PART 6

LORAN-C NAVIGATION SYSTEM

TABLES

FIGURES

A. Loran-C Chain Coverage

Figure 1 shows the North American coverage of Loran-C while Figure 2 shows further details of the Canadian West Coast and suggested rates and master-secondary pairs to use in particular areas. Figure 3 shows the individual coverage pattern provided by the Canadian West Coast Chain. The following notes pertain to Figure 2:

Note 1: The dividing lines between the Loran-C rates do not necessarily mean there are no other suitable Loran-C station pairs which could be used to safely navigate in an area. For example, while it is recommended to use 5990 XZ (i.e., Williams Lake - Shoal Cove - Port Hardy on Rate 5990) in the Hecate Strait area, coverage also exists there for 5990 XY. It is simply estimated that 5990 XZ provides better coverage in this area.

Note 2: The position repeatability of the 5990 XZ signals in this area may degrade to 1/3 nm due to geometric considerations. Theoretically 7960 XZ should be used in this area, but this is not recommended due to weak signal strength of the distant master station at Tok, Alaska.

B. Chain Details

Tables 1 through 4 give technical details of chains that provide coverage in waters off Western Canada and proximity.

C. Loran-C Coordinate Converters

Listing of vectors from the Loran-C coordinate converter position to the true position.

D. Loran-C Receiver Latitude/Longitude Corrections

Today's Loran-C receivers are equipped with microprocessors which are designed to internally compute the latitude and longitude coordinates of the receiver, based on the Time Difference (TD) readings, and directly display these values. This reduces the need to possess Loran-C charts, though it is still recommended they be procured.

The latitude/longitude computation may be based upon a pure seawater path. This leads to errors if the Loran-C signals from the various stations involve appreciable overland paths since the speed of the signal will decrease by varying amounts, depending on the nature of the earth's surface over which it is passing. Loran-C operates by measuring the difference in arrival times of the signals from the different stations in the Loran-C chain, and thus any unforeseen variation in the speed of a signal will result in an error in the latitude/longitude reading. Note that when the receiver is being used in the time difference mode (time difference readings being used to manually plot lines of position on a Loran-C chart), these errors are minimal and the system should be accurate to within 1/4 nautical mile. This is because the Loran-C lattice on a nautical chart has already been adjusted to allow for the signal variation as it travels over land.

It is recommended that mariners' using the latitude/longitude feature of their receiver check the manufacturer's operating manual to determine if corrections are necessary and how they may be applied to compensate for overland paths in order to obtain a greater fix accuracy. The correction can be applied in either of two forms: (i) insertion of a correction when the vessel is at a known location, or (ii) the insertion of a correction factor that is determined from a table or chartlet. The latter is called an Additional Secondary Phase Factor (ASF) correction, and the chartlets in Figure 4 can be used to ascertain the numeric value to apply. These corrections will normally be valid only within 50 to 100 miles of the location at which the correction was inserted because of the changing effects of land mass on the Loran signals in the different areas.

E. Cautionary Note - Fishing Near the B.C.- Alaska Coastal Boundary

Canadian fishermen using the Loran-C system for navigation must exercise caution when operating the near "A-B" Line, the coastal boundary in the waters separating B.C., and Alaska.

You should be particularly aware of the signal phase problem discussed in Section D. A receiver being used in the latitude/longitude mode can experience errors of up to several miles if ASF corrections have not been applied. In some receivers the corrections are applied automatically within the receiver, while in others the corrections must be applied manually, be it while located at a known spot or by the addition of ASF corrections.

Note that some of the ASF corrections shown in this publication stop short of the A-B line, and caution must be exercised when operating in this area.

