

AD-A035 892

NAVY UNDERWATER SOUND LAB NEW LONDON CONN  
DAMPING CHARACTERISTICS OF 185-INCH 'VITSS' AND STANDARD SONAR --ETC(U)  
DEC 66 H N PHELPS

F/G 17/1

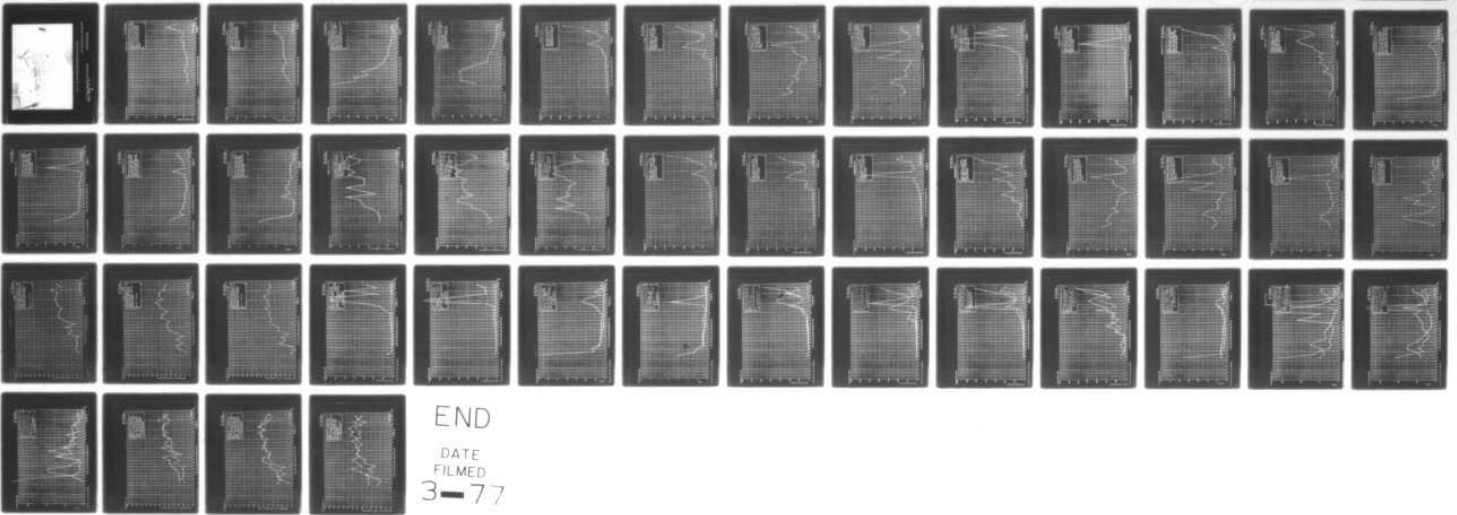
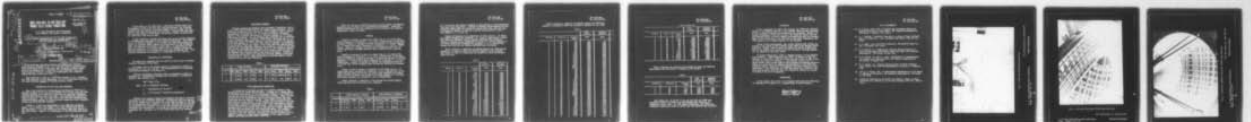
UNCLASSIFIED

USL-TM-2133-1213-66

NL

| OF |

AD  
A035892



END

DATE  
FILMED  
3-77

MOST Project - 4 NAUSHIPSYSCOM  
Copy to (SHIPS-1622)

Copy No. /

USL Problem No.  
1-650-02-00

1  
B.S.

**COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION**

U. S. Navy Underwater Sound Laboratory  
Fort Trumbull, New London, Connecticut

Good  
ADA 035892

9 DAMPING CHARACTERISTICS OF 185-INCH VITSS AND  
STANDARD SONAR DOME STRUCTURES.

10 By  
Howard N. Phelps, Jr

12 58p.

USL Technical Memorandum No. 2133-1213-66

DDC  
RECEIVED  
FEB 23 1977  
RECEIVED

DISTRIBUTION STATEMENT A 8 December 1966  
Approved for public release;  
Distribution Unlimited

14 INTRODUCTION USL-TM-2133-1213-66

This technical memorandum presents the damping and vibration characteristics, measured in air, of a 185-inch Variable-Internal-Truss-Sizes-and-Spacing (VITSS) steel sonar dome structure, without window. Results are compared with a standard 185-inch CW554/SQS steel sonar dome structure, without a window. The measurements were conducted between May 1964 and October 1964.

When reference is made to a VITSS dome structure or to a standard type dome structure in this memorandum, it is to be understood that each is a dome structure without an attached acoustic window.

DESCRIPTION OF THE VITSS DOME STRUCTURE

One of the objectives in designing and building the VITSS was to determine whether or not the use of stiffeners of various sizes and with variable spacings would reduce the vibration and resulting internally-radiated sound levels of the sonar dome. The structure was intended to reduce self-noise. The first step was to have the VITSS structure constructed without a window, to allow practical comparison with a standard window-less CW554/SQS dome structure.

Figures 1, 2 and 3 are photographs of the VITSS dome structure. Figure 1 is an overall view; Figure 2 is a view looking into the aft end; and Figure 3 is a view looking at the bottom frame just forward of the baffle plate. Figure 4 is a photograph of the CW554/SQS dome structure.

2133-1213-66

Encl ( / ) to USN/USL ITR Ser 2133-1214 March 1967

LB  
254 200

001797  
5

In the design of the VITSS dome, a particular integer from 0 to 9 was assigned to both a rod size and a spacing distance. By following consecutively the readout of variable numbers out of a table, the consecutive rod sizes and spacings were obtained. Circular rods were used for the outer chords of each truss, and vertical plates 1/4-inch thick by 1-inch wide, were used as webs.

Another objective, although mentioned, may not be covered completely in the experiments discussed in this technical memorandum. This objective is to discover whether or not variable rod sizes and spacing will reduce or eliminate echoes induced by ensonification of the stiffening rods. The bars can be involved in three ways: (1) excitation of the bars into vibration, (2) grating effect, and (3) specular reflections from the scattering of the sound waves from rigid stiffening rods. More detailed discussions are presented in references (a), (b), and (c).

#### DESCRIPTION OF EXPERIMENTS

The domes were suspended from two hoists by nylon ropes to provide vibration isolation of the domes.

The method used in the damping studies is discussed in detail in references (d), (e), (f), and (g). The instrumentation was calibrated using methods discussed in reference (e).

Vibration measurement techniques used are discussed in detail in reference (d). Accelerations measured were converted to acceleration decibels (see reference (h)).

$$\text{adB} = \text{Log}_{10} (a/a_0) \quad (1)$$

where adB = acceleration decibels

a = acceleration in cm./sec.<sup>2</sup>

a<sub>0</sub> = 10<sup>-3</sup> cm./sec.<sup>2</sup> (reference acceleration)

Vibration and vibration damping measurements were made on the dome structures at four different locations. Counting aft from the vertical rod at the forward end of the dome, and down from the flange of the dome for the horizontal rods, location 1 is on the 16th vertical rod and the 1st horizontal rod; location 2 is on the 18th vertical rod and the 8th horizontal rod; and location 3 is at the 8th vertical rod and the 4th horizontal rod. Location 4 is on the flange above the 14th vertical rod.

letter 2 on file

A

PRELIMINARY RESULTS

Vibration damping measurements were performed at locations 1 and 2 of the VITSS dome structure and of the standard dome structure. For the VITSS dome structure and at locations 1 and 2, Figures 5 and 6 present, respectively, the decay rate vs. 1/3 octave band center frequency; figures 7 and 8 present the percent of critical damping vs. 1/3 octave band center frequency. For the standard dome structure and at locations 1 and 2, Figures 9 and 10 present, respectively, the decay rate vs. 1/3 octave band center frequency; Figures 11 and 12 present the percent of critical damping vs. 1/3 octave band center frequency. On completion of the analysis of the data taken, it was noted that the damping characteristics of the VITSS dome structure were inferior to those of the standard 185-inch CW554/SQS dome structure; that is, the vibrations induced by impact on the VITSS dome structure did not decay as fast as those of the standard dome structure when it was excited by impact. Testing of the dome was halted after this comparison was made because of the unexpected results. Table I shows the maximum and minimum damping characteristics of the two dome structures.

TABLE I

Location	VITSS Structure					CW554/SQS Structure				
	Fig. No.	%C/C <sub>0</sub> (Min)	Frequency (kHz)	%C/C <sub>0</sub> (Max)	Frequency (kHz)	Fig. No.	%C/C <sub>0</sub> (Min)	Frequency (kHz)	%C/C <sub>0</sub> (Max)	Frequency (kHz)
1	6	.0020	16.0	.0700	0.2	10	.030	1.25-6.40	.185	4.0
2	7	.0025	16.0	.0435	0.5	11	.033	1.25	.365	3.2

VITSS MANUFACTURE CORRECTIONS

An inspection of the dome was made for possible defects in the manufacture of the VITSS dome structure. Although not a design defect, it was found that several of the longitudinal trusses in the bottom of the dome had not been welded to the transverse trusses. Thus, the ends of the rods of the longitudinal trusses were being excited into free vibrations when the dome was excited. Other bottom truss parts were also found to be not welded. It was apparent that the ends of the rods when excited, vibrated as cantilevers, while the intermediate sections of the rods vibrated as fixed-fixed beams. These free ends and other unwelded parts on the bottom frame of the dome were welded, eliminating the free ends and making the rods fixed-fixed beams. The lengths of the other fixed-fixed sections were shortened by welding the inter-sections of the rods together, increasing the natural frequency of all modes of vibration to some extent, depending on the length of each section and cross-sectional area of the rod.

After the ends and intermediate points had been welded, the damping experiments were repeated, with considerable improvement. Vibration-damping experiments were then conducted at four locations and vibration experiments at three locations.

### RESULTS

Figures 13 through 16 present the decay rate vs. 1/3 octave band center frequency for locations 1, 2, 3, and 4, respectively, of the VITSS structure; Figures 17 through 20 present the percent of critical damping vs. 1/3 octave band center frequency for locations 1, 2, 3 and 4, respectively. Figures 21 through 23 present the acceleration level vs. 1/3 octave band center frequency when the dome is excited with a constant force.

Figures 24 through 27 present the decay rate vs. 1/3 octave band center frequency for locations 1, 2, 3 and 4, respectively, of the standard dome structure; Figures 28 through 31 present the percent of critical damping vs. 1/3 octave band center frequency for locations 1, 2, 3 and 4, respectively. Figures 32 through 34 present the acceleration level vs. 1/3 octave band center frequency when the dome was excited with constant force.

Figures 35 and 36 present a comparison of the decay rate vs. 1/3 octave band center frequency for locations 1 and 2, respectively, on the VITSS structure before and after the bottom frame trusswork was welded; Figures 37 and 38 present the percent of critical damping vs. 1/3 octave band center frequency for locations 1 and 2, respectively.

Table 2 presents a comparison of the maximum and minimum damping before and after the truss welds were completed.

TABLE 2

Location	VITSS Structure (Welded)					VITSS Structure (Unwelded)				
	Fig. No.	%C/c (Min)	Frequency (kHz)	%C/c (Max)	Frequency (kHz)	Fig. No.	%C/c (Min)	Frequency (kHz)	%C/c (Max)	Frequency
1	16	.02	2	.92	.1	6	.002	16	.07	.2
2	17	.01	3.2	.395	5	7	.0025	16	.0435	.5

It is noted that the change in damping is much greater at some frequencies than many other frequencies. Although the damping characteristics of the completely welded dome are superior in almost every case, they are best at frequencies between 3.2 kHz and 8 kHz for both locations 1 and 2. (See Figures 6, 7, 16 and 17.)

Figures 39 through 42 are comparisons of decay rate vs. 1/3 octave band center frequency for locations 1, 2, 3 and 4, respectively, between the VITSS dome structure and the standard CW554/SQS dome structure. Figures 43 through 46 are comparisons of percent of critical damping vs. 1/3 octave band center frequency for locations 1, 2, 3, respectively, between the VITSS and the standard CW554/SQS dome structures.

Table 3 presents a comparison of damping between the VITSS and the standard at frequencies where the VITSS is superior to the standard. Care should be taken in recognizing the location at which the measurements were made.

TABLE 3

Location	Figure No.	Frequency (kHz)	VITSS Structure	CW554/SQS Structure
			%C/Cc	%C/Cc
1	42	.100	.9200	.1350
1	42	5.000	.2350	.0650
1	42	6.400	.1900	.0300
1	42	10.000	.0900	.0700
2	43	.100	.3125	.0975
2	43	.125	.1375	.0725
2	43	.160	.1025	.0825
2	43	5.000	.3920	.1025
2	43	6.400	.1375	.0475
3	44	.100	.2100	.0825
3	44	.125	.2525	.0830
3	44	.640	.0500	.0460
3	44	6.400	.0575	.0410
3	44	8.000	.0580	.0440
3	44	10.000	.0750	.0375
3	44	12.500	.1175	.0730
3	44	16.000	.1200	.0460
4	45	.100	8.0000	-----
4	45	.125	5.7500	.6000
4	45	.640	3.0000	2.6500
4	45	1.250	2.1000	1.5500
4	45	1.600	1.2500	.8200
4	45	2.000	1.3600	1.1500
4	45	4.000	1.0500	.4600
4	45	5.000	1.1600	.5500
4	45	6.400	1.1200	.8000
4	45	8.000	.6500	.3500

Table 4 presents a comparison of damping between the VITSS and standard at frequencies where the standard is superior to the VITSS.

TABLE 4

			VITSS Structure	C-554/SOS Structure
Location	Figure No.	Frequency (kHz)	%C/Cc	%C/Cc
1	h2	.200	.0500	.1100
1	h2	.250	.0500	.1100
1	h2	.320	.0500	.0750
1	h2	.400	.0400	.0900
1	h2	.500	.0350	.0700
1	h2	.640	.0300	.0700
1	h2	.800	.0300	.0700
1	h2	1.000	.0300	.0700
1	h2	1.250	.0300	.0350
1	h2	1.600	.0300	.0500
1	h2	2.000	.0250	.0700
1	h2	2.500	.0700	.0900
1	h2	3.200	.0700	.0900
1	h2	4.000	.1300	.1800
1	h2	8.000	.0300	.0500
1	h2	12.500	.0300	.0700
1	h2	16.000	.0300	.1100
2	h3	.200	.0500	.0920
2	h3	.250	.0400	.1470
2	h3	.320	.0450	.1230
2	h3	.400	.0400	.0670
2	h3	.500	.0370	.0680
2	h3	.640	.0320	.0720
2	h3	.800	.0300	.0620
2	h3	1.000	.0320	.0480
2	h3	1.600	.0300	.2180
2	h3	2.000	.0230	.1430
2	h3	2.500	.0200	.0960
2	h3	3.200	.0080	.3320
2	h3	4.000	.0480	.2340
2	h3	8.000	.0250	.0400
2	h3	10.000	.0200	.0670
2	h3	12.500	.0170	.0920
2	h3	16.000	.0200	.0880
3	h4	.160	.0630	.1150
3	h4	.200	.0930	.1540
3	h4	.250	.0630	.1480
3	h4	.320	.0670	.0980
3	h4	.400	.0420	.0820
3	h4	.500	.0350	.0580
3	h4	.800	.0300	.0670
3	h4	1.000	.0230	.0730
3	h4	1.250	.0220	.0680
3	h4	1.600	.0270	.0840
3	h4	2.000	.0230	.0920
3	h4	2.500	.0420	.1150
3	h4	3.200	.0320	.0820

TABLE 4 (Continued)

Location	Figure No.	Frequency (kHz)	VITSS Structure	CR554/CR3 Structure
			%C/Ce	%C/Ce
3	44	4.000	.1750	.5750
3	44	5.000	.0430	.0920
4	45	.160	1.2000	1.4500
4	45	.200	.4200	3.6500
4	45	.250	.3800	3.8500
4	45	.320	.4200	1.5500
4	45	.400	.2500	.8200
4	45	.800	1.1500	2.1500
4	45	1.000	1.3800	3.6500
4	45	2.500	.7500	1.0500
4	45	3.200	1.1000	1.7500
4	45	10.000	.3500	.5200
4	45	12.500	.3500	.6000
4	45	16.000	.5500	.6000

Table 5 presents the locations and frequencies where the VITSS had approximately the same amount of damping as the standard.

TABLE 5

Location	Figure No.	Frequency (kHz)	VITSS Structure	CR554/CR3 Structure
			%C/Ce	%C/Ce
1	42	.125	.1100	.1100
1	42	.160	.1300	.1300
2	43	1.250	.0375	.0375
4	45	.500	.5000	.5000

From Figures 47, 48 and 49, it can be seen that the VITSS dome structure is easier to excite than the standard dome structure at frequencies below 1 kHz. At a few higher frequencies, the VITSS dome structure is generally harder to excite than the standard dome structure.

### DISCUSSION

If all frequencies are taken into account, the VITSS dome structure appears to be slightly inferior to the standard 185-inch dome structure, as far as vibration damping characteristics are concerned. However, at certain frequencies (5 kHz and 6.4 kHz), the VITSS has better (but not considerably better) vibration damping characteristics than the standard. Also, at other locations on the dome and at some other frequencies, the VITSS appears to be slightly superior to the standard.

During initial measurements, this writer believed that welding the trusses at the bottom of the structure would improve the damping characteristics. Indeed, welded trusses did reduce the extent to which the ends of the trusses were excited into free vibration, although damping was not improved to any great extent.

At certain frequencies, VITSS is slightly superior to the standard dome structure. These frequencies are 5 kHz, 6.4 kHz and 10 kHz for location 1; 5 kHz and 6.4 kHz for location 2; and 4 kHz, 6.4 kHz, 8 kHz, 12.5 kHz and 16 kHz for location 3. The addition of more  $1/4$ " x 1" plates between truss chords might possibly improve the damping characteristics to a point where the damping characteristics of the VITSS dome structure might be superior to the standard type dome structure at more frequencies. This would make the VITSS more rigid and, therefore, the dome, when excited, would not have the tendency to vibrate to as great an extent at the lower frequencies.

### CONCLUSIONS

At the present time, there is no evidence that shows the VITSS-type of structure to be superior to a standard-type of dome structure.

*Howard N. Phelps, Jr.*  
HOWARD N. PHELPS, JR.  
Mechanical Engineer

LIST OF REFERENCES

- (a) M. F. Borg, "Some Views on Research and Development Efforts at USN/USL Pertaining to Sonar Domes", USL Technical Memorandum No. 933-026-64, 3 February 1964 (Conf.)
- (b) C. J. Burbank, "Transducer Dome Bars as a Cause of Sonar Spoking", NEL, R & D Report No. 1146, 6 November 1962 (Conf.) USL Acc. No. 38048.
- (c) O. H. Hahs, "Sonar Self-Noise Reduction", USL Research Report No. 462, 20 December 1959 (Conf.)
- (d) H. N. Phelps, Jr., "Damping and Vibration Characteristics of a 185-Inch Sand Damped CW554/SQS-4 Steel Sonar Dome, USL Technical Memorandum No. 933-182-64, 26 June 1964.
- (e) H. N. Phelps, Jr. and M. F. Borg, "Calibration of Instrumentation for Vibration and Damping Tests", USL Technical Memorandum No. 933-236-63, 22 August 1963.
- (f) H. N. Phelps, Jr., "Damping Characteristics of Three Untreated Steel Plates", USL Technical Memorandum No. 933-54-64, 17 February 1964.
- (g) LTJG J. E. Barger, USN, "An Experimental Determination of the Degree of Damping of Structures", USL Technical Memorandum No. 1210-94-59, 17 June 1959.
- (h) "Units for Vibration in the Field of Acoustics", Bureau of Ships, ALL/NOISE (371), ENS/A2-6, Ser 371-526, 8 October 1951 (Acc. #10135-13-A).

