61'



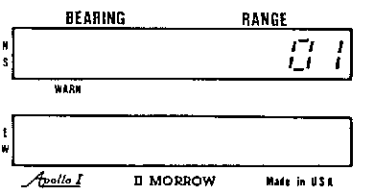
WAYPOINT MODE

Selecting a Waypoint Number:

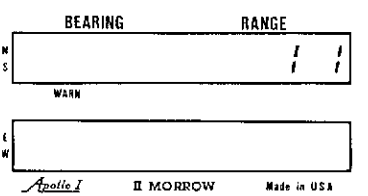
1) Turn the MODE switch to 0 - 9 . Press XFR to display the waypoint number.



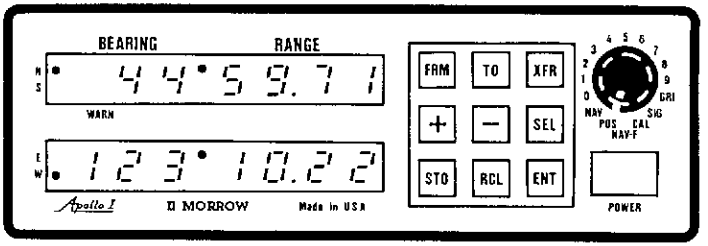
2) Turn the MODE switch to increase or decrease the waypoint number by a factor of one.



3) Press + or - to increase of decrease the waypoint number by a factor of ten.

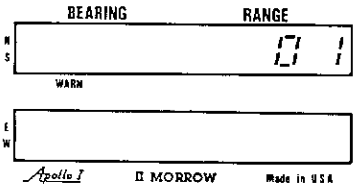


A total of 200 waypoint numbers can be displayed, from 0 to 199.

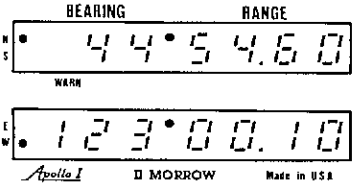


Slewing in New LAT/LONG Coordinates as a Waypoint

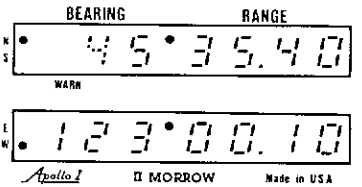
1) Select the desired waypoint number. Waypoint 1 is shown.



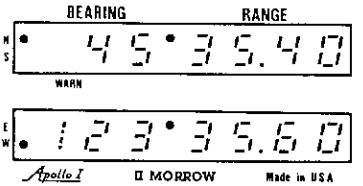
2) Press XFR and ENT to enter current position coordinates as a reference to slew from.

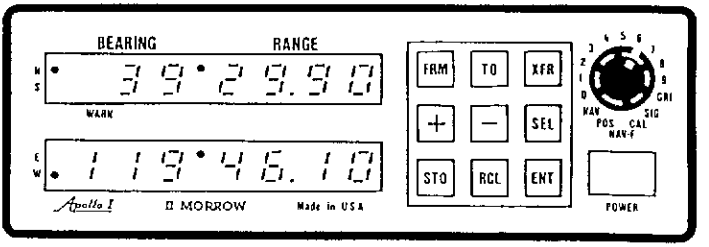


3) Press SEL to enable LAT coordinate slewing. Press + or - to slew in the desired coordinate.



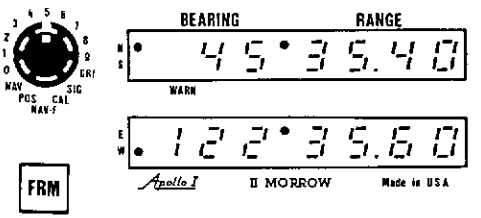
4) Press SEL again to enable LONG coordinate slewing. Press + or - to slew in the desired coordinate.



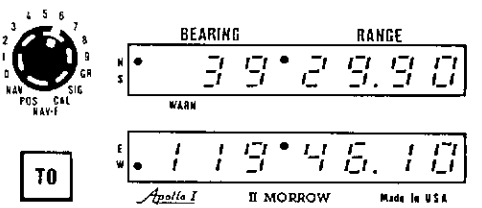


DEFINING A COURSE TO STEER

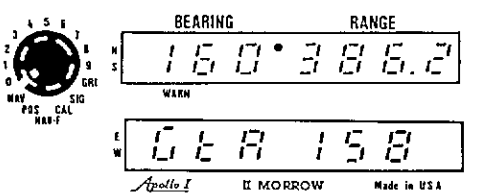
1) Select POS or a waypoint as the origin and press FRM, (Portland,OR coordinates displayed).