F. Waypoint Navigation Cautionary Note

Mariners are cautioned that an error can exist between the waypoint navigation information provided by their Loran-C receiver and the desired straight-line track plotted on a chart. A straight line course plotted between two waypoints on a mercator chart is a rhumb line, defined as a line on the earth's surface cutting the meridians of longitude at the same angle. The course and distances displayed by a microprocessor-based Loran-C receiver, used in the waypoint mode, are normally computed for a great circle track, not a rhumb line. In the northern hemisphere, a great circle track between two waypoints lies to the north of a rhumb line joining those same waypoints.

This offset distance, or error, is a maximum when sailing East-West at a latitude of approximately 45 degrees, decreasing to zero at the equator and at the North and South Poles. It also decreases to zero as your track becomes North-South, regardless of the latitude. As an example of the offset error possible, a journey from St. John's, Newfoundland, to the Lands End area, England, a distance of roughly1850 nm, would have a maximum offset of approximately 140 nm when comparing a rhumb line and a great circle track between the two places. The rhumb line versus great circle path offset becomes a danger only if the mariner has not laid off a great circle course on a Gnomonic chart, ensuring the vessel will pass clear of all navigational dangers.

G. Loran-C System Status Information

Up-to-date Loran-C status information is available by telephoning:

Loran-C Chain/Rate	Phone Number	
➲ West Coast U.S./9940	707-765-7518/98	
Canadian West Coast/5990	709-454-3129	Control/Monitor for Canadian Loran C Operations
➲ Gulf of Alaska/7960	707-765-7426/21	
➲ North Central U.S./8290	707-765-7518/98	

H. Loran-C NOTSHIPs

Loran-C Notices to Shipping (NOTSHIPS) concerning the status of Loran-C signals in the coastal waters off Western Canada and the immediate proximity are broadcast from the following Marine Communications and Traffic Services Centres (MCTS):

Vancouver	Tofino	Comox
Victoria	Prince Rupert	

Note that these broadcasts may only be made from those MCTS Centres located in the general area where the Loran-C signal normally exists.

TABLE 1
GULF OF ALASKA LORAN-C CHAIN GRI 7960

STATION	LATITUDE LONGITUDE (2)	FUNCTION	EMISSION DELAY	THEORETICAL BASELINE TRAVEL TIME (3)	RADIATED PEAK POWER
TOK, Alaska (1)	63 19 42.88N 142 48 31.35W	MASTER	—	—	560 kW
KODIAK, Alaska (1)	57 26 20.30N 152 22 10.71W	X SECONDARY	13804.45 m s	2804.45 m s	400 kW
SHOAL COVE, Alaska (1)	55 26 20.94N 131 15 19.09W	Y SECONDARY	29651.14 m s	3651.14 m s	560 kW
PORT CLARENCE, Alaska (1)	65 14 40.37N 166 53 12.00W	Z SECONDARY	47932.52 m s	2932.52 m s	1000 kW

(1) This station operated by United States of America.
(2) Based on WGS 84 Datum (Coordinate system for charting).
(3) Theoretical Baseline Travel Time is based on all-seawater transmission path between master and secondary based on WGS 84 Datum (Coordinate system for charting).

TABLE 2
CANADIAN WEST COAST LORAN-C CHAIN GRI 5990

STATION	LATITUDE LONGITUDE (2)	FUNCTION	EMISSION DELAY	THEORETICAL BASELINE TRAVEL TIME (3)	RADIATED PEAK POWER
WILLIAMS LAKE, B.C.	51 57 58.88N 122 22 01.69W	MASTER	—	—	400 kW
SHOAL COVE, Alaska (1)	55 26 20.94N 131 15 19.09W	X SECONDARY	13343.60 m s	2343.60 m s	560 kW
GEORGE, Washington (1)	47 03 48.10N 119 44 38.98W	Y SECONDARY	28927.36 m s	1927.36 m s	1400 kW
PORT HARDY, B.C.	50 36 29.83N 127 21 28.49W	Z SECONDARY	42266.63 m s	1266.63 m s	400 kW

(1) This station operated by United States of America.
(2) Based on WGS 84 Datum (Coordinate System for charting).
(3) Theoretical Baseline Travel Time is based on all-seawater transmission path between master and secondary.

