DUAL RATING OF PORT CLARENCE

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ABSTRACT

The loran station at Port Clarence, part of the North Pacific Chain (9990) has been dual rated to the Gulf of Alaska Chain (7960), to provide improved loran navigation over the central portion of Alaska. The operation of the second rate started in April, 1987, but the Coast Guard claims it will not be ready to be used for navigation for over a year, until some time in 1988. Monitoring of the signal over a period of nearly five months has shown that the signal is quite stable and useful for use in an important area. The paper questions the Coast Guard's reluctance to authorize use of the signal for navigation.

INTRODUCTION

The General Aviation community in the state of Alaska has been an entusiastic user and supporter of the loran system. The state has been served by two chains, the North Pacific chain, 9990, and the Gulf of Alaska chain, 7960. Unfortunately for the aviation community, the chains were planned with only the marine users in mind. This results in a "mid-state gap" in Alaska analagous to the notorious "mid continent gap" in the lower 48. Figure 1 shows the coverage, and the area in which the loran coverage is marginal.

The idea of dual rating the loran station at Port Clarence, Alaska (9990-Y) to the Gulf of Alaska chain, 7960, in order to improve the loran coverage especially over the central portion of the state of Alaska was first suggested seriously to a meeting of the Alaska Airmen's Association in December of 1984. The prospect of improved loran navigation over central Alaska was enthusiastically received, and the proposal received attention in the Anchorage press as well as in the aviation groups.

The idea was simple enough - merely add an additional AN/FPN-54 timer to the AN/FPN-42 transmitter at Port Clarence, synchronized to the Gulf of Alaska chain, 7960. The chain had only two secondaries, so there was ample opportunity to add a Zulu secondary to the group. The monitor station at Kodiak was already controlling the Port Clarence - St Paul baseline (9990-Y) and the Narrow Cape - Tok baseline (7960-X), so it seems obvious that it could also control a Port Clarence - Tok baseline (7960-Z), given another receiver.

With help from Senator Ted Stevens of Alaska, and various people in the FAA, as well as the Alaska Airmen's Association and other friendly Alaskans, the Coast Guard finally allowed that the dual rating could be accomplished, at a price, and the resulting coverage might be useful. Money from the FAA was transferred to the Coast Guard for the installation of the additional equipment at Port Clarence and the additional monitor required.

TEST OPERATON

The new rate went on the air in April of 1987, designated 7960-T, with stern warnings from the Coast Guard that it should not be used for navigation until some time in 1988. Many people could not understand why it should take so long to tell whether or not the signal was usable, and a number of manufacturers had already produced software for airborne loran receivers to use the new secondary. At ARNAV, we produced a new test software version for the R-40, designated T411G, and offered it to a few selected users of the R-40 for the purpose of evaluation.

In order to get a full-time evaluation of the performance of the new station, a monitor was set up at Merrill Field in Anchorage, in the facilities of Aviation Electronics, under the supervision of Carl Warfield. The monitor consisted of an ARNAV R-40 loran receiver with T411G software, a Tandy Model 100 portable computer, and a printer. Every 72 seconds, a stream of data was output to the computer, consisting of all the information available on the loran display. The time differences were averaged, and every two hours the average values were printed out, along with instantantaneous values of the loran parameters and the calculated latitude and longitude. Figure 2 shows a sample data printout. The first line contains the computed latitude and longitude, the name of the waypoint, and its bearing and distance, in hundredths of nautical miles. The second line has, in order, oscillator offset, Master ECD, Master signal strength, Master SNR, X TD, X ECD, X signal strength, X SNR. The third line shows Y and Z TD, ECD, signal strength and SNR. All these are instantaneous values, taken at the time shown on line 6. Line 4 has the average TD values for each of the secondaries, 100 readings taken over the past two hours. Line 5 shows the max and min values going into the averages. Only the values for Z were examined for this paper.

MONITORING RESULTS

Monitoring started in earnest on May 6, 1987 and continued on an almost continuous basis through September of this year. There were a couple of interruptions which were the natural result of part-time attention to the monitor. Aside from that, the monitoring showed 99.5% good data, with the probability that, even during most of the remaining 0.5% of the time, the signal from Port Clarence was usable over most of the coverage area.

The results show some variation in the time difference at the Anchorage monitor, but nothing that would prevent it from being used for air navigation. This is sespecially true because it is not approved for IFR navigation under any circumstances.

