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TOWED ARRAY PERFORMANCE PREDICTION
SYSTEM - VERSION 1.2

SAI-82-535-WA

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TOWED ARRAY PERFORMANCE PREDICTION SYSTEM - VERSION 1.2

SAI-82-535-WA

July 1981

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Final Rept.

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ABSTRACT

Several software enhancements to the Towed Array Performance Prediction System (TAPPS) are described. A technical discussion of the changes is given, and the implementation and testing of the software modifications on the Nova 820 computer are documented. The latest software is denoted as TAPPS Version 1.2.

An interim improved treatment of bottom loss, denoted as interim Bottom-Loss Upgrade (BLUG) is discussed. A set of six new bottom-loss classes and associated bottom-loss curves for the Indian Ocean, and new bottom-loss curves in the other ocean areas are presented. These changes have been fully integrated with the TAPPS propagation-loss model (FACT), as well as the TAPPS Noise Model.

A new surface-duct propagation-loss model is a refinement and extension of Labianca's virtual mode results. The results of Spofford and Ryan had previously been used to develop a replacement model for the Clay Surface-Duct Model within FACT. The implementation of these results in TAPPS are discussed.

The TAPPS shipping-noise data base has been extended to include the Indian Ocean and the capability to handle data in the southern hemisphere has been provided for.

A Rough Surface-Loss Model in FACT and other miscellaneous TAPPS software modifications are also discussed.

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Section 1
INTRODUCTION

The Towed Array Performance Prediction System (TAPPS) was developed under the Naval Ocean Research and Development Activity (NORDA) sponsorship, during the years 1976 to 1979. It was designed as a seagoing minicomputer system to provide Fleet personnel with estimates of towed array performance and to advise tactical decision makers concerning the selection of such parameters as ship speed, course, array depth, and search frequency.

TAPPS was developed using state-of-the-art modeling techniques and data bases, as they existed in 1977. However, during the last four years new acoustical models and oceanographic data bases were developed by the scientific community. Specifically, an interim Bottom-Loss Upgrade (BLUG) and a new Surface-Duct Propagation-Loss Model (SDUCT) were developed and implemented at the Fleet Numerical Oceanography Center (FNOC) in Monterey, California. These enhancements became an integral part of the CDC 6600 version of the FACT Propagation-Loss Model. Since TAPPS also uses FACT (modified to run on the Nova 800 computer), the decision to include these enhancements in TAPPS was made.

During the course of implementing interim BLUG and SDUCT within TAPPS several other areas for model improvement were identified and included in the current effort. This included Ambient Noise Data Base Improvements, Rough-Surface Losses within FACT, and four program "bugs". TAPPS with all of these improvements has been designated TAPPS Version 1.2. A previous version of TAPPS (Version 1.1) was fully documented in References 1 through 7. This report discusses only those features unique to TAPPS Version 1.2. Program listings for TAPPS Version 1.2 are available in References 8 and 9.

Section 2

SOFTWARE ENHANCEMENTS - TECHNICAL DISCUSSION

This section discusses the technical issues related to the TAPPS software enhancements.

2.1 INTERIM BOTTOM-LOSS UPGRADE (BLUG)

TAPPS Version 1.1 used two sets of bottom-loss classes to make acoustic propagation-loss and ambient-noise predictions. For low frequencies (below 1000 Hz), estimates were based on a set of three curves of loss versus grazing angle applied over specific frequency bands. The three curves are assigned based on a data base of bottom classes (1, 3 or 4) which covers most of the northern hemisphere at 1-degree intervals. These classes and associated bottom loss curves are actually a consolidation of five classes developed in 1970 (Reference 10). For high frequencies (above 1000 Hz), a set of ten classes/curves were used based on Reference 11. The TAPPS Version 1.1 bottom-class data base and bottom-loss curves were essentially the same as those used at FNOC, Monterey, except that no interpolation was performed between 1000 and 1500 Hz to smooth out potential discontinuities in acoustic predictions.

Further improvements to the approach used previously by FNOC and in TAPPS Version 1.1 were developed in 1980 and implemented at FNOC (Reference 12). First, a new geographic assignment of the three low frequency classes was developed as a result of the recognition that bottom loss appeared to correlate with sediment thickness. The three classes (still designated 1, 3 and 4) were retained as somewhat representative of measured data from poor, moderate and high-reflectivity areas. However, as more bottom-loss data yielded to interpretation in terms of geo-acoustic models, and comparisons of model predictions with measured data reinforced these interpretations, a new set of curves was developed based upon geo-acoustic modeling and data interpretation to go with the three areas of different sediment thickness. The high frequency classes/curves were not modified.

Finally, recent work by Applied Research Laboratories (ARL) and SAI has produced a set of six low-frequency bottom classes and associated bottom-loss curves (designated 1-6) for the Indian Ocean (Reference 13). These bottom-loss improvements were also implemented at FNOC, Monterey during 1980.

TAPPS has subsequently been modified to include most of the interim BLUG features currently available at FNOC. The new low-frequency bottom-class assignment for the Indian Ocean (Figures 1 and 2) have been implemented. Also, new bottom loss versus grazing angle functions (BTMLOS, BTMHF and BTMLF) were written to include the new 1, 3, 4 class curves (Atlantic, Pacific and Mediterranean) and the 1-6 class curves (Indian Ocean). In order to distinguish between the two sets of curves, a preprocessor maps classes 1, 3, 4 and 1-6 into classes 1-3 and 4-9, respectively. An interpolation routine was written to smooth out discontinuities between the low and high frequency predictions.

9	000	00000	00000	00000	55555	66666	11111	11111	16666	55055	55222	22222	25655	35555
8	000	00000	00000	00000	55444	66666	61111	11111	15665	55555	05222	22222	55565	55555
7	000	00000	00000	00005	54444	66666	66611	11111	55665	55555	05111	11111	55565	55555
6	000	00000	00000	00005	54446	56666	66611	11116	55665	55555	05111	11111	51165	55555
5	000	00000	00000	00055	54464	55666	66666	66666	65665	55555	55111	11115	51165	55555
4	000	00000	00000	00555	54464	55666	66666	66666	65665	55551	11111	11115	51155	55055
3	000	00000	00000	05555	44644	55666	66666	66666	65665	55551	11111	11115	51115	55005
2	000	00000	00000	55555	44444	45566	66666	66666	65565	55551	11111	11115	51111	15550
1	000	00000	00005	55555	44444	45556	66666	66666	65560	55511	11111	11115	51111	15550
0	000	00000	00555	55555	44445	55555	66666	66666	65565	55511	11111	11115	11111	11555
-1	000	00000	00000	55554	44445	55555	56666	66666	66665	55511	11111	11115	51111	51550
-2	000	00000	05555	55544	44455	55555	55666	66666	66665	55511	11111	11115	11111	15155
-3	000	00000	55555	54444	44555	55555	55566	66666	66665	55511	11511	11115	51111	11515
-4	000	00000	55555	44444	45555	55555	55556	66666	66665	55511	11511	11115	51111	11151
-5	000	00000	55555	44444	55555	55555	55556	66666	66665	55511	11511	11115	11111	11115
-6	000	00000	55555	44445	55555	55555	55555	66666	66665	55511	11111	11155	11111	11115
-7	000	00000	55554	44444	45555	55555	55555	66666	66665	55555	55555	55555	11111	11115
-8	000	00000	55554	44444	55555	55555	55555	66666	66665	55555	55555	55555	55551	11111
-9	000	00000	55555	45554	55555	55555	55555	66666	66665	55555	55555	55555	55555	55111
10	000	00000	55555	45555	55555	55556	66666	66666	66665	55555	55555	55555	55555	75555

30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

Figure 1: Indian Ocean Bottom Loss Class File (INDABLP)

29	000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000
28	000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000
27	000	00000	00000	00000	00000	05500	00000	00000	00000	00000	00000	00000	00000	00000
26	000	00000	00000	00000	00000	05500	00000	00000	00000	00000	00000	00000	00000	00000
25	000	00000	00000	00000	00000	05555	555[illegible]5	55500	00000	00000	00000	00000	00000	00000
24	000	00000	00000	00000	00000	05555	55555	55500	00000	00000	00000	00000	00000	00000
23	000	00000	00000	00000	00000	00553	33335	55550	00000	00000	00000	00000	00000	00000
22	000	00000	00000	00000	00000	00000	33555	55555	50550	00000	00000	00055	55500	00000
21	000	00000	00000	00000	00000	00005	35522	55555	50550	00000	00000	00555	55500	00000
20	000	00000	00000	00000	00000	00555	35222	25255	55550	00000	00000	55555	55550	00000
19	000	00000	00000	00000	00000	00553	52222	22225	55550	00000	00000	55555	55500	00000
18	000	00000	00000	00000	00000	05533	52222	22225	55550	00000	00005	52222	22255	00000
17	000	00000	00000	00000	00000	55555	22222	22222	55550	00000	50552	22222	22255	05500
16	000	00000	00000	00000	00555	55555	22222	22222	55550	00000	05522	22222	22255	05500
15	000	00000	00000	00000	00555	66555	22111	12222	56555	00000	55522	22222	22255	55500
14	000	00000	00095	00005	556[illegible]6	66661	11111	11111	56666	00000	52222	22222	22555	55550
13	000	00000	00006	00666	66555	56661	11111	11111	56666	00000	52222	22222	22555	55550
12	000	06000	00666	66666	66666	66611	11111	11111	56666	60005	52222	22222	22655	65550
11	000	00000	00666	66666	06666	66611	11111	11111	56665	50005	52222	22222	22653	35550
10	000	00000	00555	55000	05555	56666	11111	11111	16665	55005	52222	22222	22653	3555[illegible]
	3[illegible]	35	40	45	50	55	60	65	70	75	[illegible]	85	[illegible]	[illegible]

Figure 2: Indian Ocean Bottom Loss Class File (INDBBLP)

Figures 3 through 11 show the new bottom loss versus grazing angle curves for classes 1-9.

The current bottom loss curves and areas must be viewed as an interim improvement, since a more substantial change will be installed at FNOC within the next year.

Function BTMLOS is called in TAPPS by both the FACT propagation-loss model as well as the ambient-noise prediction model. Also, constants defining critical grazing angle versus bottom class were also modified to be consistent with the new BTMLOS function.

2.2 SURFACE-DUCT MODEL UPGRADE

TAPPS Version 1.1 used the Clay model within FACT for surface-ducted propagation (Reference 14). While the Clay model was recognized to have certain deficiencies, an efficient alternative was not available. The model had an over-simplified depth dependence and the wrong dependence of leakage from the duct on environmental parameters.

Following a series of evaluations which identified the short-comings of the Clay model, SAI proceeded to develop a substantially improved Surface-Duct Model based largely on the work of Labianca (Reference 15), Spofford (Reference 16), and Ryan (Reference 17).

The Surface-Duct Model is designed to compute the relative incoherent intensity level from a point source in a canonical bilinear duct. The approach used in the new model

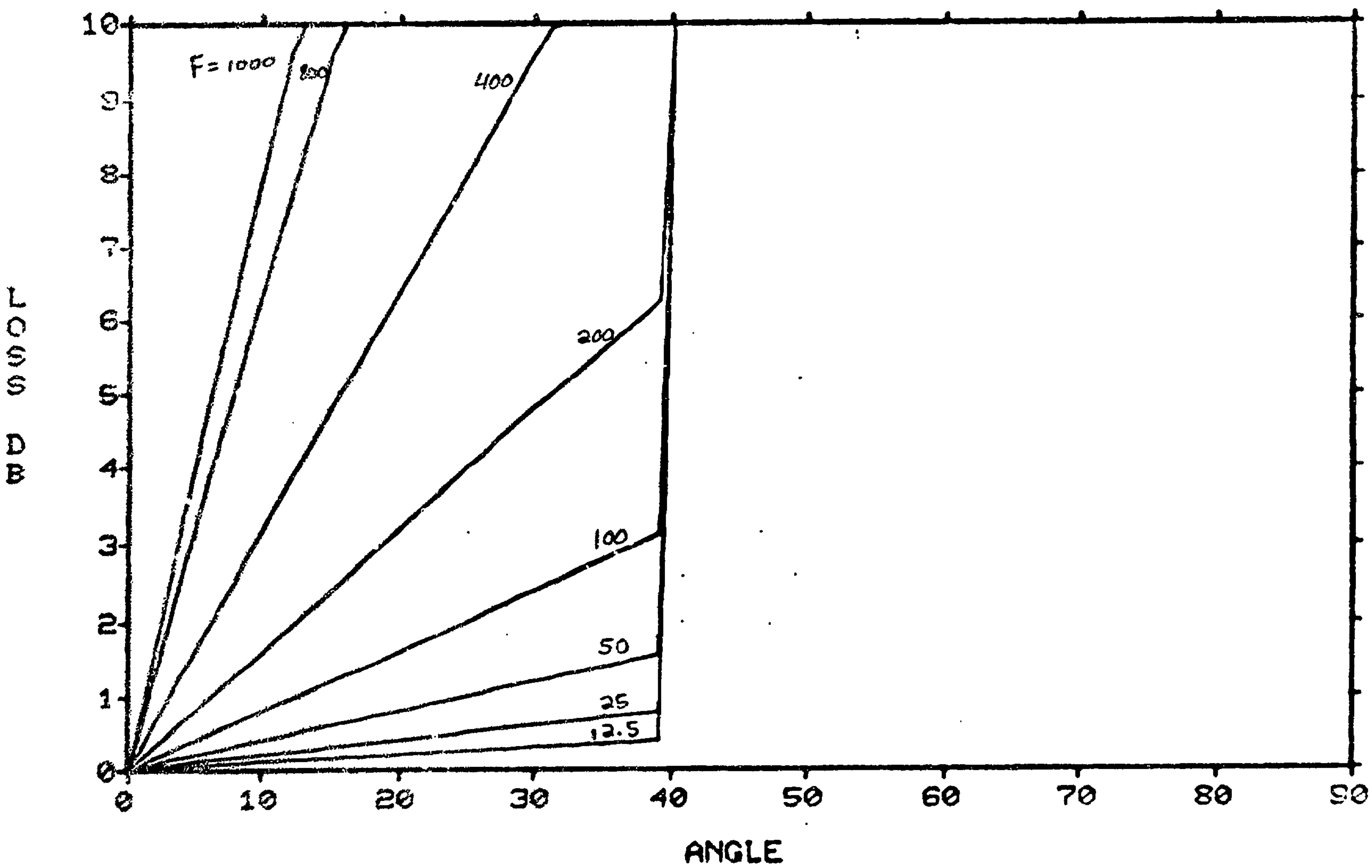

Figure 3: Bottom Loss Curves (Class 1)

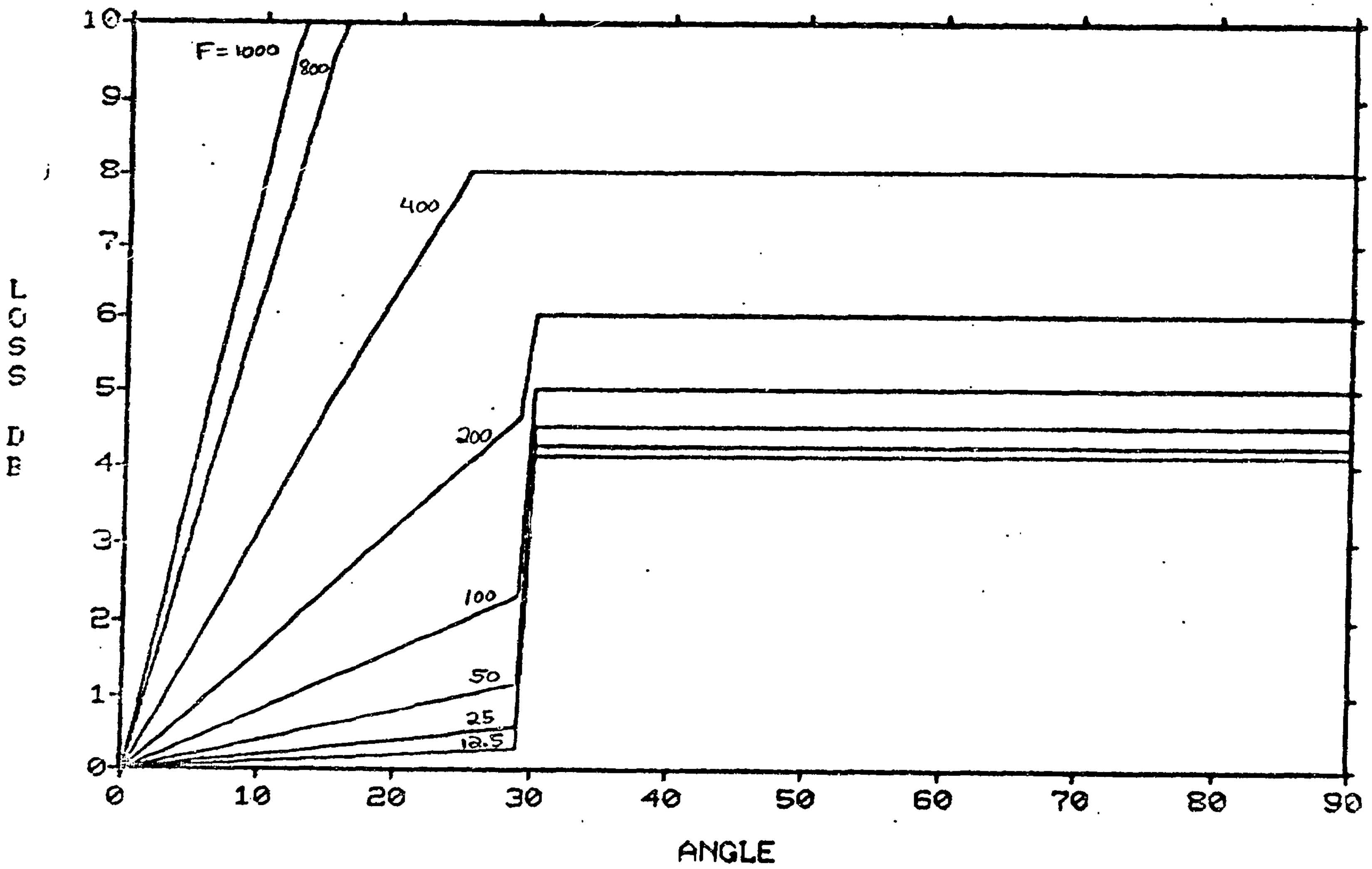

Figure 4: Bottom Loss Curves (Class 2)