TABLE 3
U.S. WEST COAST LORAN-C CHAIN, GRI 9940

STATION	LATITUDE LONGITUDE (2)	FUNCTION	EMISSION DELAY	THEORETICAL BASELINE TRAVEL TIME (3)	RADIATED PEAK POWER
FALLON, Nevada (1)	39 33 06.74N 118 49 55.82W	MASTER	—	—	400 kW
GEORGE, Washington (1)	47 03 48.10N 119 44 38.98W	W SECONDARY	13796.90 m s	2796.90 m s	1400 kW
MIDDLETON, California (1)	38 46 57.11N 112 29 43.98W	X SECONDARY	28094.50 m s	1094.50 m s	400 kW
SEARCHLIGHT, Nevada (1)	35 19 18.31N 114 48 16.88W	Y SECONDARY	41967.30 m s	1967.30 m s	560 kW

(1) This station operated by United States of America.
(2) Based on WGS 84 Datum (Coordinate system for charting).
(3) Theoretical Baseline Travel Time is based on all-seawater transmission path between master and secondary

TABLE 4
NORTH CENTRAL U.S. LORAN-C CHAIN GRI 8290

STATION	LATITUDE LONGITUDE (2)	FUNCTION	EMISSION DELAY	THEORETICAL BASELINE TRAVEL TIME (3)	RADIATED PEAK POWER
HAVRE, Montana (1)	48 44 38.59N 109 58 53.613W	MASTER	—	—	400 kW
BAUDETTE, Minnesota (1)	48 36 49.95N 94 33 17.92W	W SECONDARY	14786.56 m s	3786.56 m s	800 kW
GILLETTE, Wyoming (1)	44 00 11.1N 105 37 23.90W	X SECONDARY	29084.44 m s	2084.44 m s	400 kW
WILLIAMS LAKE, B.C.	51 57 58.88N 122 22 01.69W	Y SECONDARY	45171.62 m s	3171.62 m s	400 kW

(1) This station operated by the United States of America.
(2) Based on WGS 84 (coordinate system for charting).
(3) Theoretical Baseline Travel Time is based on all-seawater transmission path between master and secondary.

Loran-C Coordinate Converters

Many of the Loran-C Coordinate Converters on the market do not compensate for the overland propagation errors caused by radio waves travelling more slowly over land than they do over seawater. These converters assume that the radio waves are travelling over an all seawater path from the transmitters to the ship. Because the amount of the time delay in each pattern varies with location, as does the width for 1 microsecond in each pattern, and the angle of cut between patterns, and which two patterns are being used for the position determination, there can be no over-all simple error statement.

It is important to note that a Loran-C coordinate converter that does not incorporate the overland propagation corrections (Additional Secondary Factor, or ASF) within its computations will produce a systematic geographic position error. This error is often in the dangerous direction; namely, it will compute a position that is farther offshore. If you are transiting along a coast, thinking that you are safely outside the dangerous shoals, you may find yourself closer to shore than you think you are.

The Canadian Hydrographic Service (CHS) has determined the overland propagation (ASF) errors through actual observations. The overland propagation corrections were incorporated into the lattices that were/are on CHS nautical charts. These maps have been published maps showing the corrections to observed Time Differences (TD's) necessary to make them theoretical TD's that can be used with algorithms using just the seawater velocity to compute the geographic position.

Manufacturers have their own methods to compute geographic positions, which may incorporate some approximations. The receivers may or may not tell the mariner which TD's it is using to compute the position – hopefully the pair with the best repeatable geometry. Some receivers use more than two TD's to compute positions.

Some manufacturers have incorporated the overland propagation corrections into their algorithms and those receivers should perform more accurately than those that do not. The industry self-imposed standard set by the Radio Technical Commission on Marine Services – Special Committee 75 on Minimum Performance Standards for Loran-C Coordinate Converters (1980) is a ¼ mile positioning accuracy.