Table 1 below shows the variation of the two-hour averages as recorded at the monitor from May through September. The numbers shown are the decimal microseconds of the 7960-T time differences. It can be seen that there is a gradual increase in the average TD over the measurement interval. This has not been checked against data from the monitor at Kodiak, but it is assumed that the TD at Kodiak is being held constant during this period.

INTERVAL	AVERAGE	MAXIMUM	MINIMUM
May 6-31	.439	.55	.28
Jun 1-15	.446	.60	.31
Jun 16-30	.523	.62	.29
Jul 1-15	.477	.59	.40
Jul 16-31	.492	.61	.37
Aug 1-16	.487	.66	.34
Aug 17-31	.562	.92	.42
Sep 1-15	.584	.86	.43

TABLE 1 STATISTICS OF TWO-HOUR AVERAGES
7960-T TD (MICROSECONDS)

Table 1 shows an upward drift of the average TD in the order of 150 nanoseconds over the 4 1/2 month period shown. This is not a surprising development, since numerous measurements in the Northeast states have shown temporal variations in propagation velocity. The question relevant to the prospective user is whether the changes seen produce significant changes in navigation capability. To get a better understanding of the significance of TD variations, an error map was generated for the area of interest, seen in Figure 3. This map shows the expected repeatable accuracy for the MXZ triad of 7960 from latitude 60 to 70 north and longitude 140 to 166 west. The computer printout produces a very distorted map for Alaska, so only a few key points are noted for the purpose of orientation. These are the three loran stations, M,X,Z, Kotzibue, K,

Anchorage, A, and Fairbanks, F. The numbers represent repeatable accuracy in hundreds of feet, and they predict very good accuracy in Anchorage, and good accuracy from Fairbanks to Kotzibue.

The key to the usefulness of the new rate is the ability to get good position fixes consistently. To evaluate this, the instantaneous postion fixes were taken and plotted, resulting in figures 4 through 9. The number at each position represents the number of times that lat/lon was read out on the 2-hourly printout. On each an ellipse is drawn approximating the 2 sigma contour, that is, it encloses 95% of the position fixes. It is apparent that there is very little shift in position fix, even with the time difference variation seen. This is, of course, partly due to the fact that Anchorage is nearly on the M-X baseline of 7960. M is about 235 nautical miles away, X is 240, while Port Clarence (Z) (T) is 520 miles over rugged mountains. This explains why the error ellipse is narrower in the direction of the X gradient. In any case, however, the error ellipse shows performance more than adequate for air navigation. The effective radius of the eror ellipse is approximately 30 meters.

CONCLUSIONS

The evidence from the monitoring reflects the reports from people who are (experimentally) using the Port Clarence signal for navigation. The signal availability is nearly as good as all the approved loran signals, and performance is far superior to the alternatives. It would seem that the Coast Guard could find ways to speed up the certificaton of the new rate.

ACKNOWLEDGEMENT

Special thanks are due Carl Warfield of Aviation Electronics, Anchorage, for doing the real work for this paper - collecting the data on which the paper is based.

