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SETTING AIRBORNE NOISE LIMITS FOR NAVY SHIPBOARD COMPARTMENTS

Considerations based on data from existing ships

David R. Lambert

29 June 1981

Prepared for
Naval Sea Systems Command
(NAVSEA 05H)

Approved for public release; distribution unlimited

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FOREWORD

This document has been prepared for the Naval Sea Systems Command (NAVSEA 05H) for general guidance in development of noise standards for US Naval ships. It is one of several dealing with various aspects of noise as related to habitability and the safety of personnel aboard Navy ships.

The contributions of the following personnel are gratefully acknowledged:

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This document reports data relevant to cost-benefit evaluation of noise limits for Navy shipboard compartments. It relates noise effects, determined from subjective responses of personnel, to shipboard sound levels. It provides a procedure for determining noise-limit goals based on subjective noise effects, and proposes such goals for various types of compartments. Sound level data of existing ships are presented for estimating the amount of noise control required to meet present or proposed noise limits.

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INTRODUCTION

Airborne noise limits have been established for Navy shipboard compartments for the purpose of ensuring that noise does not interfere with ships' missions or with the health of personnel. The noise limits actually enforced on particular ships have varied, largely because of increasing performance requirements and changing noise measurement and control technologies. Navy ships tend to be noisy because of factors such as propulsion and ventilation requirements, as well as size, weight, cost, and schedule constraints. These factors are continually exerting pressure for changes or waivers to ship specifications which would permit higher levels than might otherwise be optimal. Consequently, from a practical viewpoint, some interference and bothersomeness from noise is to be expected. The amount of noise considered acceptable depends on its effects on ships' missions and personnel. It also depends on the effects of getting rid of the noise: not only the benefits, but also the associated impact of the noise control on the factors listed above.

The purpose of this document is to provide information for use in evaluating subjective effects of noise on personnel; that is, effects they perceive noise to have on comfort and sleep in quarters, performance, and speech communication. Specifically, it provides a procedure for estimating the likely responses of personnel to noise levels in various shipboard compartment types. It also presents measured sound levels for estimating the amount of noise reduction necessary to reach noise limits which may be under consideration. The information presented is based on steady-state noise levels. This document does not directly address low-frequency, tonal, intermittent, transient, or impulse/impact noise.

Implementation of the estimation procedure produced the graphs presented in figures 1 through 9 of this document. Since these graphs represent the author's interpretation of questionnaire responses of shipboard personnel, and therefore reflect any biases introduced by the author's judgments and the data collection procedure, provision has been made for refining the graphs and their interpretation on the basis of future field experience.

The Navy has defined a number of compartment categories which depend on compartment function. They are reviewed in reference 1 and defined in table 1. In specifying noise limits, compartments are assigned to these categories. For example, compartments in which direct speech communication is essential are required to meet the Category A-3 or Category A-12 limits; general living and sleeping areas are required to meet the Category B limit; and compartments requiring especially quiet conditions, such as medical (hospital) and sonar spaces, are required to meet the Category C limit. This document does not address Category D compartments in which hearing damage risk is the primary concern.

Category	Definitions
A	Spaces where direct speech communication must be understood with minimal error and without need for repetition. Category A-3 applies to spaces where maximum talker-listener distance is less than 6 feet. Category A-12 applies to spaces where maximum talker-listener distance is 6 feet or greater.
B	Spaces where comfort of personnel is the primary consideration; where speech communication considerations are secondary.
C	Spaces where it is essential to maintain especially quiet conditions.
D	Spaces where high noise levels exist, where speech communication is not mandatory; where ear protection is not provided; and where the prevention of hearing loss is the primary consideration.
E	Spaces where high noise levels exist, where speech communications are required over short distances but can be accomplished with high vocal effort and where speech amplification and amplified telephones are normally available.

Table 1. Definitions of airborne noise categories applicable to ship spaces, compartments, and topside locations (see reference 5).