The following tables give the vectors from the Loran-C coordinate converter position to the true position. These will give some guide as to the possible errors. It is suggested, however, that mariners **NOT** correct their positions by the stated amounts, but to use the listed information as an advisory. Your coordinate converter may behave differently.

5990 – Canadian West Coast Chain

Information in **Bold** is for the TD pair that gives the best repeatability.

Vicinity of:	**Latitude**	**Longitude**	**5990XY**	**5990XZ**	**5990YZ**
Gulf of Georgia					
Cape Mudge	49 55N	125 10W			**0.0 nm**
Cape Lazo	49 45N	124 45W			**0.0 nm**
Sisters Islets	49 30N	124 30W			**0.0 nm**
Nanaimo	49 15N	123 55W			**0.1 nm @ 055°T**
Point Grey	49 15N	123 20W			**0.1 nm @ 080°T**
Patos Island	48 45N	123 00W			**0.1 nm @ 095°T**
Juan de Fuca Strait					
Hein Bank	48 20N	123 00W			**0.2 nm @ 225°T**
Trial Island	48 20N	123 20W			**0.2 nm @ 235°T**
Race Rocks	48 15N	123 30W			**0.1 nm @ 230°T**
Port Renfrew	48 30N	124 30W			**0.2 nm @ 015°T**
Neah Bay, Wash	48 23N	124 35W			**0.1 nm @ 035°T**
Vancouver Island, West Coast					
Amphitrite Point	48 50N	125 30W	0.1 nm @ 345°T		**0.1 nm @ 045°T**
Estevan Point	49 15N	126 30W	**0.1 nm @ 090°T**		0.1 nm @ 085°T
Cape Cook	50 00N	128 00W	**0.3 nm @ 155°T**	0.7 nm @ 185°T	0.5 nm @ 115°T
Triangle Island	51 00N	129 00W	**0.6 nm @ 190°T**	0.4 nm @ 060°T	
Queen Charlotte Sound					
Pine Island	51 00N	127 45W	0.2 nm @ 175°T	**0.3 nm @ 040°T**	
Goose Group	52 00N	129 00W	0.4 nm @ 195°T	**0.4 nm @ 055°T**	
E of Kunghit I	52 00N	130 30W	0.4 nm @ 175°T	**0.5 nm @ 080°T**	
Hecate Strait					
Hecate Strait	53 00N	131 00W	0.5 nm @ 195°T	**0.7 nm @ 075°T**	
Seal Rocks	54 00N	131 00W	0.6 nm @ 190°T	**0.9 nm @ 080°T**	
Dixon Entrance					
Chatham Sound	54 30N	130 35W		**0.6 nm @ 075°T**	
Zayas Island	54 35N	131 10W		**0.8 nm @ 085°T**	
Cape Chacun	54 40N	132 00W	0.4 nm @ 120°T	**1.1 nm @ 085°T**	
Masset	54 10N	132 00W	0.7 nm @ 215°T	**1.1 nm @ 080°T**	
Forrester Island	54 40N	133 30W	0.6 nm @ 145°T	**1.2 nm @ 100°T**	

Queen Charlotte Islands, West Coast

Langara Island	54 20N	133 15W	0.7 nm @ 215°T	**1.3 nm @ 095°T**	
Buck Point	53 10N	133 00W	0.6 nm @ 200°T	**0.7 nm @ 090°T**	
W of Kunghit I	52 00N	131 30W	0.4 nm @ 180°T	**0.6 nm @ 075°T**	

Offshore, near the 200 nm limit

	46 30N	129 00W	0.7 nm @ 065°T	0.7 nm @ 060°T	**0.7 nm @ 065°T**
	49 00N	133 00W	**0.4 nm @ 130°T**		
	51 30N	137 00W	0.5 nm @ 160°T	**1.8 nm @ 075°T**	
	54 00N	137 00W		**2.1 nm @ 095°T**	