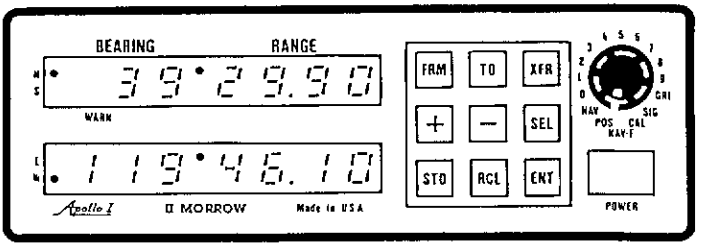


2) Select the destination waypoint and press TO, (Reno,NV coordinates displayed).



3) Turn the MODE to NAV or NAV-F and specify the desired display with the XFR switch.

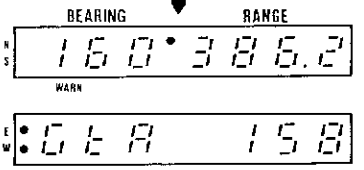




NAV DISPLAYS

The NAV displays are specified by the operator with the XFR switch. Bearing and Range to the destination is displayed.

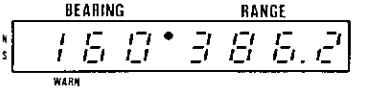
Bearing and Range



GTA - Ground Track Angle

XFR

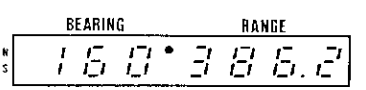
Bearing and Range



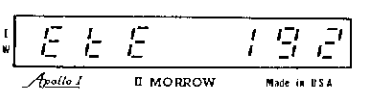
GS - Ground Speed in knots

XFR

Bearing and Range

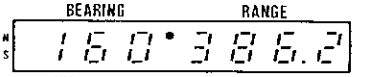


ETE - Estimated Time Enroute

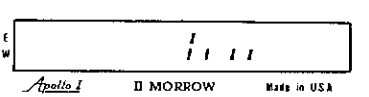


XFR

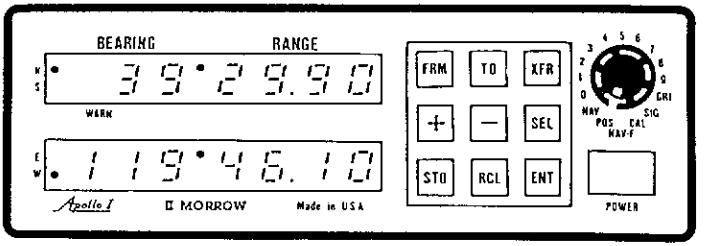
Bearing and Range



CDI - Cross Track Error



XFR



NAV-F DISPLAYS

The NAV F displays are specified by the operator with the XFR switch. Bearing and Range to the origin is displayed.