BACKGROUND

MEASURES OF NOISE

A variety of measures are used in describing noise. Among others, these include octave band levels; linear, A-weighted, and C-weighted sound pressure levels (reference 2); the noise rating (NR) (reference 3); and three- and four-band speech interference levels (PSIL and four-band SIL) (reference 4). For the analyses presented in this document, the A-weighted sound pressure level, or "sound level," has been used.*

The sound pressure level may be measured in each of the octave bands centered at 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. When a simpler descriptor is desired, these may be combined into a single number. In determining the linear sound pressure level, each of the octave bands is given equal weight. However, other single-number descriptors have been developed which correspond more closely to the sound heard by the ear, which is not equally sensitive at all frequencies. The A-weighted sound pressure level, or "sound level," is often used because it is relatively simple to handle during measurement and analysis. However, it does contain less information about frequency content than octave bands, and is relatively insensitive to low frequencies. Consequently, linear or C-weighted sound pressure levels are sometimes used to supplement it.

Another single-number descriptor often used is NR, which is determined by comparing the octave band levels with a standard set of NR curves.

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*Rule-of-thumb estimates, which must be used with caution, include the following:

A-weighted sound pressure level = level in the 500-Hz octave band
= NR + 5 dB
= PSIL + 7 dB
= four-band SIL + 10 dB.

When speech communication is the primary concern, SIL or PSIL are frequently used. The 4-band SIL is the arithmetic average of the sound pressure levels in the 500, 1000, 2000, and 4000-Hz octave bands. In the 3-band PSIL, the 4000-Hz octave band level is omitted. The SIL and the PSIL can differ from each other by several dB, especially on ships where the 4000-Hz octave band sound pressure level is likely to be relatively low. For communication in a normal voice at 3 feet, a PSIL of 58 dB or lower is required. This corresponds to about 65 dB(A). For communication in a raised voice at 3 feet, a PSIL of 64 dB is required. This corresponds to about 71 dB(A).

NOISE LIMITS

Table 2 shows the noise limits for Navy surface ships listed in a proposed revision of the general specifications for ships (reference 5). The limits on A-weighted sound level recommended in reference 1 are identical to those in reference 5, except for the recommended Category B limit of 75 dB(A). For comparison, table 3 lists some noise limits recommended by NOSC for US merchant ships (reference 6). Lower noise limits are often practical for merchant ships because they generally have much lower propulsion power requirements than Navy ships. For example, the current Navy limit for staterooms, berthing areas, and other Category B spaces is 70 dB(A); the corresponding proposed limit for merchant ships is 65 dB(A).

It is of some interest to note that noise limits recommended for civilian shore-based facilities are much lower than is practical aboard a ship. According to reference 2, a "moderately noisy" private office or conference room is 56 dB(A), which permits communication in a normal voice at 9 feet. A "moderately noisy" secretarial, drafting, or business machines office is 68 dB(A), which requires a slightly raised voice at 3 feet. The following suggested levels have been derived by adding 7 dB to PSIL values listed in reference 2:

- Small private office . . . . . 52 dB(A)
- Conference room for 20 42

Airborne noise acceptance levels for ship spaces, stations and areas (Note 1):
Decibels re: 20 μPa (Note 2)

Airborne Noise Category	Octave Band Center Frequency, Hz										
	SIL	31.5	63	125	250	500	1000	2000	4000	8000	dB(A)
A-3	64	82	79	76	73	SIL Value Requirement				61	70
A-12	54	72	69	66	63	SIL Value Requirement				51	60
B	N/A	82	79	76	73	70	67	64	61	61	70
C	N/A	77	74	71	68	65	62	59	56	56	65
D	N/A	105	99	93	87	84	81	78	78	78	84
E	72	99	93	87	81	SIL Value Requirement				72	82

Note 1: Ship spaces, stations, and areas which meet the octave band sound pressure and dB(A) sound levels specified above are acceptable. The noise level in any one octave band (and only one octave band) may be exceeded by 2 dB for each airborne noise category, except in the SIL octave bands when the SIL value applies, provided the dB(A) level is not exceeded. When the SIL value applies, the noise level may exceed the SIL value in any of the SIL octave bands provided the arithmetic average of levels in the four SIL octave bands does not exceed the specified SIL value and provided the dB(A) level is not exceeded.

Note 2: 20 μPa = 0.0002 dyne/cm^2.

Table 2. Airborne noise limits for US Navy surface ships listed in reference 5. The limits on A-weighted sound level [dB(A)] are identical to those recommended in reference 1, except that the category B limit is 5 dB lower. Note that a four-band SIL is specified.