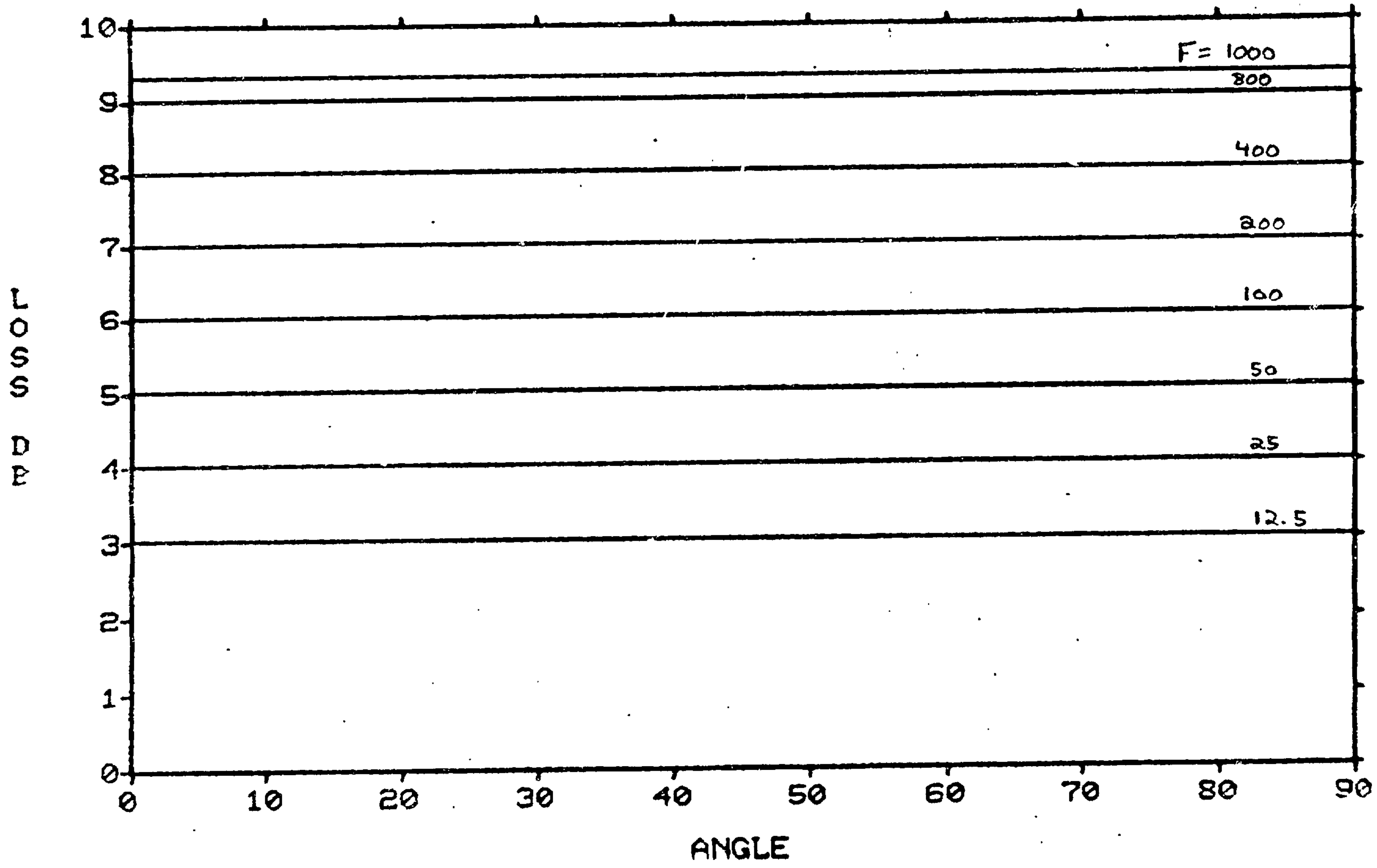

Figure 5: Bottom Loss Curves (Class 3)

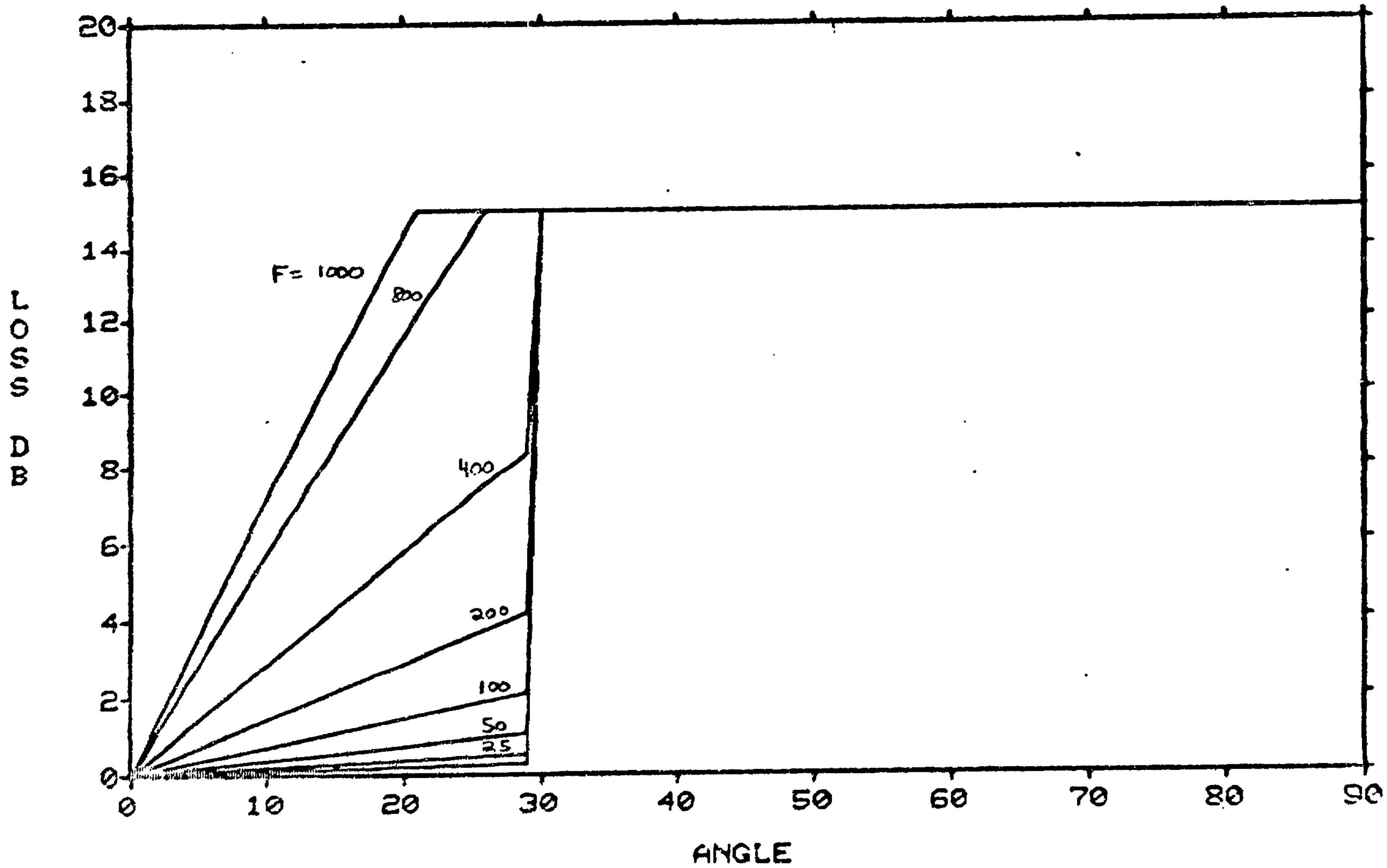

Figure 6: Bottom Loss Curves (Class 4)

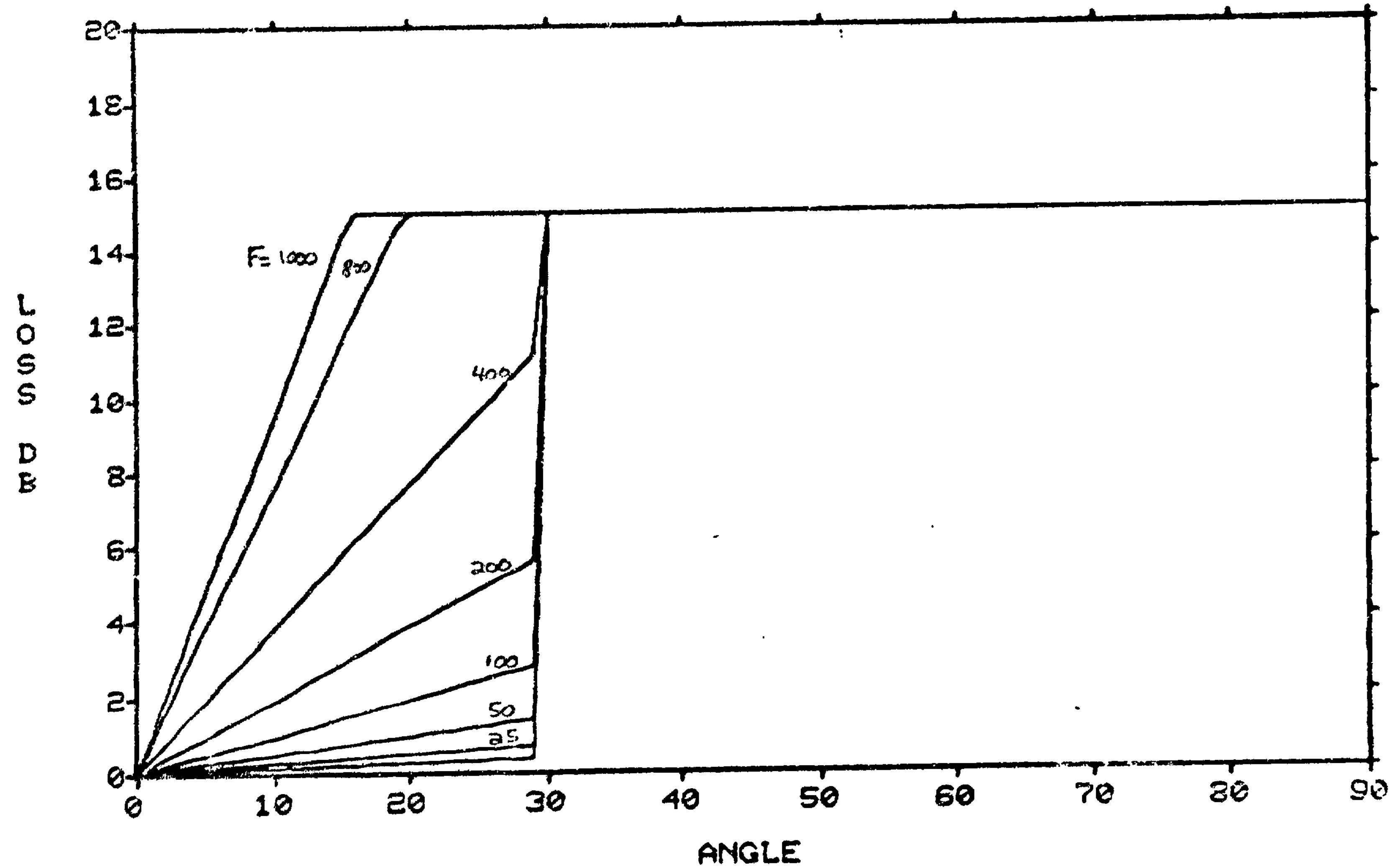

Figure 7: Bottom Loss Curves (Class 5)

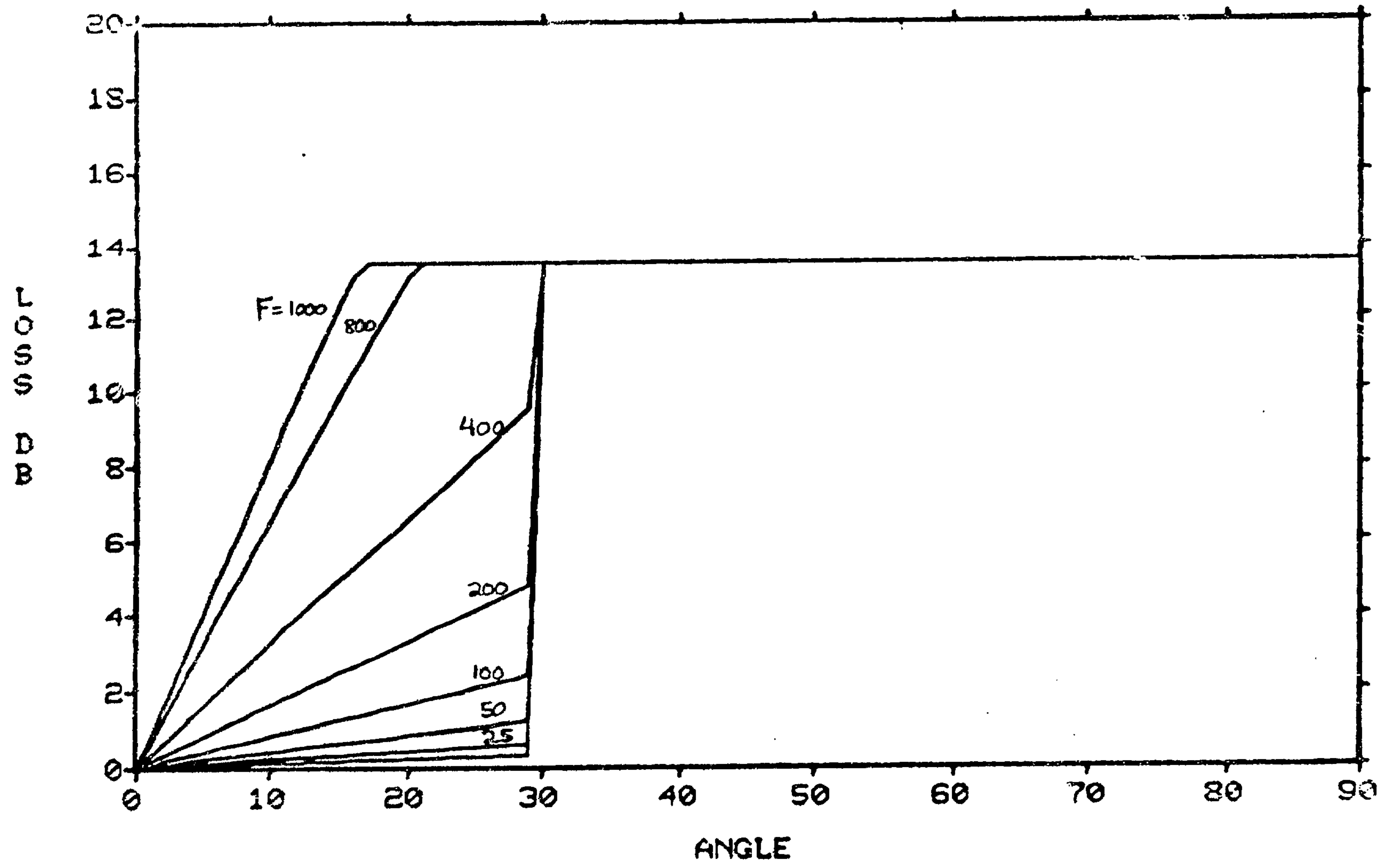

Figure 8: Bottom Loss Curves (Class 6)

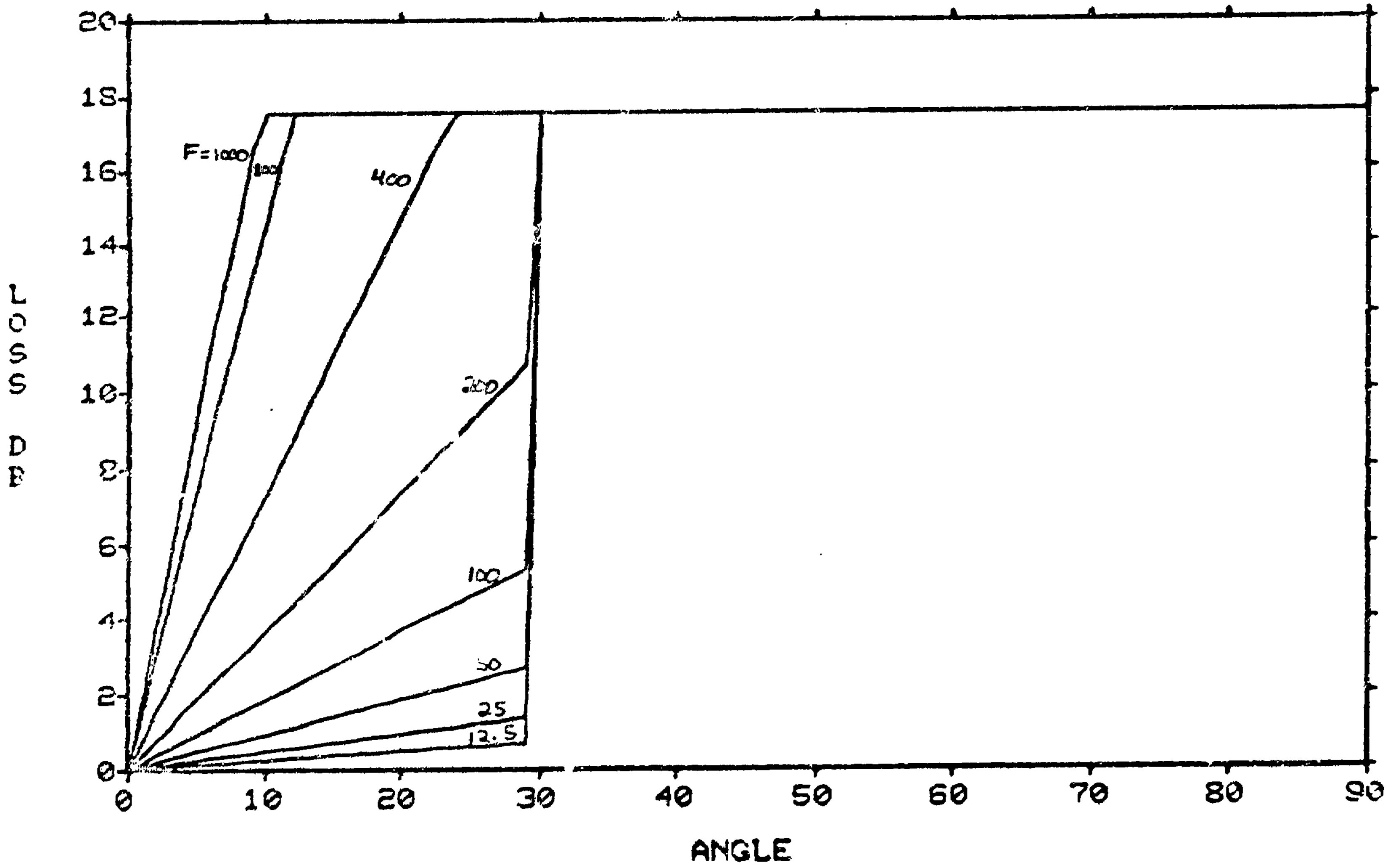

Figure 9: Bottom Loss Curves (Class 7)