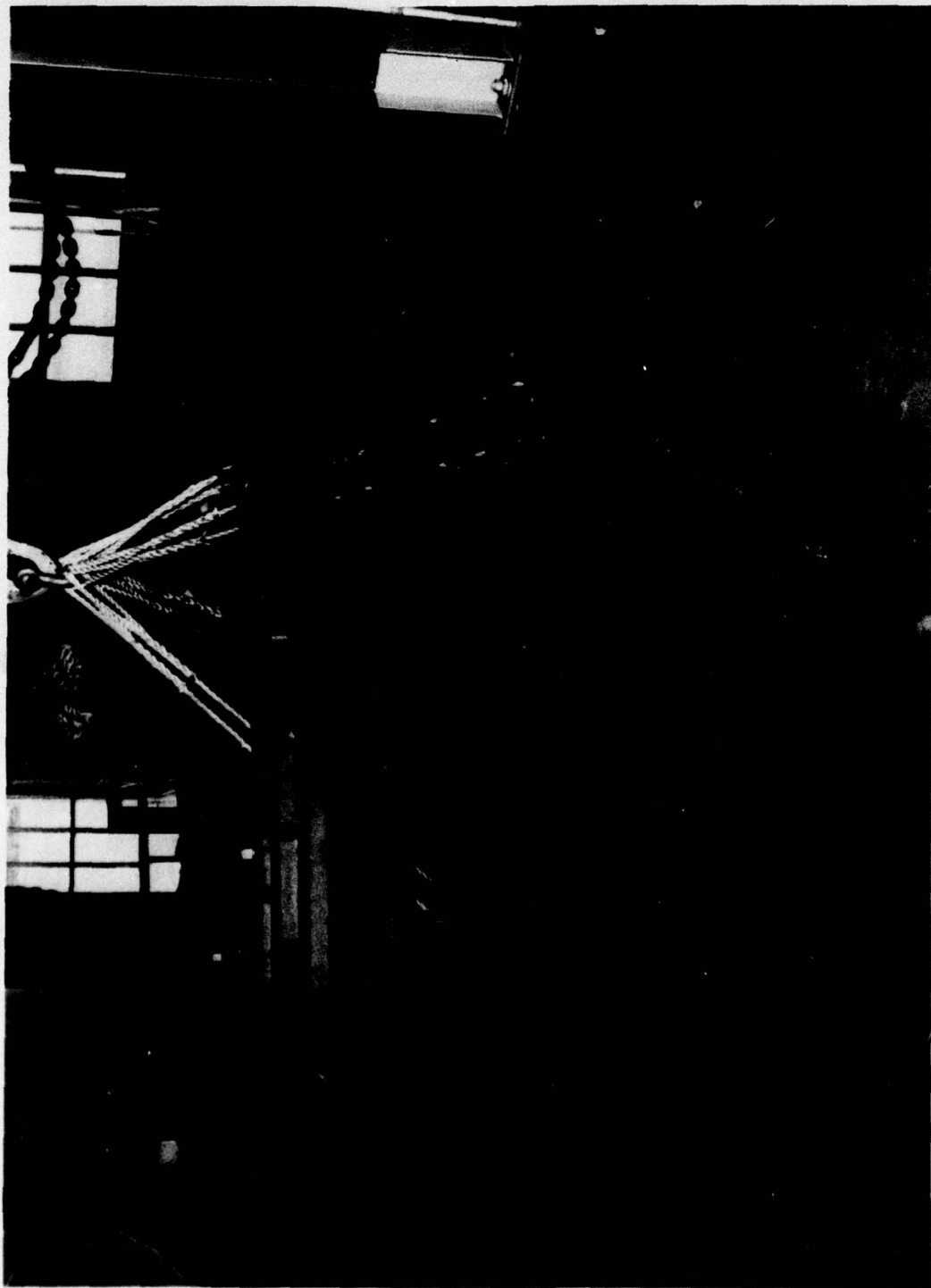


Fig. 1 - 185-inch VITSS Dome Structure

USL Tech Memo No. 2133-1213-66

U. S. Navy Underwater Sound Laboratory  
NP24 - N29433 - 12 - 66

Official Photograph

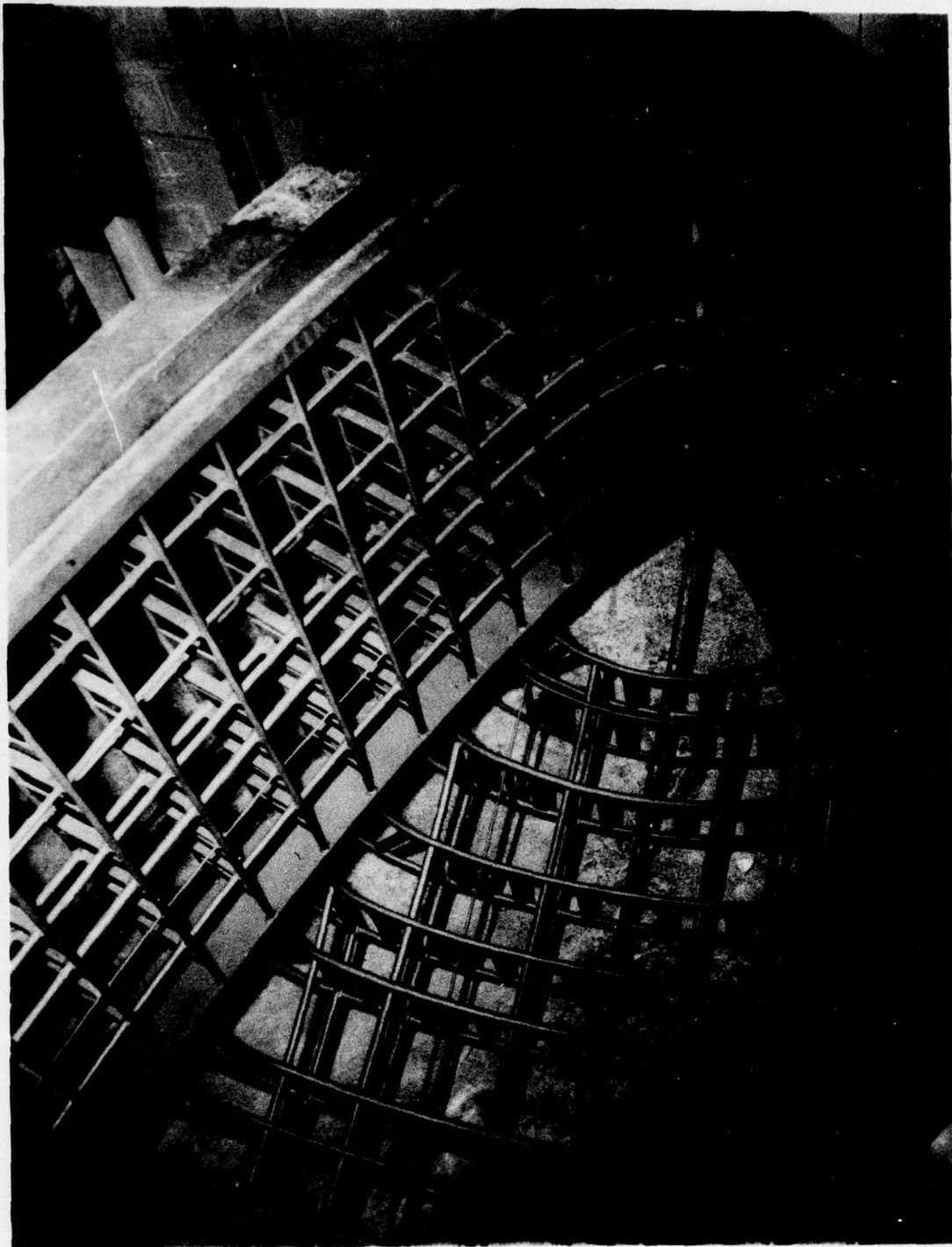


Fig. 2 - Aft End of 185-inch VITSS Dome Structure

USL Tech Memo No. 2133-1213-66

U. S. Navy Underwater Sound Laboratory  
NP24 - N29434 - 12 - 66

Official Photograph

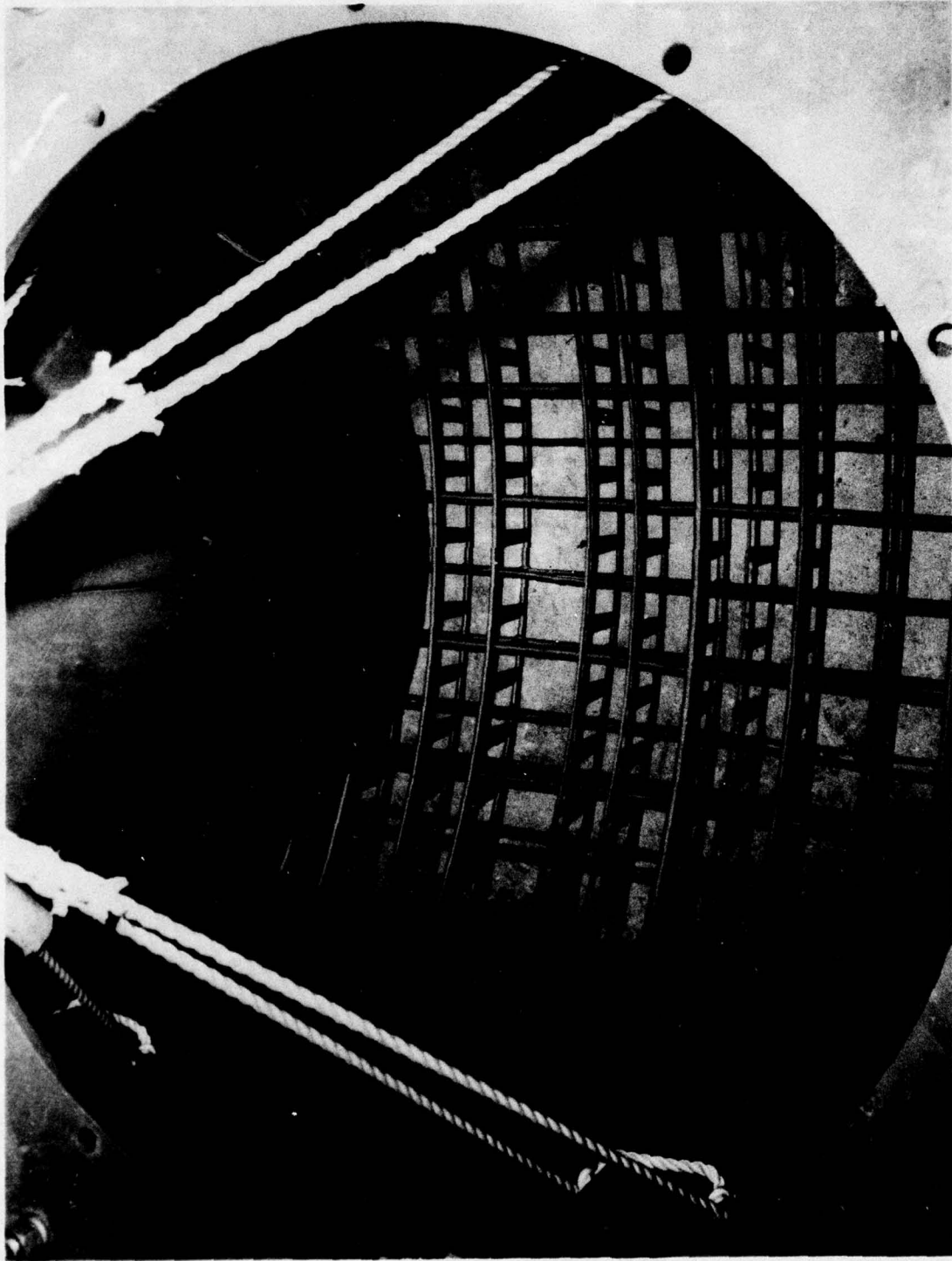


Fig. 3 - Forward of Baffle in 185-inch VITSS Dome Structure

USL Tech Memo No. 2133-1213-66

U. S. Navy Underwater Sound Laboratory  
NP24 - N29435 - 12 - 66

Official Photograph

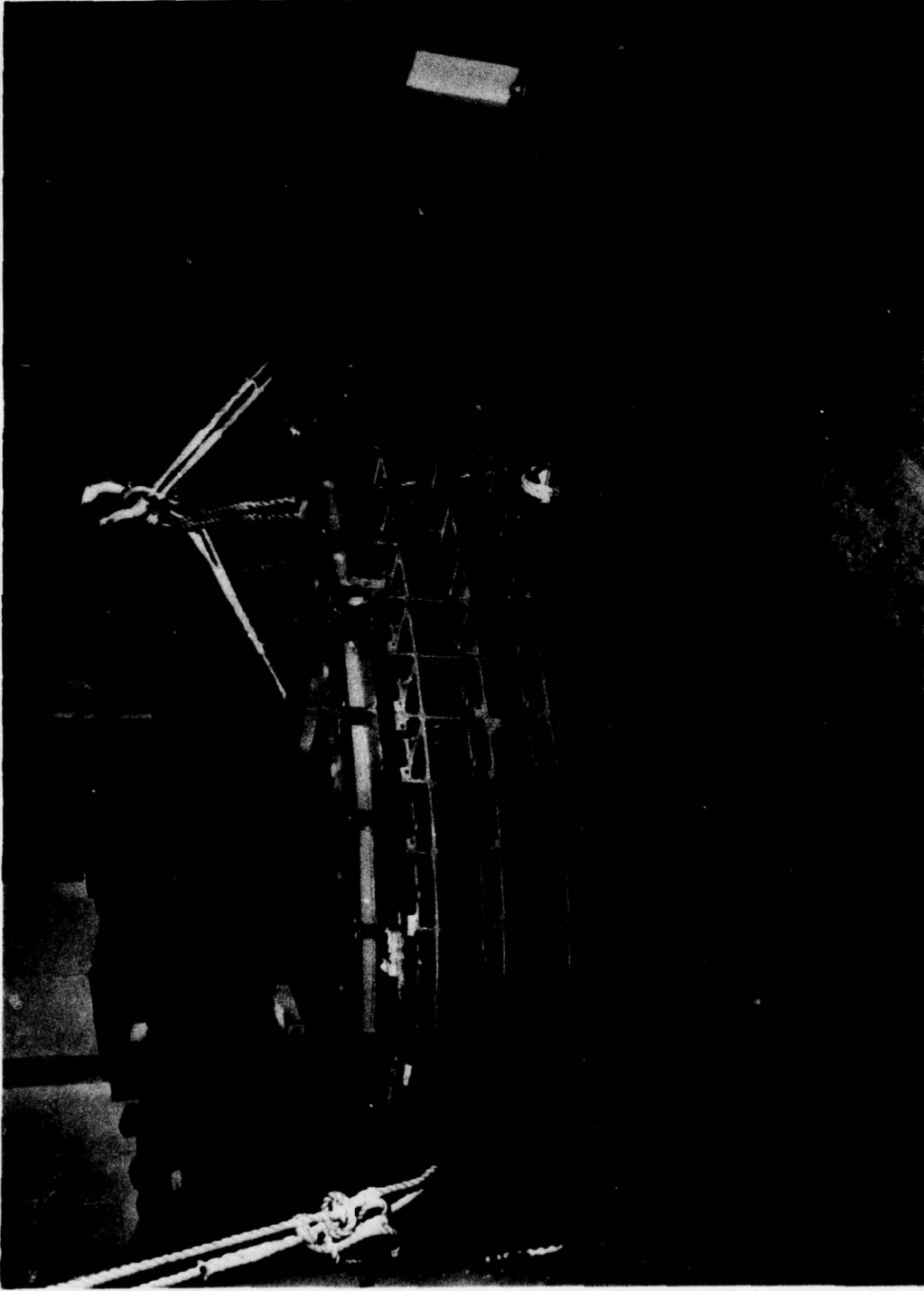


Fig. 4 - 185-inch CW554/SQS Standard Dome Structure

USL Tech Memo No. 2133-1213-66

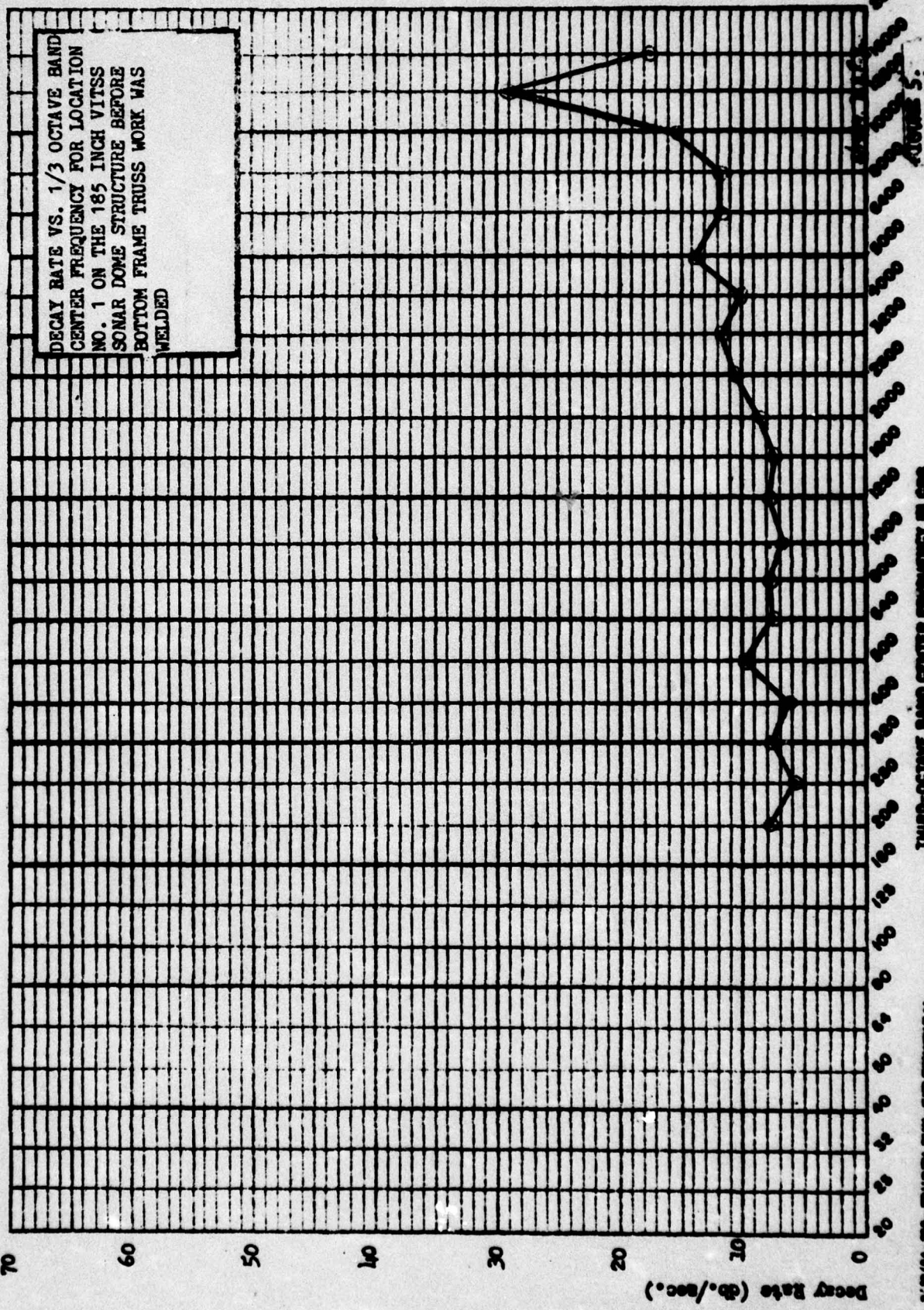
U. S. Navy Underwater Sound Laboratory  
NP24 - N29436 - 12 - 66

Official Photograph

USL Tech Memo  
 TEMPERATURE = 70 F. No. 2133-1213-66

DECAY RATE VS. 1/3 OCTAVE BAND  
 CENTER FREQUENCY FOR LOCATION  
 NO. 1 ON THE 185 INCH VITSS  
 SONAR DOME STRUCTURE BEFORE  
 BOTTOM FRAME TRUSS WORK WAS  
 WELDED

USN-USU-883 (Rev. 1/66)



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

2/21/64-20-FOURTH RUN-SEP EXPERIMENTAL

USL Tech Memo  
No. 2133-1213-66

15-N-USL-851 (Rev. 1/60)

TEMPERATURE = 70 F.

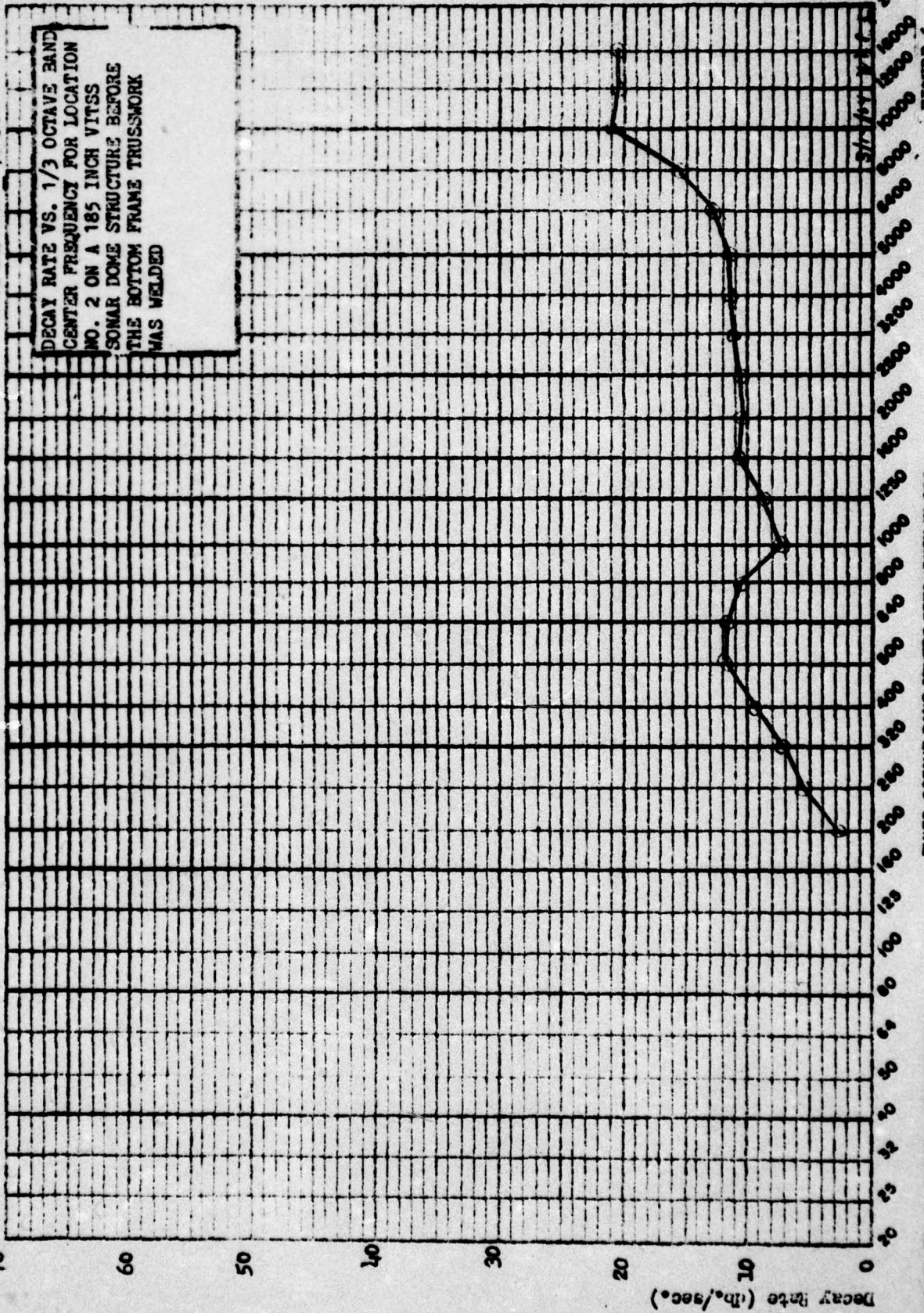


FIGURE 6

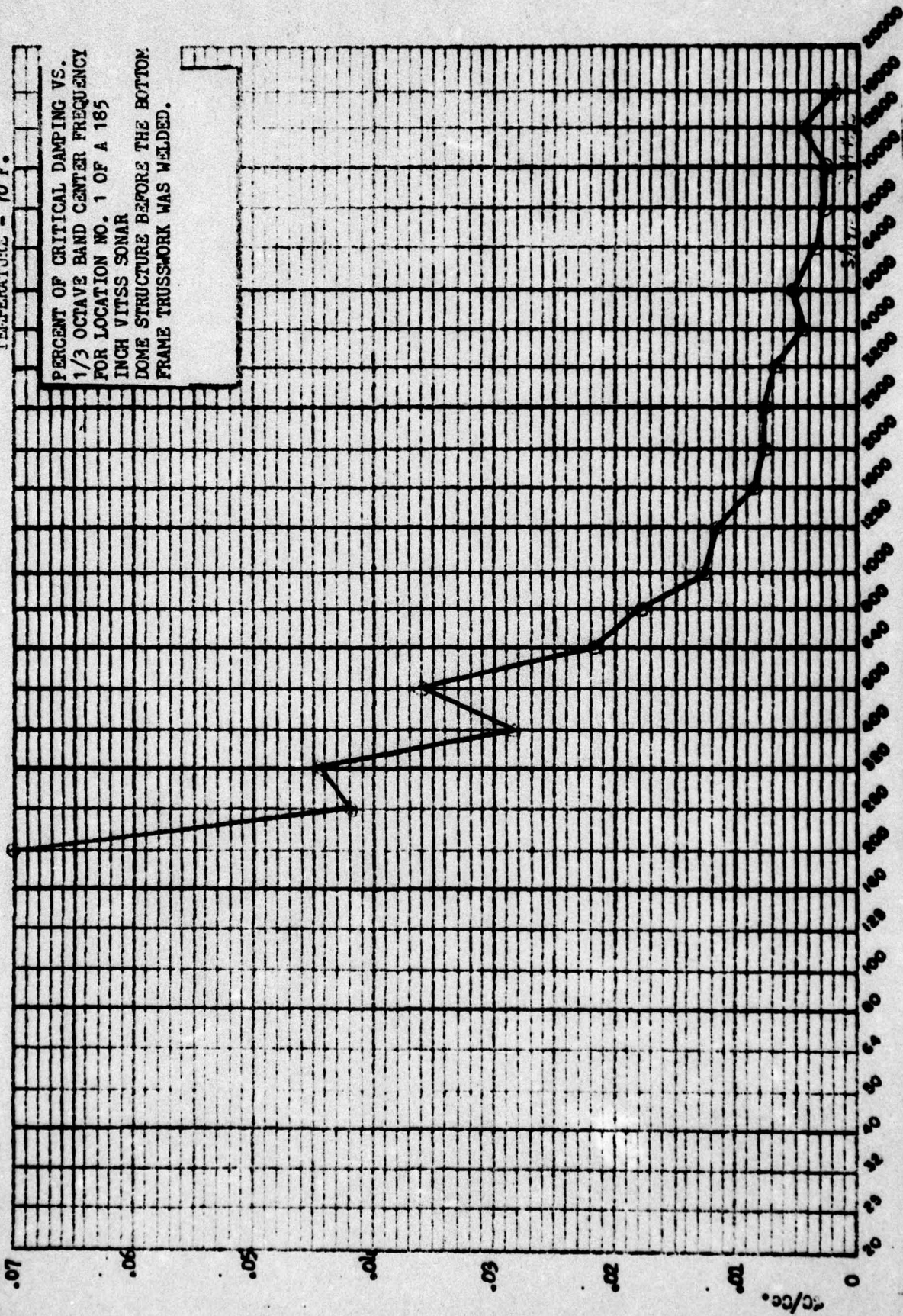
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 70 F.

PERCENT OF CRITICAL DAMPING VS.  
1/3 OCTAVE BAND CENTER FREQUENCY  
FOR LOCATION NO. 1 OF A 185  
INCH VITSS SONAR  
DOME STRUCTURE BEFORE THE BOTTOM  
FRAME TRUSSWORK WAS WELDED.

USN-USL-003 (Rev. 1/60)



9-52-66-20-4 FOURTH MAN-EMP EXPERIMENTAL

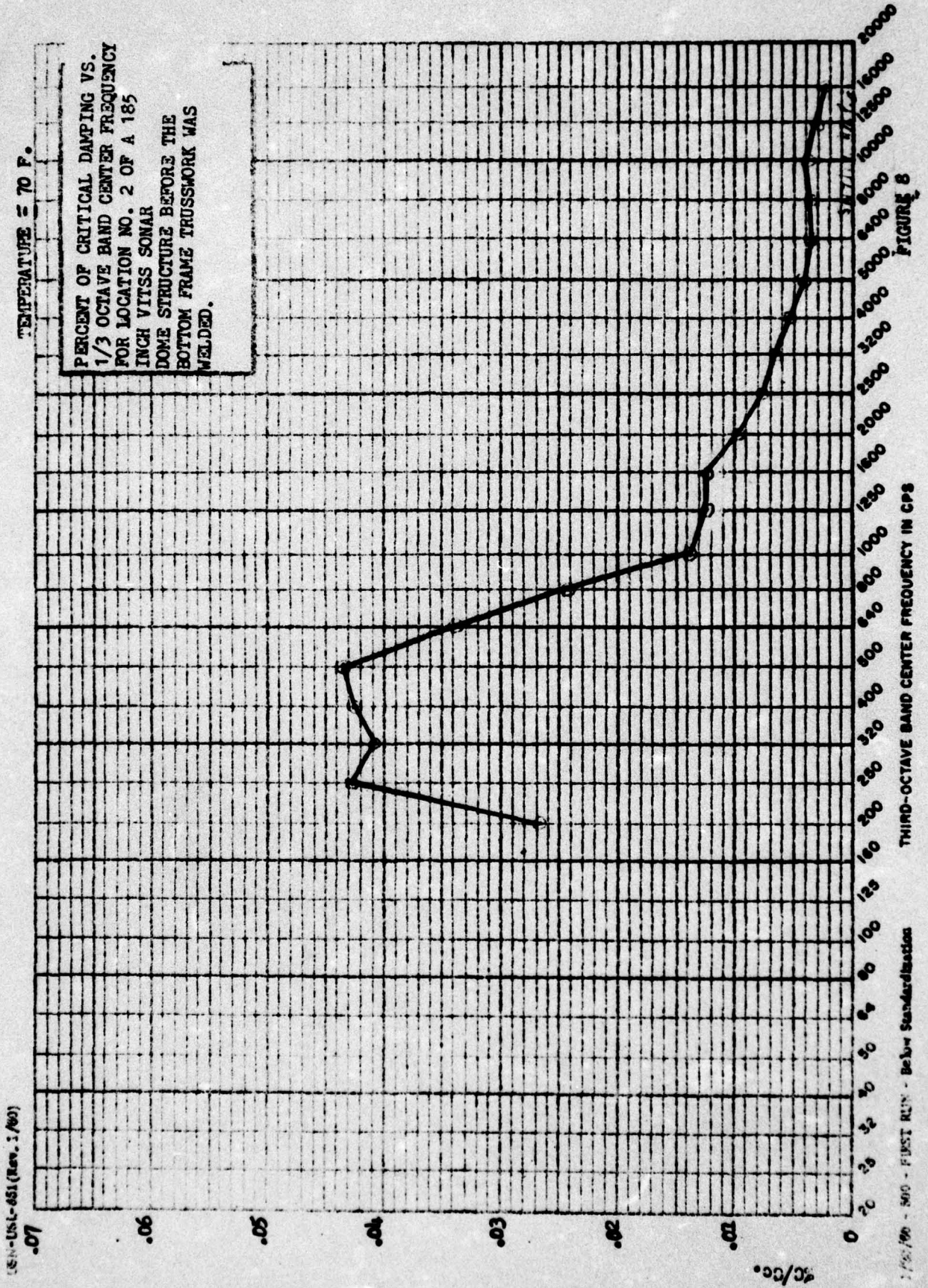
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 7

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 70 F.

PERCENT OF CRITICAL DAMPING VS.  
1/3 OCTAVE BAND CENTER FREQUENCY  
FOR LOCATION NO. 2 OF A 185  
INCH VITSS SONAR  
DOME STRUCTURE BEFORE THE  
BOTTOM FRAME TRUSSWORK WAS  
WELDED.