ACTIVITY AND SHIP SPACE	IMMEDIATE SLIGHTLY LENIENT LIMIT FOR EXISTING MERCHANT SHIPS	MORE STRINGENT FUTURE GOAL FOR NEW (1985) MERCHANT SHIPS	LIMITS FOR US NAVY SURFACE SHIPS
REST, RECOVERY FROM TEMPORARY HEARING LOSS, AND SLEEP			
Mess/rec room	70	65	70 (Category B)
Office/day cabins	70	65	70 (Category A3)
Sleep cabins	65	60	70 (Category B)
Hospital	65	60	65 (Category C)
HEARING WARNING SIGNALS			
Whistle at listening posts	110	100	-
Listening post lookout	70	65	-
SPEECH COMMUNICATION			
Engine control room	80	75	82 (Category E)
Enclosed bridge/wheelhouse	65	60	60 (Category A12)
Radio room	70	65	70 (Category A3)

(The limits proposed for merchant ships in reference 6 are based principally on the effects of noise on the activities listed in the left column.)

Table 3. Recommended noise limits [dB(A)] for Merchant ships (reference 6) and US Navy surface ships (reference 5).

- o Secretarial (typing) office. . 67
- o Homes (sleeping) 37
- o School rooms 37

SETTING COST-EFFECTIVE NOISE LIMITS

In deciding upon a noise limit for a given shipboard compartment type, both the benefit and the cost of achieving the limits must be considered. To assist in determining the benefit of a given amount of noise control, this document presents graphs which show the effect of noise level on personnel responses. The graphs have been been derived from sound level measurements and subjective opinions of the effects of noise on personnel. The data were obtained for selected compartments aboard eight Navy ships, and were analyzed by using a very simple method (reference 7) to relate them and put them into a form convenient for evaluating noise limits. Considerable subjective judgment is required in setting a value on the benefit of reducing noise effects. The method used in this document permits the designer to use his own experience and judgment in each particular case to decide how important it is to achieve these benefits.

For the cost-benefit decision process, one needs specific information on the cost and technical practicality of noise control in addition to the information in this document. To assist in determining cost, the graphs presented may be used to estimate the difference between existing shipboard levels and any given noise limit; ie, how many compartments would need to be improved and how much noise reduction would be required.

SOME NOISE EFFECTS CONSIDERATIONS

The effects of noise on people have been reviewed in reference 8. An effect of primary concern for engineering personnel aboard ships is hearing damage risk. The risk depends not only on the level and duration of the noise exposure, but also on the opportunity the ears are given to recover. For the unprotected ear, the Department of Defense has set 84 dB(A) as the maximum

level to be permitted for 8 hours per day, with an increase of 4 dB per time-halving. To permit adequate recovery from such noise exposure, sound levels in spaces in which these personnel spend the remainder of their time should be 70 dB(A) or lower.

Noise can also cause stress, elevated blood pressure, and fatigue (reference 8). Experts differ on just how damaging stress induced by noise is. Kryter has suggested that damage from stress caused by meaningless noise is unlikely if the level of the noise is kept low enough for required sleep and auditory communication (reference 9). This suggests that shipboard noise limits which satisfy sleep or speech communication requirements will also be satisfactory from a stress standpoint.

Noise may also adversely affect activities which are necessary in the various shipboard compartments. Reference 10 reports the responses of personnel regarding requirements for three activities: sleep, solving problems, and speech communication. For example, for staterooms, 100 percent of the personnel responded that sleep is necessary, 96 percent that solving problems is necessary and 96 percent that normal conversation is necessary. Of these three activities, speech communication had the most consistently indicated need over all compartments. Personnel responses regarding the effect of noise on sleep and speech communication are reported later in this document.

Noise can disturb sleep and thereby adversely affect work efficiency and health. Steady or regular periodic noises appear to affect sleep less than nonsteady noise. Schieber et al (reference 11) found relatively nonsteady, low-density traffic sounds averaging 61 dB were more disruptive of sleep than relatively steady, high density traffic sounds averaging about 70 dB. Thus, if it masks lower-level transient noises which would otherwise be audible, steady noise at the current US Navy 70-dB(A) noise limit for staterooms could allow better sleep than noise of lower level.