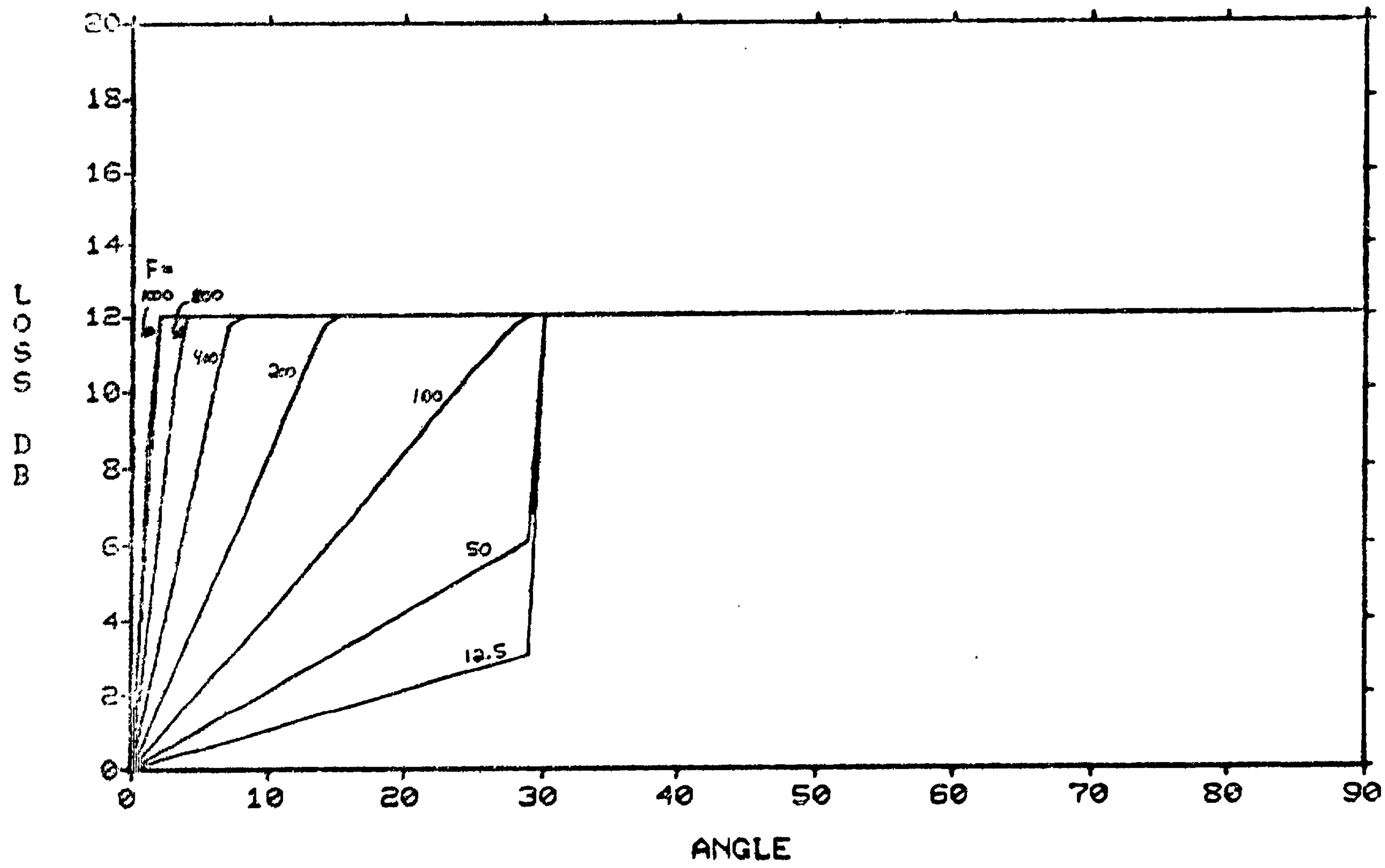

Figure 10: Bottom Loss Curves (Class 8)

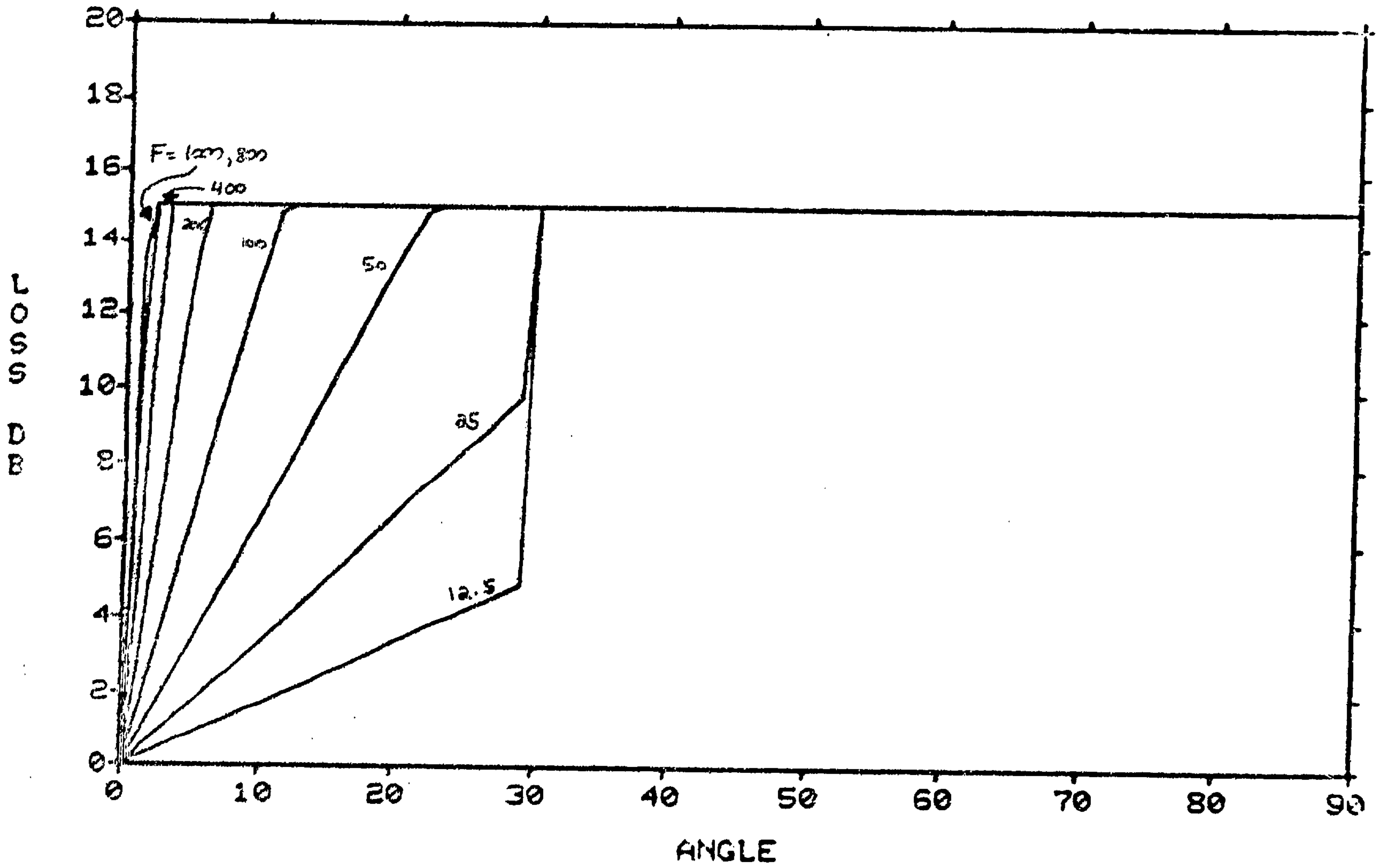

Figure 11: Bottom Loss Curves (Class 9)

is a refinement and extension of Labianca's virtual mode results to include modes near cutoff as well as leaky modes.

Rough surface-reflection losses are computed in a separate module (see Section 2.4) as a function of the ray's surface grazing angle, wave height and frequency.

The integration of the new Surface-Duct Model required the development of a preprocessor to transform the surface-duct portion of the sound speed profile into a three point (bilinear) profile. A routine (SDINIT) was developed to perform this function as well as error checking.

2.3 AMBIENT NOISE UPGRADE

TAPPS Version 1.1 contains average shipping-noise levels for each five-degree square in the northern hemisphere from 0 to 75 degrees North. Although provision was made to include the Indian Ocean in this data base, this portion of the file was left empty due to the lack of data at the time the file was created (1977). Recently several sources of noise measurements in the Indian Ocean have become available (References 18, 19 and 20). Hence, the decision to extend the TAPPS shipping noise file (ANFILE) to include the Indian Ocean was made.

The noise measurements were for 16 separate areas in the Indian Ocean, and were typically time and frequency averaged measurements at relatively deep depths (at least 300 feet). This minimized the possibility of contamination by surface-image interference and other dynamic effects.

The data base was derived by overlaying on a single grid the basic noise measurement levels, shipping density (low, medium and high), and areas with depth excess. Regions with no depth excess were denoted by the bottom class (low, medium or high). Based on all of these factors, areas with no noise measurements were filled in by interpolation/extrapolation. Values were determined for each five-degree square in the Indian Ocean from 10°S to 30°N. This was necessary to be consistent with the existing water-mass/bottom-class files in TAPPS which cover these same locations.

The existing ANFILE was expanded to include the southern hemisphere, and provision to access the southern hemisphere portion of the file was made by modifying subroutine SHPSR. Although only a small section of the Indian Ocean uses the southern hemisphere, future modifications to include other areas of the world can now be made with minimal effort. Several points in the Mediterranean were found to be in error and corrected.

The revised ANFILE is shown in Figure 12. The first half of the file contains the northern hemisphere and the second half the southern hemisphere.

2.4 ROUGH-SURFACE LOSS UPGRADE

A routine to compute rough surface losses was developed based on Reference 21.

The surface loss is computed as:

0E	79	0	0	0	0	0	0	100	0	90	95	80	75	80
5W	81	0	0	0	0	0	95	95	90	90	90	82	82	87
10W	84	85	0	0	0	89	90	94	95	94	90	82	80	74
15W	75	81	87	87	87	83	80	83	87	89	88	78	78	69
20W	75	75	78	79	85	85	90	82	88	92	84	80	74	69
25W	78	86	91	75	82	80	78	79	83	93	85	80	78	74
30W	77	85	82	83	82	81	77	79	90	93	91	85	78	74
35W	78	82	81	80	81	0	80	88	91	90	89	84	83	69
40W	76	76	75	74	76	80	79	91	92	86	88	81	70	0
45W	77	78	76	75	75	79	85	91	92	89	86	79	0	0
50W	0	78	74	73	85	88	89	90	92	90	87	81	79	0
55W	0	77	77	75	87	90	85	92	92	90	0	79	82	82
60W	0	0	85	86	91	82	89	93	94	90	0	80	78	73
65W	0	0	89	89	90	88	86	92	94	0	0	0	0	0
70W	0	0	90	90	87	92	85	95	95	0	0	0	0	0
75W	0	0	91	89	90	87	87	0	0	0	0	0	0	0
80W	80	84	0	0	0	0	0	0	0	0	0	0	0	0
85W	80	84	82	79	0	0	0	0	0	0	0	0	0	0
90W	77	79	85	0	0	0	0	0	0	0	0	0	0	0
95W	77	78	81	0	0	0	0	0	0	0	0	0	0	0
100W	72	72	80	83	0	0	0	0	0	0	0	0	0	0
105W	72	72	73	82	82	0	0	0	0	0	0	0	0	0
110W	75	72	73	73	81	81	0	0	0	0	0	0	0	0
115W	80	75	76	73	78	83	77	0	0	0	0	0	0	0
120W	77	78	73	73	78	80	85	84	0	0	0	0	0	0
125W	72	79	76	73	77	74	86	87	81	84	83	0	0	0
130W	72	72	77	73	74	79	84	85	83	83	83	79	0	0
135W	72	72	72	76	74	79	82	86	83	84	85	79	0	0
140W	69	72	72	78	74	81	81	85	80	84	83	80	0	0
145W	69	69	72	77	79	78	81	81	84	83	83	80	0	0
150W	69	69	72	78	81	79	82	82	84	83	82	78	0	0
155W	69	72	72	73	81	80	80	80	83	84	80	75	0	0
160W	72	72	72	72	81	83	79	82	83	85	83	75	0	0
165W	72	75	72	72	76	83	81	81	83	86	73	75	71	65

Figure 12: Shipping Level File (ANFILE)

170W	72	72	72	73	76	83	80	81	84	87	72	85	70	65
175W	72	72	72	73	77	80	80	81	83	86	83	83	65	0
180W	72	72	72	75	75	81	80	80	85	87	78	83	65	0
175E	69	69	72	75	75	75	80	81	80	84	88	83	83	0
170E	69	69	72	78	75	81	81	82	85	88	83	70	0	0
165E	69	72	72	78	78	81	83	82	85	88	82	65	0	0
160E	72	72	78	78	81	83	83	84	88	85	69	65	0	0
155E	77	83	82	82	82	85	84	85	88	82	72	72	0	0
150E	72	76	84	83	83	85	90	89	81	78	65	65	0	0
145E	69	79	73	75	76	83	87	85	79	76	69	69	0	0
140E	72	72	79	75	75	78	83	80	77	76	0	69	0	0
135E	75	75	76	81	81	84	81	80	78	0	0	0	0	0
130E	76	74	81	84	87	84	80	78	0	0	0	0	0	0
125E	76	76	77	79	84	81	79	80	0	0	0	0	0	0
120E	73	78	79	85	81	0	0	0	0	0	0	0	0	0
115E	79	83	85	82	80	0	0	0	0	0	0	0	0	0
110E	85	85	76	77	0	0	0	0	0	0	0	0	0	0
105E	80	83	76	0	0	0	0	0	0	0	0	0	0	0
100E	85	81	80	78	0	0	0	0	0	0	0	0	0	0
95E	90	90	85	80	78	0	0	0	0	0	0	0	0	0
90E	100	100	90	82	78	0	0	0	0	0	0	0	0	0
85E	95	90	85	79	0	0	0	0	0	0	0	0	0	0
80E	95	75	75	0	0	0	0	0	0	0	0	0	0	0
75E	85	95	97	95	95	0	0	0	0	0	0	0	0	0
70E	85	90	92	92	95	95	0	0	0	0	0	0	0	0
65E	75	85	90	90	95	95	0	0	0	0	0	0	0	0
60E	85	90	90	88	102	105	0	0	0	0	0	0	0	0
55E	90	90	98	95	100	100	0	0	0	0	0	0	0	0
50E	90	90	95	0	0	95	0	0	0	0	0	0	0	0
45E	90	0	95	95	0	0	0	0	0	0	0	0	0	0
40E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35E	0	0	0	0	0	0	95	95	0	0	0	0	0	0
30E	0	0	0	0	0	0	95	95	0	0	0	0	0	0
25E	0	0	0	0	0	0	92	92	0	0	0	0	0	0
20E	0	0	0	0	0	0	90	95	90	0	0	0	0	0

Figure 12 (Continued): Shipping Level File (ANFILE)

15E	0	0	0	0	0	0	87	95	83	0	0	0	0	0
10E	71	0	0	0	0	0	0	90	90	0	0	0	80	80
5E	78	0	0	0	0	0	0	97	94	0	93	88	80	80
0E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150W	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 12 (Continued): Shipping Level File (ANFILE)

155W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180W	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100E	85	85	0	0	0	0	0	0	0	0	0	0	0	0
95E	85	85	0	0	0	0	0	0	0	0	0	0	0	0
90E	95	85	0	0	0	0	0	0	0	0	0	0	0	0
85E	90	85	0	0	0	0	0	0	0	0	0	0	0	0
80E	85	80	0	0	0	0	0	0	0	0	0	0	0	0
75E	80	75	0	0	0	0	0	0	0	0	0	0	0	0
70E	75	75	0	0	0	0	0	0	0	0	0	0	0	0
65E	75	75	0	0	0	0	0	0	0	0	0	0	0	0
60E	85	75	0	0	0	0	0	0	0	0	0	0	0	0
55E	90	85	0	0	0	0	0	0	0	0	0	0	0	0
50E	90	90	0	0	0	0	0	0	0	0	0	0	0	0
45E	90	90	0	0	0	0	0	0	0	0	0	0	0	0
40E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35E	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30E	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 12 (Continued): Shipping Level File (ANFILE)

```
 25E   0  0  0  0  0  0  0  0  0  0  0  0  0  0
 20E   0  0  0  0  0  0  0  0  0  0  0  0  0  0
 15E   0  0  0  0  0  0  0  0  0  0  0  0  0  0
 10E   0  0  0  0  0  0  0  0  0  0  0  0  0  0
  5E   0  0  0  0  0  0  0  0  0  0  0  0  0  0
ANFILE CREATED
STOP

>>
```

Figure 12 (Continued): Shipping Level File (ANFILE)

$$SURLOS = (e^{-G})^{NB}$$

where

NB = number of surface reflections

$G = (WH^2/8)\,(4\pi F/5000)^2 \sin^2\theta$

WH = wave height (ft)

F = frequency (Hz)

θ = grazing angle at surface

The parameter G is limited to a maximum of $\log_e(10)$, to limit SURLOS to a maximum of 10 dB per surface reflection.