GEN-USL-651 (Rev. 1/60)

1/25/70 - 500 - FIRST RUN - Below Standardization

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 8

USL Tech Memo  
 No. 2133-1213-66

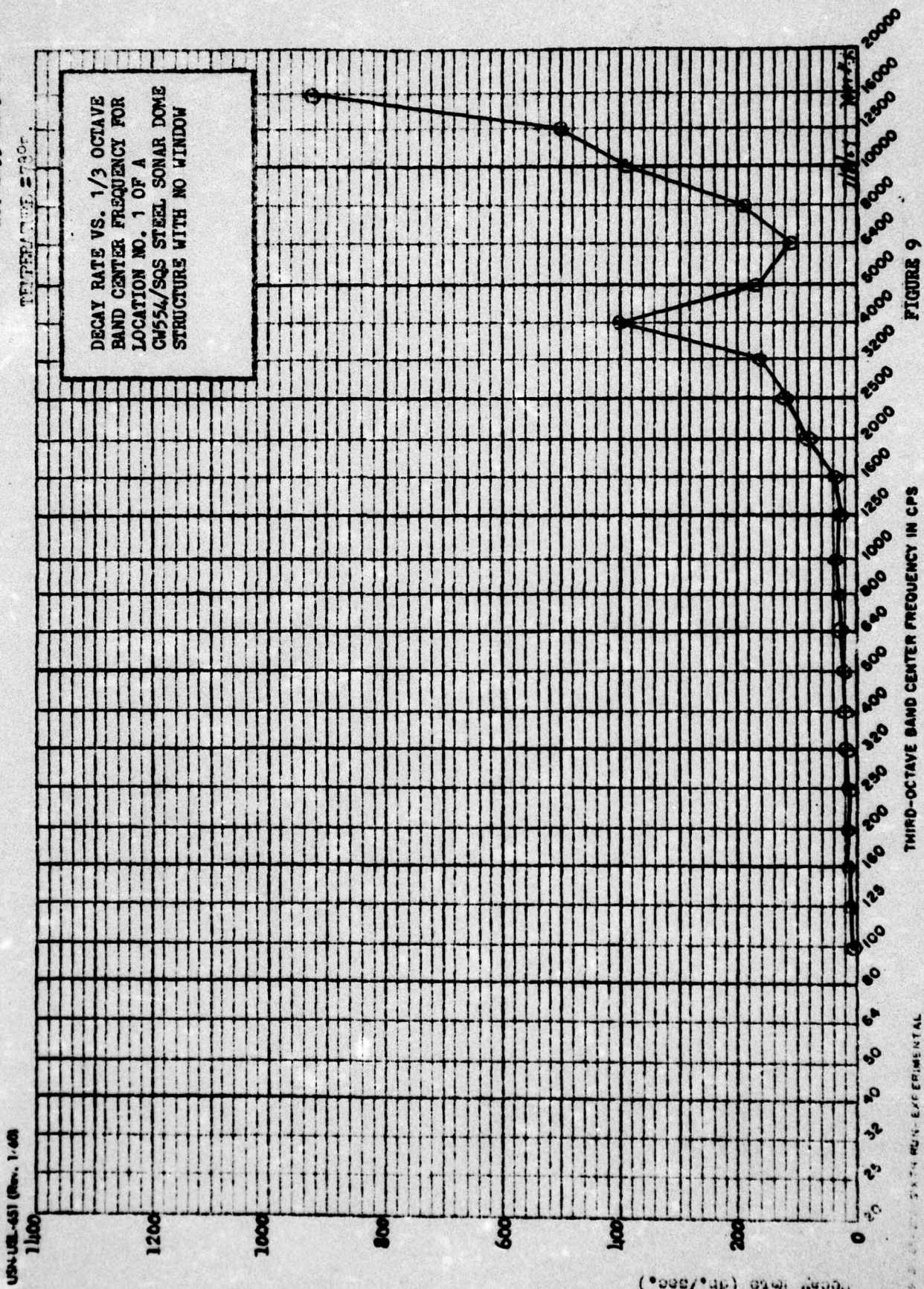


FIGURE 9

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

EXPERIMENTAL

USN-451 (Rev. 1-60)

Decay Rate (db./sec.)

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 78°F.

DECAY RATE VS. 1/3 OCTAVE  
BAND CENTER FREQUENCY FOR  
LOCATION NO. 2 OF A CM554/SQS  
STEEL SONAR DOME STRUCTURE  
WITH NO WINDOW.

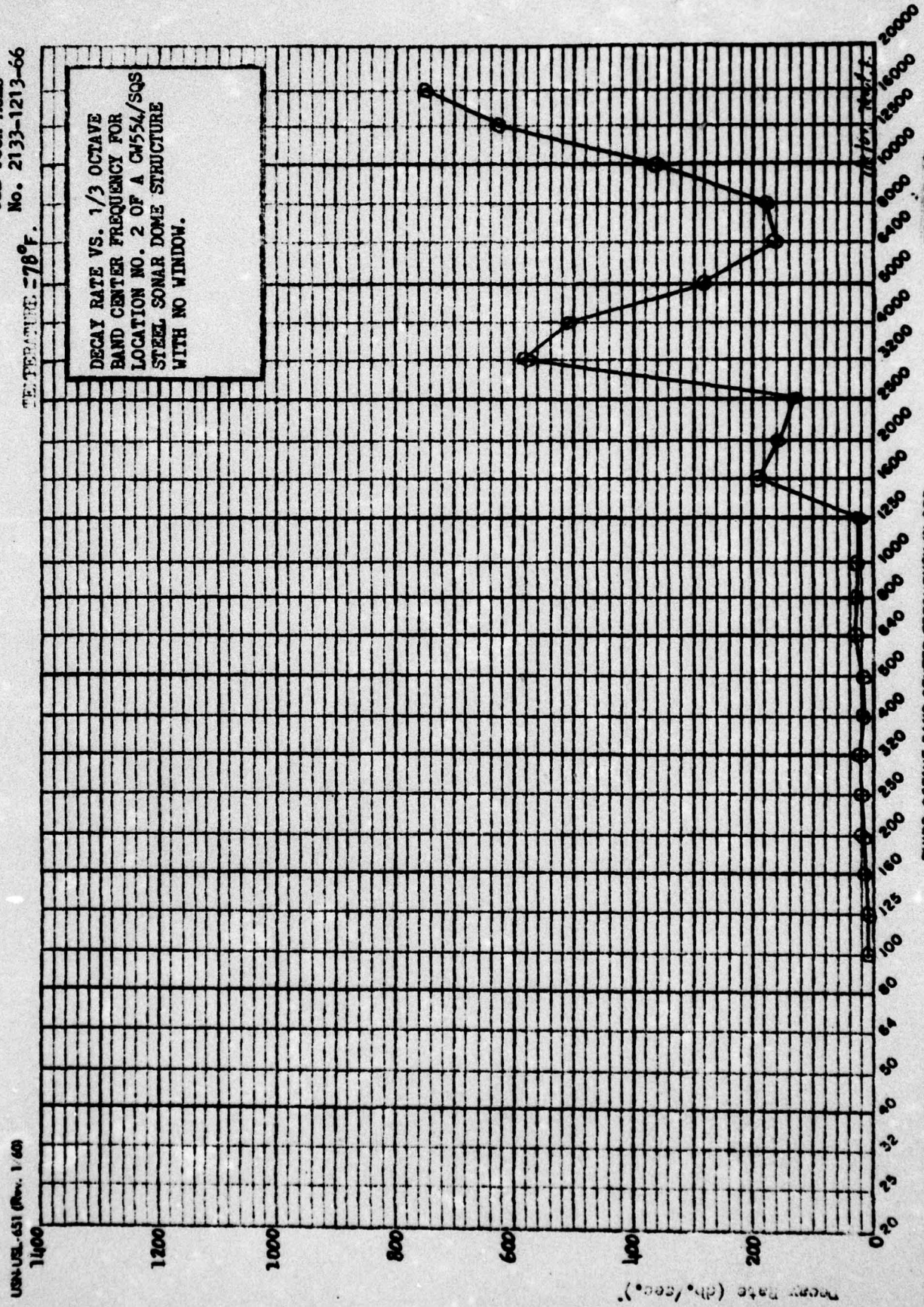
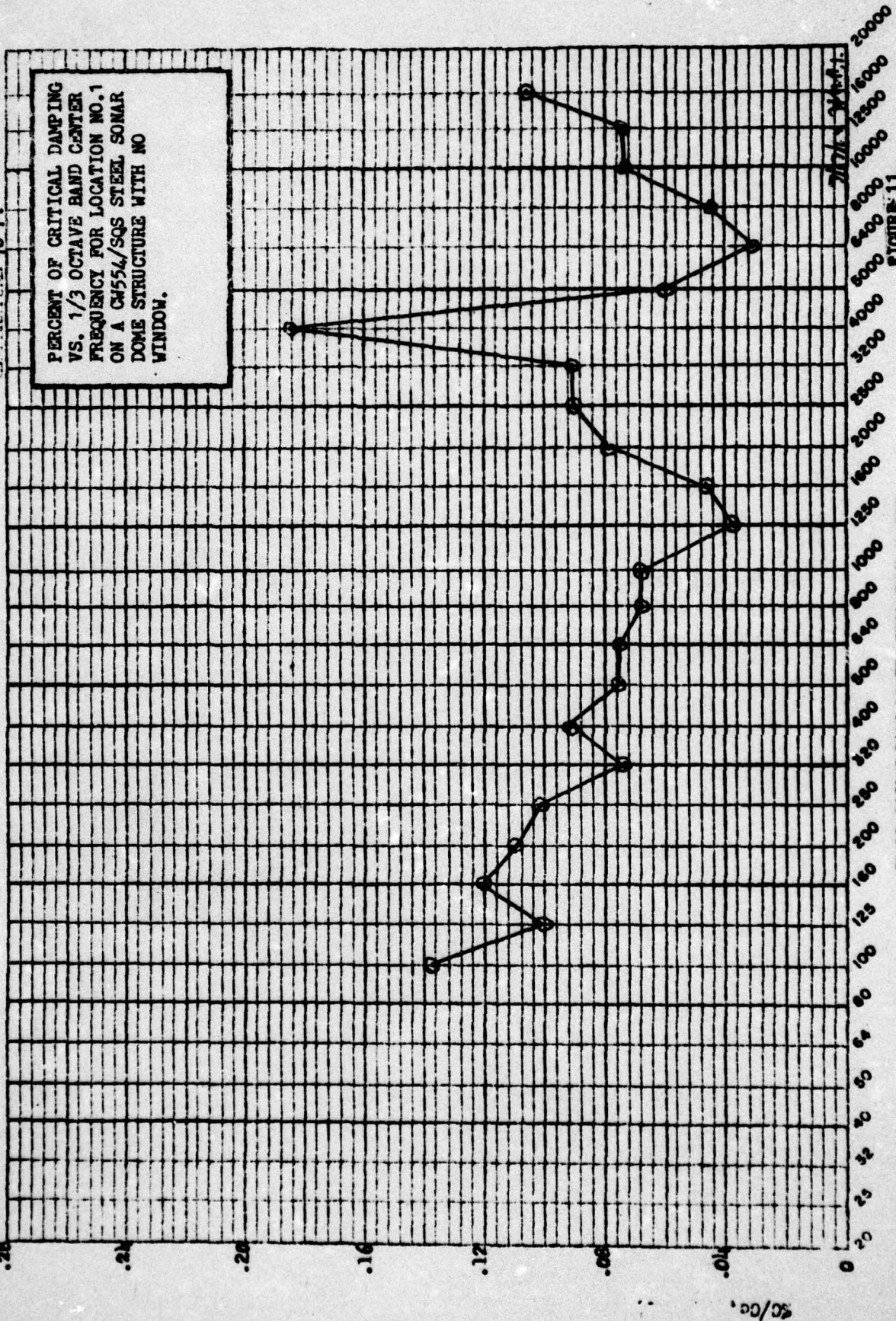


FIGURE 10

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

TEMPERATURE 78° F.

PERCENT OF CRITICAL DAMPING  
VS. 1/3 OCTAVE BAND CENTER  
FREQUENCY FOR LOCATION NO. 1  
ON A C4554/SQS STEEL SONAR  
DOME STRUCTURE WITH NO  
WINDOW.



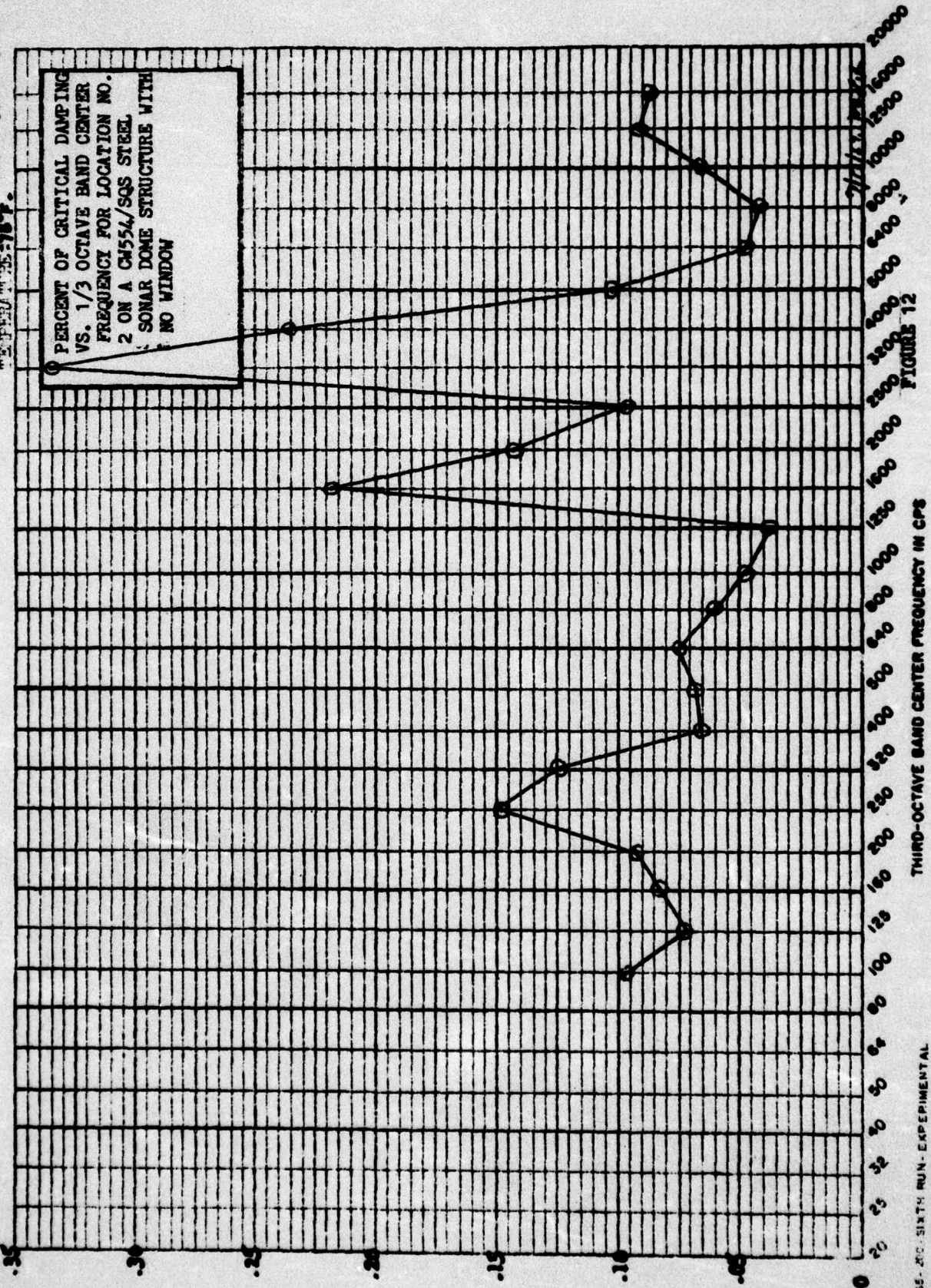
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 11.

TEMPERATURE: 78°F.

PERCENT OF CRITICAL DAMPING  
 VS. 1/3 OCTAVE BAND CENTER  
 FREQUENCY FOR LOCATION NO.  
 2 ON A CH554/SQS STEEL  
 SONAR DOME STRUCTURE WITH  
 NO WINDOW

USNUSL-451 (Rev. 1/60)



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
 No. 2133-1213-66

TEMPERATURE = 78 F.

LEN-USL-661 (Rev. 1/60)

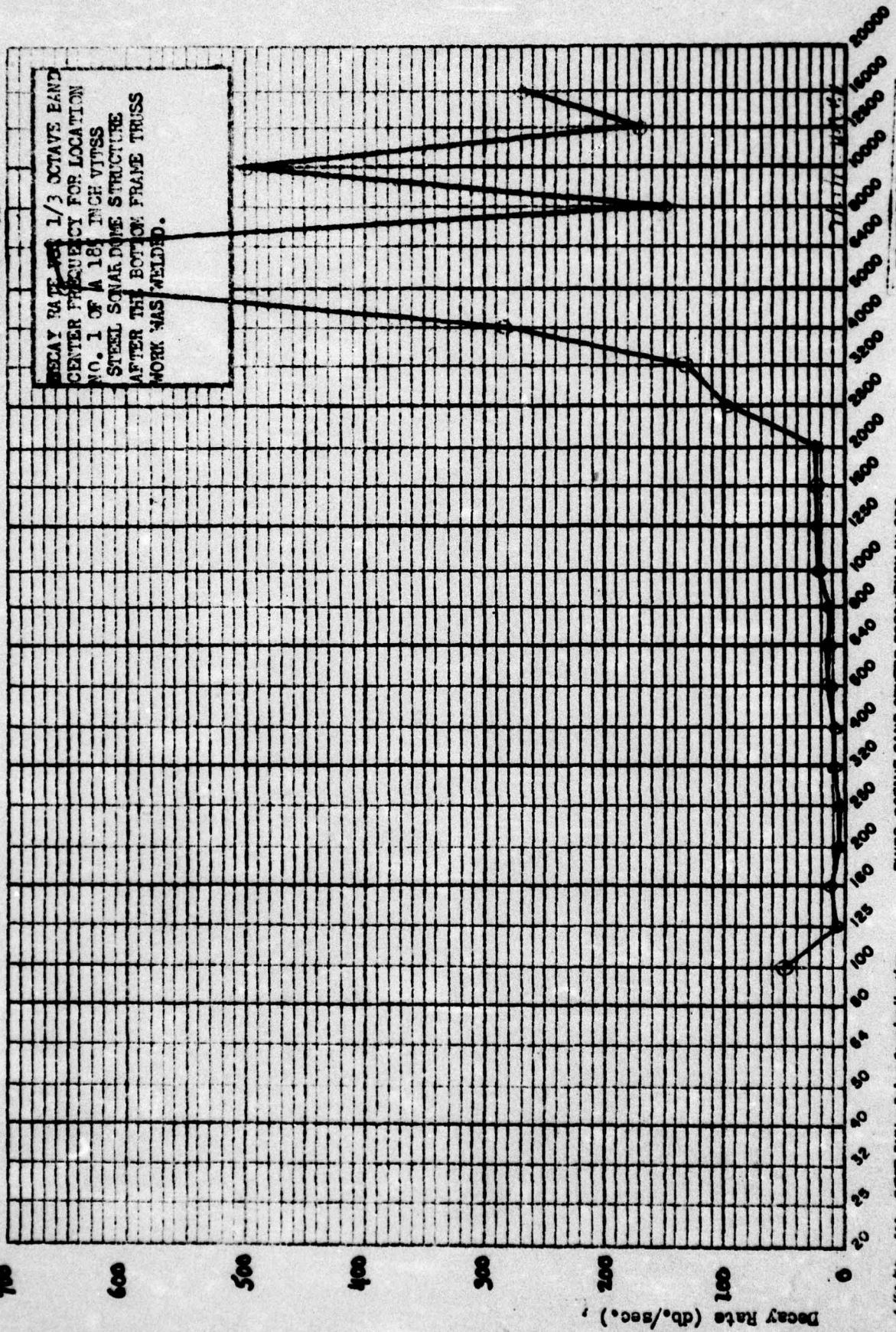


FIGURE 13

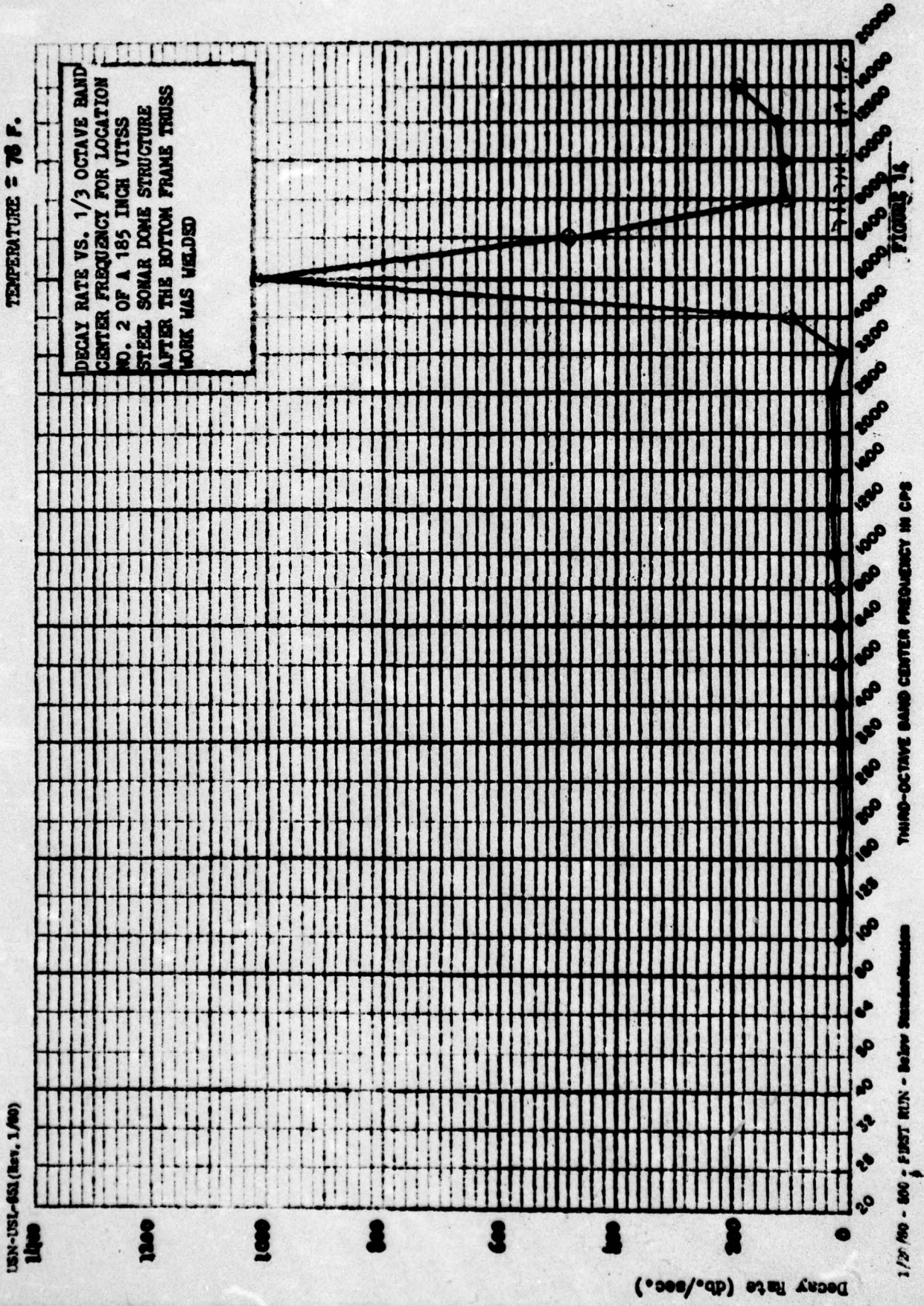
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/20, 1/3 - 600 - FIRST RUN - Below Standardization

USL Tech Memo  
 No. 2133-1213-66

TEMPERATURE = 78 F.

DECAY RATE VS. 1/3 OCTAVE BAND  
 CENTER FREQUENCY FOR LOCATION  
 NO. 2 OF A 185 INCH VITSS  
 STEEL SONAR DOME STRUCTURE  
 AFTER THE BOTTOM FRAME TROSS  
 WORK WAS WELDED



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/2" / 100 - 500 - FIRST RUN - Below Standardization

FIGURE 12

TEMPERATURE = 75 F. USL Tech Memo  
No. 2133-1213-66

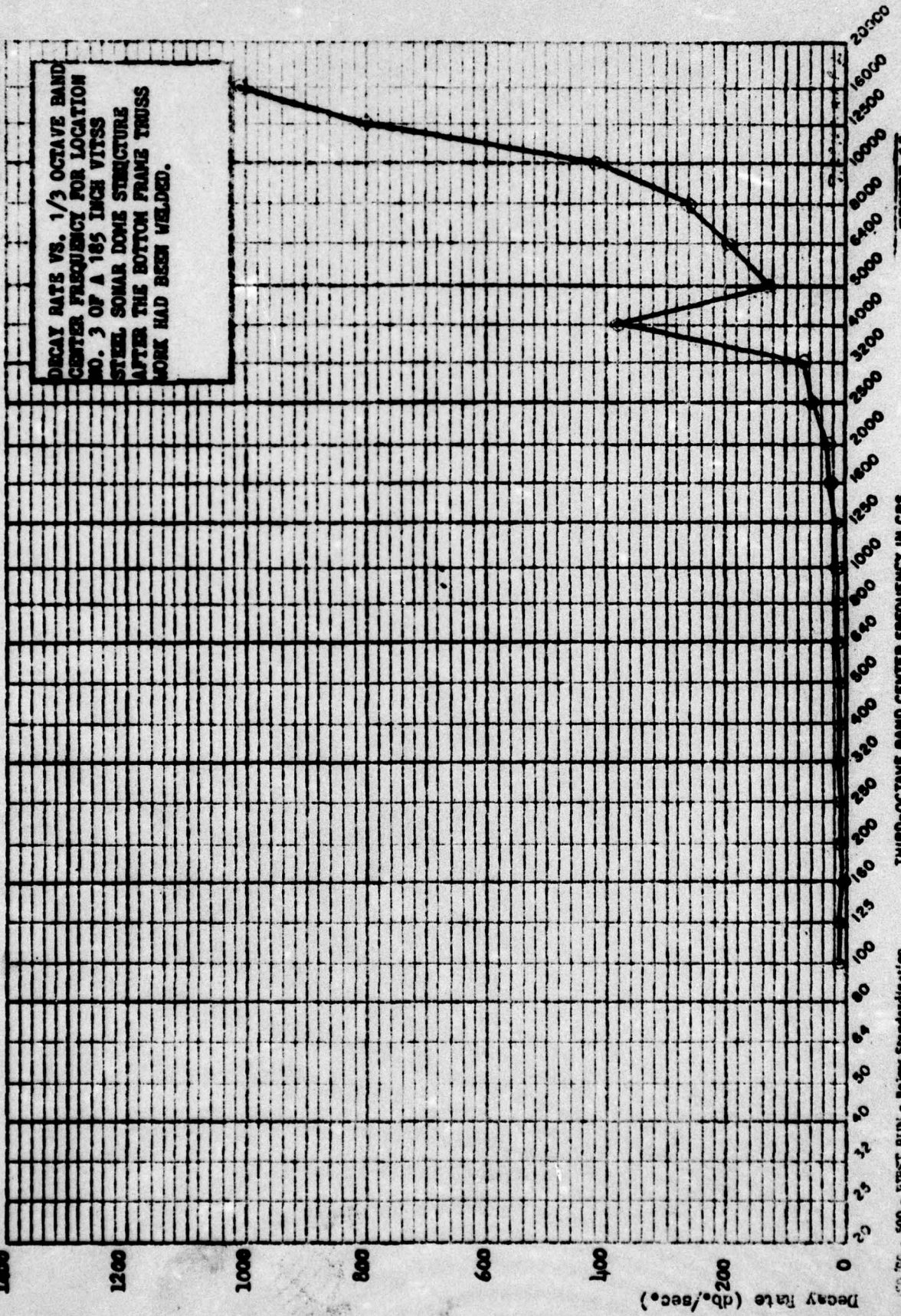
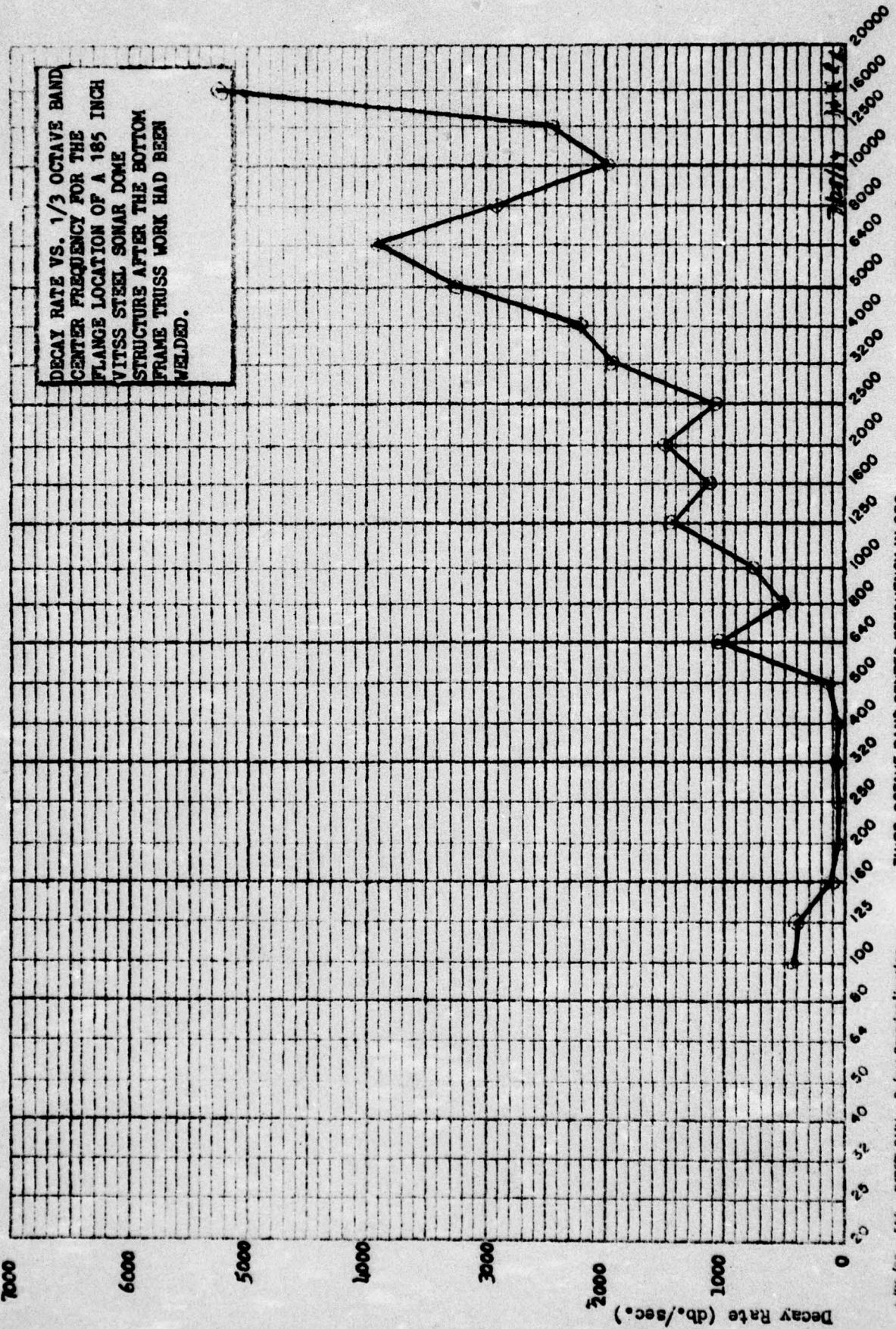


FIGURE 13

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 75 F.