Noise, especially intermittent and/or aperiodic noise, can also affect work performance. However, the literature fails to strongly support this

because in many cases such effects have proven small or difficult to measure. People can usually work effectively even when annoyed because they are adaptable. In noisy environments, they can draw on a considerable reserve capacity to maintain nearly constant performance. Noise is most likely to interfere during times of unusually great demand when a person is performing at the limits of his capacity; that is, when his reserve capacity is inadequate to handle both the task requirements and the noise. This may occur, for example, in long-term vigilance tasks, complex tasks, or during periods of exceptionally high workload (see reference 8).

DATA COLLECTION PROCEDURE

Sound levels and subjective questionnaire data were collected from a total of 22 ships during three different surveys, as described below.

NOSC 1978 DATA (8 SHIPS)

In the present study, the data collection procedure followed that described in reference 7. Compartments aboard eight Navy ships were surveyed on a not-to-interfere basis while the ships were underway, usually at normal cruising speed. The ships were the CV-61, CV-64, DD-972, DD-976, DDG-13, FF-1063, LST-1185, and LST-1191. The types of compartments surveyed are listed in table 4. In addition, data for a sonar compartment were obtained from a ninth ship, the DDG-7, at dockside. In each compartment, A-weighted, C-weighted, and octave band sound pressure levels were measured by using the "slow" scale on the meter. Simultaneously, questionnaires were used to collect subjective data on the effects of the noise on personnel. Among others, ratings of interference with communication, solving problems, and sleep were included.

NOSC 1980 (AD-41) DATA

A contractor and NOSC collected sound level data aboard the AD-41 destroyer tender during builder's and acceptance trials. SUPSHIPS personnel collected subjective responses of ship trials personnel to noise, using an NOSC questionnaire (appendix A) during the acceptance trials.

NOSC 1972 DATA (12 SHIPS)

Sound level and questionnaire data (reference 12) were obtained in 1972 from the following ships: CVS-14, CVA-43, CVA-63, CVA-64, CVA(N)-65, DE-1053, DE-1070, DD-718, DD-875, LKA-115, TAGM-10, and PG-98. A sample of the questionnaire used is included in appendix A.

Abbreviation	Compartment Type
(SR)	Staterooms
(B)	Large berthing compartments
(L)	Lounges/recreation areas
(M)	Mess areas
(W)	Wardrooms
(H)	Medical (Hospital) compartments
(C)	Command, control, and communication spaces
(O)	Offices
(S)	Workshops
(S/L)	Sonar and Library Compartments
(P/C)	Pilot houses/bridges and Chartrooms/Logrooms

Table 4. List of shipboard compartment types surveyed by NOSC in 1978, with abbreviations used in this document. Engineering spaces were not included.