2.5 MISCELLANEOUS MODIFICATIONS

Several minor software bugs were discovered during the course of software testing. Fixes for these problems are discussed in Section 3.5.

Section 3
SOFTWARE IMPLEMENTATION NOTES

This section summarizes the software modifications required to implement the enhancements discussed in Section 2. The revised program listings, load maps, etc. are not included due to the large number of pages involved (References 8 and 9). They are available at either Science Applications, Inc. (McLean, VA) or at Analysis and Technology (North Stonington, CT).

A summary of the source-code modifications is shown in Table 1. Almost all of the TAPPS overlays are affected by the software modifications. A further breakdown and discussion of the program modifications is contained in Sections 3.1 to 3.5. Tables 2 and 3 contain the latest TAPPS master disks maps as of 16 June 1981.

3.1 INTERIM BOTTOM-LOSS UPGRADE (BLUG) SOFTWARE MODIFICATIONS

3.1.1 TAPPS BLUG Software Modifications

INPUTOV:SR Ocean areas 1-4 are defined to distinguish between the Pacific (1), Atlantic (2), Mediterranean (3) and Indian Ocean (4). Ocean areas 1-3 use bottom classes 1-3 and ocean area 4 now uses classes 4-9. A call to Function IBCON is made to unpack, reset and pack the bottom class variable IB based on ocean area. Unused code was removed to make room for the latest changes.

TABLE 1

Software Modification Summary

TAPPS OVERLAY	BLUG	SDUCT	AN	SURFACE LOSSES	MISCELLANEOUS BUGS
AN	M,S		S		
FACTL1	M,S	M			
FACTL2	S	M		M,S	
FACTL3	M,S	M,S		S	
INIT02					L
INIT12					L
INPUT					
INPUTOV	M,S				S
INTR					
MEASOV	M		S		S
MEASUR	M,S				
MIZR					
OACV	S				
ODEBUG					
OFOM	S				
OGDEPOV					
OMBC	S				
ONDB	S				S
OOUT	S				
OSBC	S				
OSDB	S				S
OSEX	S				
OTLS	S				
PREOPT					
SONO	M,S		S		
STLSS					
TAPPS	S				

Key: M - Main program modified
S - Subroutine called from overlay modified
L - Loader file modified

LS ..DP1,2

(FREE)	1946	
(USED)	12401	
(TOTAL)	14347	
AN:LD	1	
AN:SR	22	D
ANFCREAT:LD	1	B
ANFCREAT:SR	2	
ANFILE:SR	37	
ANTEST:SR	3	
ATLAS	12	
ATLSHIP:SR	10	B
BTGRAPH:RB	6	
BTGRAPH:SR	7	D
BTMLOS:RB	14	
BTMLOS:SR	14	
DBLIB	124	
DBLIB:LD	1	
DBLIB:SR	63	
DCRTTST	31	B
DFMCPY	10	B
DFMCPY:AB	7	B
DFMDIAG	23	B
DIAADR	1	B
DIACKB:2	1	B
DIACKB:3	3	B
DIACKB:4	4	B
DIADCM:RD	1	B
DIADCM:WT	1	B
DIADCT	5	B
DIADCTLD	1	B
DIADISK	12	B
DIAEXEC	13	B
DIAINST	13	B
DIALOG	14	B

TABLE 2

TAPPS Version 1.2 Master Disk Map (Source)

DIATAPE	25	B
DIATELET	10	B
DSPLY	132	D
DSPLY:LD	1	D
DSPLY:SR	73	D
EASMB	33	B
EDIT	14	B
EGLIB	112	D
EGLIB:LD	1	D
EGLIB:SR	74	D
EGLSFIT:RB	3	
EGLSFIT:SR	5	
EGSDCOM:RB	5	
EGSDCOM:SR	4	
EGSDINIT:RB	10	
EGSDINIT:SR	14	
EGSDINM	46	
EGSDINM:LD	1	
EGSDINM:SR	3	
EGSDMAIN	161	
EGSDMAIN:LD	1	
EGSDMAIN:SR	17	
EGSDOLD:RB	5	
EGSDOLD:SR	3	
EGSDPLOT	174	
EGSDPLOT:LD	1	
EGSDUCT:RB	40	
EGSDUCT:SR	64	
EGSLOSS:RB	3	
EGSLOSS:SR	3	
EGSLSMN	40	
EGSLSMN:LD	1	
EGSLSMN:SR	2	
EGTLOUT:RB	6	
EGTLOUT:SR	4	

TABLE 2 (Continued)

TAPPS Version 1.2 Master Disk Map (Source)

EGTLPLT:RB	11	
EGTLPLT:SR	5	
ERLDR	16	B
ERROR:RB	3	
ERROR:SR	2	D
EXECP:SR	34	D
FACT	63	
FACT:LD	1	
FACT:SR	13	
FACTLIB1	164	
FACTLIB1:LD	1	
FACTLIB1:SR	372	
FACTLIB2	157	
FACTLIB2:LD	1	
FACTLIB2:SR	400	
FACTLIB3	114	
FACTLIB3:LD	1	
FACTLIB3:LX	1	
FACTLIB3:SR	132	
FACTL1:LD	1	
FACTL1:SR	55	
FACTL2:LD	1	
FACTL2:SR	143	
FACTL3:LD	2	
FACTL3:SR	12	
FASMB:AB	34	B
FCOMP	77	B
FLIB	247	B
GETENV:RB	22	
GETENV:SR	21	D
GETTGT:RB	12	
GETTGT:SR	11	D
GOIT0000:SR	1	
GSONAR:RB	65	B
GSONAR:SR	44	B

TABLE 2 (Continued)

TAPPS Version 1.2 Master Disk Map (Source)

IECON:RE	3	
IECON:SR	5	
INDAINP	4	B
INDAOUT	11	B
INDBINP	4	B
INDBOUT	11	B
INIT:LD	2	
INIT02:SR	17	D
INIT12:SR	17	D
INPUT:LD	1	
INPUT:SR	75	
INPUTOV:LD	1	
INPUTOV:SR	76	D
INTR:LD	1	
INTR:SR	15	D
JLGLIB	157	D
JLGLIB:LD	1	D
JLGLIB:SR	124	D
LSBTM:LD	1	
LSBTM:SR	3	
LSCBLP:LD	1	
LSCBLP:SR	11	
LSDBLOS:LD	1	
LSDBLOS:SR	6	
LSDBLP:LD	1	
LSDBLP:SR	7	
LSIBTEST:SR	1	
LSLIB	5	
LSLIB:LD	1	
LSLIB:SR	6	
MEASOV:LD	1	
MEASOV:SR	72	D
MEASUR:LD	1	
MEASUR:SR	53	D
MEDSHIP:SR	16	B

TABLE 2 (Continued)

TAPPS Version 1.2 Master Disk Map (Source)

MERGE:RB	6	
MERGE:SR	6	D
MIDR:LD	1	
MIDR:SR	77	D
NOISE:RB	71	
NOISE:SR	110	
NSLIB	115	
NSLIB:LD	1	D
NSLIB:SR	55	
OACV:LD	1	
OACV:SR	14	D
ODBCM	2	
ODEBUG	100	
ODEBUG:LD	1	
ODEBUG:SR	23	D
ODEBUGS	105	
OFOM:LD	1	
OFOM:SR	13	D
OGDEPOV:LD	1	
OGDEPOV:SR	4	D
OMBC:LD	1	
OMBC:SR	14	D
ONDB	162	
ONDB:LD	1	
ONDB:SR	7	D
OOUT:LD	1	
OOUT:SR	7	D
OPRIN	107	D
OPRIN:LD	1	D
OPRIN:SR	64	D
OSBC:LD	1	
OSBC:SR	14	D
OSDB	167	
OSDB:LD	1	
OSDB:SR	10	D

TABLE 2 (Continued)

TAPPS Version 1.2 Master Disk Map (Source)

WILSON:SR	2	B
WSF1:LD	1	D
WSF1:SR	26	D
WSF4:LD	1	D
WSF4:SR	21	D
WSF5:LD	1	D
WSF5:SR	16	D
WSF6:LD	1	D
WSF6:SR	16	D
WSF7:LD	1	D
WSF7:SR	16	D
XFDRGN	11	B
XFEXGN	42	B
XFLBGN	11	B
XFLDGN	15	B
XFMNGMIN	44	B
XFMNGNTA	56	B
XNTERP:RB	3	B
XNTERP:SR	3	B
XNTF:RB	2	B
XNTF:SR	2	B
YDMOTAPP:AC	1	D
YDMOTAPP:IN	14	D
YDMOTAPP:OU	14	D
YDMOTAPP:SU	104	D
YDMOTAPP:TL	66	D
Z999EDIT:IM	12	
Z999FCMP:IM	152	
Z999FCMP:RB	55	

>>

TABLE 2 (Continued)

TAPPS Version 1.2 Master Disk Map (Source)

```
LS :DP0,S
(FREE)        1152
(USED)       13175
(TOTAL)      14347
AM             123
AM:LD            1
AMFILE          13 B
ATLABLP         11 B
ATLAFAL         56 B
ATLASPR         56 B
ATLASUM         56 B
ATLAWIN         56 B
ATLBBLP          6 B
ATLBFAL         33 B
ATLBSPR         33 B
ATLBSUM         33 B
ATLBWIN         33 B
ATLCBLP         11 B
ATLCFAL         62 B
ATLCSPR         62 B
ATLCSUM         62 B
ATLCWIN         62 B
ATLDBLP         10 B
ATLDFAL         55 B
ATLDSPR         55 B
ATLDSUM         55 B
ATLDWIN         55 B
ATLEBLP          5 B
ATLEFAL         26 B
ATLESPR         26 B
ATLESUM         26 B
ATLEWIN         26 B
ATLSHIP          4 B
DFMCPY          10 B
EDIT            14 B
```

TABLE 3

TAPPS Version 1.2 Master Disk Map (Load)

EPLDR	16	B
EXECP	55	
FACT	63	
FACT:LD	1	
FACTL1	146	
FACTL1:LD	1	
FACTL2	167	
FACTL2:LD	1	
FACTL3	157	
FACTL3:LD	2	
FACTL3:LX	2	
FACT01:AC	1	
FACT11:AC	1	
FACT14:AC	1	
FACT331:AC	1	
FACT333:AC	1	
FACT334:AC	1	
FACT431:AC	1	
FACT432:AC	1	
FASMB:AB	34	B
FCOMP	77	B
ICIN	14	
ICOUT	14	
INDABLP	11	B
INDABLP:OL	11	B
INDAFAL	47	B
INDASPR	47	B
INDASUM	47	B
INDAWIN	47	B
INDBBLP	11	B
INDBBLP:OL	11	B
INDBFAL	42	B
INDBSPR	42	B
INDBSUM	42	B
INDBWIN	42	B

TABLE 3 (Continued)

TAPPS Version 1.2 Master Disk Map (Load)

INDSHIP	2	B
INIT:LD	2	
INIT02	3	
INIT12	3	
INPUT	216	
INPUT:LD	1	
INPUTOV	203	
INPUTOV:LD	1	
INPUTOV:LX	1	
INTR	156	
INTR:LD	1	
MEASOV	141	
MEASOV:LD	1	
MEASUR	144	
MEASUR:LD	1	
MEDBLP	6	B
MEDFAL	24	B
MEDSHIP	6	B
MEDSPR	24	B
MEDSUM	24	B
MEDWIN	24	B
MIZR	147	
MIZR:LD	1	
MIZR:LX	1	
NSMS	1	
OACV	162	
OACV:LD	1	
ODBCM	0	
ODEBUG	100	
ODEBUG:LD	1	
ODEBUGS	0	
OFOM	154	
OFOM:LD	1	
OGDEPOV	61	
OGDEPOV:LD	1	

TABLE 3 (Continued)

TAPPS Version 1.2 Master Disk Map (Load)

OGDEPSV	152	
OMEC	163	
OMEC:LD	1	
OMDB	163	
OMDB:LD	1	
OOUT	176	
OOUT:LD	1	
OSBC	161	
OSBC:LD	1	
OSDB	167	
OSDB:LD	1	
OSEX	165	
OSEX:LD	1	
OTLS	146	
OTLS:LD	1	
OXXX:LD	6	
PACABLP	11	B
PACAFAL	56	B
PACASPR	56	B
PACASUM	56	B
PACAWIN	56	B
PACBBLP	10	B
PACBFAL	53	B
PACBSPR	53	B
PACBSUM	53	B
PACBWIN	53	B
PACCBLP	10	B
PACCFAL	51	B
PACCSPR	51	B
PACCSUM	51	B
PACCWIN	51	B
PACDBLP	7	B
PACDFAL	50	B
PACDSPR	50	B
PACDSUM	50	B

TABLE 3 (Continued)

TAPPS Version 1.2 Master Disk Map (Load)

PACDWIN	50	B
PACEBLP	11	B
PACEFAL	54	B
PACESPR	54	B
PACESUM	54	B
PACEWIN	54	B
PACFBLP	11	B
PACFFAL	63	B
PACFSPR	63	B
PACFSUM	63	B
PACFWIN	63	B
PACGBLP	11	B
PACGFAL	62	B
PACGSPR	62	B
PACGSUM	62	B
PACGWIN	62	B
PACSHIP	4	B
PACSHIP:SR	12	B
PREOPT	112	
PREOPT:LD	1	
RPFE	12	B
SF1:DT	5	B
SONO	166	
SONO:LD	1	
STLSS	65	
STLSS:LD	1	
TAPPS	51	
TAPPS:LD	1	
TAPPS:LX	1	
TAPPS01:AC	1	
TAPPS02:AC	1	
TAPPS03:AC	1	
TAPPS04:AC	1	
TGTFL	4	B
TLDRIV	210	

TABLE 3 (Continued)

TAPPS Version 1.2 Master Disk Map (Load)

```
TLFILE            136
TOW:DT              1  B
TOW1:DT             1  B
Z999EDIT:IM         1
Z999FCMP:IM         0
Z999FCMP:RB         0
Z999TASS:IM         2

>>
```

TABLE 3 (Continued)

TAPPS Version 1.2 Master Disk Map (Load)

AN:SR The array STHC was increased in size from 3 to 9 to handle the new Indian Ocean classes 4-9. Values for STHC, the sin of the critical grazing angle, were redefined to be consistent with the new bottom-loss curves incorporated in Function BTMLOS. The new critical angles are defined for classes 1 to 9 to be 40, 30, 0, 30, 30, 30, 30, 0 and 0 degrees, respectively.

MEASUR:SR The size of the array STHC was increased from 3 to 9 (see AN:SR).

MEASOV:SR The size of the array STHC was increased from 3 to 9 (see AN:SR).

FACTL1:SR The critical grazing angle (THETMB) in FACT was redefined as 0.5 radians for all bottom classes. The array THETCR(3) is no longer used.

SONO:SR The size of the array STHC was increased from 3 to 9, and the values modified to be consistent with the new BTMLOS (see AN:SR). The same changes were also made to subroutine SNOISE.

TAPPS:SR The low-frequency bottom class (packed in IB) is no longer reset in subroutine STRC since IBCON now performs this function in overlay INPUTOV.

BTMLOS:SR This Function was completely rewritten to compute the revised low-frequency bottom-loss curves for classes 1-9, and to interpolate between the low- and high-frequency curves between 1000 and 1500 Hz. New Functions BTMLF and BTMHF were written to perform the low- and high-frequency calculations, respectively.

IBCON:SR A new Function IBCON was written to transform the low-frequency bottom class obtained from the TAPPS bottom-class data files. For ocean areas 1, 2 and 3, classes 1-5 are transformed to 1-3; and for area 4 classes 1-6 are transformed to 4-9. The new low-frequency class is then repacked with the original high frequency class in IB. The transformation was required to give BTMLOS a way to distinguish between the two sets of bottom-loss curves.

DBLIB:SR (BNGET) The arrays THCR and CTHC were increased in size from 3 to 9 to accommodate the new bottom classes 4-9.

NOISE:SR The arrays THCR and CTHC were increased in size from 3 to 9 to accommodate the new bottom classes 4-9. New critical angles were defined to be consistent with the new Function BTMLOS (see AN:SR).

ANGSCH:SR Debug printout was added to aid in model checkout.

TWDPT:SR Unused code was deleted to make room for the latest changes.

INDABLP/INDBBLP The Indian Ocean bottom-class data files were updated with new low-frequency bottom classes (1-6). The high-frequency classes were not changed. The file coverage extends from 10 degrees South to 30 degrees North in the Indian Ocean.

3.1.2 BLUG Support Software

LSCBLP:SR This routine modifies the Indian Ocean bottom-class data files INDABLP and INDBBLP. It accepts as input two ASCII data files INDAINP and INDBINP, which contain the new low-frequency bottom-class geographic assignment by one-degree squares. Also inputted are the original bottom class files INDABLP and INDBBLP, which contain packed low- and high-frequency entries. The routine outputs new data files INDAOUT and INDBOUT with the new low-frequency classes, packed with the original high-frequency classes.

LSDBLP:SR This routine reads and displays any TAPPS bottom-class file (e.g., INDABLP).

LSBTM:SR A test driver for subroutine BTMLOS. The routine lists bottom loss versus grazing angle for each class and for selected frequencies.

LSDBLOS:SR A test driver for subroutine BTMLOS. The routine graphically displays bottom loss versus grazing angle for each class and for selected frequencies.

LSLIB:SR A utility library for character input and manipulation. It contains routines MOVEIT, KCOMP and CINPUT.

3.2 SURFACE-DUCT MODEL SOFTWARE MODIFICATIONS

3.2.1 TAPPS Surface-Duct Software Modifications

FACTL1:SR The old Surface-Duct Model (Clay) equations were removed. Subroutine SDINIT is called to see if their is a surface duct. IML and IMLP are set to zero if their is no surface duct, or an error condition exists which would prevent the successful completion of the Surface-Duct Model.

FACTL2:SR The old Surface-Duct Model contribution and volume absorption loss were deleted and replaced with a call to a third FACT overlay (FACTL3).