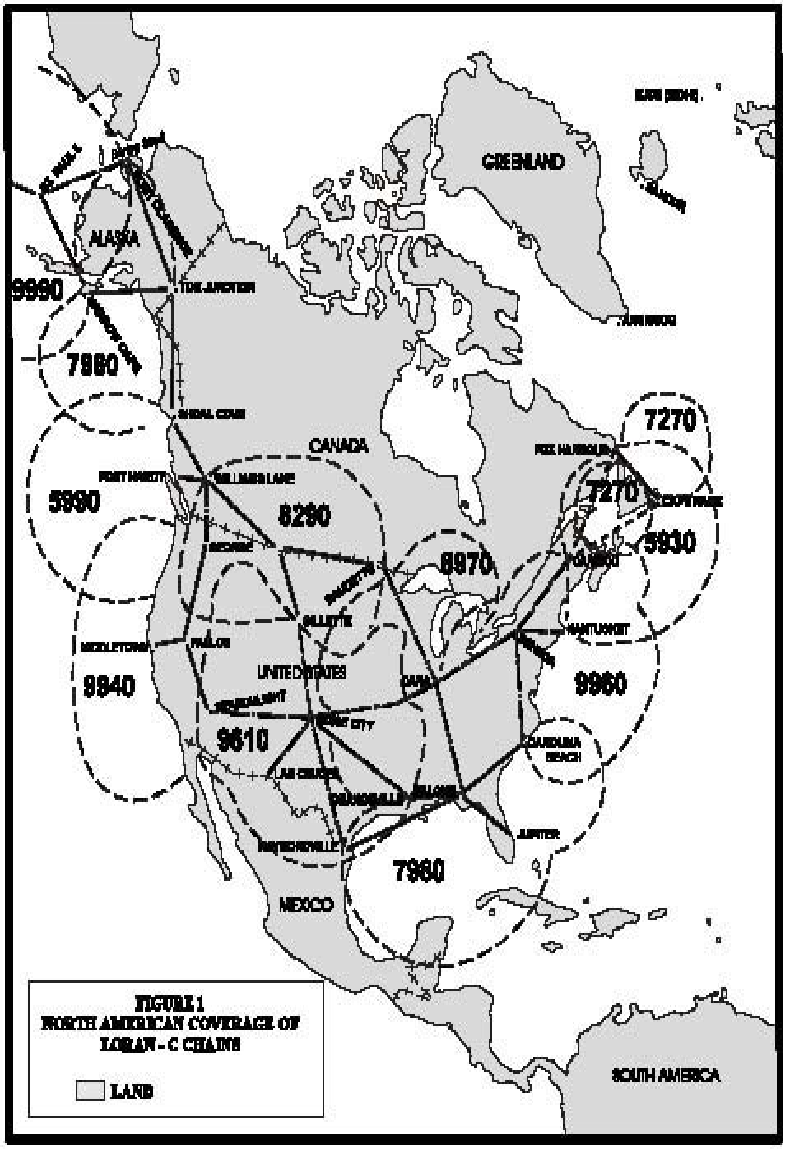