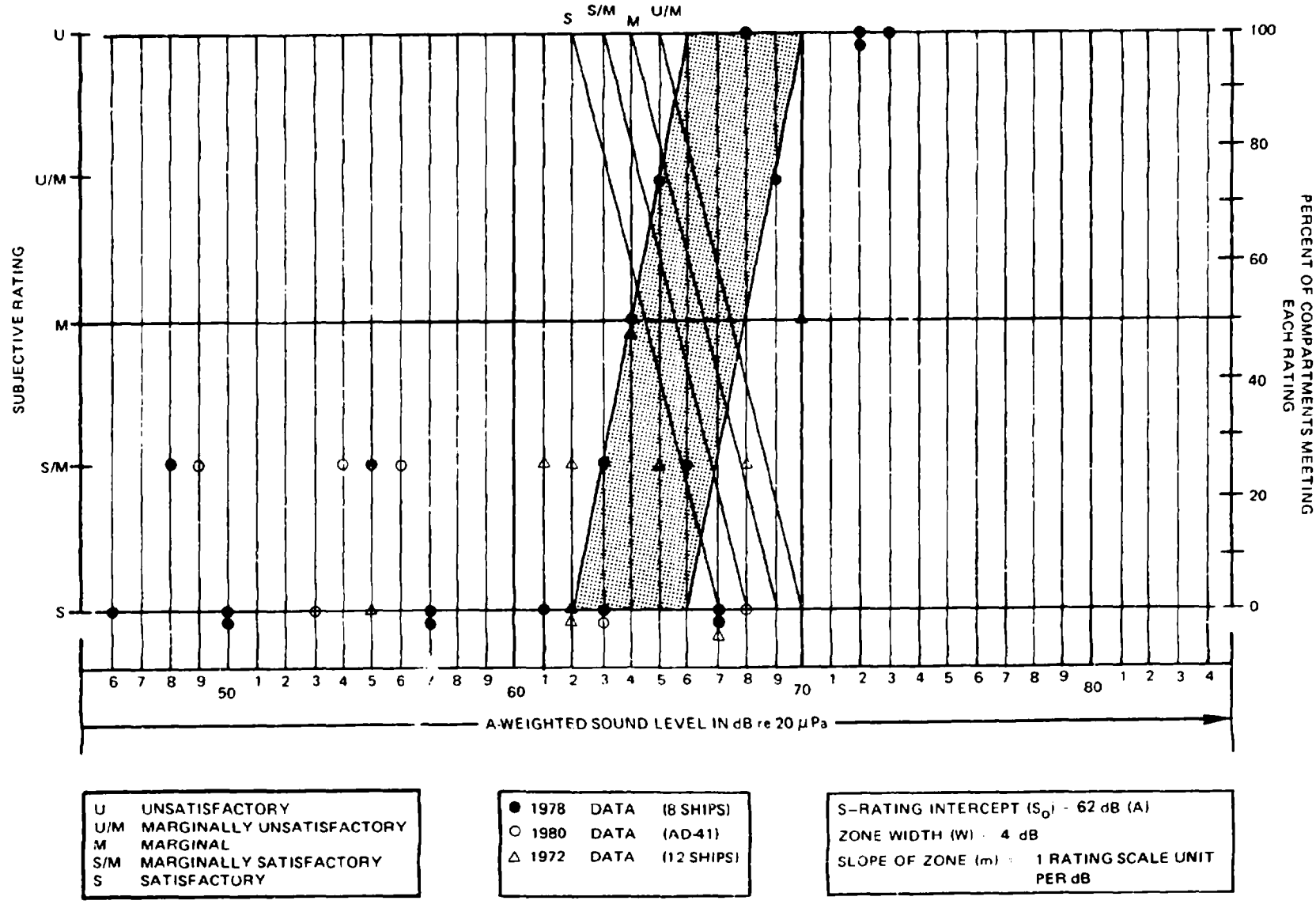

Figure 1. Subjective ratings of noise in staterooms (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 63 dB(A). Analysis is based on 1978 data.

GENERATION AND USE OF FIGURES 1 THROUGH 9

Reference 7 describes the simple method used to analyze the data. Since a general understanding of it is required for using the graphs reported in the results section, it will also be summarized briefly here.

First, sound levels were determined. Next, a single number which represents the effect of the measured noise was determined for each compartment from the subjective ratings as follows. The author examined all of the subjective data for each shipboard compartment. Then, using the scale in table 5 as a guide, he made a judgment of how satisfactory he felt the noise level was, rating each compartment subjectively on a 5-point scale: satisfactory (S), marginally satisfactory (S/M), marginal (M), marginally unsatisfactory (U/M), and unsatisfactory (U). The rating procedure thus involved the author's own subjective judgments in addition to the opinions of the occupants of the compartments. These data were then plotted to produce a graph of subjective rating versus sound level.

As an example, refer to figure 1. It shows the results for the staterooms measured on the eight ships. At sound levels at or below 62 dB(A), nearly all of the spaces are rated as satisfactory. At levels at or above 70 dB(A), none is satisfactory. In between, there is a transition zone in which the ratings shift from satisfactory to unsatisfactory as sound level increases. The boundaries of this transition zone were approximated by two parallel straight lines, ignoring about 10 percent of the points. Three parameters were then estimated:

- o The satisfactory rating intercept (S_o),
- o The width of the zone (W), and
- o The slope of the zone (m).

In figure 1, S_o is 62 dB(A), W is 4 dB, and m is one rating scale division per dB. These three parameters were then used to plot predicted subjective rating as a function of sound level, as described in reference 7.