FACTL3:SR The new FACT Surface-Duct Model. It first calls SDINIT to compute the Surface-Duct Model input parameters. Next, it calls SDUCT if IMLP is greater than one (if a duct is present and no error condition exists). Next, it adds the surface-duct contribution and volume absorption to the previously computed TL array which includes signal intensity levels from all other propagation paths other than surface duct. The TL array is converted to dB and then to integers to save space before returning to the overlay that requested a FACT run.

EGSDUCT:SR The main Surface-Duct Model routine, called from FACTL3 as SDUCT. The physical and mathematical basis for this routine and its supporting routines is documented in Reference 17.

EGSDCOM:SR A Block Data Subprogram to initialize common area variables for the Surface-Duct Model.

EGSDINIT:SR The Surface-Duct input parameter initialization routine. The routine computes the equivalent bilinear (two lines) sound speed profile based on the complete sound speed profile. It calls subroutine LSFIT to perform a least squares fit to the in-layer and below-layer segments of the profile

EGLSFIT:SR This routine does a least squares fit to the set of profile depth points Z(1), ..., Z(N) and the corresponding functional values

$$F(I) = [1 - C(1)/C(I)]^2, \quad I=1, \ldots, N$$

where C(I) are the profile sound speeds. The function was chosen because the Surface-Duct Model assumes this function to be linear for the in-layer and below-layer segments of the profile.

EGTLOUT:SR This routine is called from FACTL3 to display the TL array for debug purposes only.

EGSLOSS:SR FACT rough surface reflection-loss routine, called by SDUCT.

FACTLIB3:SR This library of routines includes supporting software for the main FACT surface-duct routine, SDUCT. It includes LEAKY, TRAPED, SMODE, HISQ, REFLK, AIRY and FANG.

3.2.2 Surface-Duct Model Support Software

FACT:SR A test driver program for the FACT propagation-loss model. It transfers control to the FACT overlays (FACTL1, FACTL2, and FACTL3), and displays the results numerically and/or graphically.

EGSDMAIN:SR A test driver program for the Surface-Duct Model. For comparison, the user may select either the old model (Clay) or the new model (SAI/Ryan). Two versions of the program can be executed, one without graphics output, but with detailed debug output capability (EGSDMAIN); and the other with graphics output but with no detailed debug output capability (EGSDPLOT).

EGSDINM:SR A test driver program for subroutine SDINIT.

EGTLPLT:SR A transmission-loss graphics output routine.

3.2.3 Surface-Duct Model - Special Considerations

The Surface-Duct Model uses a number of complex arithmetic relationships. During the course of testing the model a number of inconsistencies were found when the CDC 6600 and DEC-10 versions of the model were compared with the TAPPS Nova 800 implementation. The lack of agreement was traced to a number of places where the Data General compiler did not generate correct code for FORTRAN statements which use various types of complex arithmetic expressions. Although it was possible to program around these problems in all cases, care must be taken if the model is to be modified in the future to ensure correct results.

3.3 AMBIENT NOISE SOFTWARE MODIFICATIONS

3.3.1 TAPPS Ambient Noise Software Modifications

NSLIB:SR (SHPSR) Subroutine SHPSR was modified to handle the new shipping-noise file (ANFILE), which was expanded to include the southern hemisphere.

ANFILE This file was modified to include the Indian Ocean. Also, provision was made for the complete southern hemisphere and some entries in the Mediterranean Sea were found to be in error and subsequently modified.

3.3.2 Ambient Noise Support Software

ANFCREAT:SR This routine creates ANFILE. It accepts as input the ASCII file ANFILE:SR, which contains omni-directional shipping levels for each five degree square.

3.4 ROUGH-SURFACE LOSS SOFTWARE MODIFICATIONS

3.4.1 TAPPS Rough-Surface Loss Software Modifications

FACTL2:SR The variable CSC2 was added to compute the ratio of sound speed at the surface to the sound speed at C(K2). CSC2 and WHF (wave height) are passed as arguments to subroutines CUSP and INSTOR for rough surface calculations.

FACTLIB2:SR (CUSP) CUSP was modified to compute the sin squared of the grazing angle at the surface and to call SLOSS for rough-surface losses.

FACTLIB2:SR (INSTOR) INSTOR was modified to compute the sin squared of the grazing angle at the surface and to call SLOSS for rough-surface losses.

EGSDUCT:SR Subroutine SDUCT was modified to call SLOSS for the rough-surface loss contribution to the surface-duct propagation.

EGSLOSS:SR Subroutine SLOSS was created to compute the rough-surface loss as a function of wave height, the sin of the surface grazing angle squared, the number of surface reflections, and the frequency.

3.4.2 Rough-Surface Loss Support Software

EGSLSMN:SR A test driver program for subroutine SLOSS.

3.5 MISCELLANEOUS SOFTWARE MODIFICATIONS

NSLIB:SR (SHIPMS) The variable SCOR was limited to be at least 10^{-15} to prevent TAPFS from trying to take the log of a negative number. This is equivalent to limiting the shipping noise correction level to be at least -150 dB on each beam.

DBLIB:SR (TLGET) The variable NSAMP (the number of depth points computed in PREOPT) was tested to detect the case where PREOPT does not compute any depth points.

GETENV:SR The variable SHPDEN was previously spelled SHIPDEN in several places.

INIT:LD The Assign Console File INIT:LD did not save the memory locations 3542-3640, which contained initialization for the variables ALDZ, ADMIN, BFUNC and AFUNC (Common area ANAP). These locations were added to the save command.

Section 4
TEST RUNS

A number of test cases were run to verify the TAPPS software modifications. Prior to full integration within TAPPS each of the major subroutines and data files were tested using test driver programs:

LSDBLP	- read and display any TAPPS Bottom Loss class data file (e.g., INDABLP)
LSBTM/LSDBLOS	- call BTMLOS to compute and display bottom loss versus grazing angle, frequency and bottom class. LSDBLOS displays results in graphical format.
EGSDINM	- test subroutine SDINIT
EGSDMAIN/ EGSDPLOT	- test surface-duct program in a stand-alone mode (subroutine SDUCT). EGSDPLOT displays results in graphical format
FACT	- test FACT in a stand-alone mode (overlays FACTL1, FACTL2 and FACTL3
EGSLSMN	- test rough-surface loss routine (SLOSS)

The source (:SR) and loader files (:LD) for each of the above test programs has been retained on the TAPPS master source (fixed) disk for additional testing if required.

A number of full-scale TAPPS runs were also run to test the full impact of the model changes.

Assign Console files were developed for many of the FACT and TAPPS test cases and have been retained on the TAPPS master load (removable) disk for additional use if needed. The files are named FACTXXX:AC and TAPPSXX:AC.

Figure 13 contains a FACT stand-alone test run, with the TAPPS Version 1.2 modifications. The Assign Console file is FACT331:AC.

Figures 14a, 14b and 14c contain TAPPS test runs for TAPPS Version 1.1, with the BLUG modifications, and for TAPPS Version 1.2. The Assign Console file is TAPPS04:AC. These test runs dramatically illustrate the impact of the software modifications on the TAPPS performance estimates.

```
H  FACT331:AC

  R FACT
NUMBER OF RANGE INCREMENTS (--.LE.250)=250
RANGE INCREMENT (NM) =1
GRAPH LIMITS(MIN,MAX) (DB) =70.,130.
LIST,GRAPHICS OUTPUT (0=NO,1=YES)=0,1
WAVE HEIGHT(FT)=5
LOW FREQUENCY BOTTOM CLASS(1-3 OR 4-9) =1
HIGH FREQUENCY BOTTOM CLASS(1-9) =1
SOURCE DEPTH(FT)=60
RECEIVER DEPTH(FT)=60
NUMBER OF FREQUENCIES(1-5)=3
FREQUENCY(HZ)=50
FREQUENCY(HZ)=200
FREQUENCY(HZ)=800
INDEX OF LAYER=2
NUMBER OF DEPTH-VELOCITY PAIRS=5
DEPTH=0
VELOCITY=5046
DEPTH=200
VELOCITY=5050
DEPTH=1000
VELOCITY=4960
DEPTH=6000
VELOCITY=4905
DEPTH=19000
VELOCITY=5100
DEBUG MODE(0=NO,1=YES)=0
CALL FACTL1
SDINIT-IML,YS,YR,Z,C :      4      50.0       60.0
    0.0   50.0   60.0  200.0 1000.0 6000.919008.6
 5046.0 5047.0 5047.2 5050.0 4960.2 4906.4 5104.6
LSFIT-KWT,ZD,N,Z,C:    0   200.001    4
    0.0   50.0   60.0  200.0
```

Figure 13: FACT Test Run FACT 331:AC

IBL,IBH = 1 1
60.0 60.0 F= 50. 200. 800.

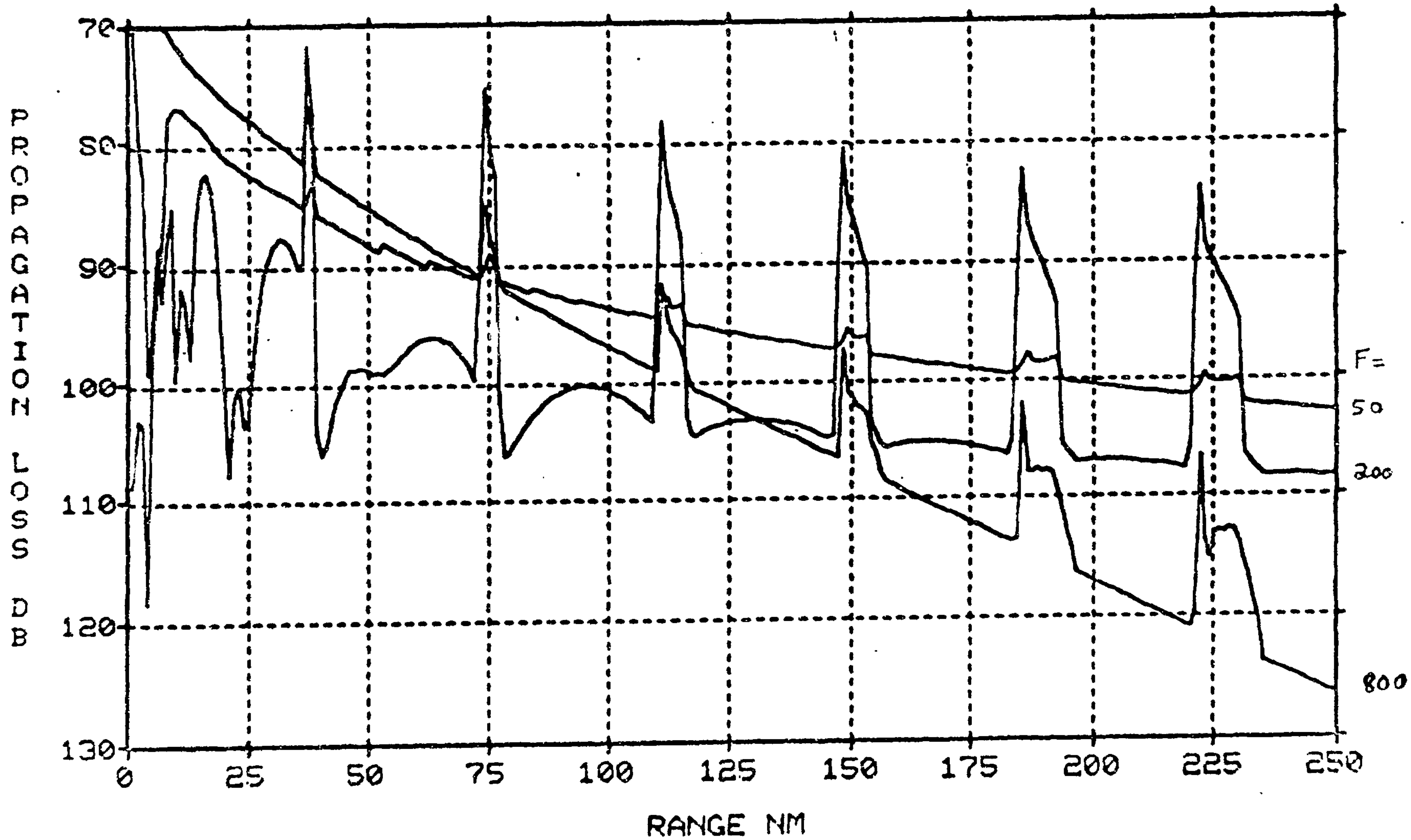

Figure 13 (Continued): FACT Test Run FACT 331:AC

UH = 5.0 IBL,IBH = 1 1
SPI,RCU= 60.0 400.0 F= 50. 200. 800.

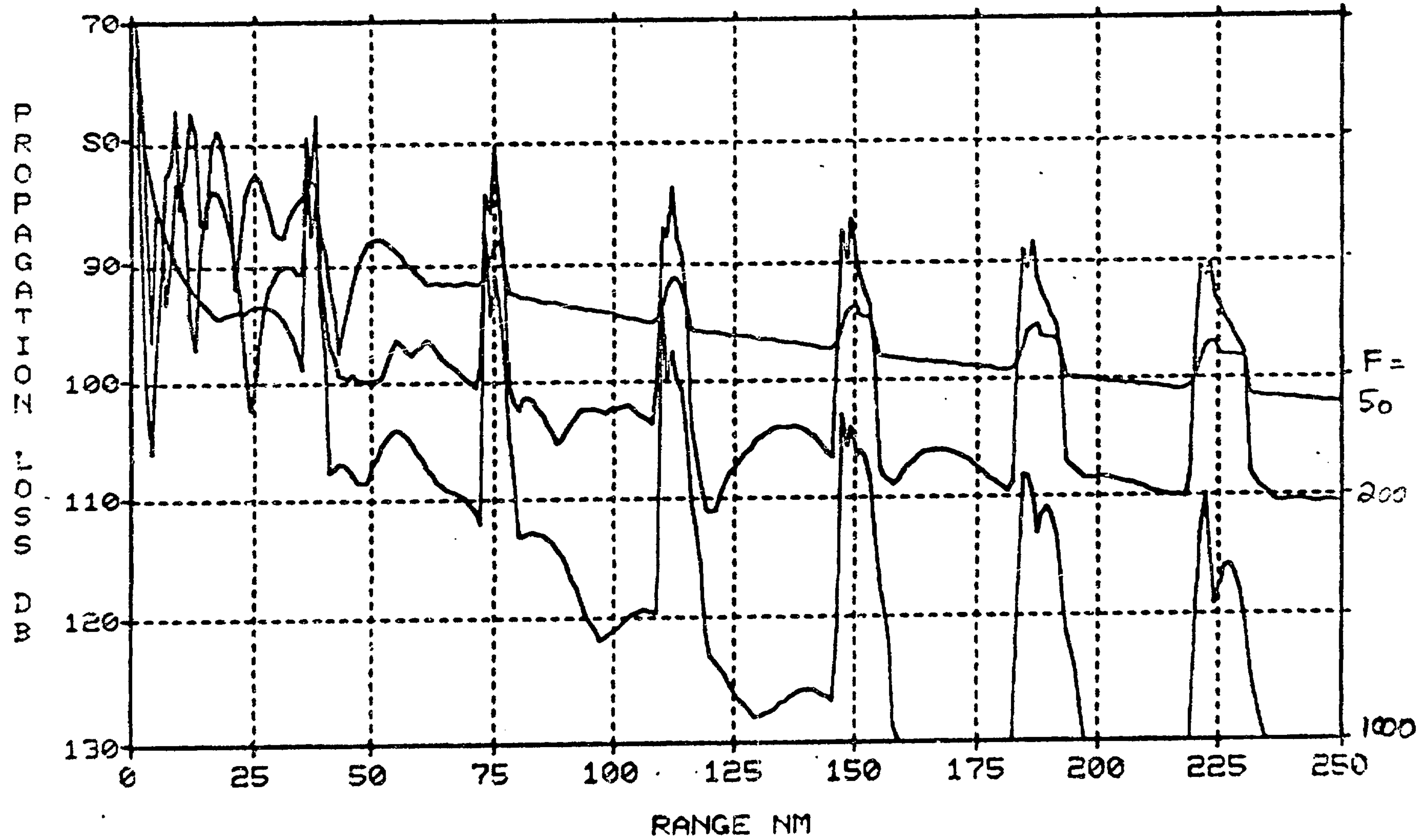

Figure 13 (Continued): FACT Test Run FACT 331:AC

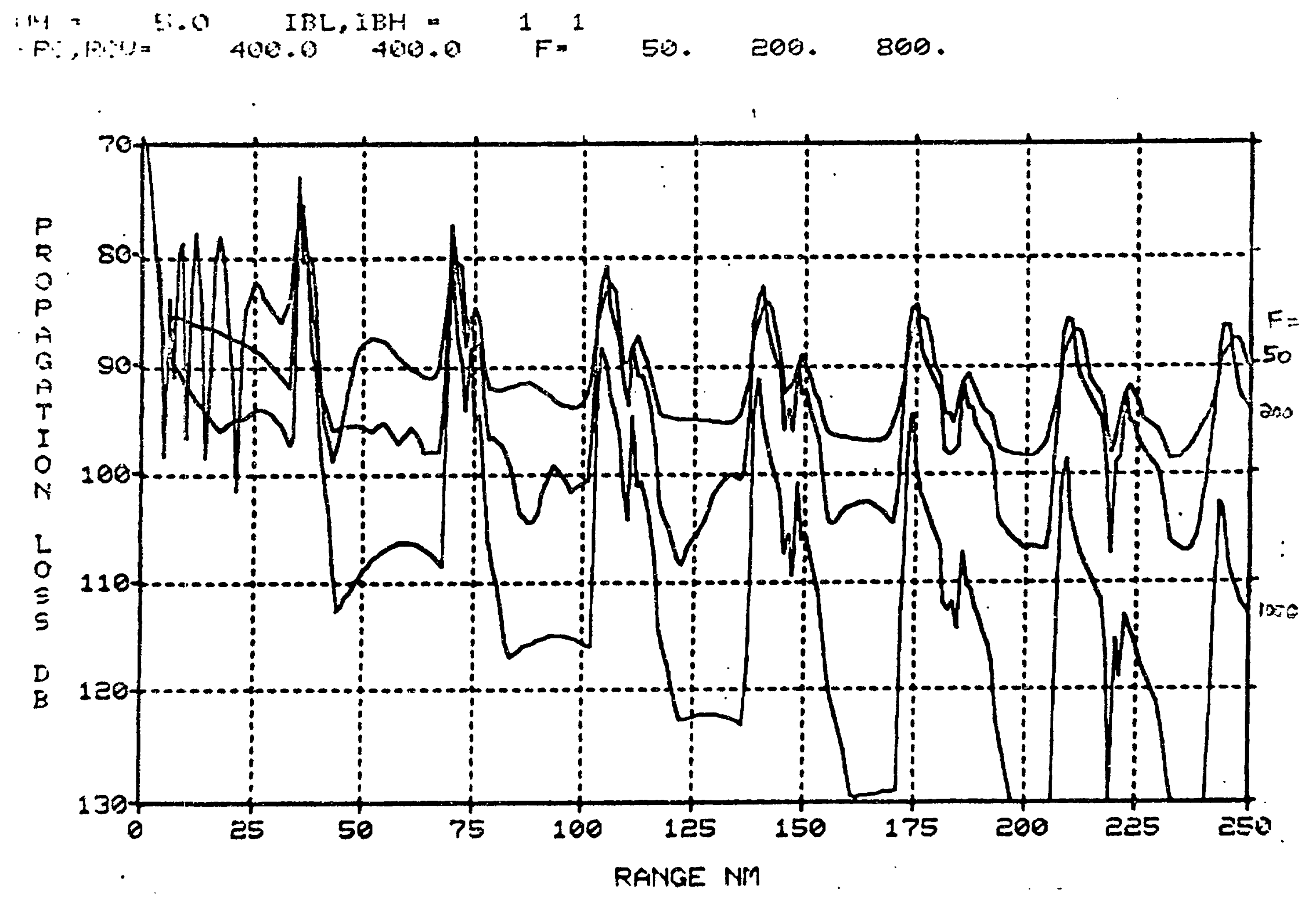

Figure 13 (Continued): FACT Test Run FACT 331:AC

```
RUN LABEL: 1-1S-NEW
DTG:        011200Z AUG 80   TOW SPEED:     5 KTS
POSIT:         100N , 9200E  THREAT DEP:   60 FT
```