Bearing and Range

GTA - Ground Track Angle

XFR

Bearing and Range

GS - Ground Speed in knots

XFR

Bearing and Range

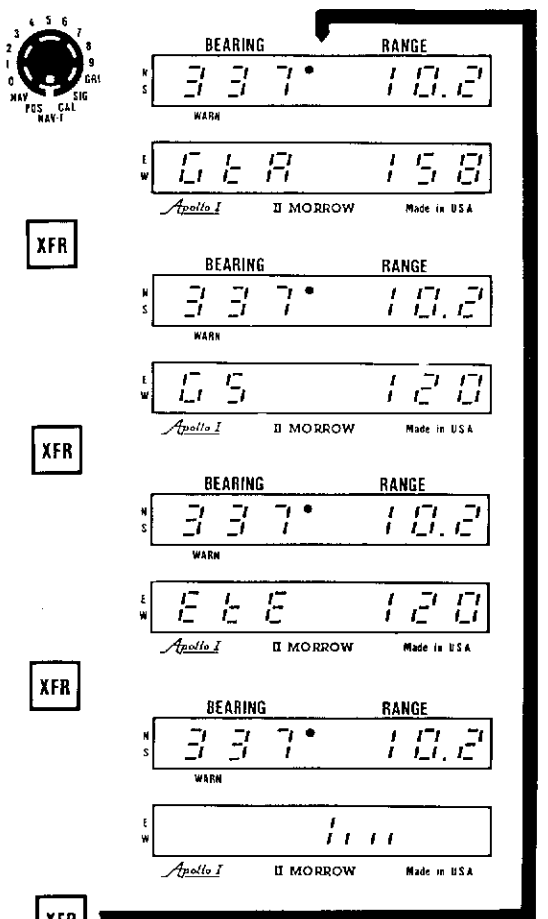
ETE - Estimated Time Enroute

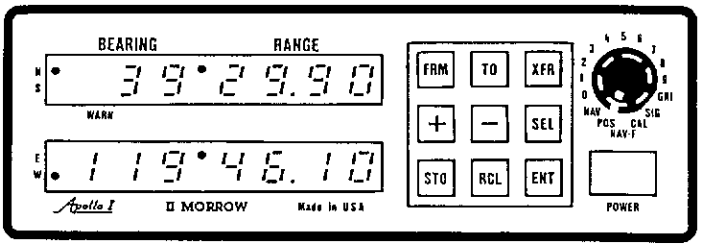
XFR

Bearing and Range

CDI - Cross Track Error

XFR

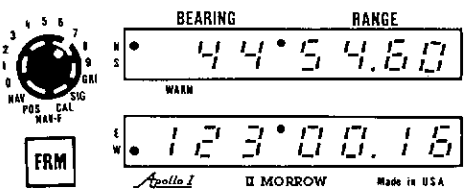




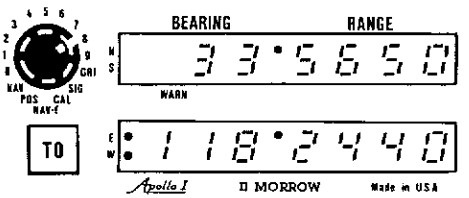
POINT-TO-POINT BEARING AND RANGE

This mode is intended to supply you with point-to-point Bearing and Range between any two pre-defined waypoints. This mode will not update with position changes but will aid in pre-programming a flight.

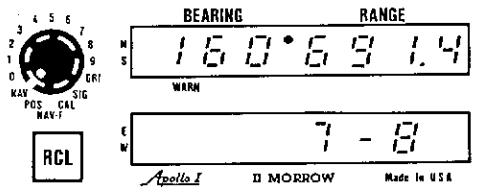
1) Select POS or a waypoint as the origin and press FRM, (Salem, OR coordinates displayed).



2) Select the destination waypoint and press TO, (Los Angeles, CA coordinates displayed).



3) Turn the MODE switch to NAV or NAV F and press RCL, (NAV shown).



4) Press RCL again to clear the point-to-point mode.

ABBREVIATIONS USED IN THIS MANUAL

ARP - Airport Reference Point

BNK - Blink

CDI - Course Deviation Indicator

CYC - Cycle

ECD - Envelope-To-Cycle-Difference

ENT - Enter

ETE - Estimated Time Enroute

FRM - From a Starting Point

GND - Electrical Ground (0 VDC potential)

GRI - Group Repetition Interval

GS - Ground Speed in knots

GTA - Ground Track Angle

KHz - Kilohertz (1,000 Hertz)

LED - Light-Emitting Diode

LF - Low-Frequency Band

LOP - Line Of Position

Loran - Long Range Navigation

M - Master

PWR - Power

SIG - Signal Analyzer Mode

SNR - Signal-to-Noise Ratio

STO - Store

STS - Status

(over)

(continued)

TCXO - Temperature Compensated Crystal Oscillator

TD - Time Difference

TO - To a Destination Point

VOR - Very-High-Frequency Omnidirectional Range

WP - Waypoint

\+ - Add or Increase

\- - Subtract or Decrease

XFR - Transfer or Change

GLOSSARY OF TERMS

Absolute Accuracy

--- The ability to determine true geographic position (latitude and longtitude) from a navigational system such as Loran-C.

Baseline

--- The great circle line connecting the master transmitting station and a secondary transmitting station.

Baseline Extension

--- The extension of the baseline beyond either the master or secondary transmitting station (see map on C-6).

Chain

--- A Loran-C network consisting of a master transmitting station and two to four secondary transmitting stations.

Cross Track Error

--- A fix error to the left or right from the desired track to the present position, measured perpendicular to the desired track. Displayed in the NAV MODE by a bar graph or a numerical display.

Cycle Slip

--- Distorted or prevented reception of Loran-C signal in some areas of high noise or fringe coverage areas. For cycle slip detection and correction see page A-67.