USN-USL-651 (Rev. 1/60)



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/20/60 - 500 - FIRST RUN - BELY Standardization

FIGURE 16

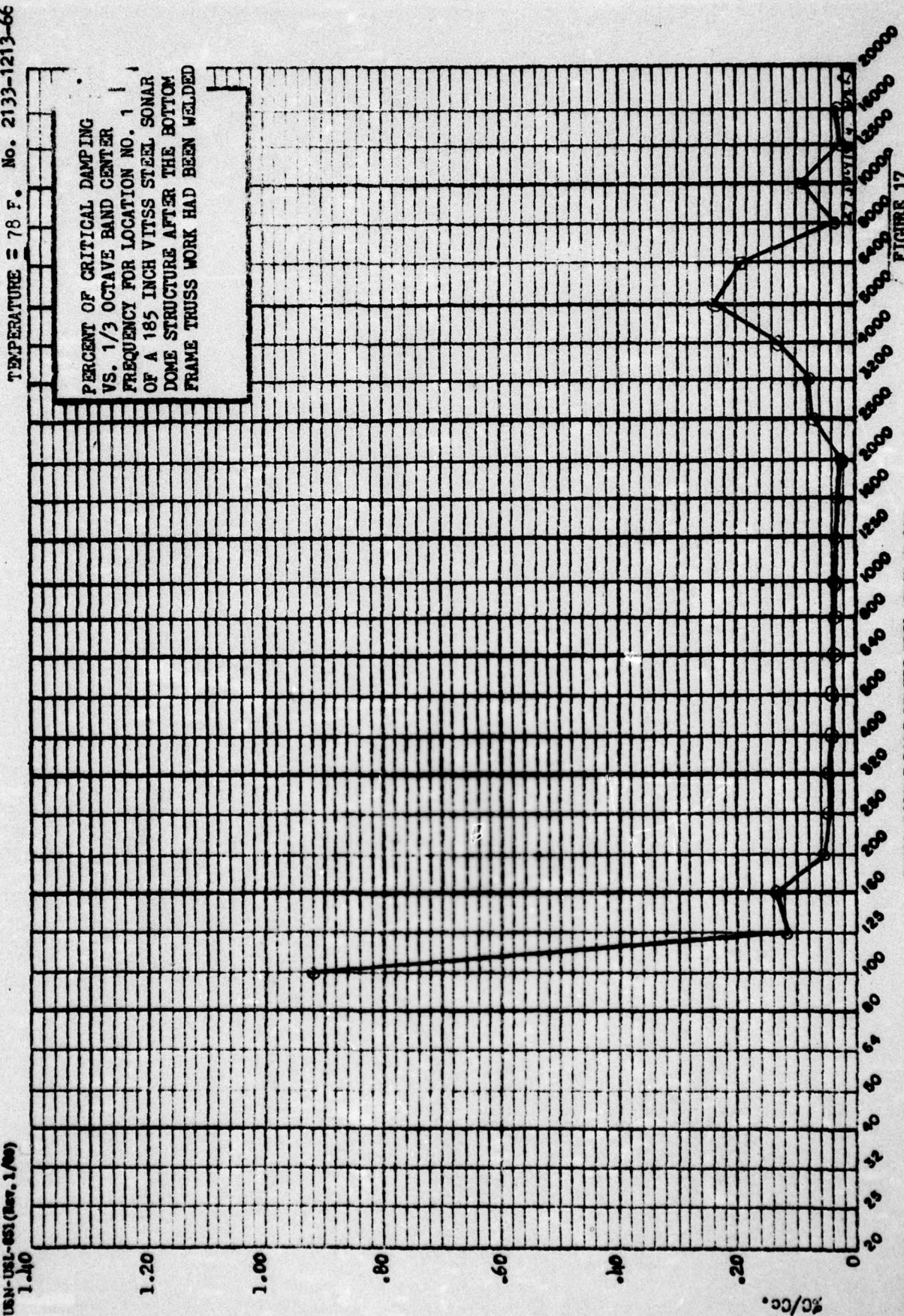


FIGURE 17

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

TEMPERATURE = 76 F.

USN-USL-651 (Rev. 1/60)

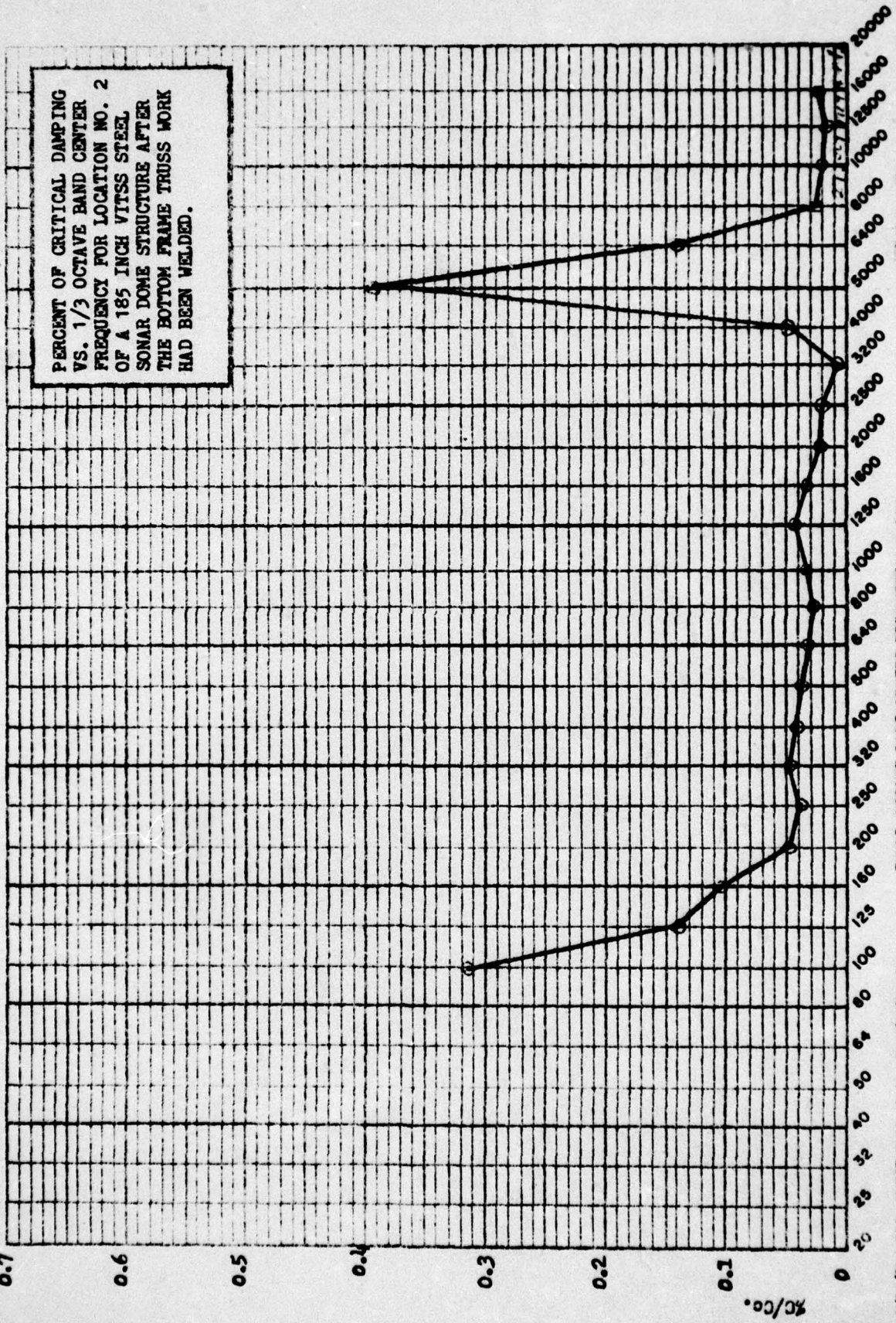


FIGURE 18

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/20/60 - 560 - FIRST RUN - Below Standardization

USL Tech Memo  
 No. 2133-1213-66

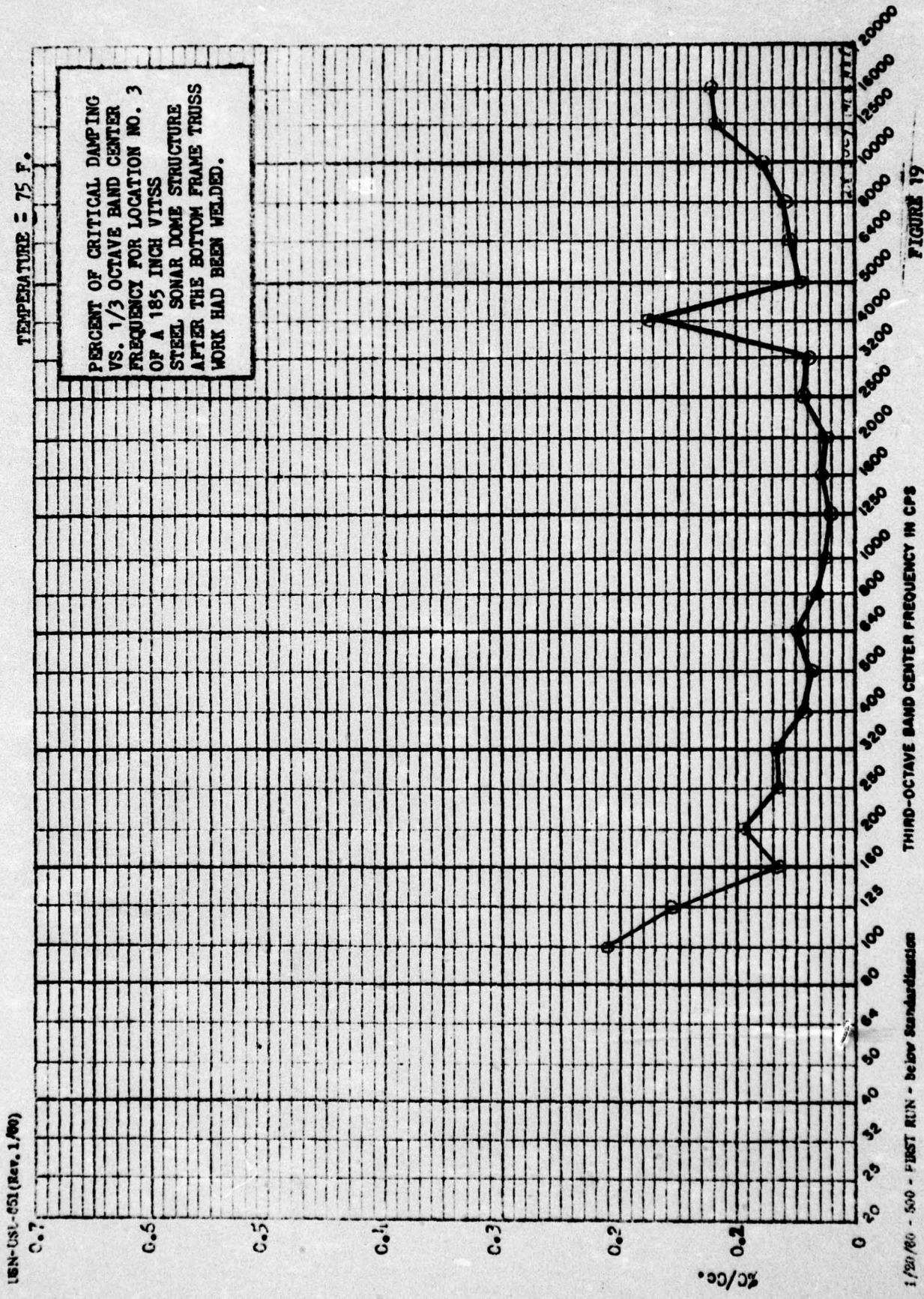


FIGURE 19

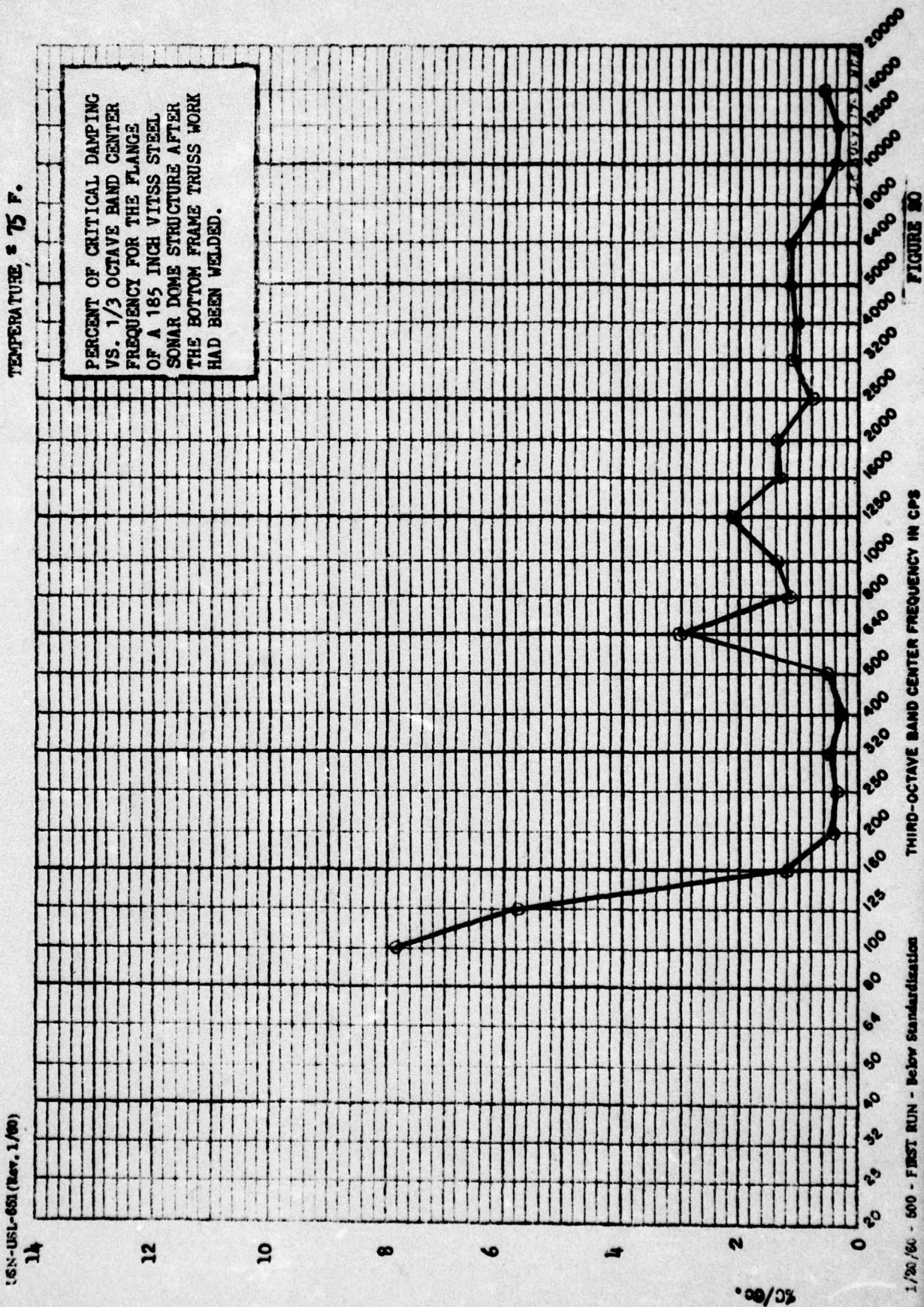
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/20/66 - 500 - FIRST RUN - Below Standardization

USL Tech Memo  
 No. 2133-1213-66

TEMPERATURE = 75 F.

PERCENT OF CRITICAL DAMPING  
 VS. 1/3 OCTAVE BAND CENTER  
 FREQUENCY FOR THE FLANGE  
 OF A 185 INCH VITSS STEEL  
 SONAR DOME STRUCTURE AFTER  
 THE BOTTOM FRAME TRUSS WORK  
 HAD BEEN WELDED.



USN-USL-651 (Rev. 1/60)

14

12

10

8

6

4

2

0

%C/60.

1/20/60 - 500 - FIRST RUN - Below Standardization

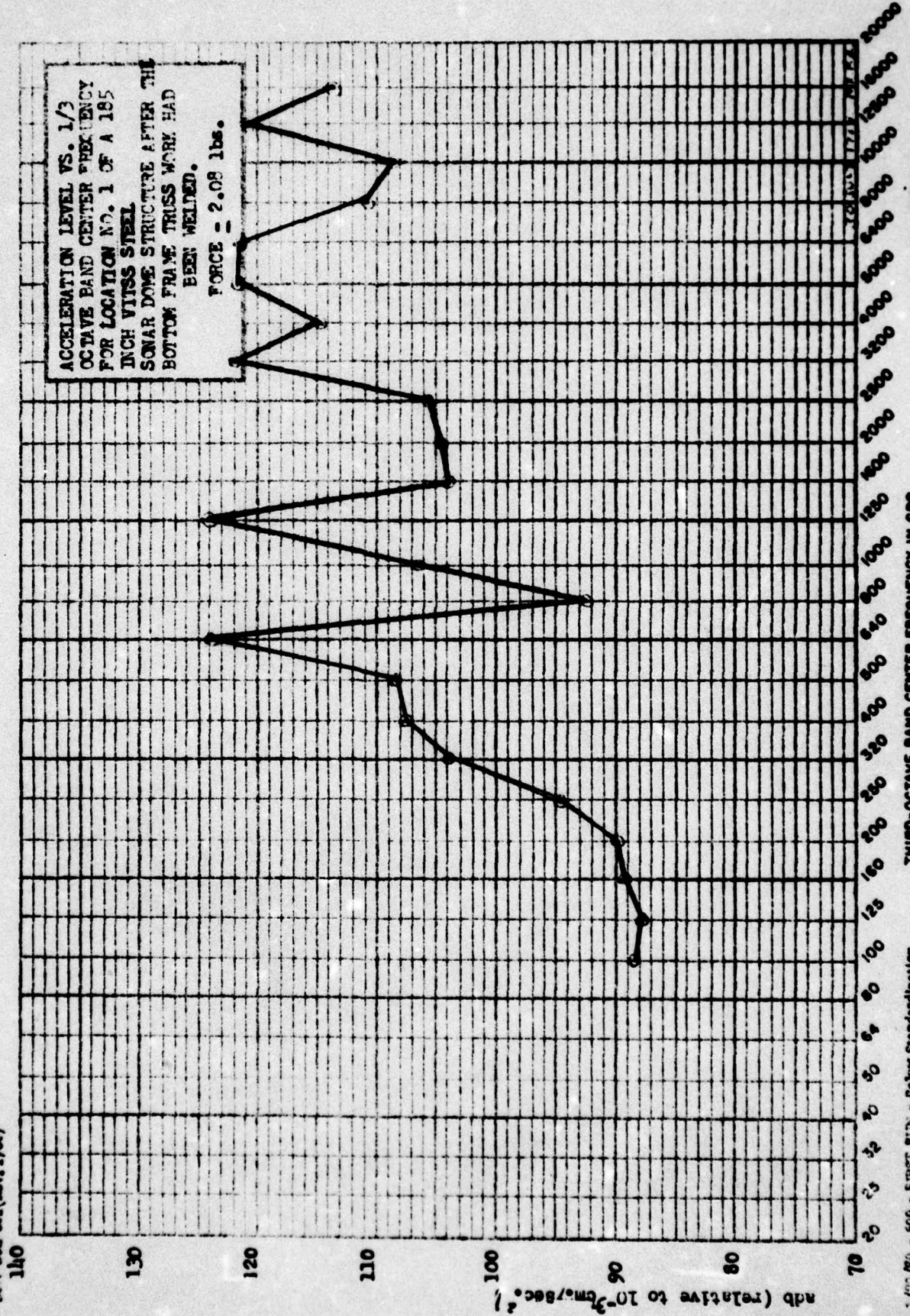
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 20

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 79 F.

USL-661 (Rev. 1/60)

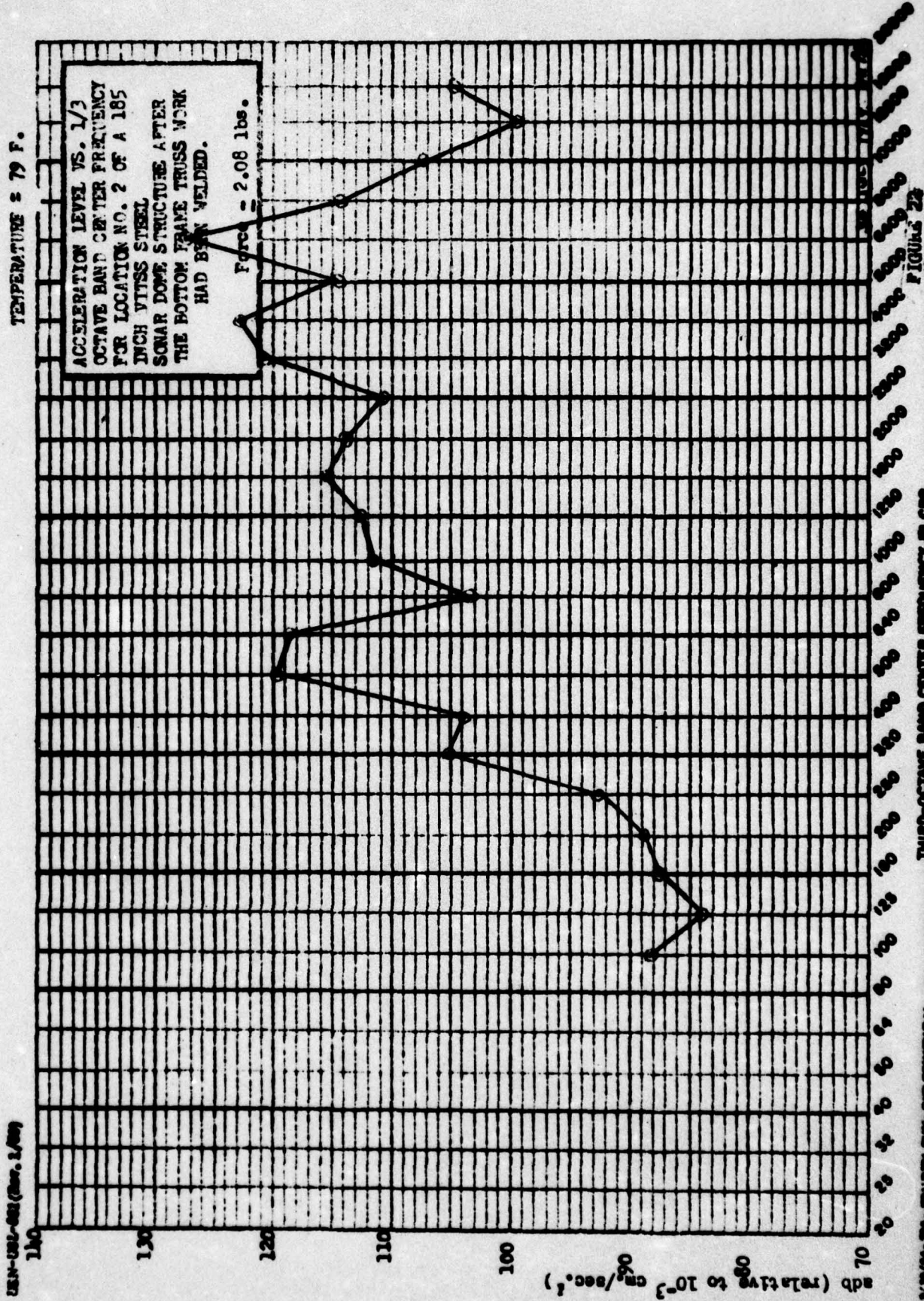


USL Tech Memo  
 No. 2133-1213-66

TEMPERATURE = 79 F.