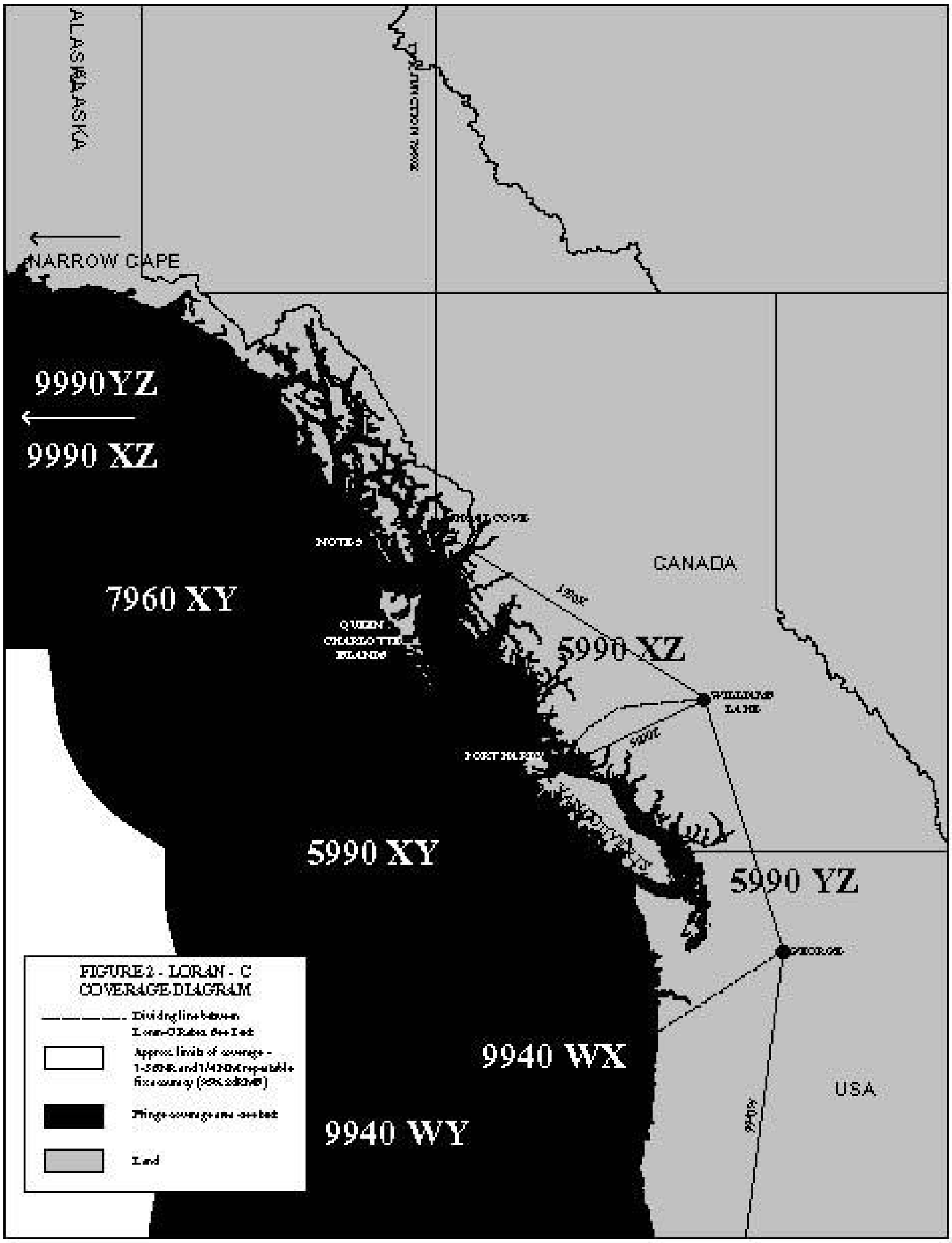