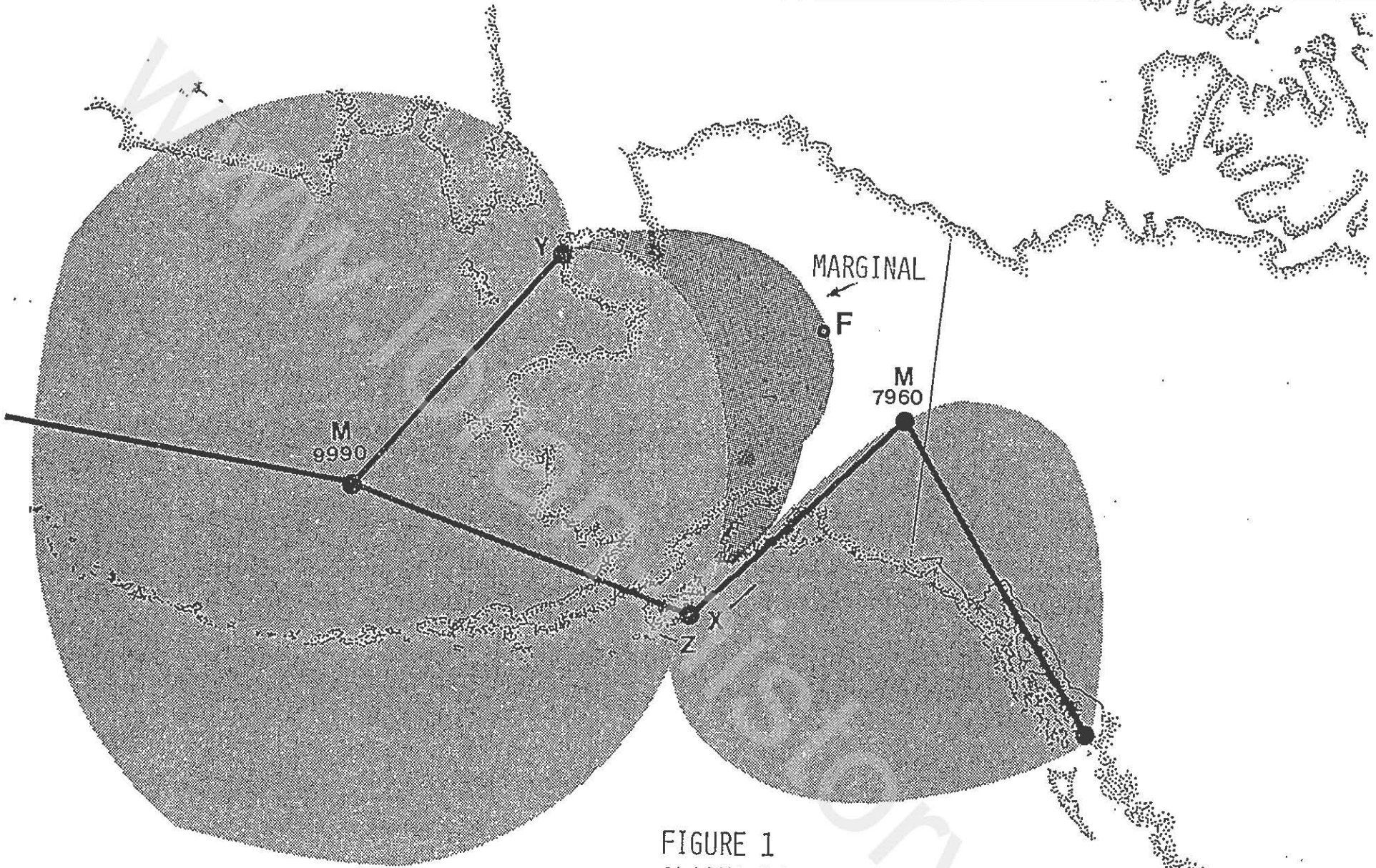

FIGURE 1
ALASKA LORAN
COVERAGE 1984

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09/15/92       23:54:09 KDT    100 SAMPLES


LAT N 61 1297 LON W 149 5127                  WP AVEL        BRG 0039       DIS 00011
TDV -022       E +23   S 70   SN 96   TD 1383667   E +24   S 75   SN 90
TD 3240250     E +02   S 64   SN 62   TD 4969538   E +12   S 65   SN 84
AVG. TDX=13836.0+ .615 AVG. TDY=32402.0+ .5745 AVG TDZ=49695.0+ .4883
X MAX= .72 X MIN= .49 Y MAX=-32402   Y MIN=-32402 Z MAX= .63    Z MIN= .36
09/16/92       01:56:32 KDT    100 SAMPLES