ACCELERATION LEVEL VS. 1/3  
 OCTAVE BAND CENTER FREQUENCY  
 FOR LOCATION NO. 2 OF A 185  
 INCH VISSS STEEL  
 SONAR DOME STRUCTURE AFTER  
 THE BOTTOM FRAME TRUSS WORK  
 HAD BEEN WELDED.

Force = 2.08 lbs.



TEMPERATURE = 79 F.

ACCELERATION LEVEL VS. 1/3  
 OCTAVE BAND CENTER FREQUENCY  
 FOR LOCATION NO. 3 OF A 185  
 INCH . VITSS STEEL  
 SONAR DOME STRUCTURE AFTER  
 THE BOTTOM FRAME CRUSS WORK  
 HAD BEEN WELDED.

Force = 2.06 lbs.

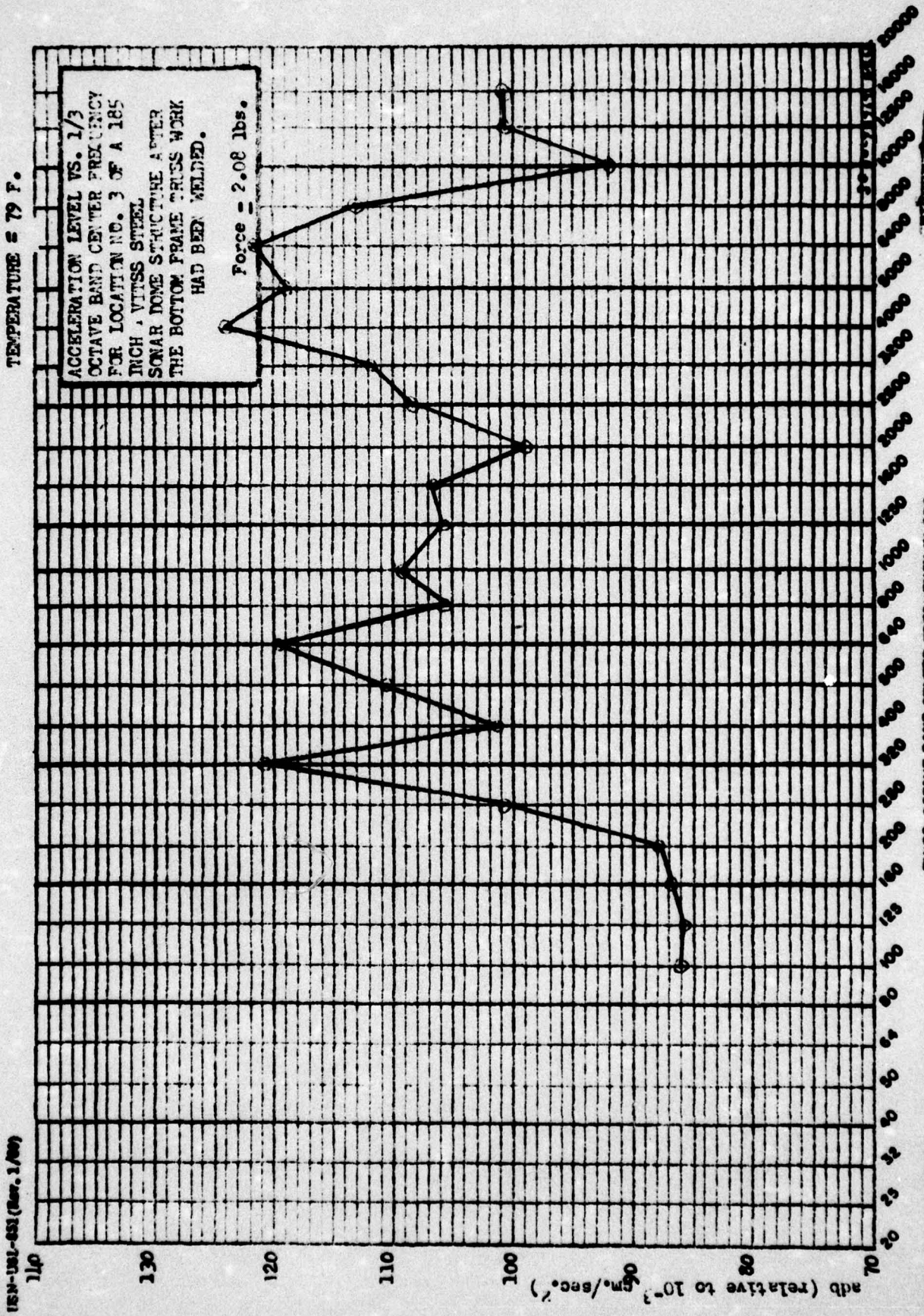


FIGURE 23

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
 No. 2133-1213-66

USA-USE-651 (Rev. 1-60)  
 1400

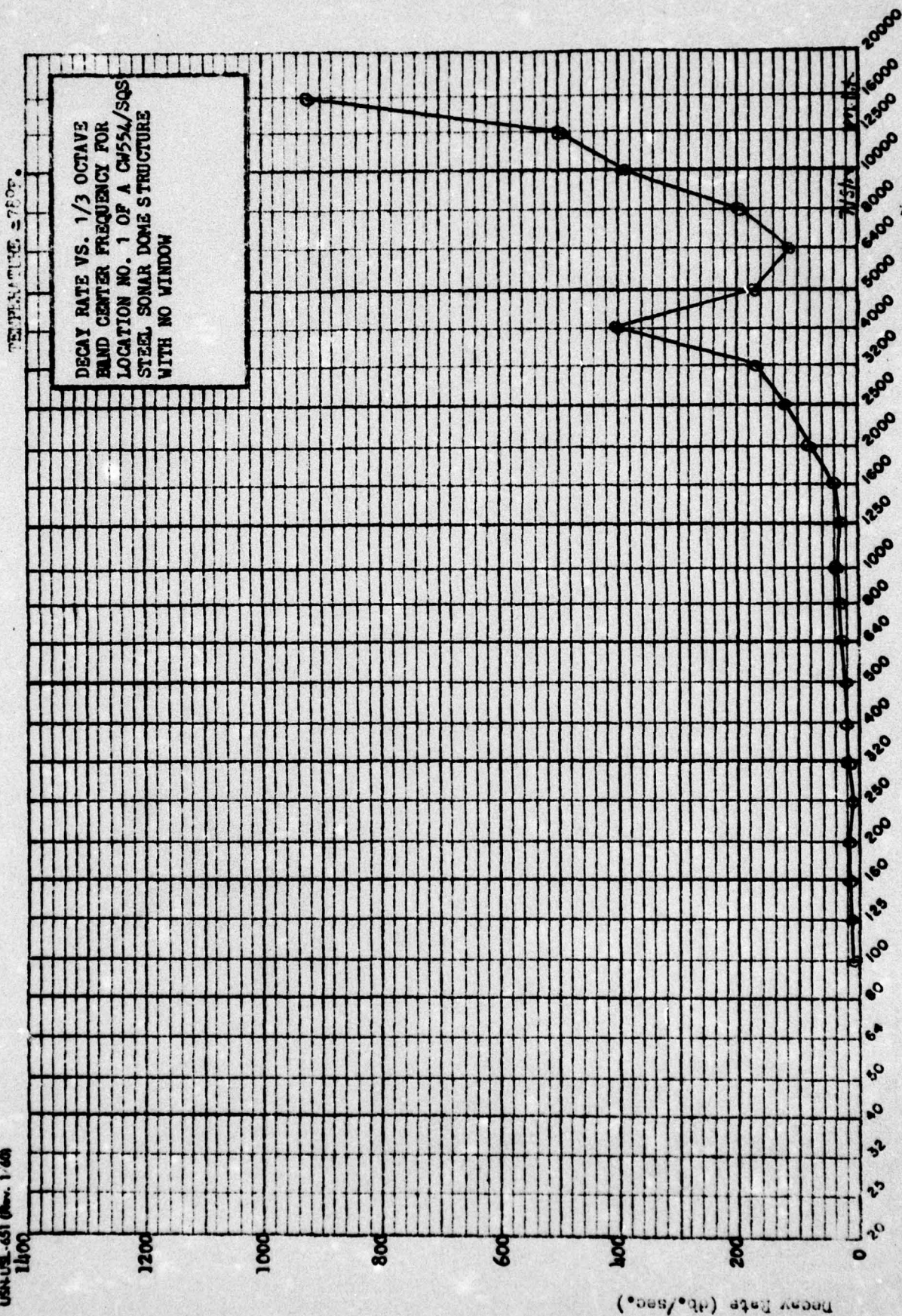


FIGURE 24

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

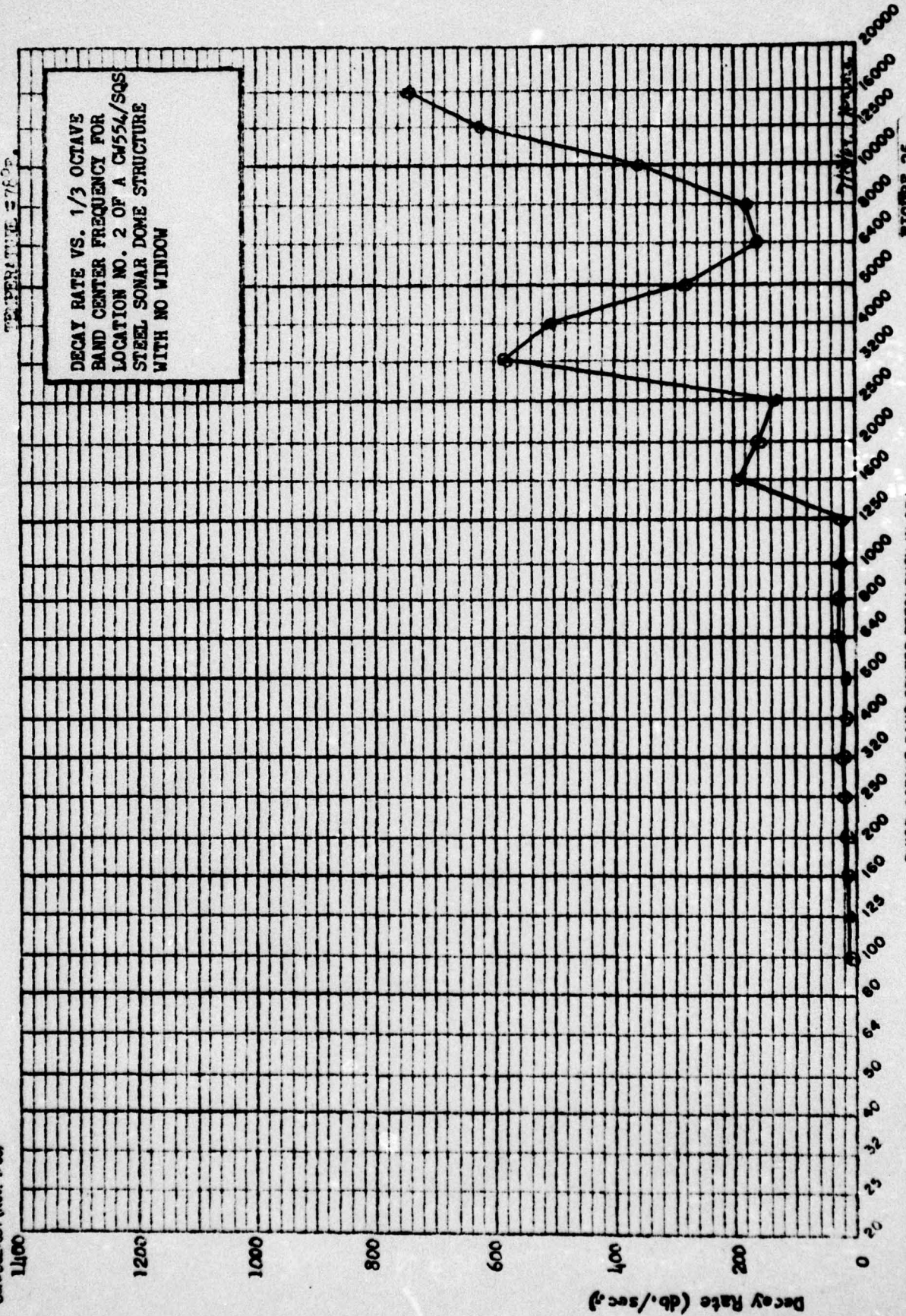


FIGURE 25

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
 No. 2133-1213-66

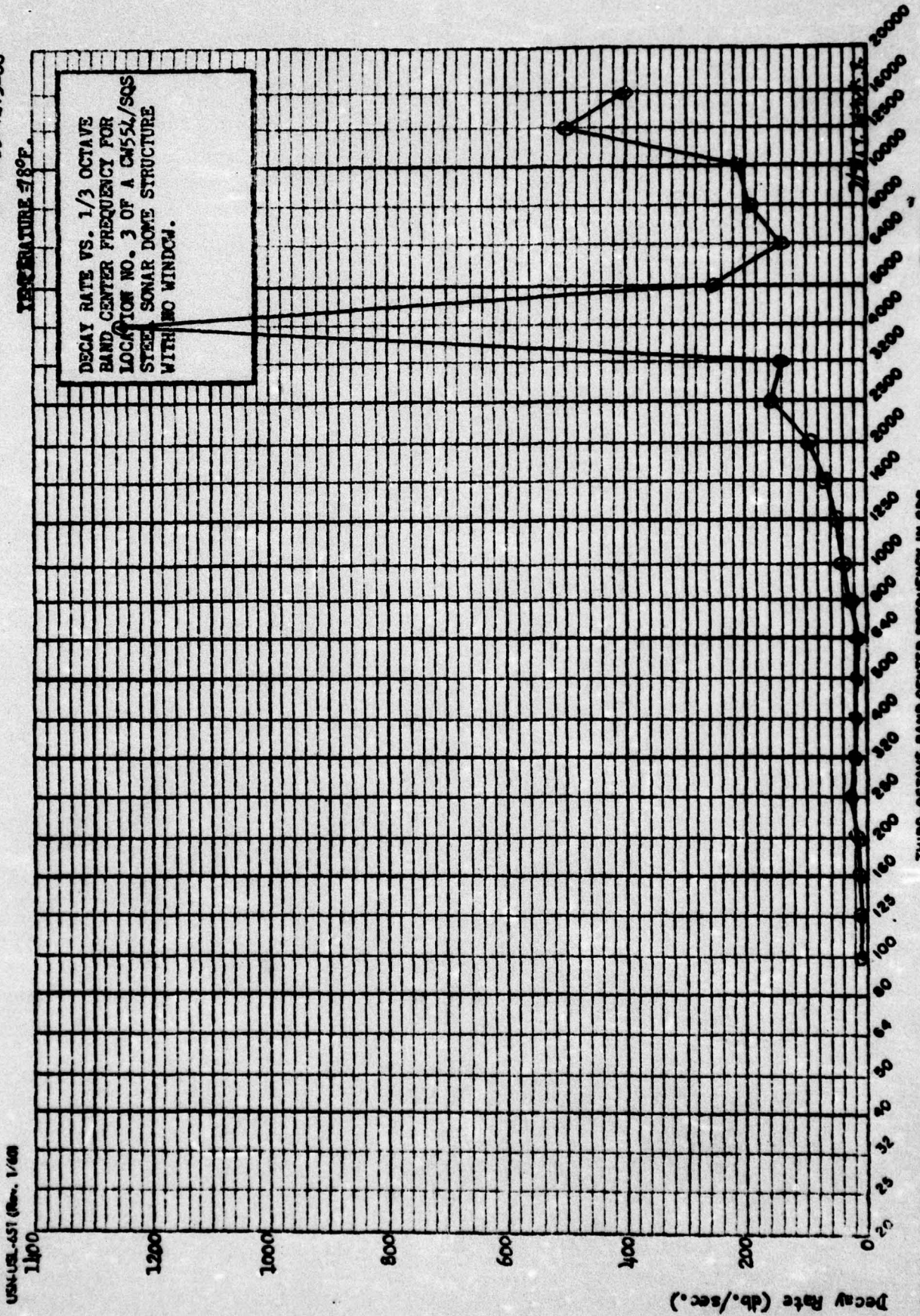


FIGURE 26

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

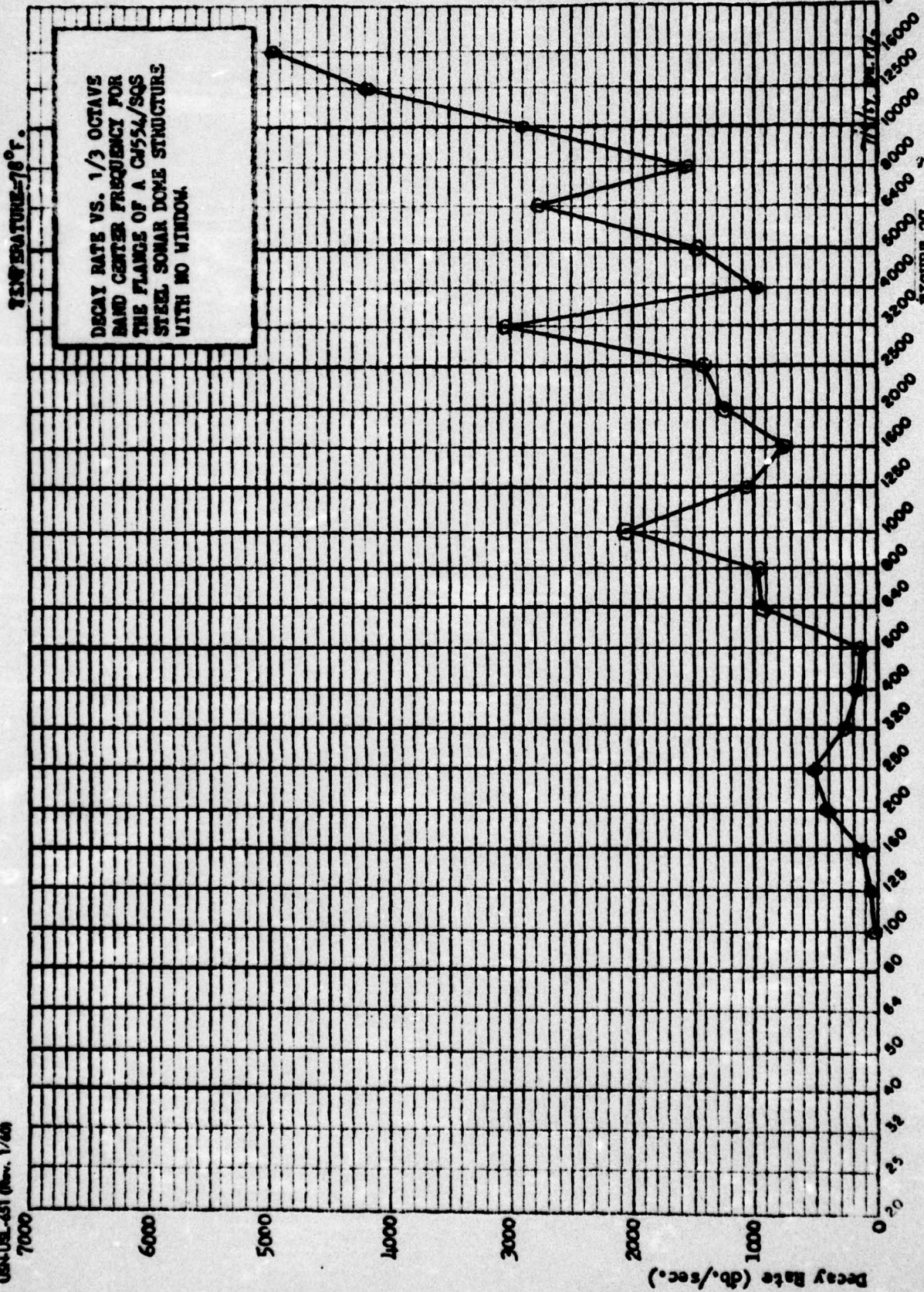


FIGURE 27.

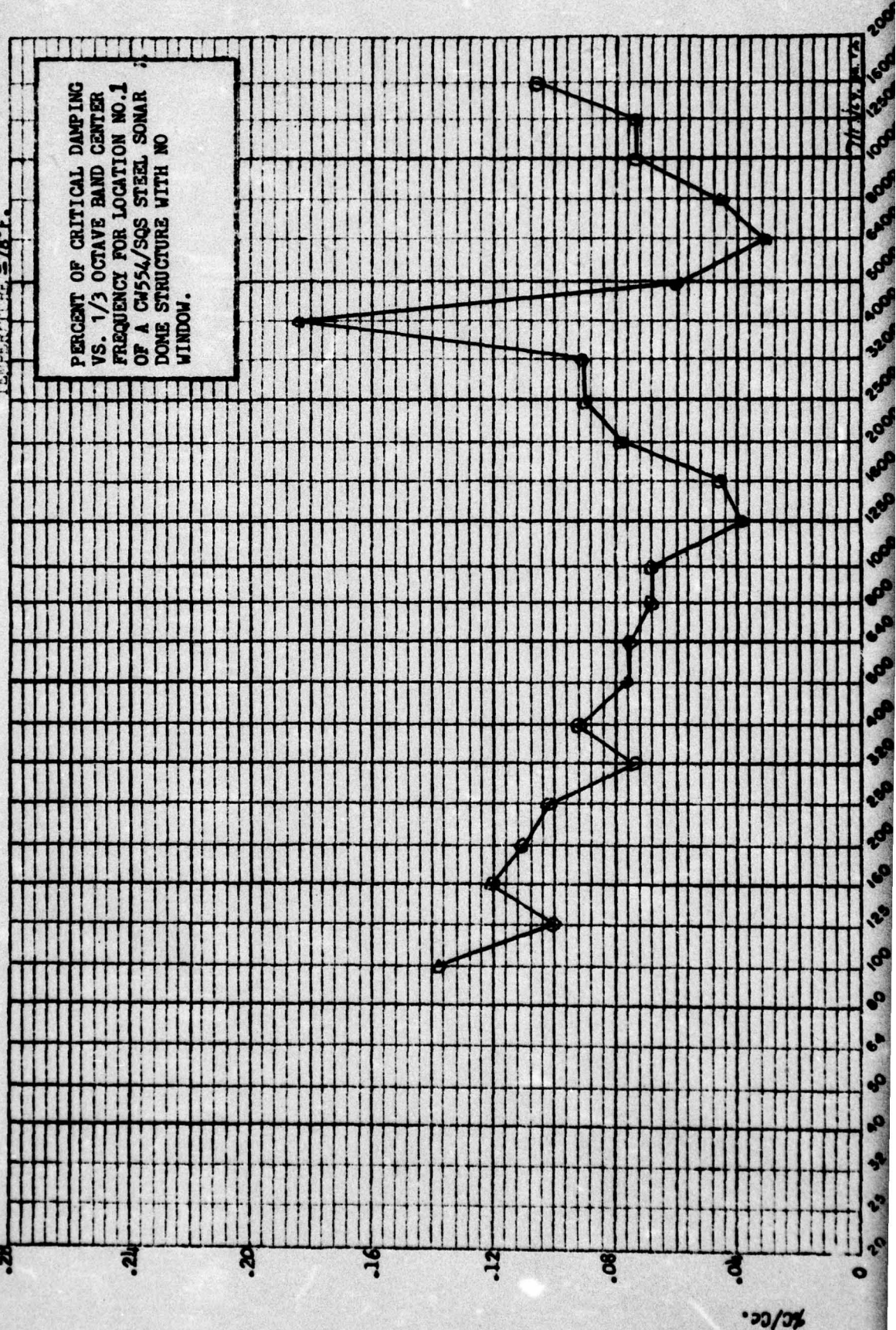
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
No. 2133-1213-66

TEMPERATURE = 78° F.

PERCENT OF CRITICAL DAMPING  
VS. 1/3 OCTAVE BAND CENTER  
FREQUENCY FOR LOCATION NO. 1  
OF A CW554/SQS STEEL SONAR  
DOME STRUCTURE WITH NO  
WINDOW.

USA-USL-451 (Rev. 1/68)



%/cc.

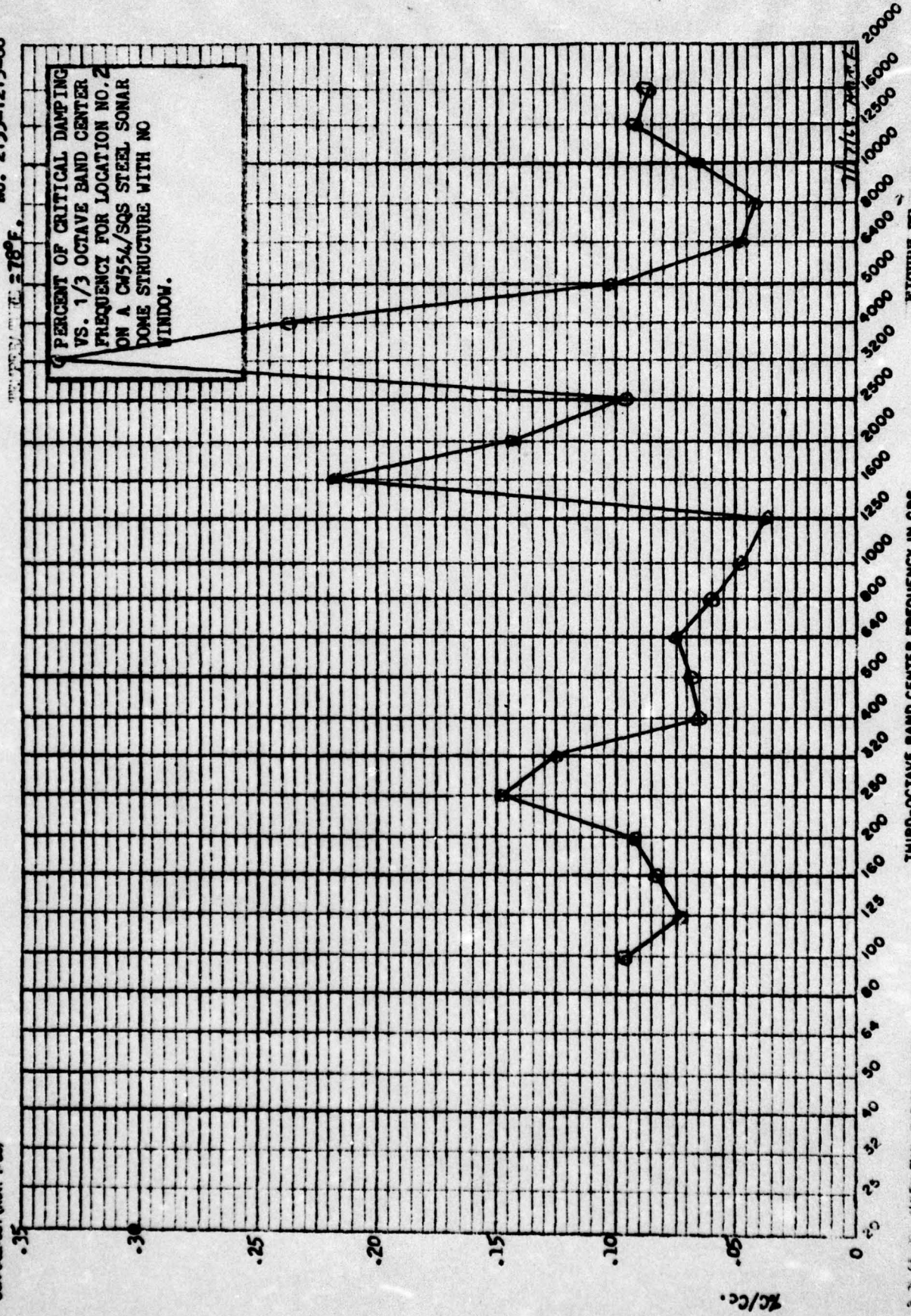


FIGURE 29

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

TEMPERATURE = 78°F.