RECOMMENDED TOW PARAMETERS:

TOW DEPTH(FT)	60
SEARCH FREQUENCY (HZ)	50

TOW DEPTHS CONSIDERED:

MINIMUM TOW DEPTH (FT)	0
MAXIMUM TOW DEPTH (FT)	8000
NOISE MEASUREMENT DEPTH (FT)	60

PERFORMANCE RANKING:

	FREQUENCY (HZ)		
	50	200	800
RECOMMENDED DEPTH	999	179	0
MEASURED DEPTH	999	179	0

Figure 14a: TAPPS Test Run TAPPS04:AC (Version 1.1)

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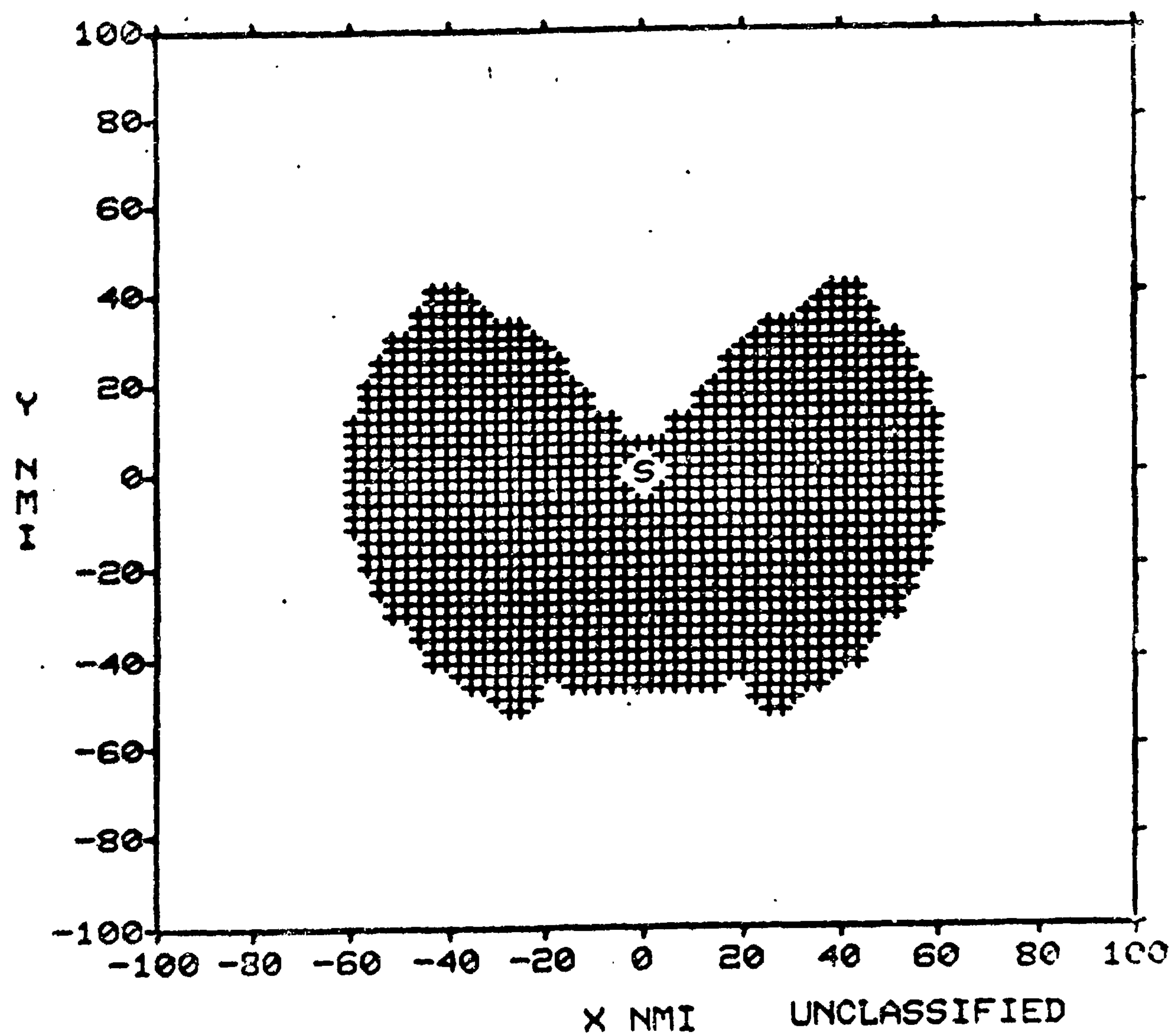
RUN LABEL: 1-1S-NEW

DTG: 011200Z AUG 80
POSITION: 100N 9200E
TOW SPEED: 5 KTS
THREAT DEP: 60 FT

DETECTION COVERAGE
TOW DEP: 60 FT(R)
FREQ: 50 HZ(R)

KEY:

+ 50% PD



UNCLASSIFIED

Figure 14a (Continued): TAPPS Test Run TAPPS04:AC (Version 1.1)

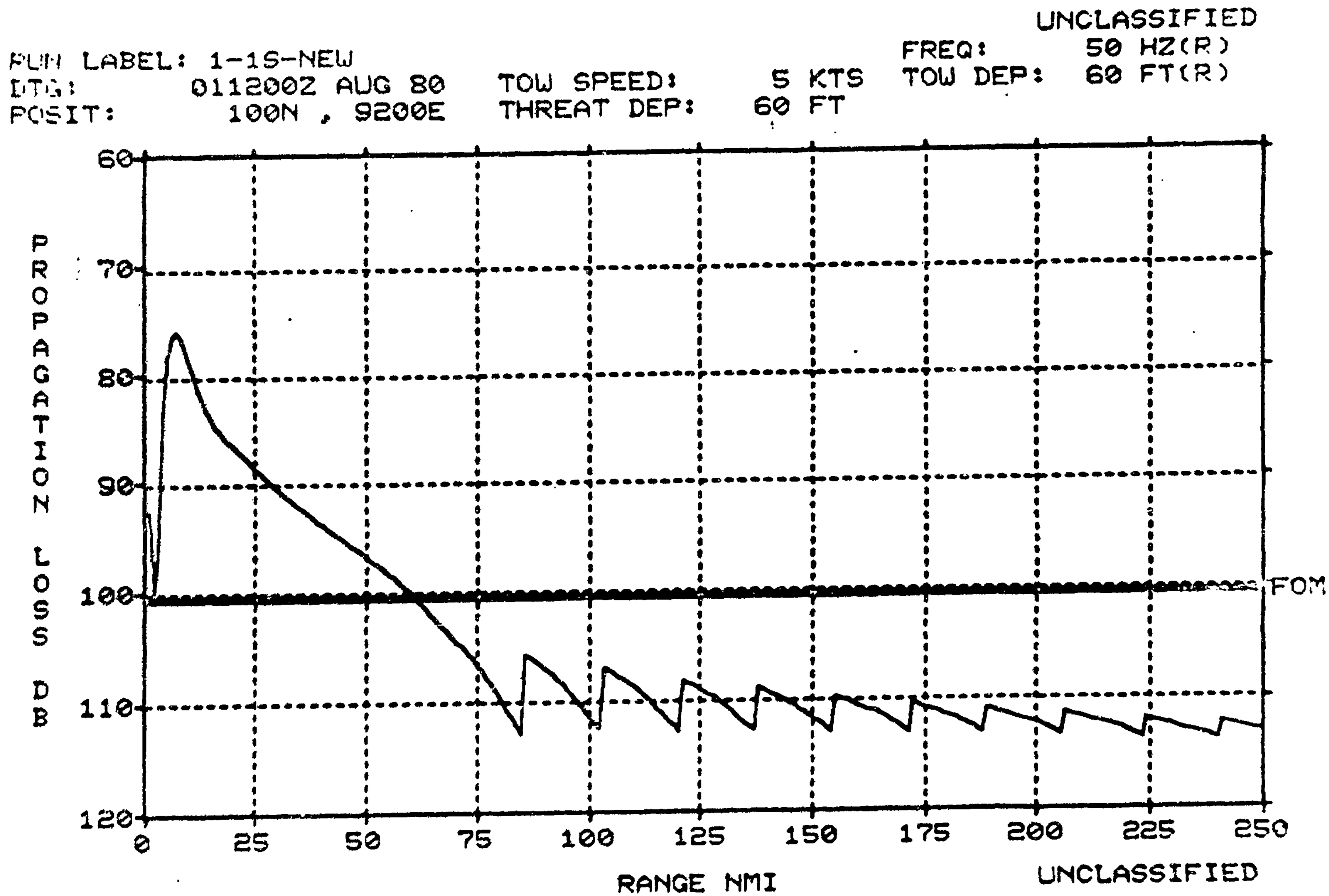


Figure 14a (Continued): TAPPS Test Run TAPPS04:AC (Version 1.1)

UNCLASSIFIED

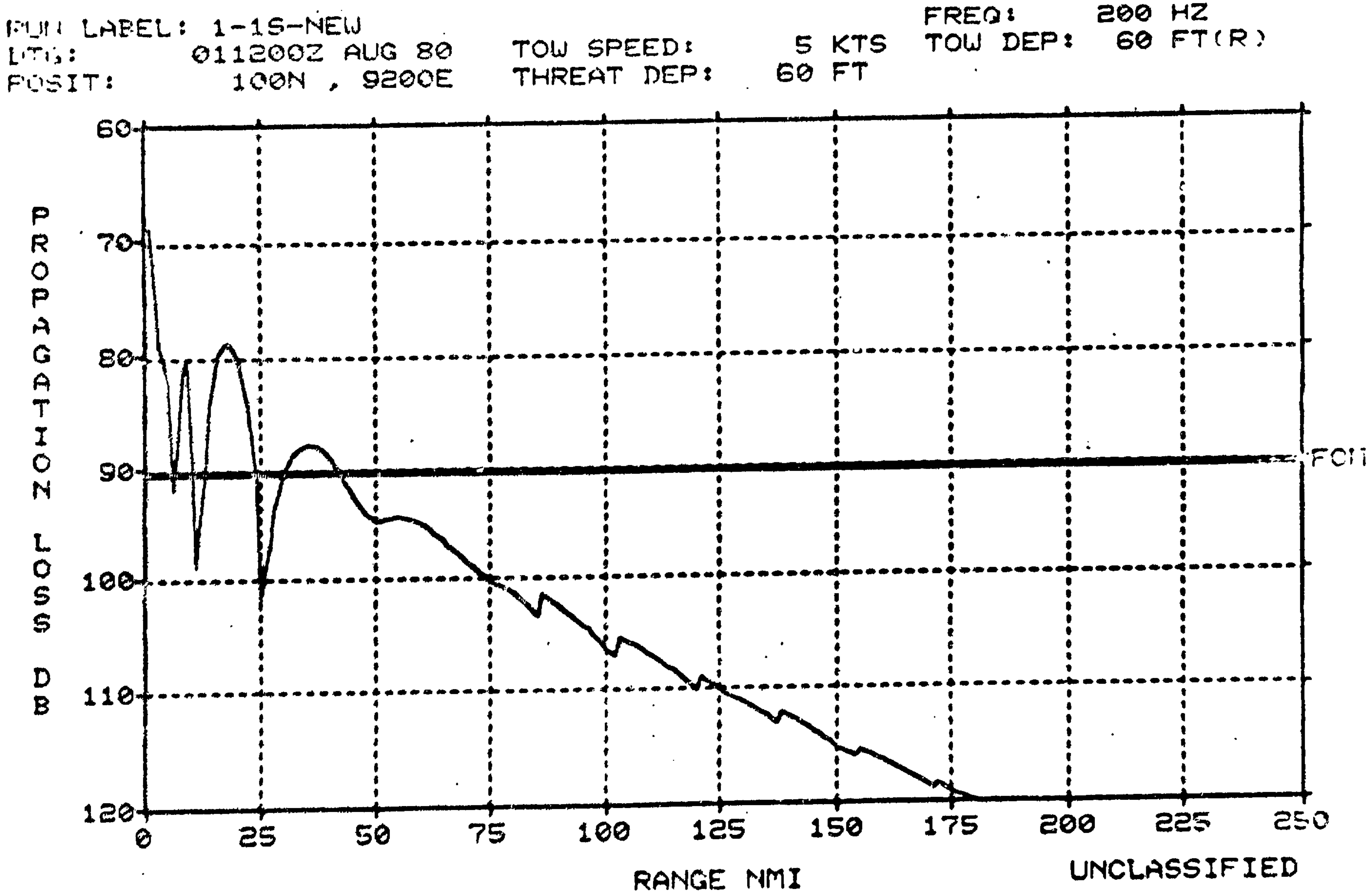


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Figure 14a (Continued): TAPPS Test Run TAPPS04:AC (Version 1.1)

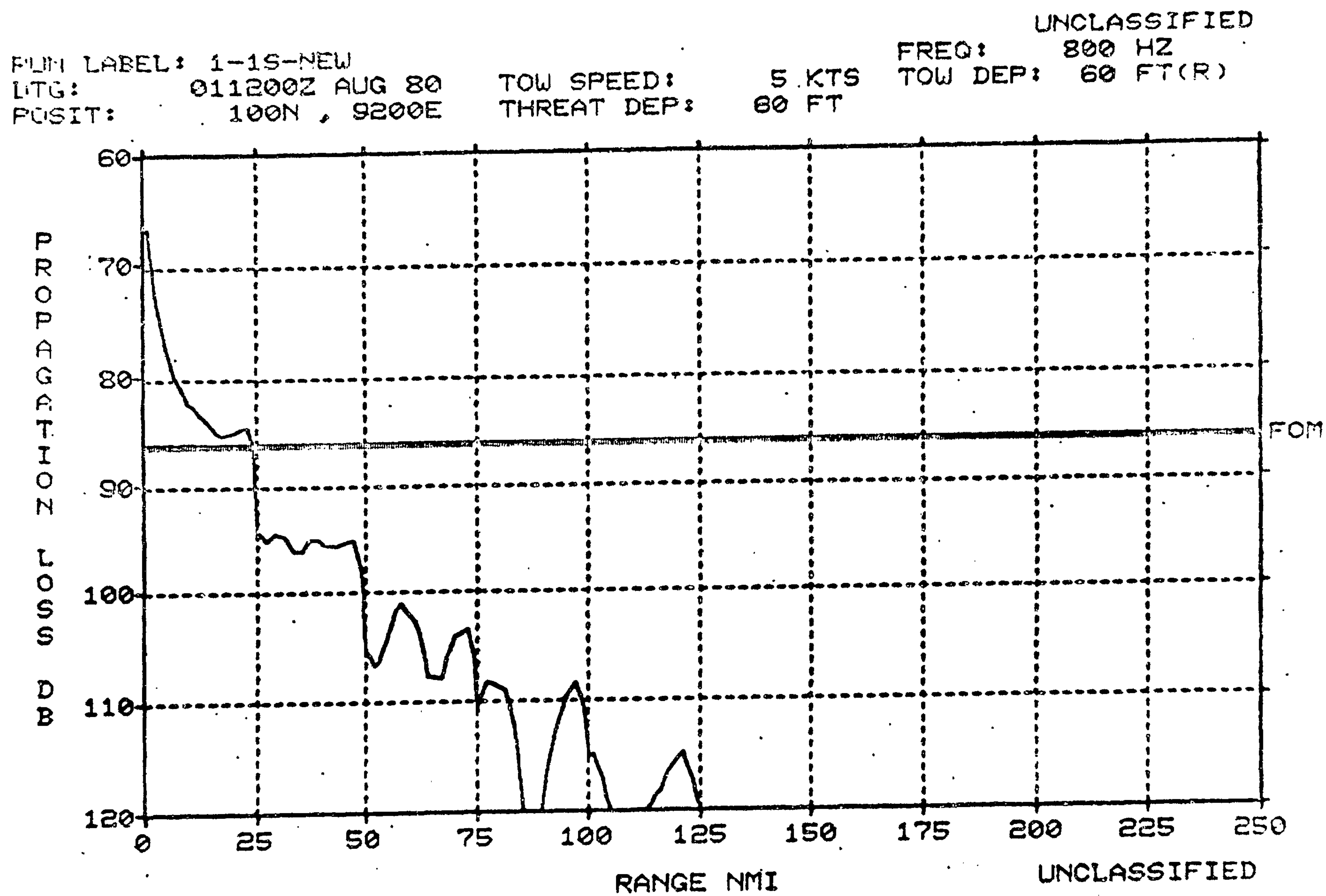


Figure 14a (Continued): TAPPS Test Run TAPPS04:AC (Version 1.1)