Date Code

--- The software date code needs to be provided when contacting the factory or your II Morrow dealer regarding APOLLO performance or operation.

Envelope-To-Cycle Difference

--- In SIG MODE: represents the tracking point of the Loran signal for the master and secondary stations.

Fix

--- Navigational position determined by two or more lines of position.

Groundwave

--- A radio wave traveling near or along the surface of the Earth.

LAT/LONG Calibration Factor

--- The adjustment for transmission delay of Loran-C signal.

Line Of Position

--- A line of location determined through a single navigational observation. This line shows the series of locations of constant Loran-C signal time difference. The intersection of two or more LOP's results in a fix.

Lower Secondary

--- The Secondary displayed on the bottom readout in the POS MODE.
--- In the GRI MODE: the Secondary entered and displayed on the far right of the upper readout.

Magnetic Variation

--- Adjustment for Bearing and GTA display to read magnetic bearings (see page A-40).

Mode Switch

--- Function selector switch.

MODE SWITCH FUNCTIONS:

GRI (Group Repetition Interval)

--- used to display and enter chain and secondaries;

CAL (Calibration)

--- used to display and enter calibration factors;

SIG (Signal)

--- used to display the SNR, ECD, and signal strength values;

NAV-F (Navigation From)

--- used to display Bearing and Range to the point of origin and to select navigation data on the lower read-out;

POS (Position)

--- used to display current position coordinates;

NAV (Navigation)

--- used to display Bearing and Range to the destination waypoint and to select navigation data on the lower read-out;

0-9 (Waypoint Numbers)

--- used to enter up to 200 waypoints.

Notch Filters

--- Filters in the receiver to reduce the effects of interfering signals.

PUSH BUTTON FUNCTIONS:

FRM

--- sets the origin waypoint;

TO

--- sets the destination waypoint;

XFR

--- transfers the readout displays in the SIG, CAL, NAV, NAV-F, and waypoint modes.

+/-

--- slews (increases/decreases) the displayed numbers.

SEL

--- selects a display for slewing;

STO

--- stores current position coordinates in memory;

RCL

--- recalls stored coordinates in the POS MODE;
--- displays or clears point-to-point in the NAV and NAV-F MODES.

ENT

--- enters the desired chain and secondaries in memory;
--- enters current position coordinates in the CAL MODE or 0-9 waypoint MODE.

Repeatable Accuracy

--- The ability to return to a position where you have been before by using a navigation system such as Loran.

Secondary Stations or Secondaries

--- General designation of the two to four secondary transmitting stations in a Loran-C chain. The secondary stations transmit in sequence after the master at fixed, predetermined intervals.

Signal-To-Noise Ratio

---The ratio of the Loran-C signal level to the level of background noise.

Skywave

--- An indirect radio wave that reflects off the ionosphere instead of traveling directly from the transmitter to the receiver.

Time Difference

--- The difference in time of arrival (measured in microseconds) of two Loran-C signals, one from the master transmitting station and the other from one of the secondaries.

Upper Secondary

--- The secondary displayed on the top readout in the POS MODE;
--- In the GRI MODE: the first secondary entered and displayed in the middle of the upper readout.

Waypoint

--- A predetermined geographical position used for route definition and/or progress reporting purposes.

TIMEWORLD INC.

WAYPOINT LOG

This worksheet is intended to help you keep track of your waypoint numbers and the locations. The format allows versatility for your particular need.

You should be recording not only your latitude and longitude but also the chain and secondaries used and magnetic, latitude and longitude calibration factors. Depending on your use, you may require this information with each waypoint or you may require it for a group of waypoints.

EXAMPLE 1

994 CHAIN	1 2 SECONDARIES	-21 MAG VAR	-.36 LAT CAL	-.49 LONG CAL

NO.	NAME	LATITUDE	LONGITUDE
01	SLE 31	44° 54.23	122° 59.71
02	SLE 34	44° 54.19	123° 00.23
03	INDEPENDENCE	44° 52.12	123° 11.87
04	McMINNVILLE	45° 11.61	123° 08.25

EXAMPLE 2

CHAIN	SECONDARIES	MAG VAR	LAT CAL	LONG CAL

NO.	NAME	LATITUDE	LONGITUDE
01	SALEM SLE	44° 54.60	123° 00.10
994	1 2	-21 -.36	-.49
02	SACRAMENTOSMA	38° 41.70	121° 36.00
994	2 4	-17 +0.07	-0.10