PERCENT OF CRITICAL DAMPING  
VS. 1/3 OCTAVE BAND CENTER  
FREQUENCY FOR LOCATION NO. 3  
ON A G155L/SQS STEEL SONAR  
DOME STRUCTURE WITH NO  
WINDOW.

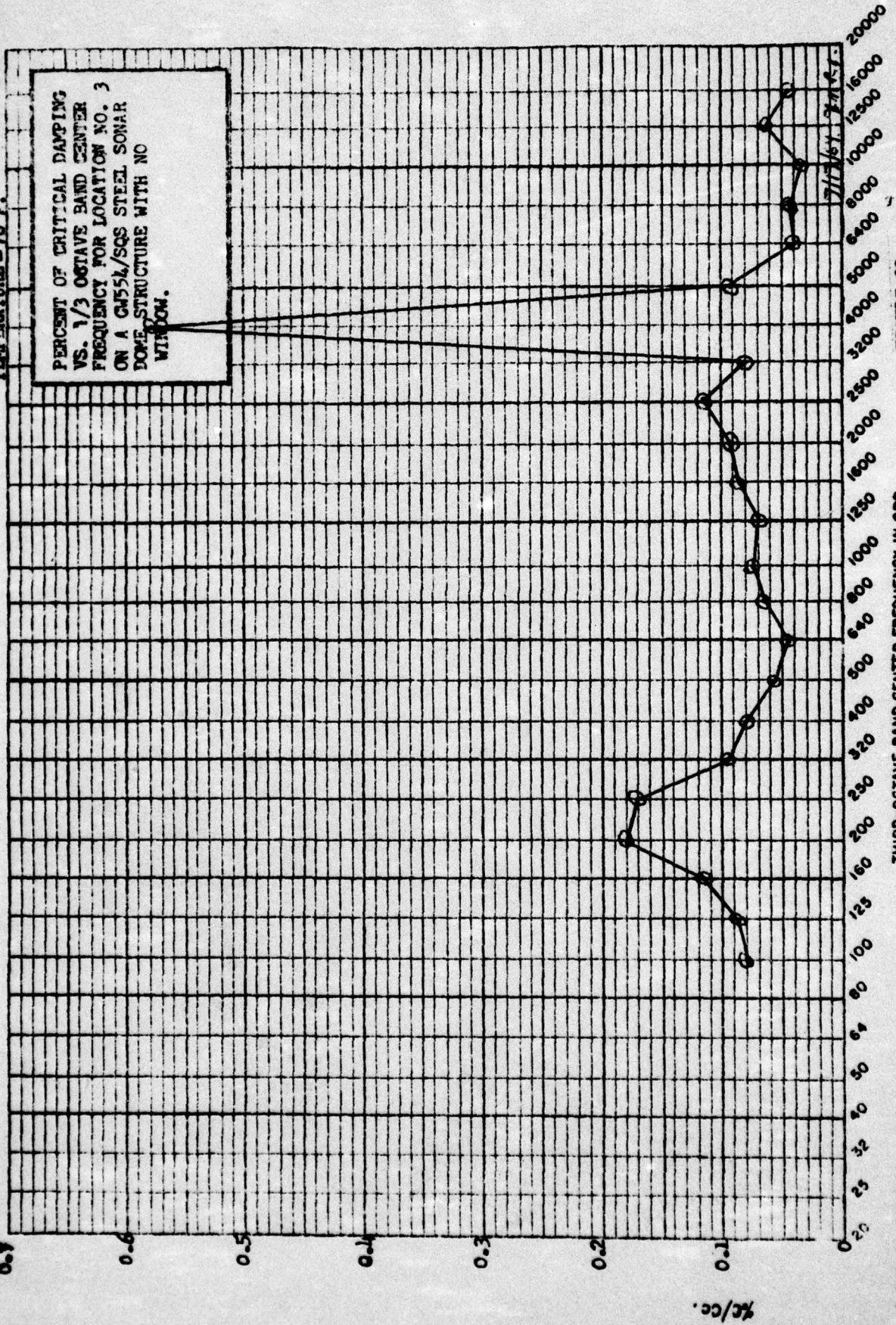


FIGURE 30

USL Tech Memo  
 No. 2133-1213-66

USN-USL-651 (Rev. 1/60)

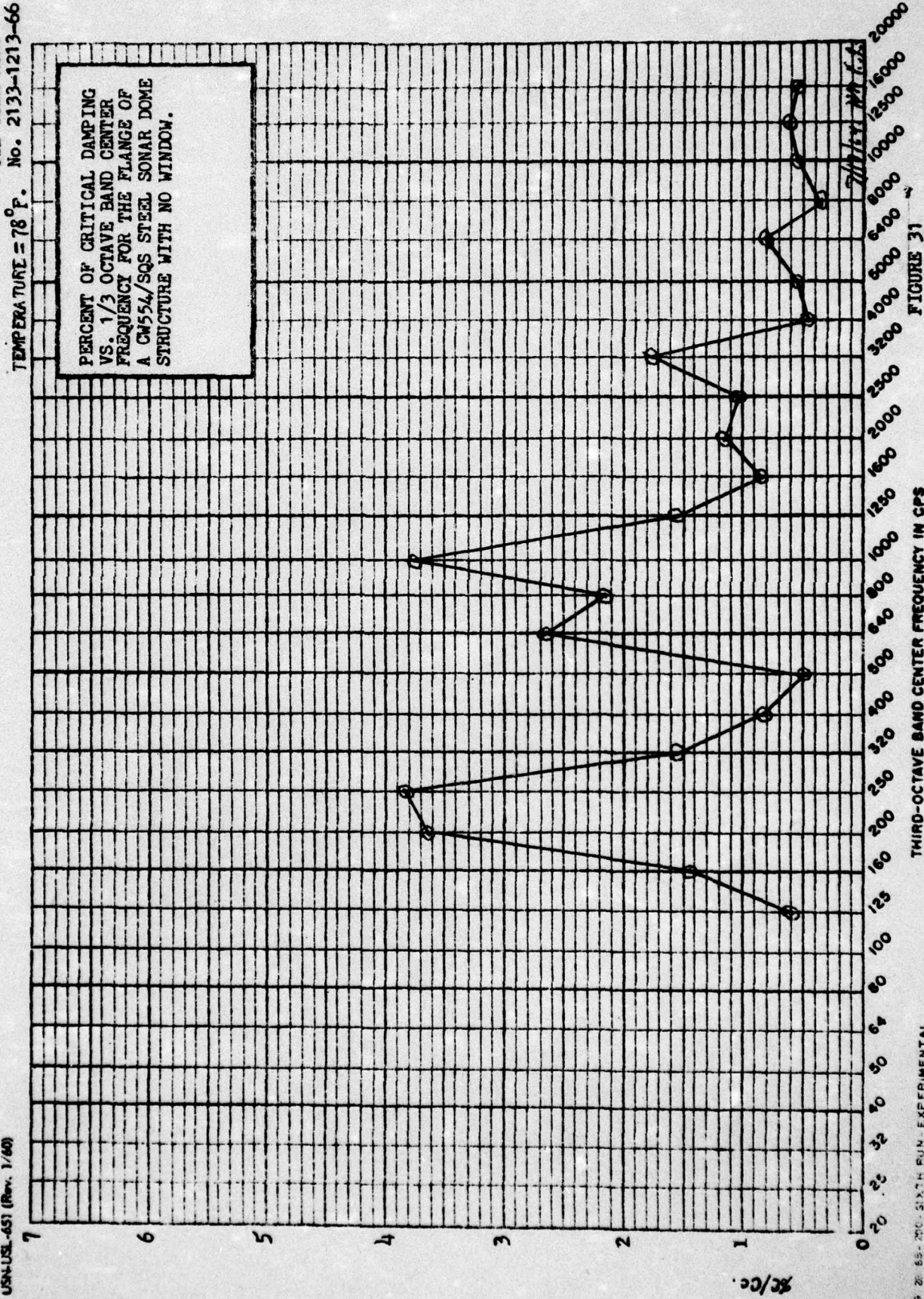


FIGURE 31

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

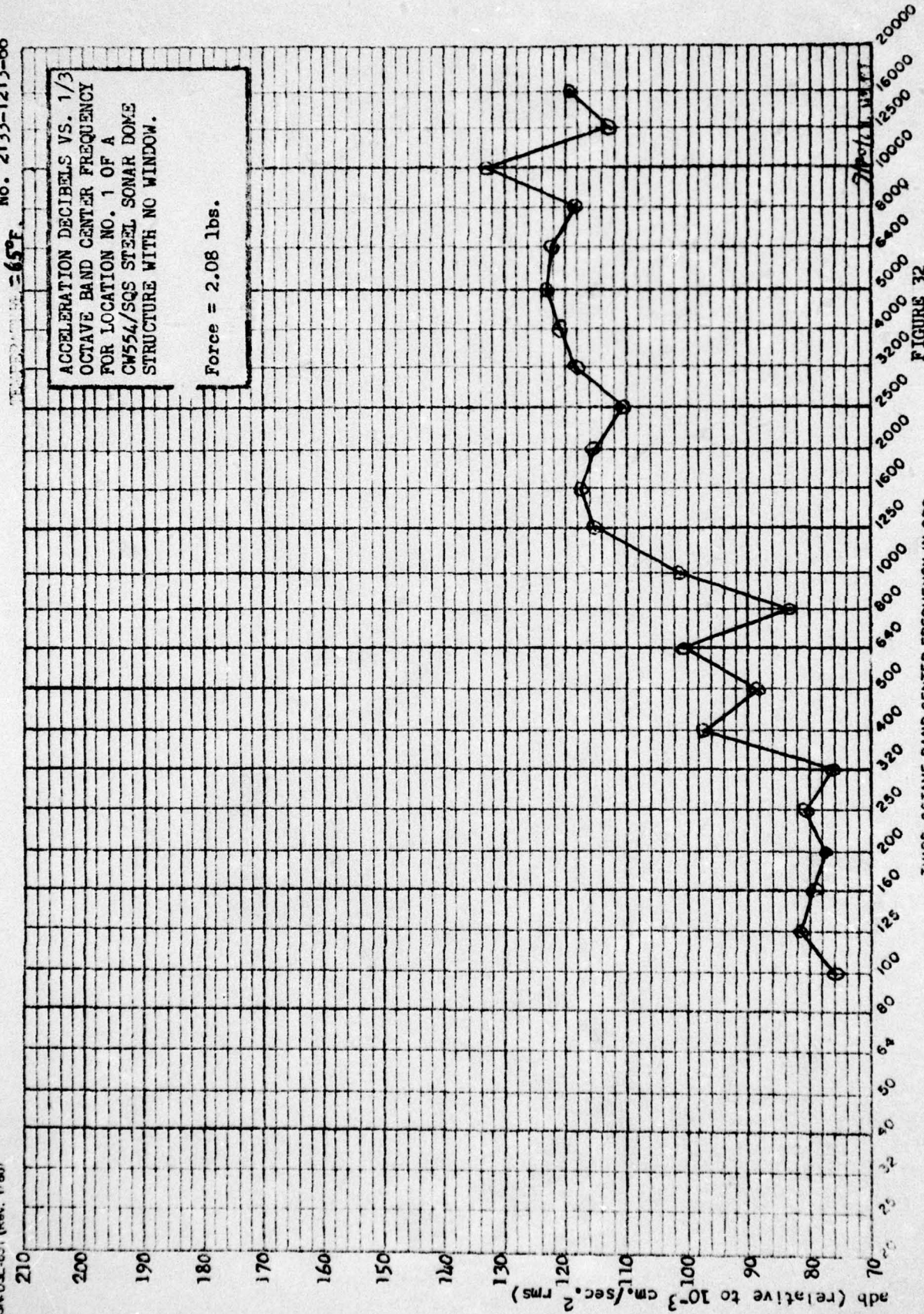


FIGURE 32

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
 No. 2133-1213-66

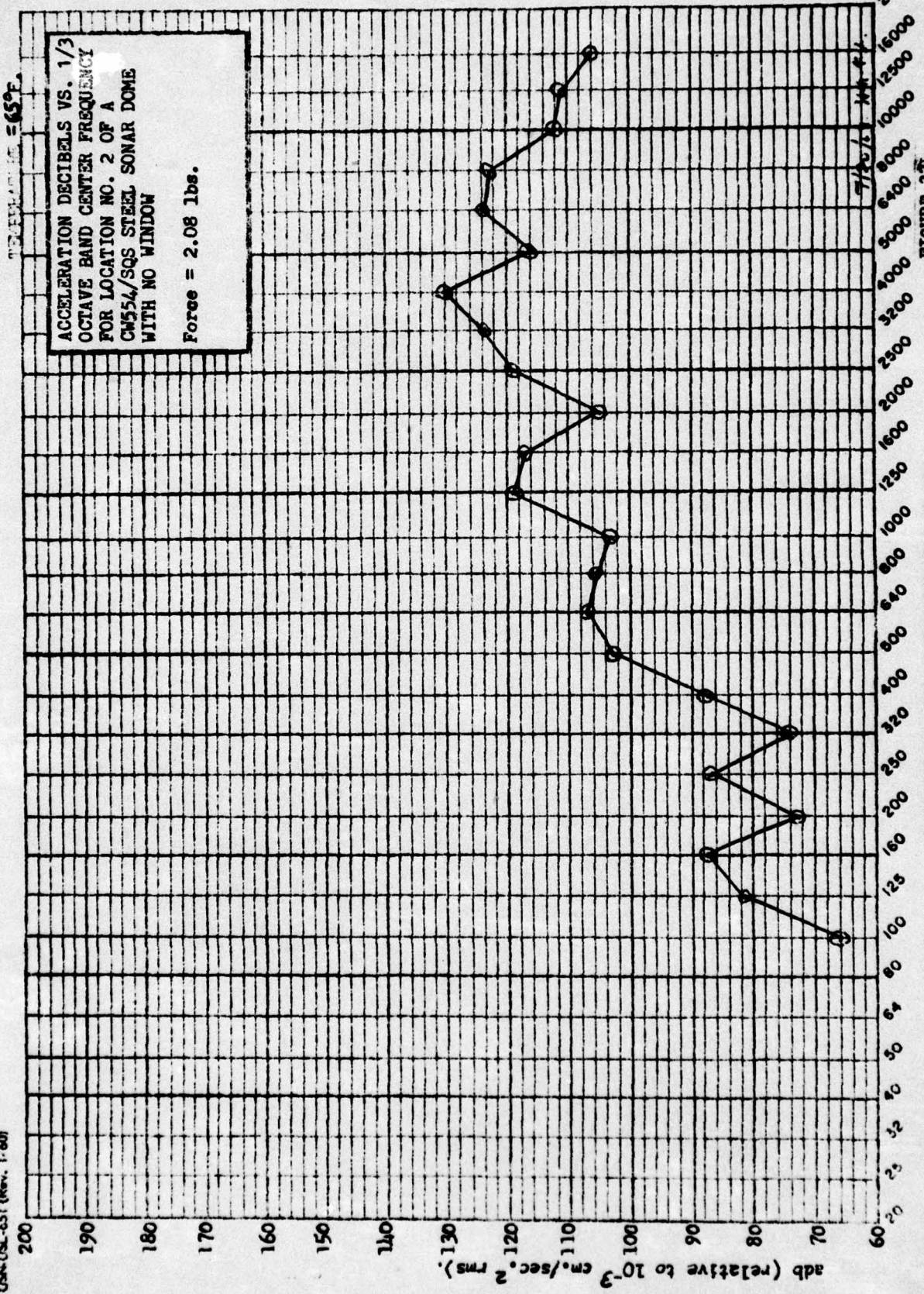


FIGURE 35

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

EXPERIMENTAL

USA USL-651 (Rev. 1-60)

USL Tech Memo  
No. 2133-1213-66

USA-UEL-631 (Rev. 1/60)

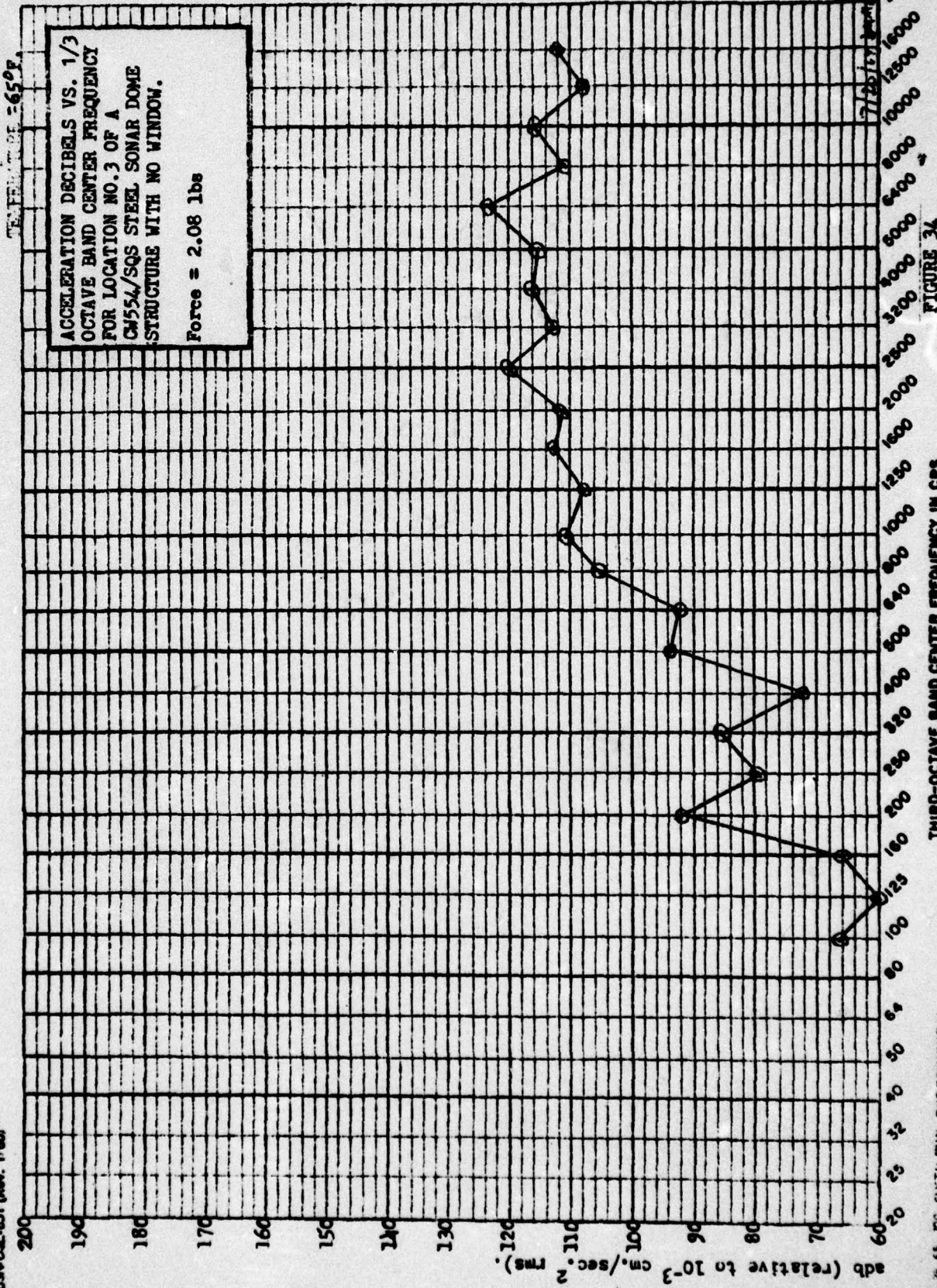


FIGURE 34

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
 No. 2133-1213-66

USN-USL-851 (Rev. 1/66)

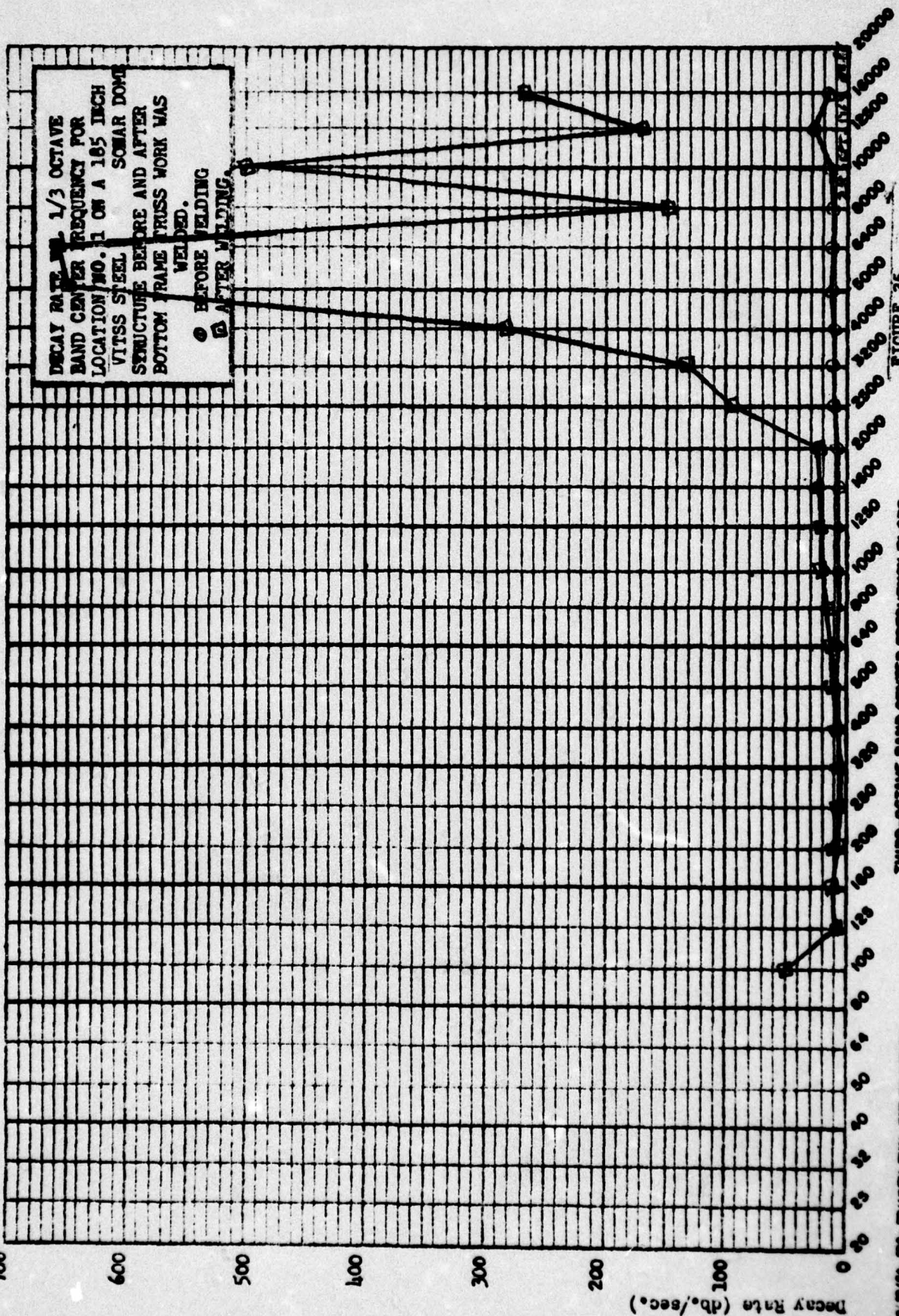


FIGURE 35

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

SI 82/84-280-FOURTH BHM-EXP EXPERIMENTAL

100-1000-000 (Rev. 1/66)

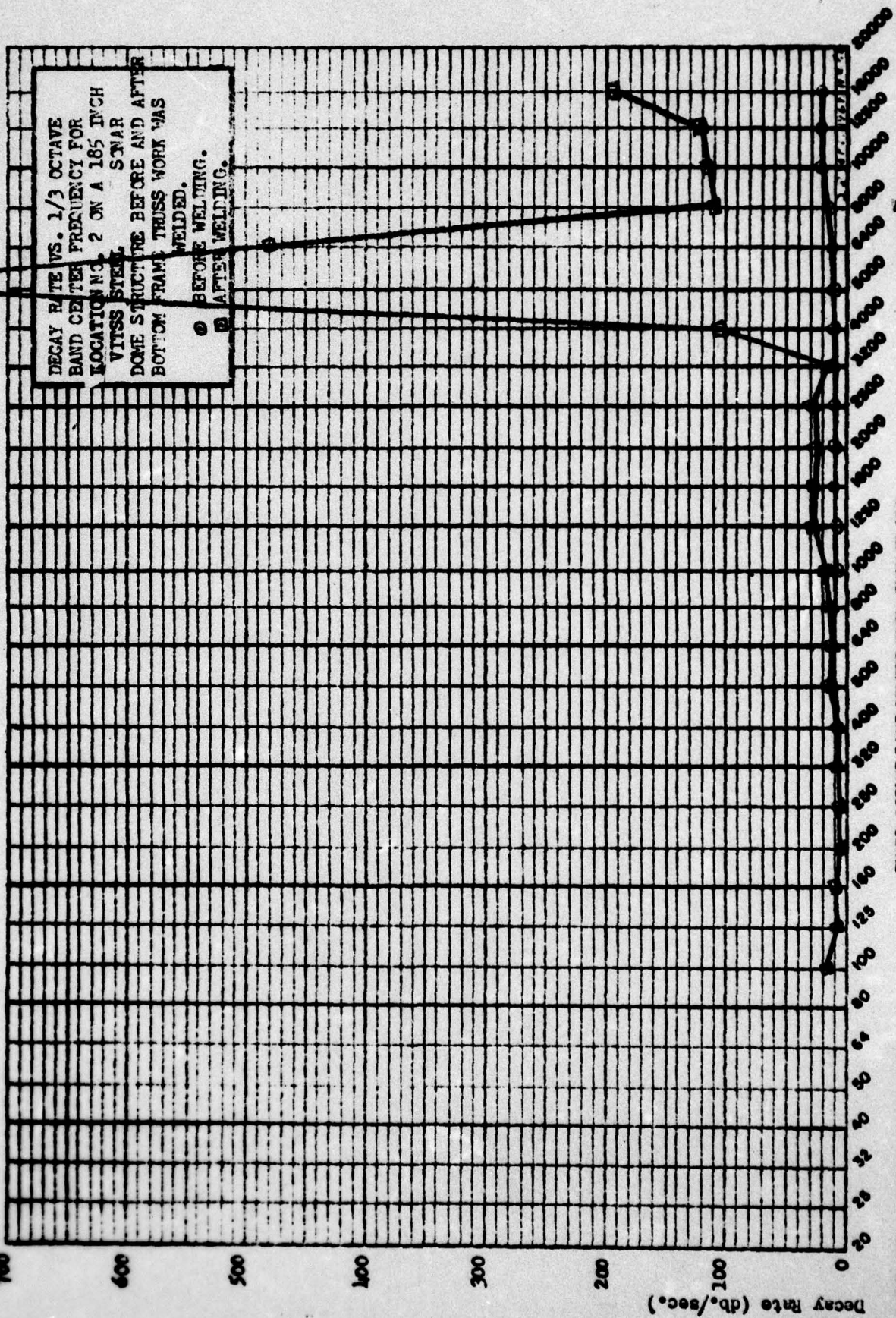


FIGURE 36

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

1/21/64-28- FOURTH RUN- EXPERIMENTAL

USL Tech Memo  
No. 2133-1213-66

PERCENT OF CRITICAL DAMPING  
VS. 1/3 OCTAVE BAND CENTER  
FREQUENCY FOR LOCATION NO.  
ON A 185 INCH VITSS  
TYPE SONAR DOME BEFORE AND  
AFTER THE BOTTOM FRAME TRUSS  
WORK WAS WELDED.