LAT N 61 1296 LON W 149 5126                  WP AVEL        BRG 0033       DIS 00011
TDV -020       E +22   S 70   SN 95   TD 1383747   E +23   S 74   SN 95
```

FIGURE 2 TYPICAL DATA PRINTOUT

PORT CLARENCE ESTIMATED ERROR

DEGREES LONGITUDE

DEGREES LATITUDE	167	166	165	164	163	162	161	160	159	158	157	156	155	154	153	152	151	150	149	148	147	146	145	144	143	142	141	140
70	14	12	11	10	9	8	8	7	7	6	6	6	5	5	5	4	4	5	6	6	7	8	8	9	10	11	13	14
	13	12	10	9	8	8	7	7	6	6	5	5	5	4	4	4	4	5	5	6	6	7	8	9	10	11	13	14
69	13	11	10	9	8	7	6	6	5	5	5	4	4	4	4	3	4	4	5	5	6	7	8	8	10	11	12	14
	12	10	9	8	7	6	6	5	5	5	4	4	4	3	3	3	4	4	5	5	6	6	7	8	9	11	12	15
68	12	10	8	7	6	6	5	5	4	4	4	3	3	3	3	3	3	4	4	5	5	6	7	8	9	10	12	15
	11	9	7	6	6	K 5	4	4	4	4	3	3	3	3	2	3	3	3	4	4	5	6	6	7	9	10	12	15
67	11	8	7	6	5	4	4	4	3	3	3	3	2	2	2	3	3	3	4	4	5	5	6	7	8	10	12	16
	10	7	6	5	4	4	4	3	3	3	3	2	2	2	2	2	3	3	3	4	4	5	6	7	8	10	13	17
66	10	6	5	4	4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3	4	4	5	6	8	10	13	19
	11	Z 5	4	4	3	3	3	3	2	2	2	2	2	1	2	2	2	2	3	3	3	4	5	6	7	10	15	
65	4	3	3	3	3	3	3	2	2	2	2	2	1	1	2	2	2	2	3	3	F 3	4	4	5	7	11	19	
	4	4	3	3	3	3	2	2	2	2	2	1	1	1	2	2	2	2	2	3	3	3	4	5	7	12	35	
64	4	4	3	3	3	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	3	3	3	4	6	20	53	
	4	4	3	3	3	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	3	3	3M	5	15	13	
63	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	14	999	
	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	6	12	
62	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	5	8	
	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	A 2	2	2	2	3	3	4	5	7	
61	5	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	5	6	
	5	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	5	6	
60	5	4	4	4	3	3	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	3	3	4	5	6	
59																												
58																												

X

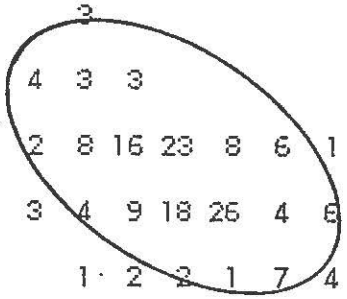