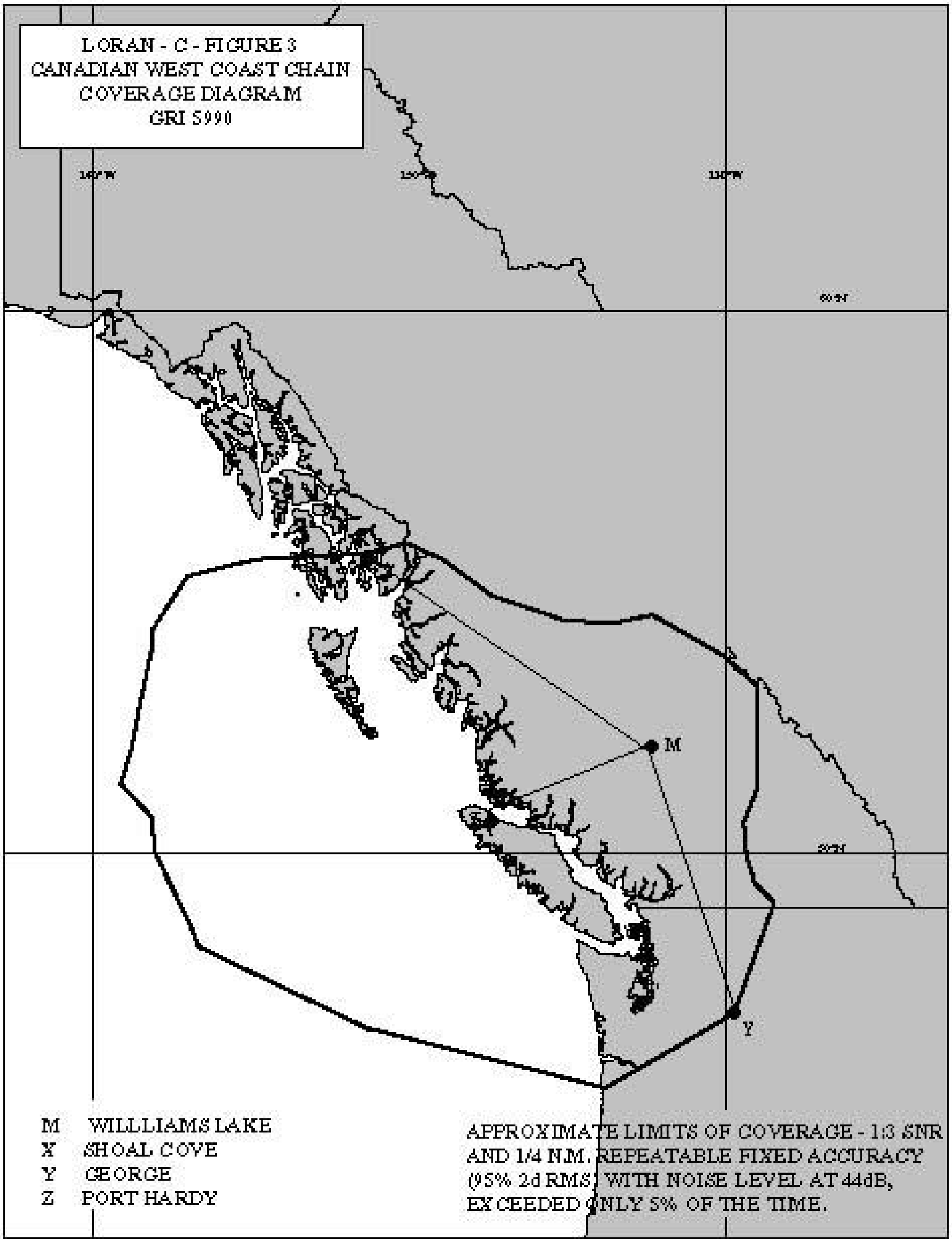