○ BEFORE WELDING.  
□ AFTER WELDING.

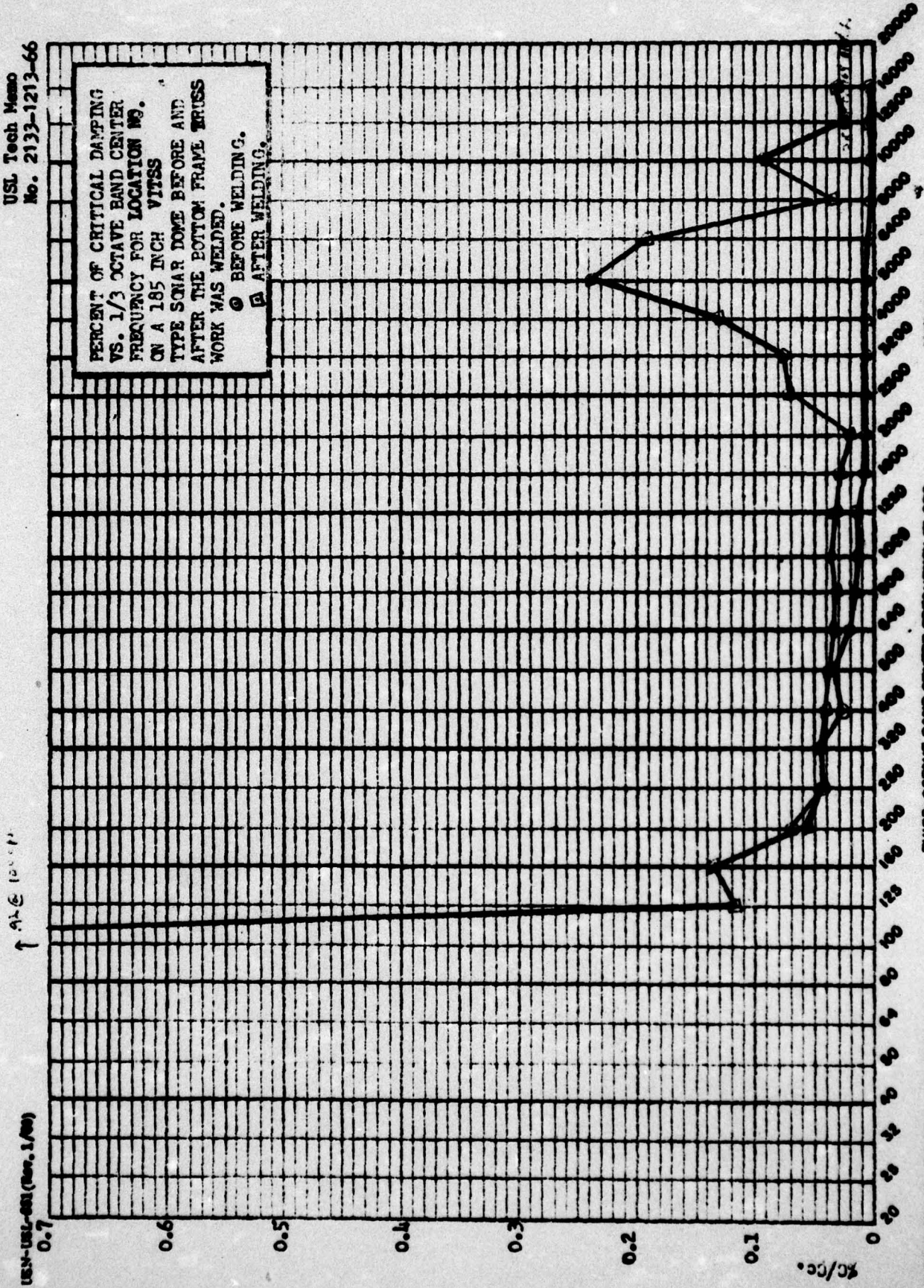


FIGURE 37

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

3/21/64. 260-FOURTH SUB-EXPERIMENTAL

USL Tech Memo  
 No. 2133-1213-66

1834-USL-661 (Rev. 1/66)

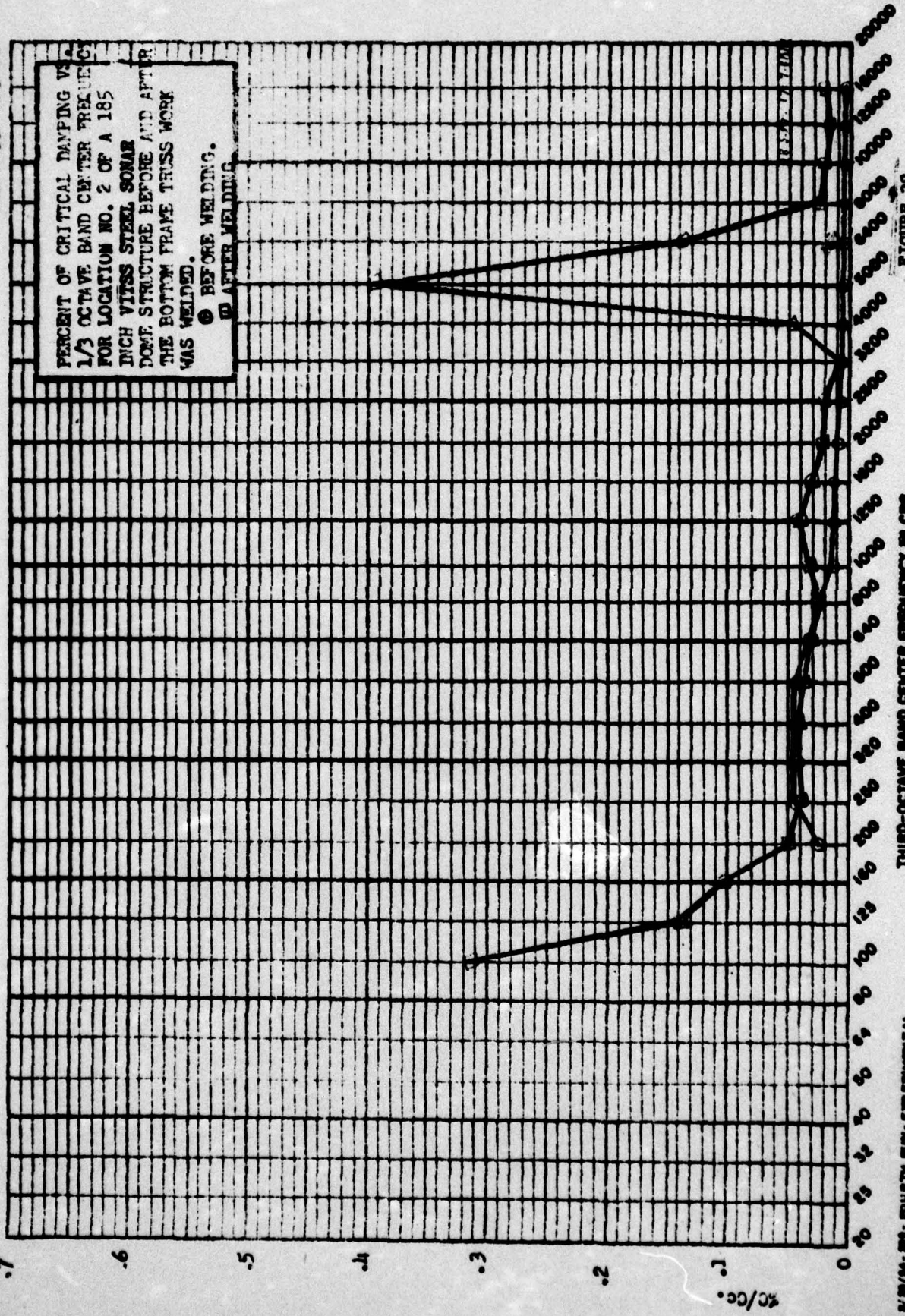


FIGURE 38

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

2/28/66-260-FOURTH RUN-EXPERIMENTAL

USL Tech Memo  
 No. 2133-1213-66

COMPARISON OF DECAY RATE VS.  
 1/3 OCTAVE BAND CENTER FRE-  
 QUENCY FOR LOCATION NO. 1 ON  
 THE 185 INCH VITSS  
 TYPE DOME STRUCTURE AND THE  
 185 INCH CM554/SCS DOME STRUC-  
 TURE

● CM554/SCS Structure.  
 □ VITSS Structure.

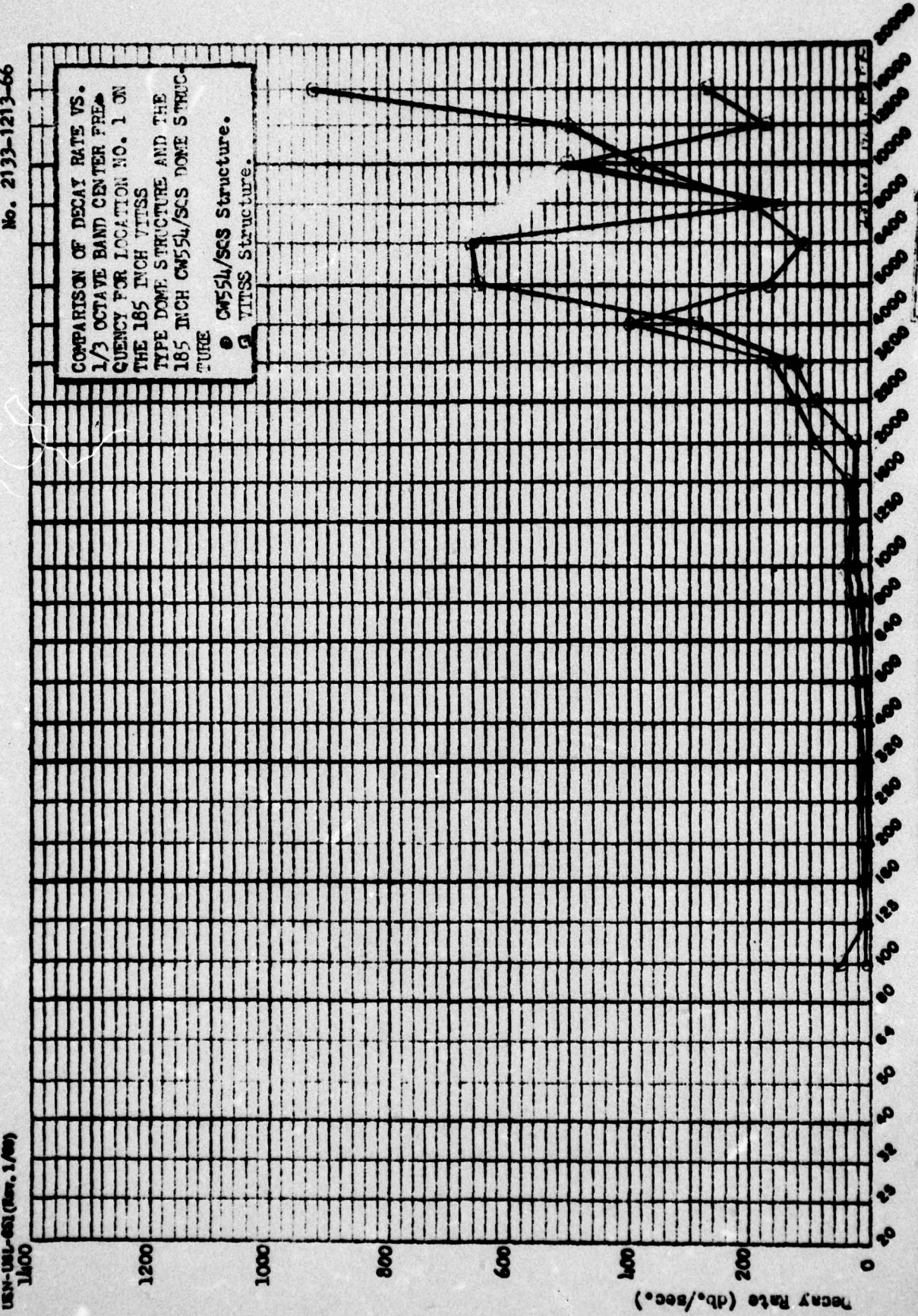


FIGURE 39c

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

8/28/64. 20- FOURTH RUN. EXP. ENVIRONMENTAL

USL Tech Memo  
No. 2133-1213-66

USN-UNL-651 (Rev. 1/60)

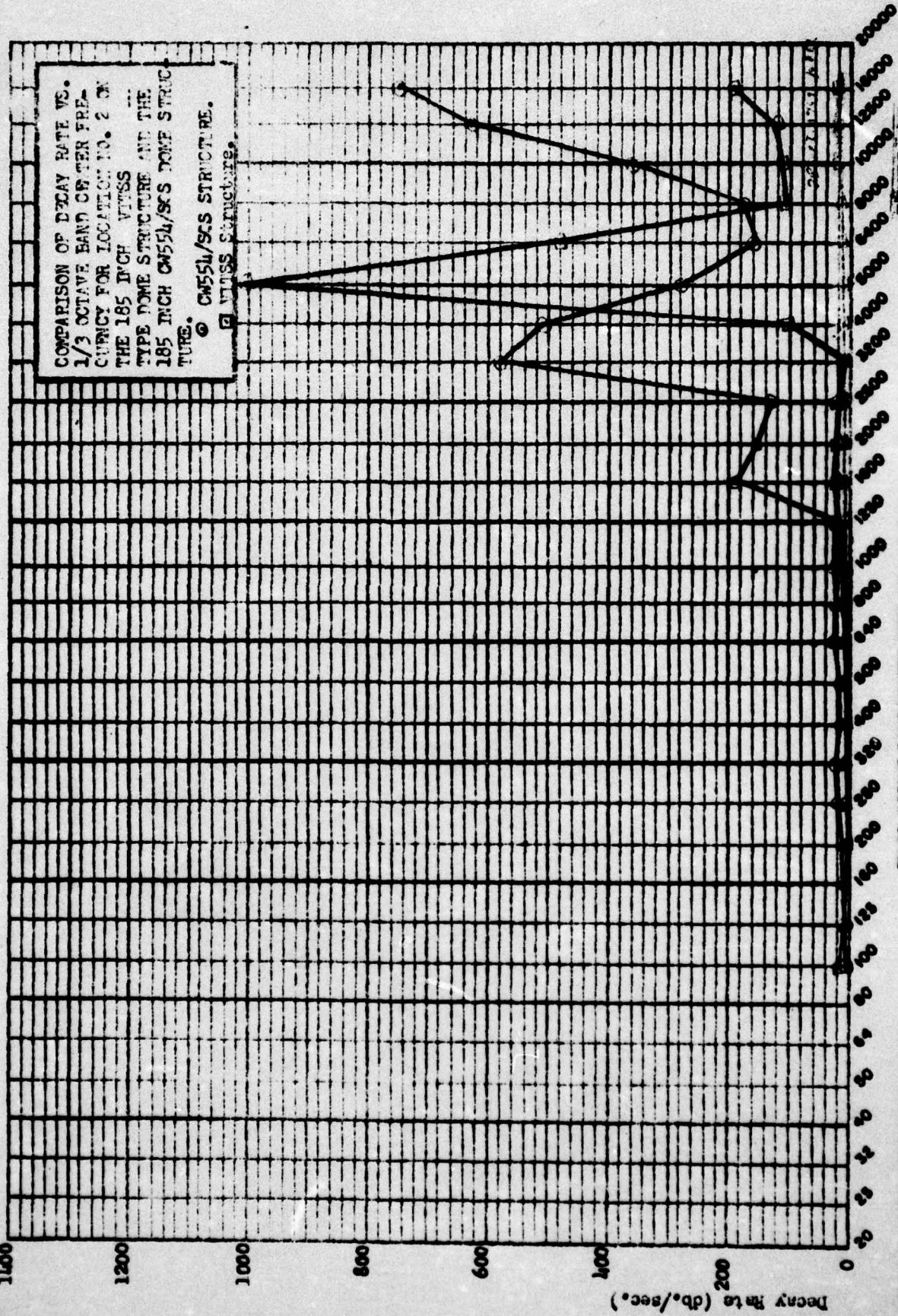


FIGURE 40

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

S/S/64-80 - FOURTH SEM - EXPERIMENTAL

USL Tech Memo  
 No. 2133-1213-66

USN-121-663 (Rev. 1/66)  
 11/60

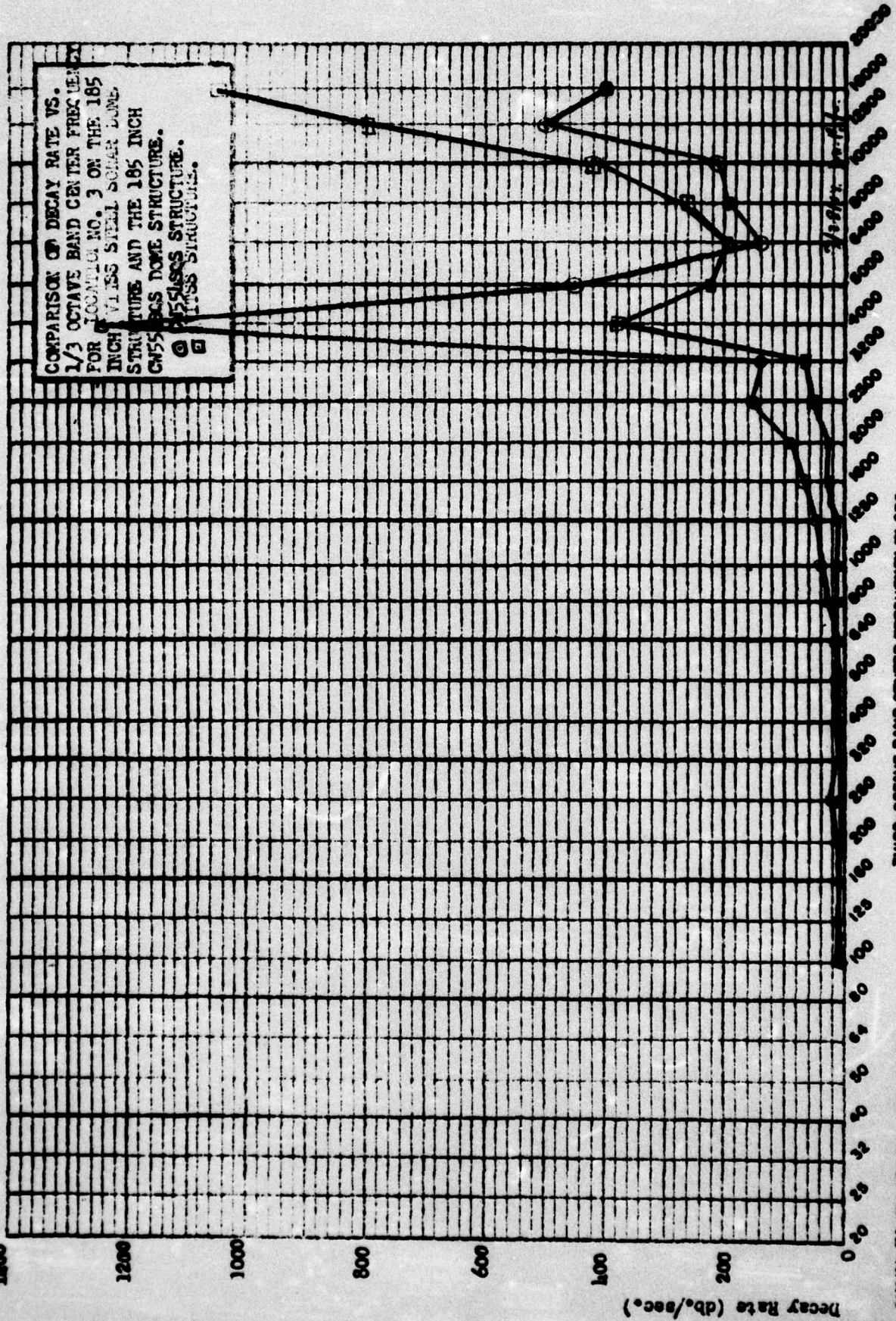


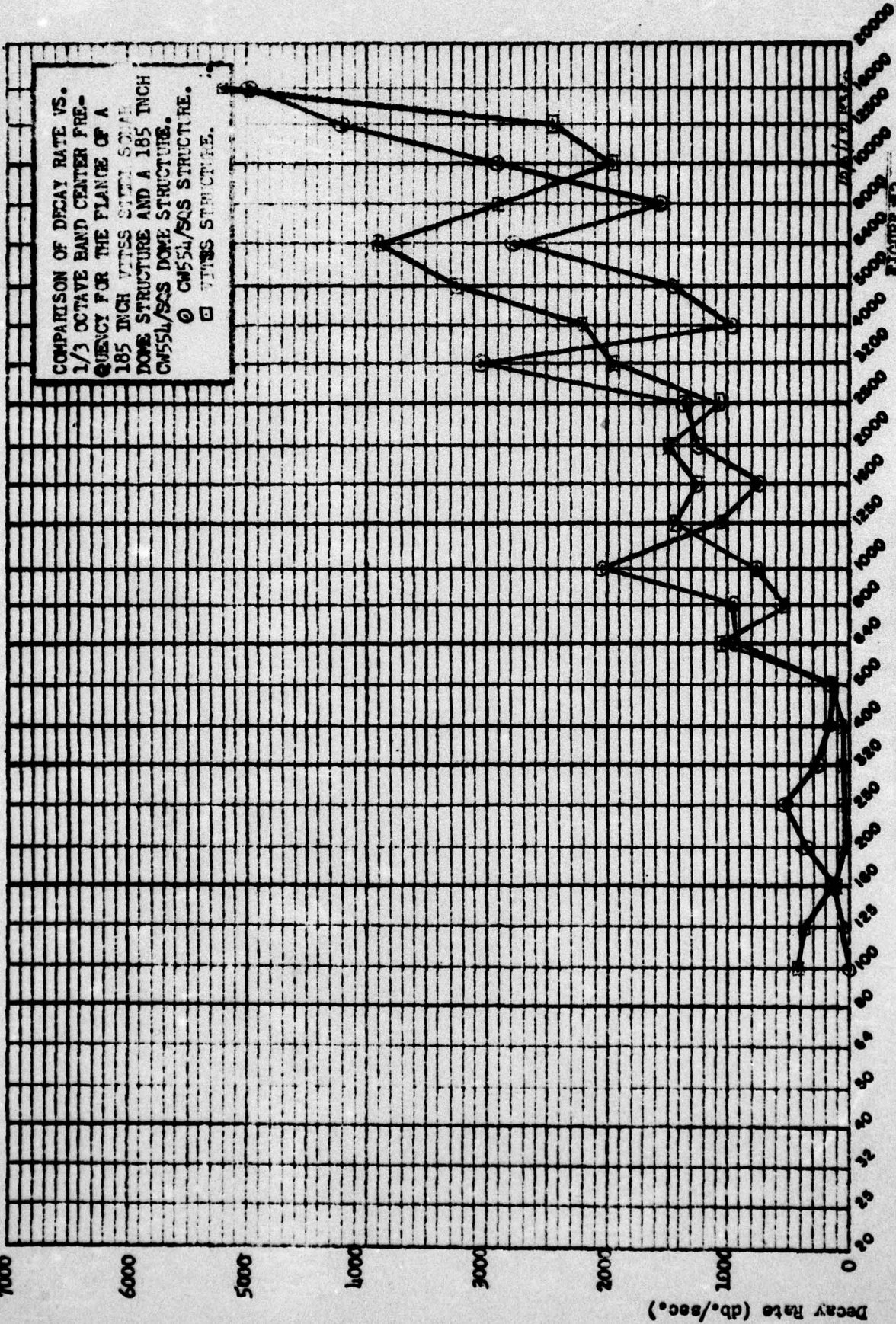
FIGURE 43

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

2/20/64-288-FOURTH RUN-EXPERIMENTAL

USL Tech Memo  
No. 2133-1213-66

15N-15L-031 (Rev. 1/66)