FIGURE 3 7960 MXZ ACCURACY MAP

LONGITUDE W 149 51.XX

39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20

PORT CLARENCE AT ANCHORAGE MAY 1987

!---------- 100 M ----------!



LAT N 61 12.XX																					
2																				0	
1																				4	4
0	99	---						1		3										4	4
		!																			
	98	!							2	4	3	3					1			13	17
	97	1							1	2	8	16	23	8	6	1				65	82
		0																			
	96	0								3	4	9	18	26	4	6	3			73	155
	95	M									1	2	2	1	7	4	3			20	175
	94	!																	1	1	176
		---																1		1	177
	93																				
	92																				
								1	3	9	19	30	43	35	17	11	6	1	1	0	1	177
							0	1	4	13	32	62	105	140	157	168	174	175	176	176	177

FIGURE 4

LONGITUDE W 149 51.XX

39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20

PORT CLARENCE AT ANCHORAGE JUN 1987

!------- 100 M ----------!

LAT N61 12.XX

2																					
1																					
0																				0	
99	---				1														1	1	
98	!					2	2	4	4	2	1	1							16	17	
97	1					1	3	8	17	16	24	12	6						87	104	
96	0							1	9	10	46	36	25	5	3				135	239	
95	M							1		1	4	12	9	4	5				36	275	
94	!														2				2	277	

93																					
92																					
						1	3	5	14	30	29	75	61	40	9	10			277		
				0	1	4	9	23	53	82	157	218	258	267	277						

FIGURE 5

LONGITUDE W 149 51.XX

39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20

PORT CLARENCE AT ANCHORAGE JUL 1987

!---------- 100 M ----------!

LAT N 61 12.XX

2																					
1																					
0																					
99	---																				0
98	!					1			1											2	2
97	1						2	10	17	24	17	6								76	78
	0																				
96	0						4	9	22	40	54	37	16	3	1					186	264
95	M							1	5	8	12	16	14	4		1	2			63	327
94	!													1						1	328

93																					
92																					
						1	6	20	45	72	83	59	30	8	1	1	2			328	