RUN LABEL: 1-1S-NEW
DTG: 011200Z AUG 80 TOW SPEED: 5 KTS
POSIT: 100N , 9200E THREAT DEP: 60 FT

RECOMMENDED TOW PARAMETERS:

TOW DEPTH(FT)	60
SEARCH FREQUENCY (HZ)	200

TOW DEPTHS CONSIDERED:

MINIMUM TOW DEPTH (FT)	0
MAXIMUM TOW DEPTH (FT)	8000
NOISE MEASUREMENT DEPTH (FT)	60

PERFORMANCE RANKING:

	FREQUENCY (HZ) 50	200	800
RECOMMENDED DEPTH	86	999	0
MEASURED DEPTH	86	999	0

Figure 14b: TAPPS Test Run TAPPS04:AC (with BLUG Mods Only)

UNCLASSIFIED

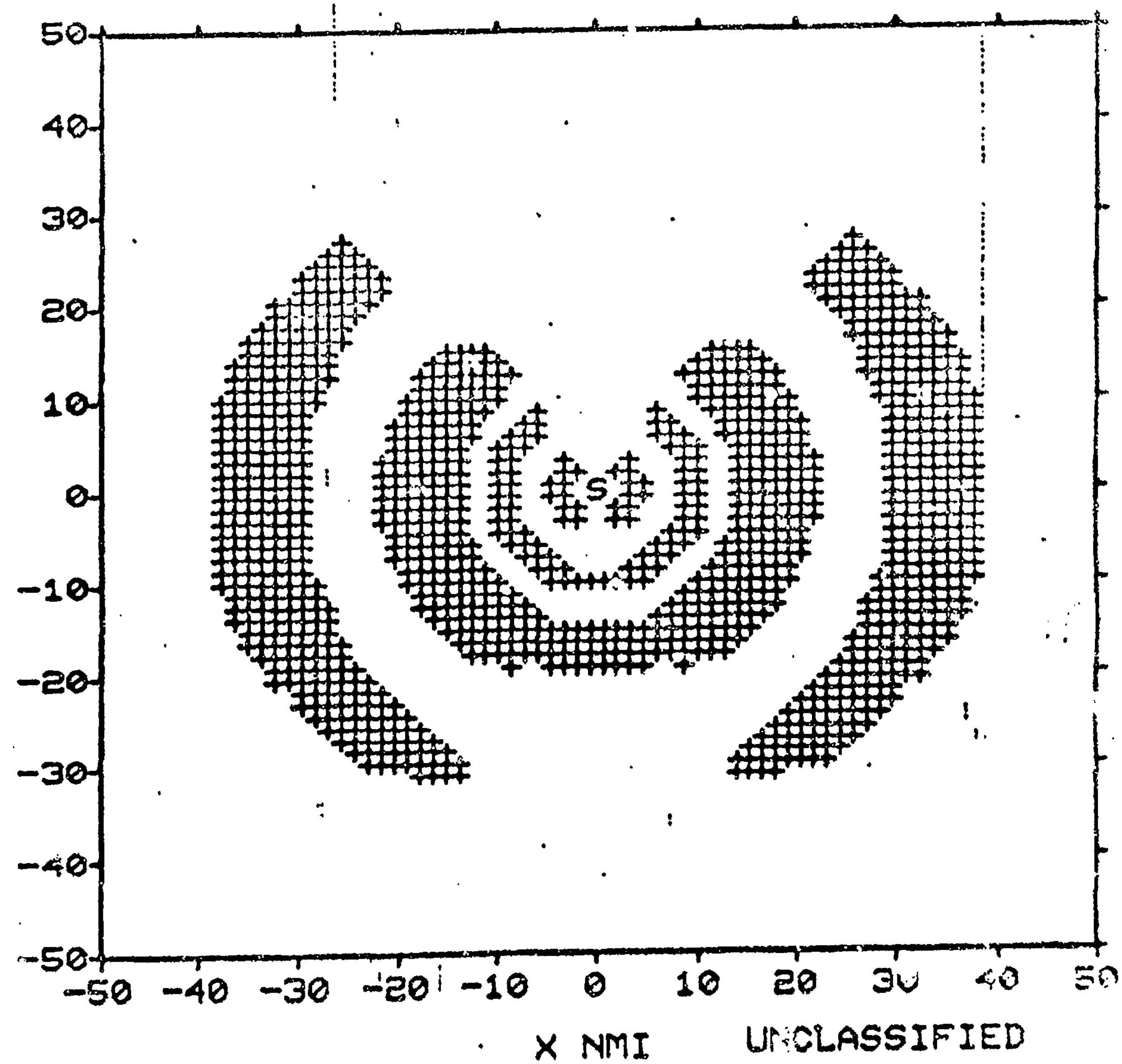
RUN LABEL: 1-1S-NEW

DTG: 011200Z AUG 80
POSITION: 100N 9200E
TOW SPEED: 5 KTS
THREAT DEP: 60 FT

DETECTION COVERAGE
TOW DEP: 60 FT(R)
FREQ: 200 HZ(R)

KEY:

+ 50% PD



UNCLASSIFIED

Figure 14b (Continued): TAPPS Test Run TAPPS04:AC (with BLUG Mods Only)

UNCLASSIFIED

RUN LABEL: 1-1S-NEW
DTG: 011200Z AUG 80 TOW SPEED: 5 KTS FREQ: 50 HZ
POSIT: 100N , 9200E THREAT DEP: 60 FT TOW DEP: 60 FT(R)

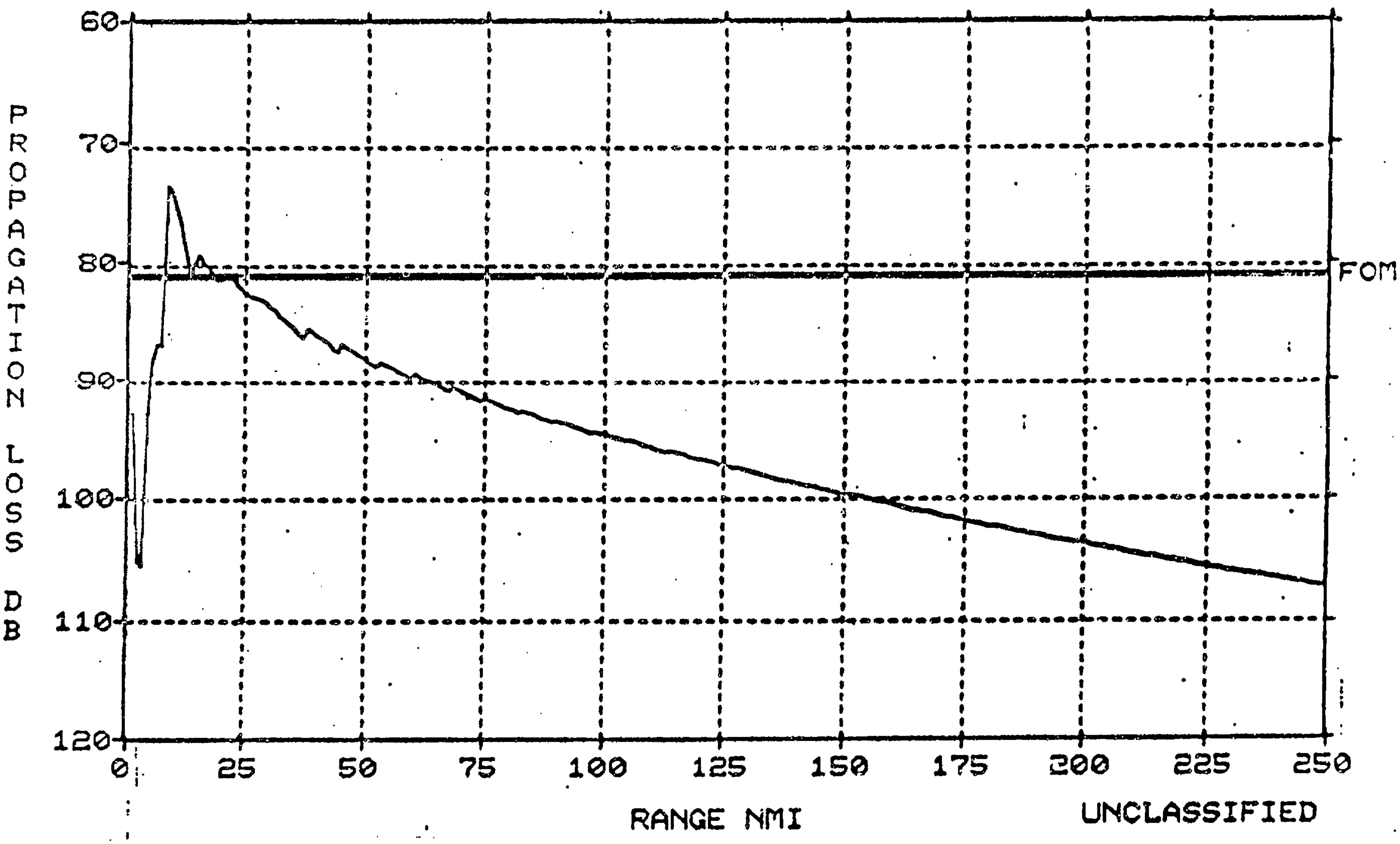


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Figure 14b (Continued): TAPPS Test Run TAPPS04:AC (with BLUG Mods Only)

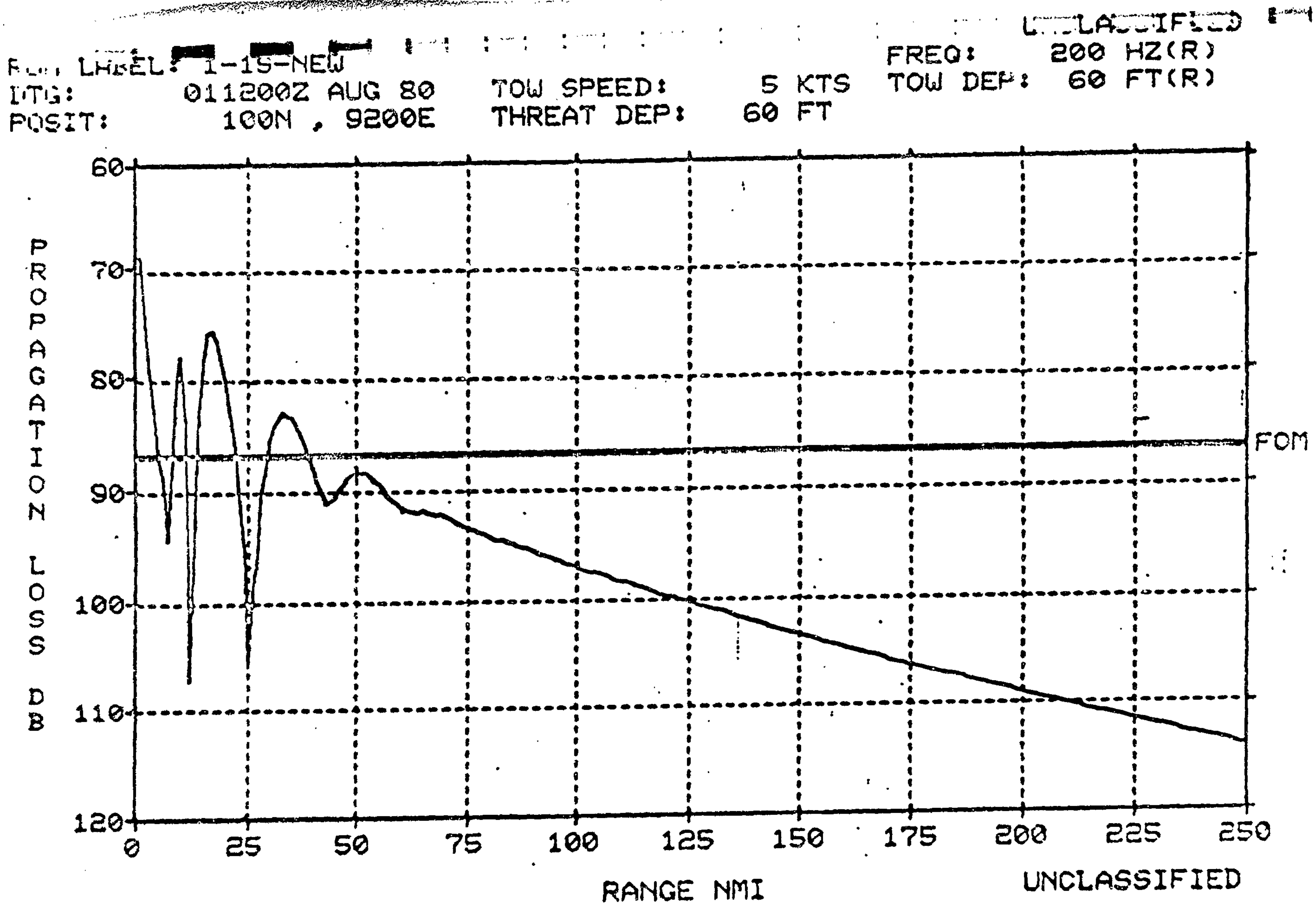

Figure 14b (Continued): TAPPS Test Run TAPPS04:AC (with BLUG Mods Only)

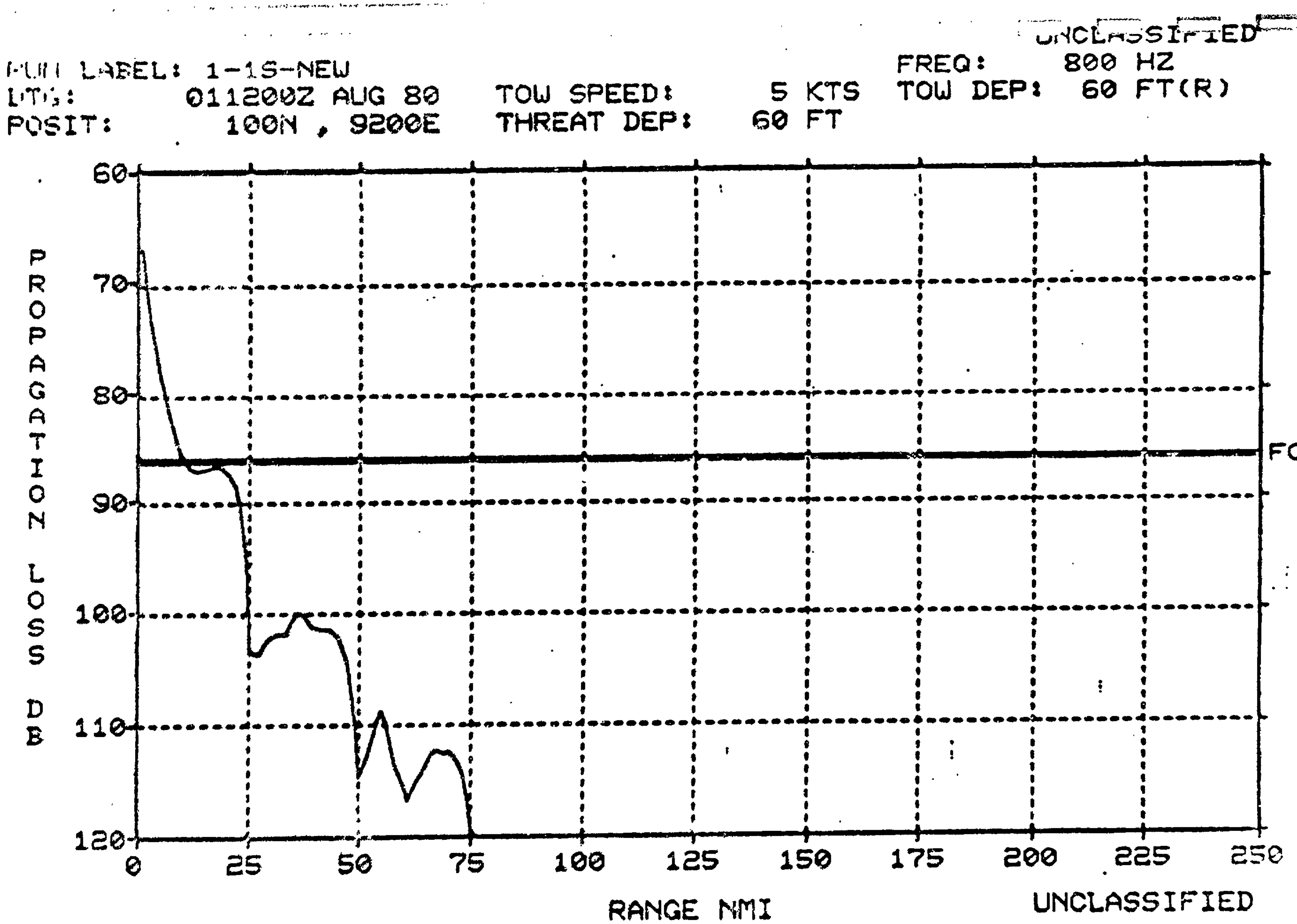

Figure 14b (Continued): TAPPS Test Run TAPPS04:AC (with BLUG Mods Only)

RUN LABEL: 1-1S-NEW
DTG: 011200Z AUG 80   TOW SPEED: 5 KTS
POSIT: 100N , 9200E   THREAT DEP: 60 FT

RECOMMENDED TOW PARAMETERS:

TOW DEPTH(FT)	60
SEARCH FREQUENCY (HZ)	800

TOW DEPTHS CONSIDERED:

MINIMUM TOW DEPTH (FT)	0
MAXIMUM TOW DEPTH (FT)	8000
NOISE MEASUREMENT DEPTH (FT)	60

PERFORMANCE RANKING:

	FREQUENCY (HZ) 50	200	800
RECOMMENDED DEPTH	0	183	999
MEASURED DEPTH	0	183	999

Figure 14c: TAPPS Test Run TAPPS04:AC (Version 1.2)