FIGURE 1
NORTH AMERICAN COVERAGE OF
LORAN - C CHAINS


ALASKA
NARROW CAPE
9990YZ
9990 XZ
7960 XY
CANADA
5990 XZ
5990 XY
5990 YZ
9940 WX
9940 WY
USA
FIGURE 2 - LORAN - C
COVERAGE DIAGRAM
Land


LORAN - C - FIGURE 3
CANADIAN WEST COAST CHAIN
COVERAGE DIAGRAM
GRI 5990
M
Y
M WILLLIAMS LAKE
X SHOAL COVE
Y GEORGE
Z PORT HARDY
APPROXIMATE LIMITS OF COVERAGE - 1:3 SNR
AND 1/4 N.M. REPEATABLE FIXED ACCURACY
(95% 2d RMS) WITH NOISE LEVEL AT 44dB,
EXCEEDED ONLY 5% OF THE TIME.

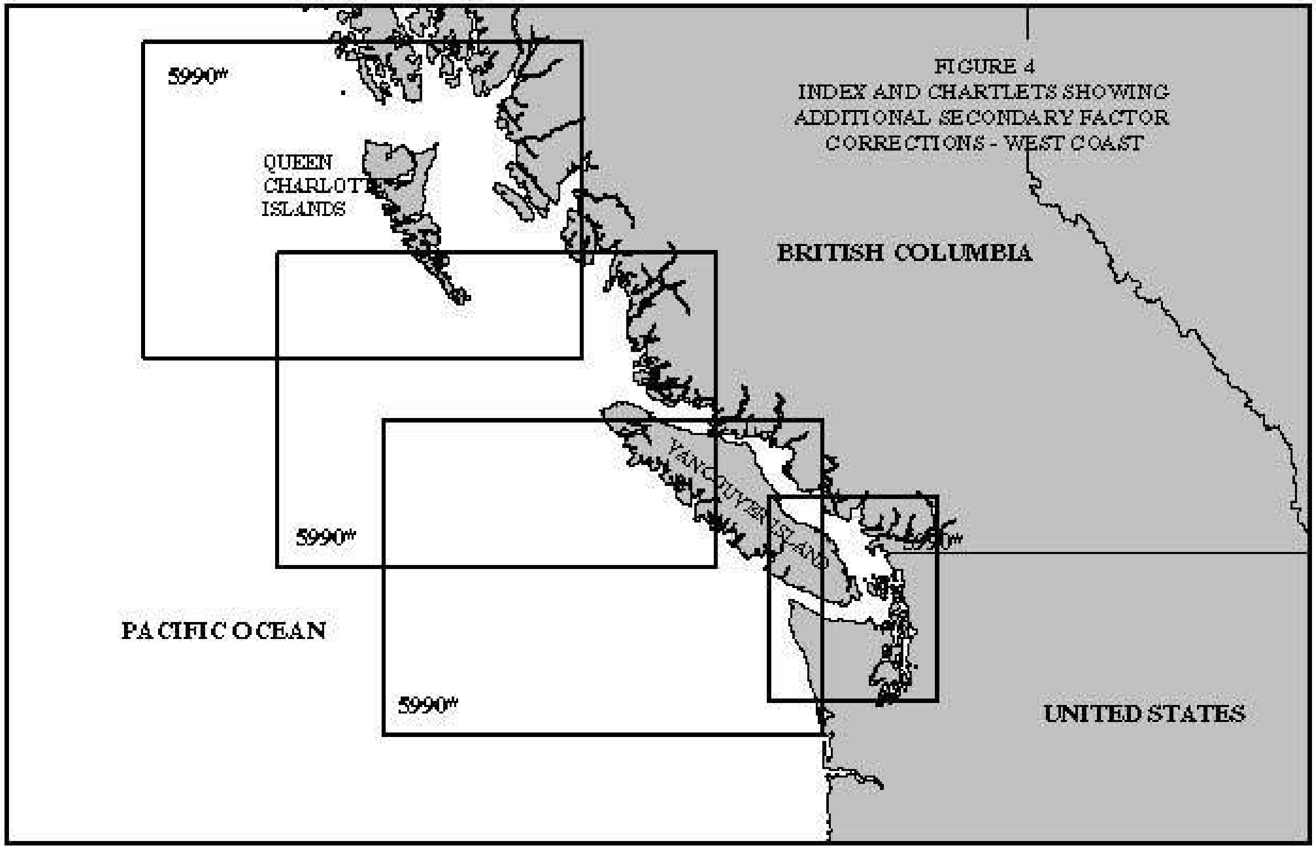


FIGURE 4
INDEX AND CHARTLETS SHOWING
ADDITIONAL SECONDARY FACTOR
CORRECTIONS - WEST COAST