					0	1	7	27	72	144	227	286	316	324	325	326	328				

FIGURE 6

LONGITUDE W 149 51.XX

PORT CLARENCE AT ANCHORAGE AUG 1987

!---------- 100 M ----------!

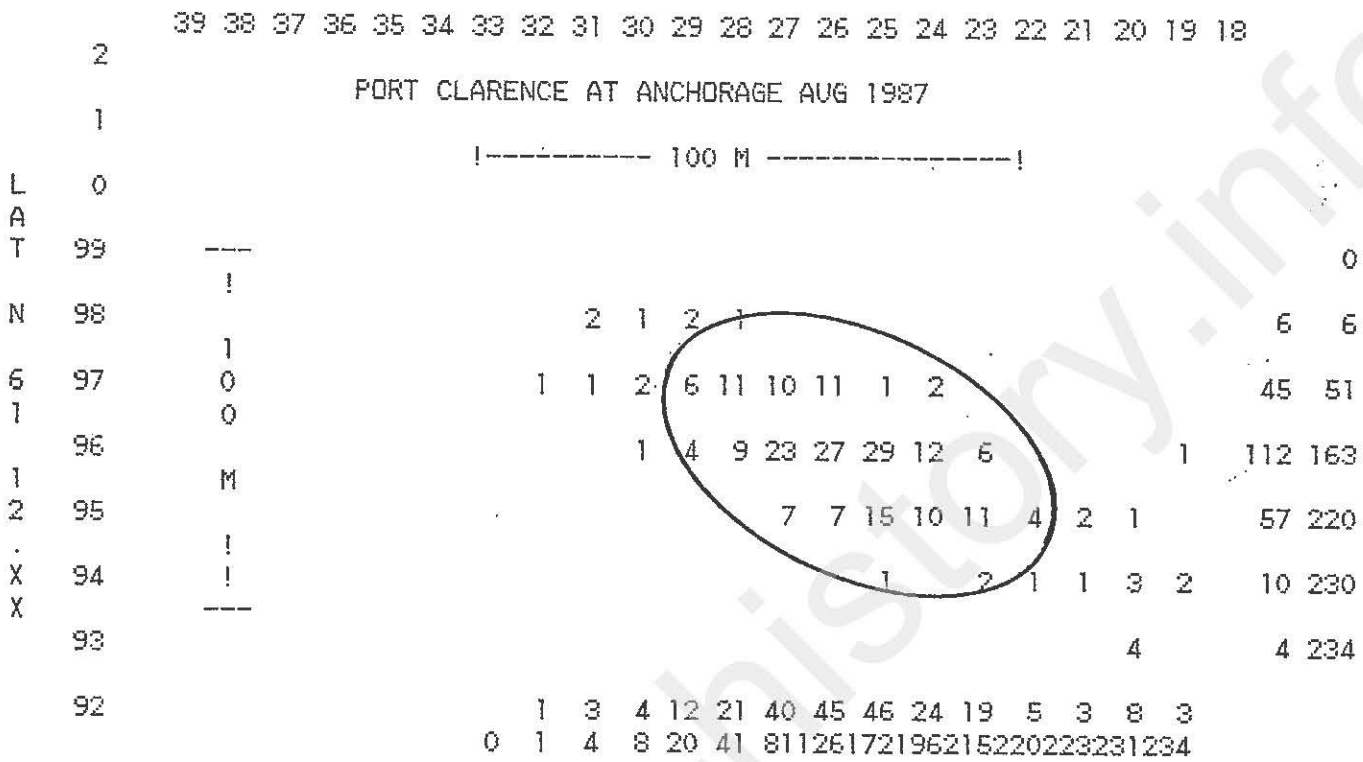


FIGURE 7

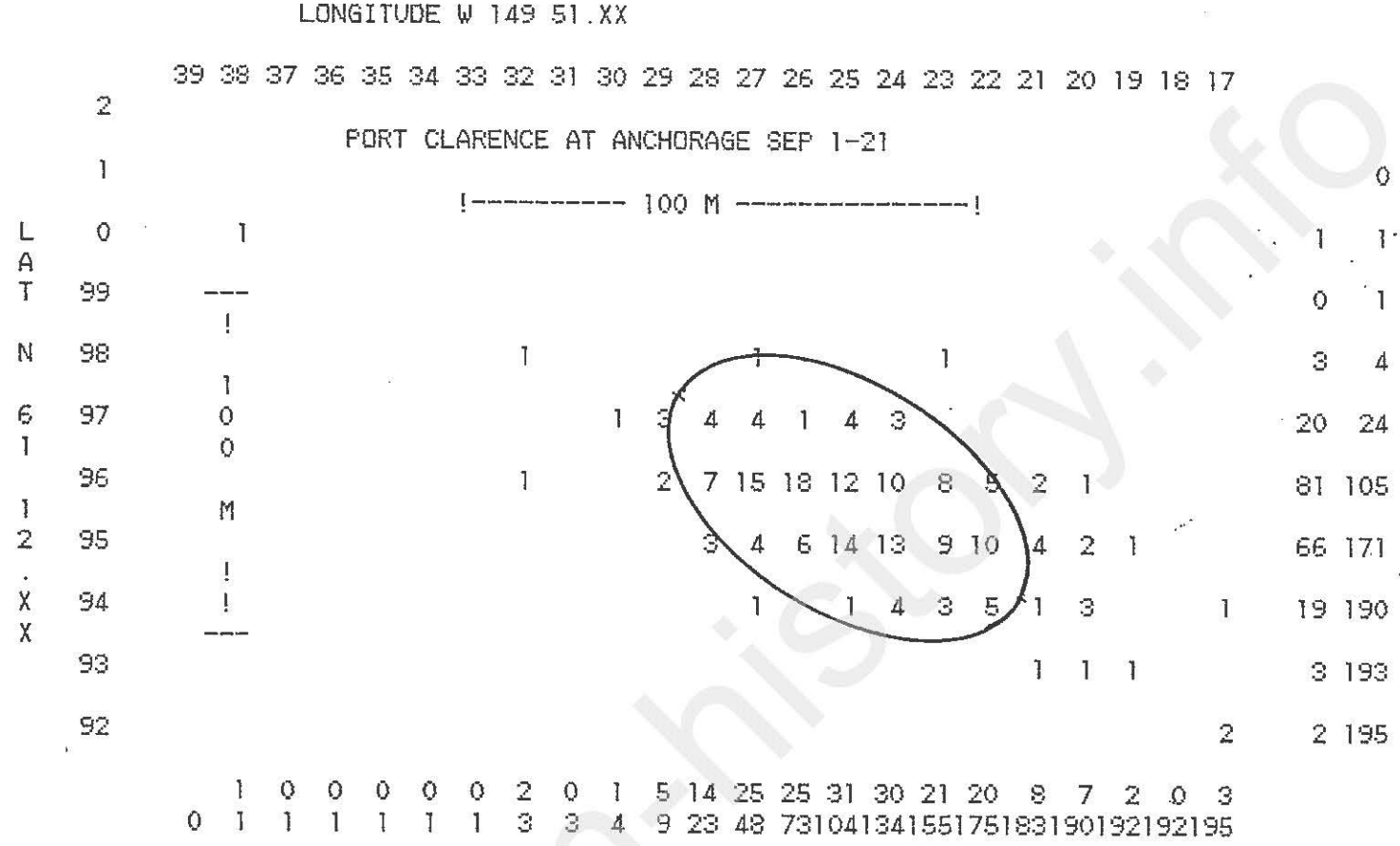


FIGURE 8

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                          LONGITUDE W 149 51.XX

                 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17
      2
                             PORT CLARENCE AT ANCHORAGE MAY - SEP 1987
      1                                                                                  0
                                     !---------- 100 M --------------!
L     0        1                                                                     1   1
A
T    99      ---                 2        3                                          5   6
               !
N    98                              5  9  8  7  4  2           1                   36  42
               1
6    97        0                     3  6 21 52 71 70 47 18  5                     293 335
1              0
     96                              1  3 10 33 66150139109 46 20  6  2  1  1      587 922
1              M
2    95                                    2  3 11 24 44 58 44 29 14  7  5  1      242 1164
.              !
X    94        !                                     1     2  4  8  6  2  7  2   1 33 1197
X            ---
     93                                                          1  1  5  1         8 1205

     92                                                                          2  2 1207

                   1  0  0  0  0  2  9 18 44 95152247230187 99 58 27 12 18  5  0  3
                0  1  1  1  1  1  3 12 30 741693215687989 85************************
                                                             841421691811992204204207
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FIGURE 9