RUN LABEL: 1-1S-NEW

DTG: 011200Z AUG 80

POSITION: 100N 9200E

TOW SPEED: 5 KTS

THREAT DEP: 60 FT

DETECTION COVERAGE

TOW DEP: 60 FT(R)

FREQ: 800 HZ(R)

KEY:

\+ 50% PD

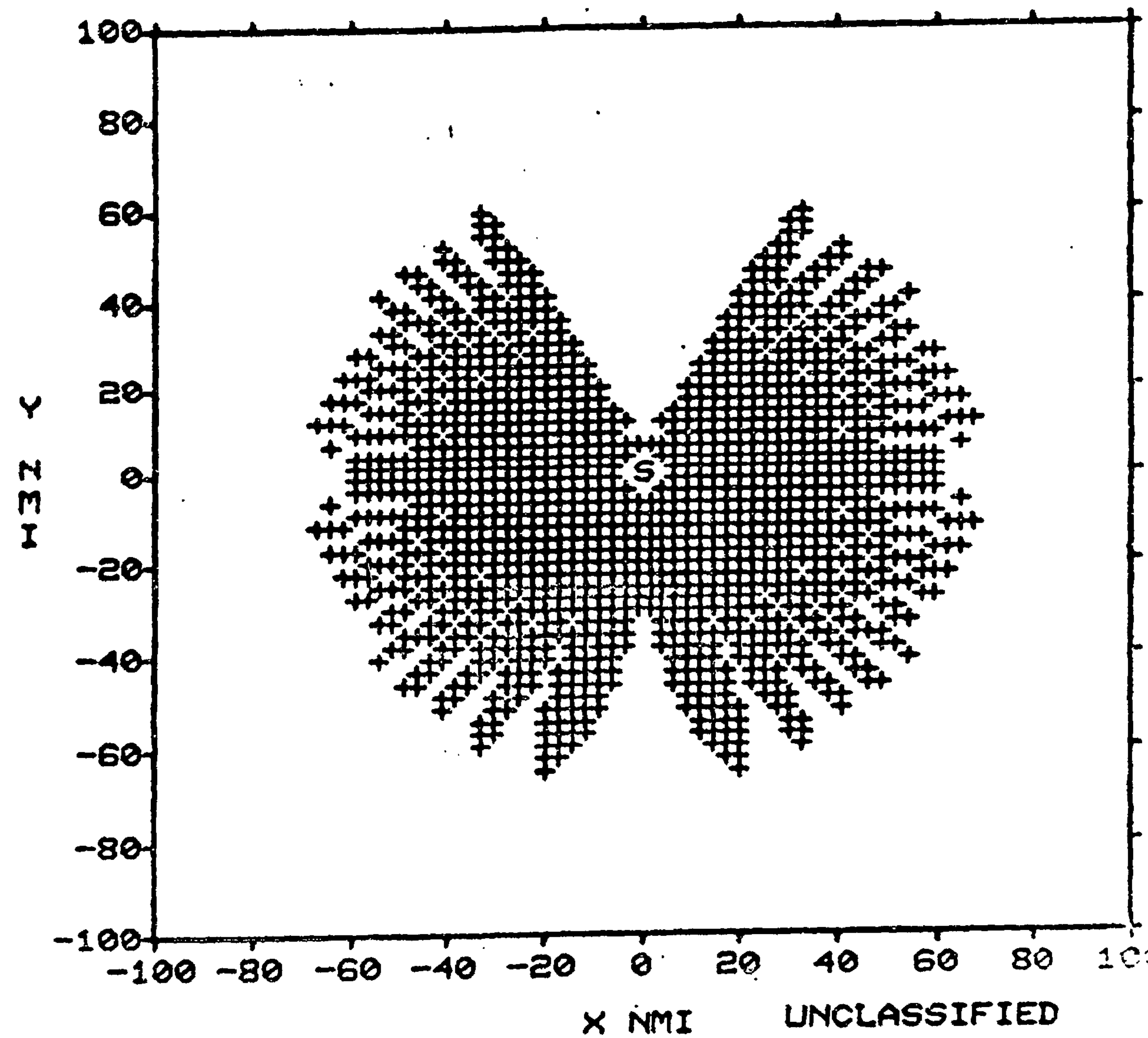

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Figure 14c (Continued): TAPPS Test Run TAPPS04:AC (Version 1.2)

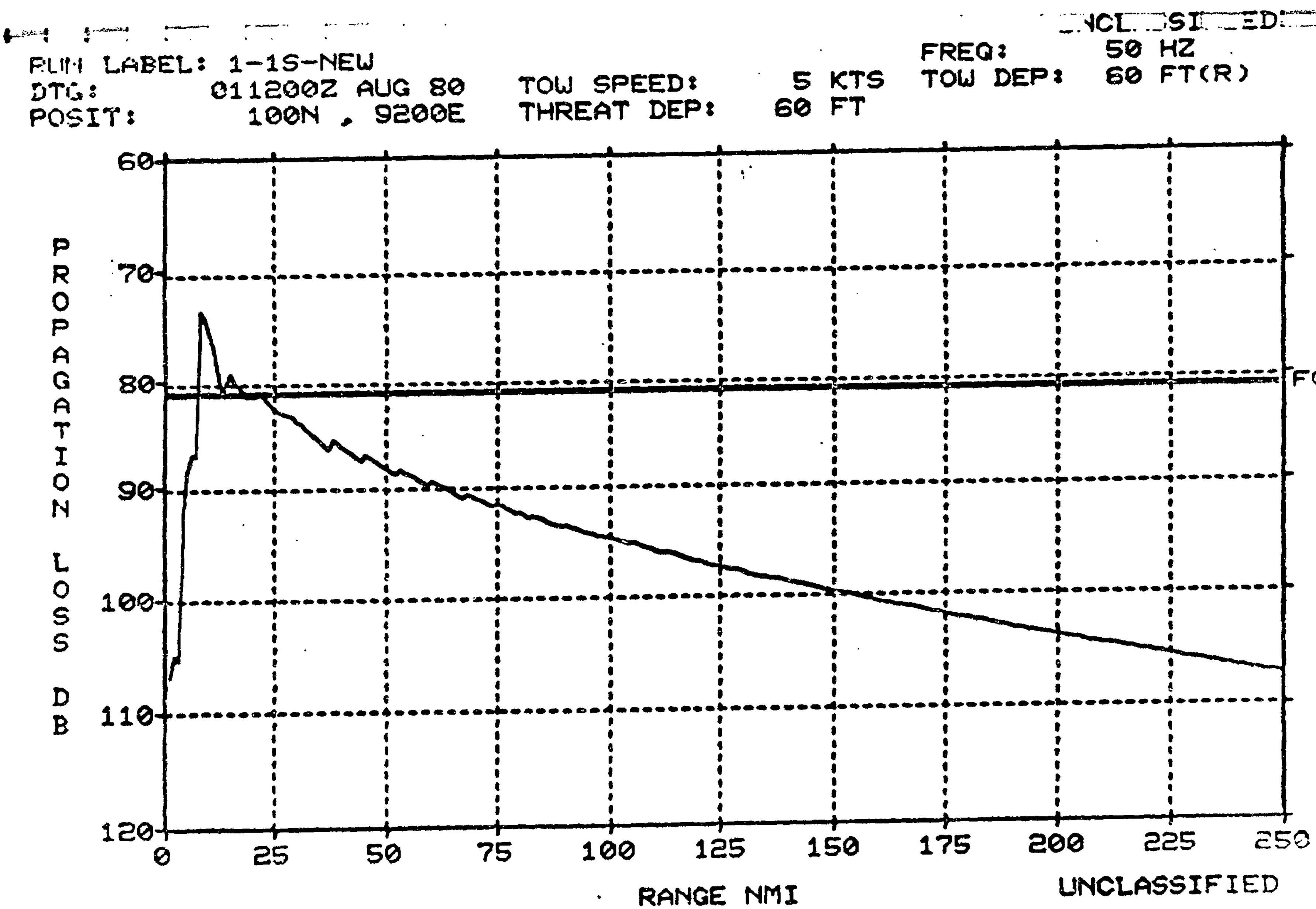

Figure 14c (Continued): TAPPS Test Run TAPPS04:AC (Version 1.2)

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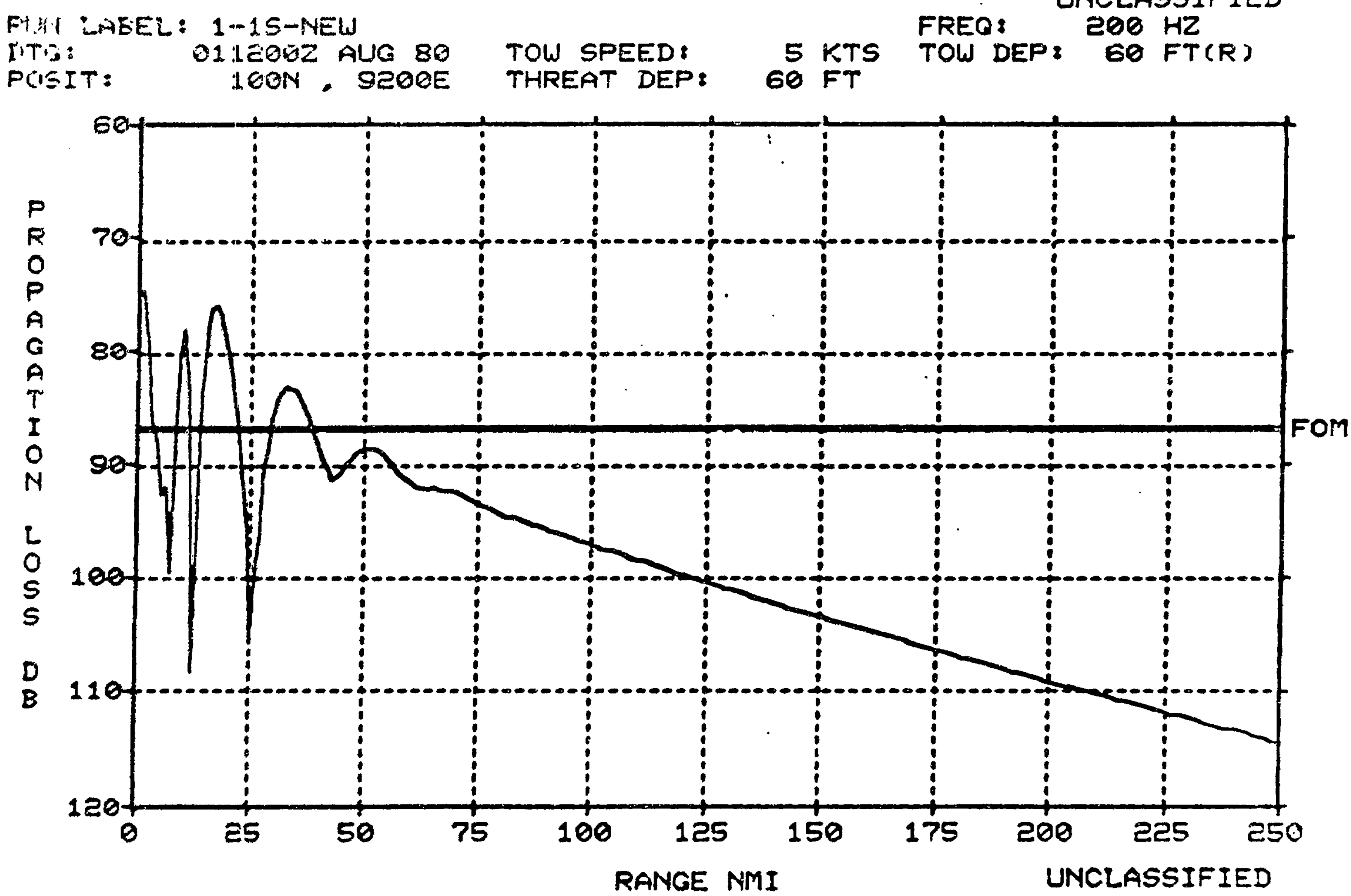

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Figure 14c (Continued): TAPPS Test Run TAPPS04:AC (Version 1.2)

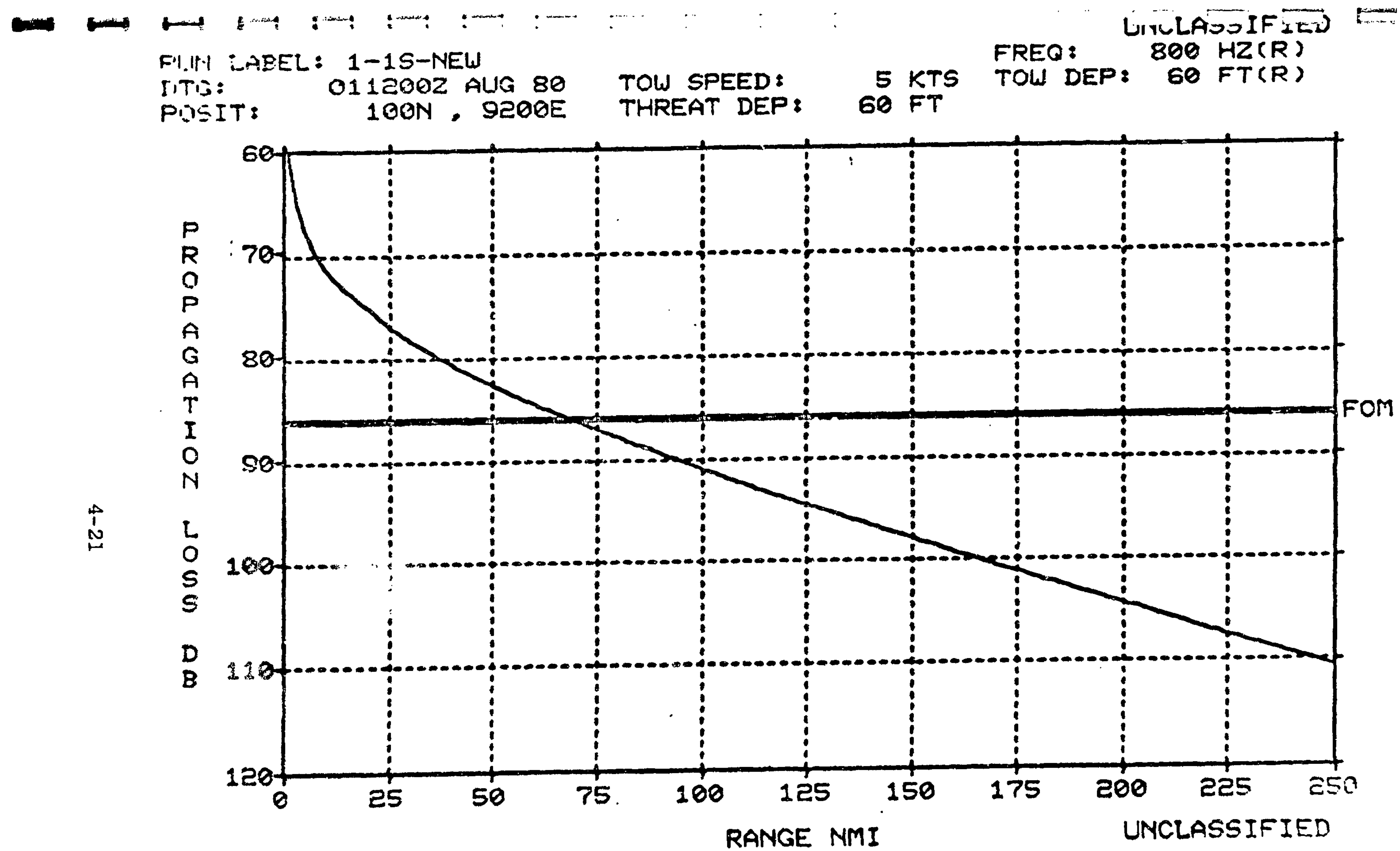

Figure 14c (Continued): TAPPS Test Run TAPPS04:AC (Version 1.2)

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2. The LRAPP documents listed in enclosure (1) have been downgraded to UNCLASSIFIED and have been approved for public release. These documents should be remarked as follows:

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Declassified LRAPP Documents

Report Number	Personal Author	Title	Publication Source (Originator)	Pub. Date	Current Availability	Class.
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IVB. DATA POINTS 10, 11 AND 12 RAW DATA	Sanders Associates, Inc.	790109	ADC017579	U
ARLTR7924	Mitchell, S. K., et al.	ANALYSIS OF ACOUSTIC BOTTOM INTERACTION IN BEARING STAKE (U)	University of Texas, Applied Research Laboratories	790223	ADE001369; NS; ND	U
TIU1886502F	Eichenberger, D.	REPORT FOR CHURCH STROKE II OCEANOGRAPHIC SERVICES	Texas Instruments, Inc.	790326	ADB036751; ND	U
Unavailable	Unavailable	FINAL REPORT, 1 NOVEMBER 1976-31 DECEMBER 1978	Xonics, Inc.	790430	ADB037987	U
Unavailable	Mitchell, T. M.	PREMOBILIZATION OF R/V INDIAN SEAL	Texas Instruments, Inc.	790531	ADB039703	U
Unavailable	Hays, E. E.	ACODAC AMBIENT NOISE PROGRAM	Woods Hole Oceanographic Institution	790601	ADB040404	U
LRAPPR79029	Unavailable	INTRODUCTION TO THE LRAPP ENVIRONMENTAL-ACOUSTIC DATA BANK (U)	Naval Ocean R&D Activity	790601	ADB041066; NS	U
USRD NO. 4807	Unavailable	MEASUREMENTS ON AQUADYNE MODEL AQ-1 ELEMENTS FOR THE UPGRADED LAMBDA ARRAY	Naval Research Laboratory	790802	ND	U
Unavailable	Ellis, G. E.	SUMMARY OF ENVIRONMENTAL ACOUSTIC DATA ANALYSIS	University of Texas, Applied Research Laboratories	790814	ADA073876	U
BR U0048-9C2	Unavailable	TAP III FINAL REPORT (U)	Bunker-Ramo Corp. Electronic Systems Division	790901	ND	U
ORITR1245	Moses, E. J.	OPTIONS, REQUIREMENTS, AND RECOMMENDATIONS FOR AN LRAPP ACOUSTIC ARRAY PERFORMANCE MODEL (U)	ORI, Inc.	790917	NS; ND	U
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