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

2/18/64. 26. FOURTH MIN. EXP. EXPERIMENTAL

FIGURE 12

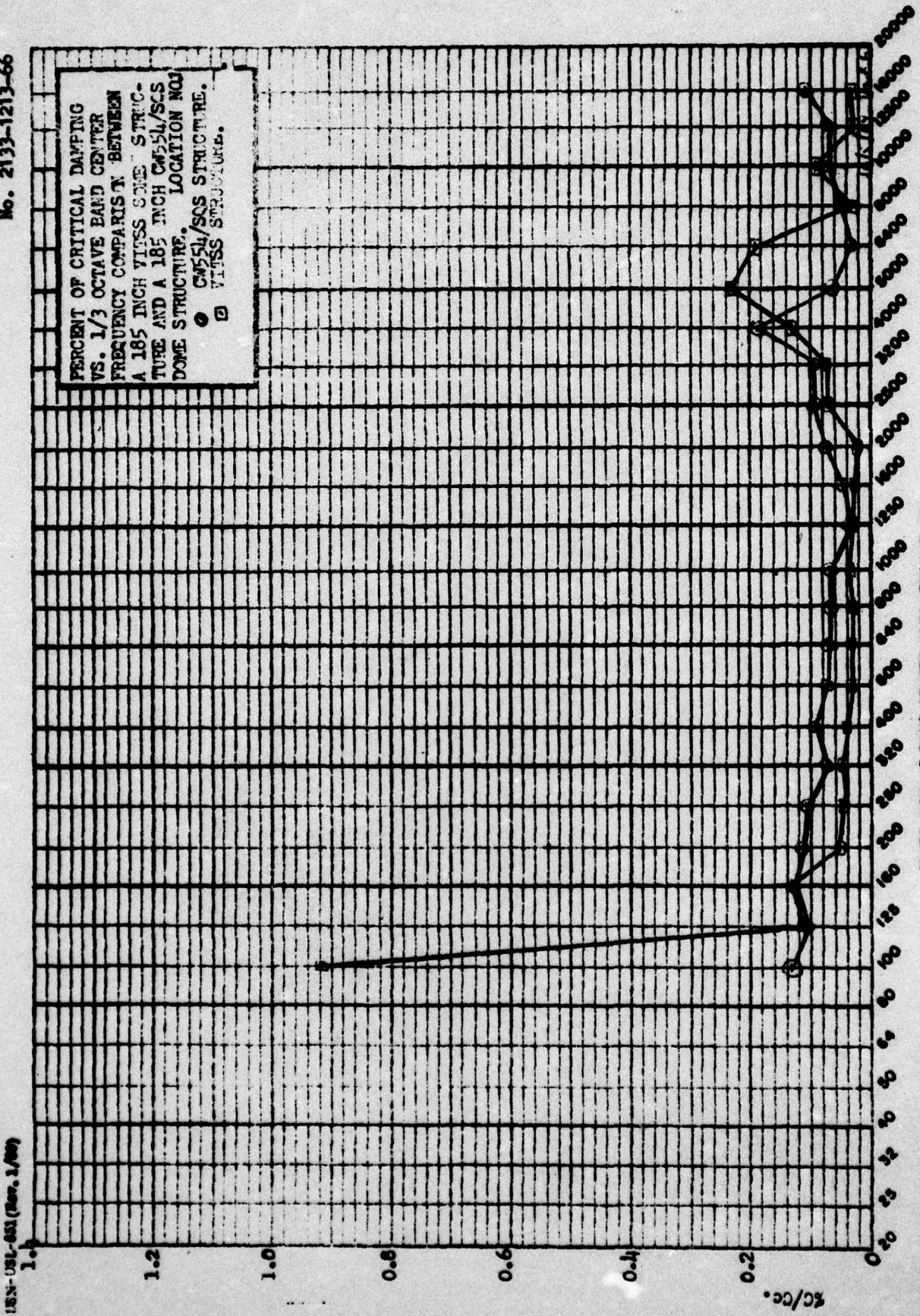


FIGURE 4.3

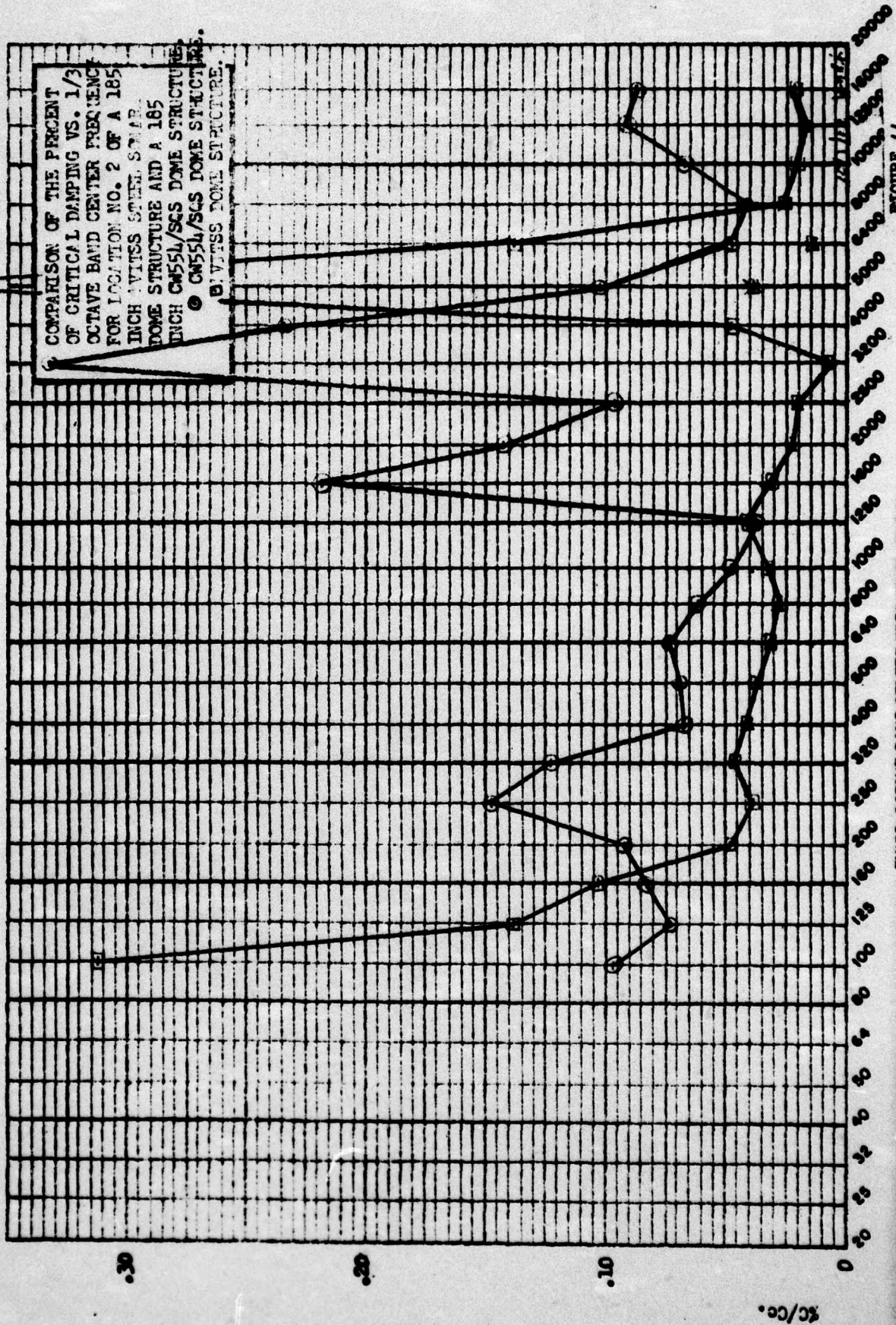
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

3/28/66-250-FOURTH RUN-EXPERIMENTAL

0.392 ● 5Kcps

USL Tech Memo  
No. 2133-1213-66

COMPARISON OF THE PERCENT  
OF CRITICAL DAMPING VS. 1/3  
OCTAVE BAND CENTER FREQUENCY  
FOR LOCATION NO. 2 OF A 185  
INCH WITSS STEEL STRIP  
DOME STRUCTURE AND A 185  
INCH CM55L/SCS DOME STRUCTURE.  
● CM55L/SCS DOME STRUCTURE.  
□ WITSS DOME STRUCTURE.



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 44

USL Tech Memo  
No. 2133-1213-66

5750

USN-USL-651 (Rev. 1/66)

COMPARISON OF PERCENT OF CRITICAL DAMPING VS. 1/3 OCTAVE BAND CENTER FREQUENCY FOR A 185 INCH VITSS TYPE SMALL DOME STRUCTURE AND A 185 INCH OMSL/SCS DOME STRUCTURE. LOCATION: . . . . .  
 ○ OMSL/SCS STRUCTURE  
 □ VITSS STRUCTURE

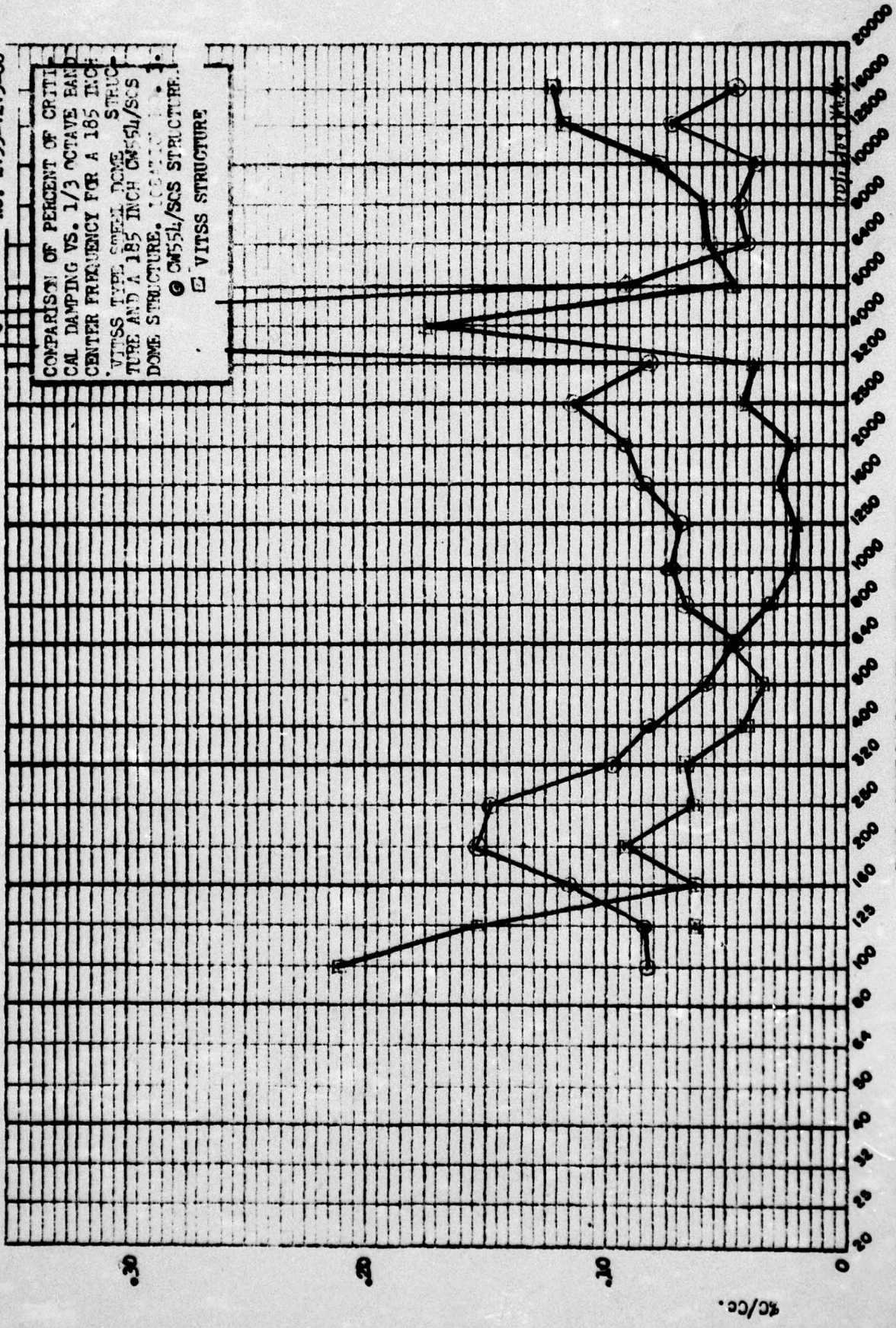


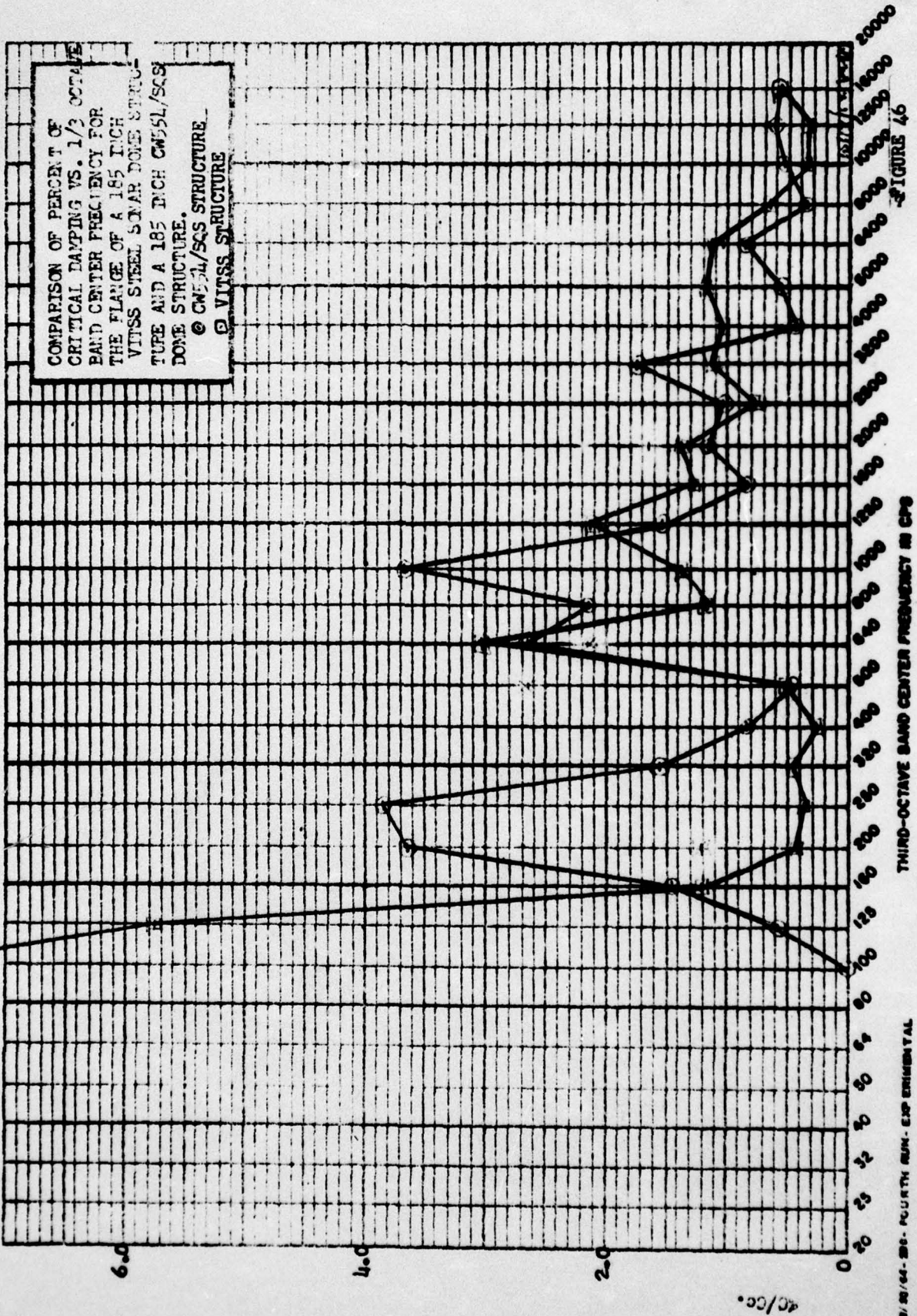
FIGURE 4.5.

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

9/25/64-289-FOURTH RUN-EXPERIMENTAL

USL Tech Memo  
No. 2133-1213-66

USN-USL-651 (Rev. 1/66)



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

2/20/64-286-FOURTH RUN - EXP EXPERIMENTAL

FIGURE 46

USL Tech Memo  
 No. 2133-1213-66

USN-USL-651 (Rev. 1/60)

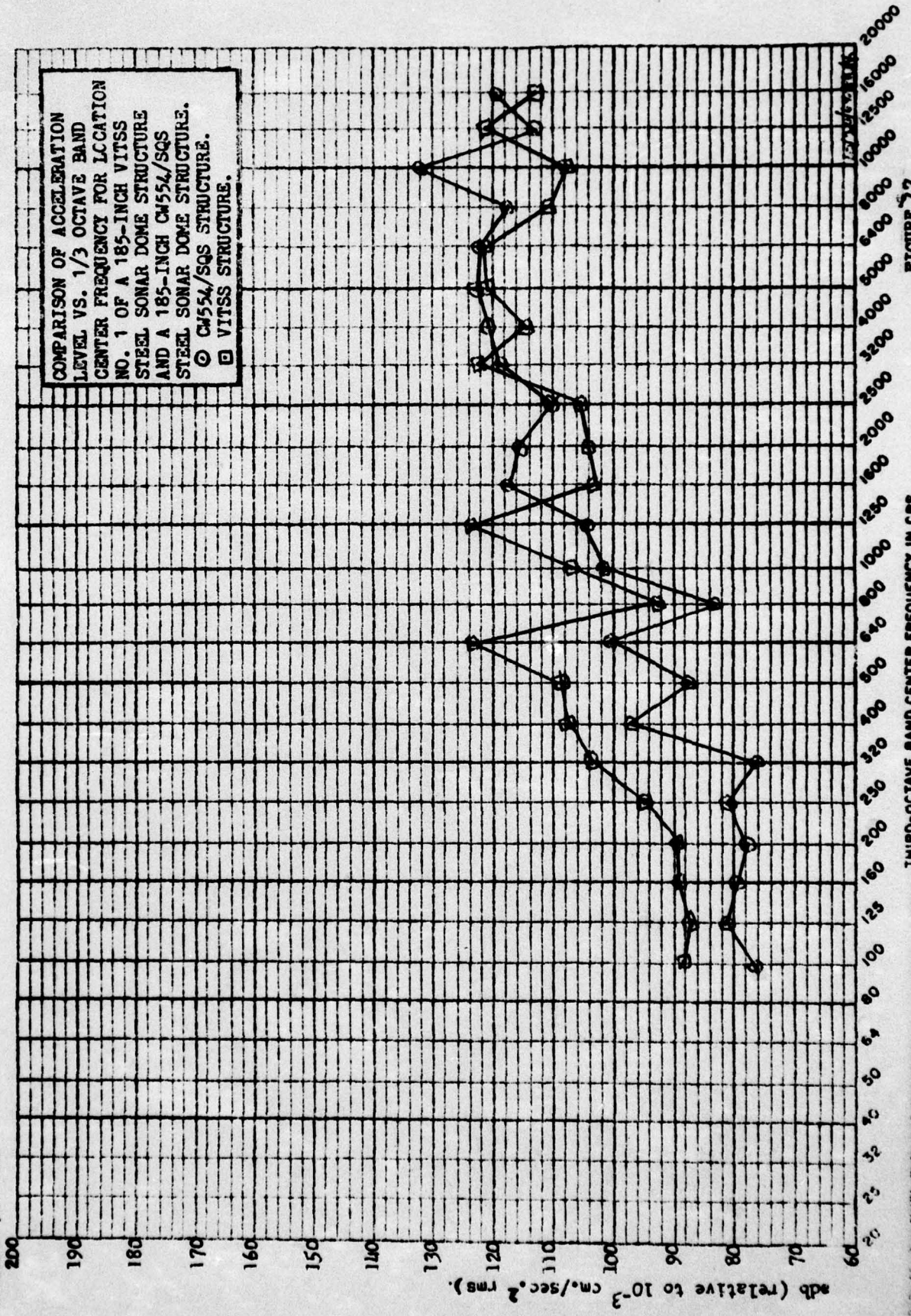


FIGURE 27

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

USL Tech Memo  
No. 2133-1213-66

USA-USL-651 (Rev. 1-60)

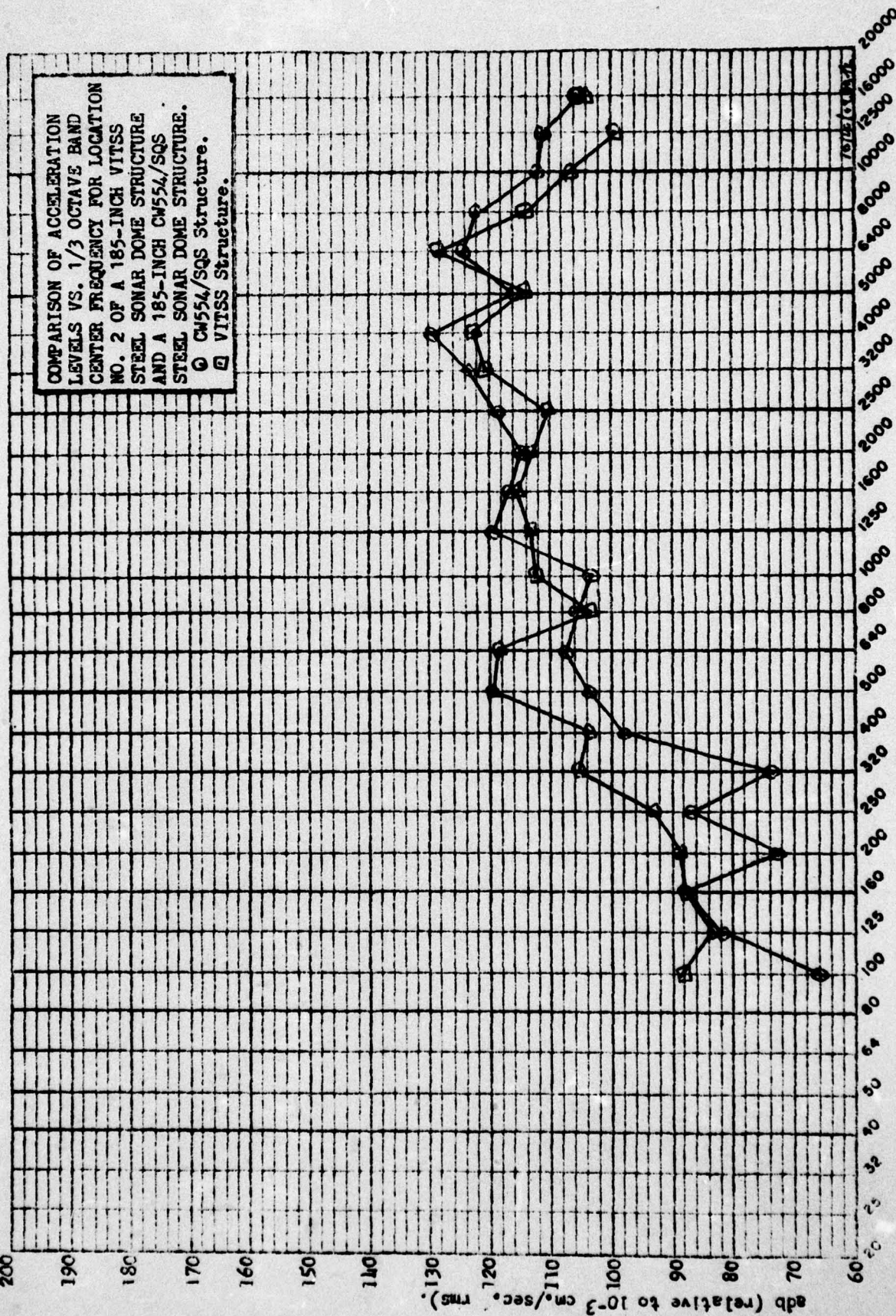
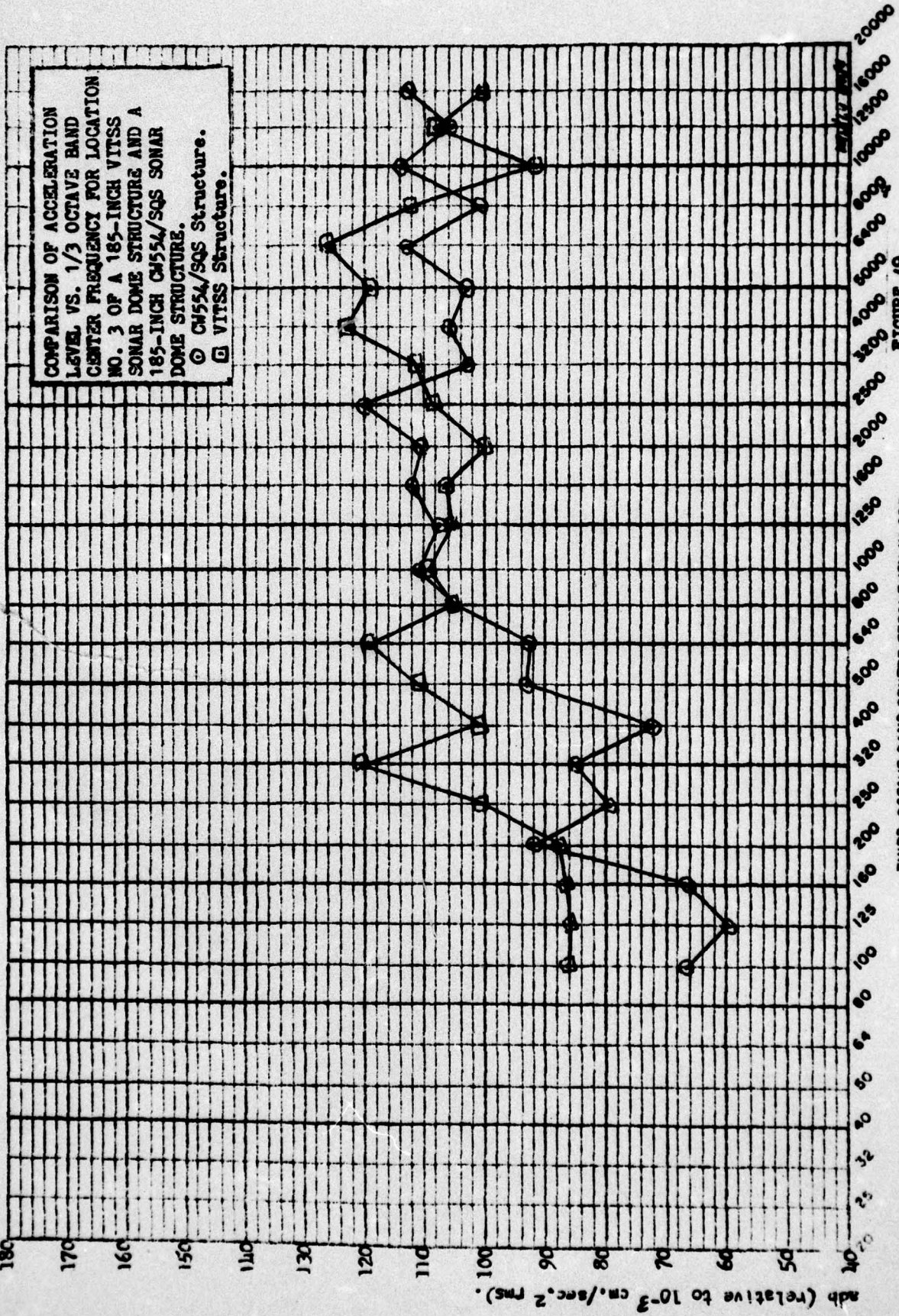


FIGURE 48

THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

SIXTH RUN EXPERIMENTAL



THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIGURE 49

EXPERIMENTAL