Define a rating scale as follows:

Rating	Bothersomeness	Interference Complaints	Impact on Important Functions
S (Satisfactory)	Not bothersome	Negligible	None
S/M (Marginally) satisfactory)	Slightly bothersome	Scattered	Slight
M (Marginal)	Moderately bothersome	Trend beginning	Some probable
U/M (Marginally unsatisfactory)	Quite bothersome	Definite pattern	Definite
U (Unsatisfactory)	Very bothersome	Widespread	Severe

Note: This scale is a composite which the author found useful for general guidance in rating compartments. The individual measures would normally be treated separately, since they are not necessarily related to one another as shown here. In his subjective analysis, the author weighted interference reports much more heavily than bothersomeness reports.

Table 5. A rating scale for guiding the evaluation of subjective opinions of compartment sound levels.

To use figure 1, first select a rating and locate the corresponding negatively sloping rating line. The value of the rating line is read from the right vertical axis of the graph. The rating line value decreases linearly from 100 percent at some noise level to 0 percent at some higher noise level. For noise levels below or above this linearly decreasing section, its value is 100 percent or 0 percent, respectively. As an example, select a rating of marginally satisfactory (S/M). The value of the S/M rating line is 100 percent for noise levels below 63 dB(A), decreases linearly from 100 percent to 0 percent between 63 dB(A) and 68 dB(A), and is 0 percent above 68 dB(A).

Next, locate the noise level of interest on the horizontal axis. The value of the rating line at this noise level is an estimate of the percentage of compartments with this noise level which will meet the selected rating. For example, if the noise level of interest is 65 dB(A), the value of the S/M rating line is 60 percent. So it is estimated that, of compartments with a noise level of 65 dB(A), 60 percent would be rated as S/M or better. In addition, the amount of noise reduction needed to achieve the noise level of interest may be estimated by examining the data points above and below that level. For example, of the 20 staterooms in the 1978 survey which are plotted in figure 1, 12 would meet a noise limit of 65 dB(A). The remaining eight would require from 1 to 8 dB of noise reduction.

A noise limit goal may be derived from figure 1 by requiring that a given percentage of compartments meet a particular rating. For example, if the goal is that 100 percent of the compartments meet a rating of S/M, figure 1 shows that the required noise limit is 63 dB(A).

Mathematically, the sound level at which 100 percent of the compartments meet any given rating is equal to $S_0 + (1/m - 1) + i/m$, where $i = 0$ for a rating of S, 1 for S/M, 2 for M, and 3 for U/M. This reduces to $S_0 - 1 + 2/m$ for a goal of 100 percent of the compartments being rated as S/M or better. Thus a noise limit derived in this way depends only on S_0 and m. A noise limit based on fewer than 100 percent of the compartments meeting a given rating would also depend on the zone width w.

RESULTS

Graphs of subjective ratings versus A-level and analyses using the method of reference 7 are presented in figures 1 through 9. These figures will be discussed in detail in the "Discussion" section. Unless otherwise stated, the analyses are based only on the 1978 data; the 1980 and 1972 data are shown on the graphs for comparison as an indication of data reliability. The two data points obtained from the DDG-7 are included in figure 6.

1978 DATA (8 SHIPS)

The sound levels measured have been reported in reference 13. The distribution of measured sound levels in each compartment type is presented in table 6. Only the 1978 data have been included in this analysis.

A total of 356 questionnaires were obtained. The number obtained per compartment was usually about three, but ranged from one to seven. The shipboard experience of the Navy personnel comprising the sample population was as follows. The mean number of "years spent on ships at sea" was 4.1 (sigma* = 3.9; 332 responses; the means for the eight ships ranged from 3.0 to 4.7). The mean number of "years spent on this ship" was 1.2 (sigma = 1.0; 326 responses; ship means ranged from 0.3 to 1.9). The mean number of "hours in this compartment per day" was 7.5 (sigma = 3.8; 342 responses; ship means ranged from 5.8 to 9.5). Ninety-six percent of the personnel indicated their hearing was normal or nearly normal, as follows:

Hearing	Number of Responses	Percent of Total Responses
Normal	285	82
Slight loss.	50	14
Substantial loss	11	3
Trouble hearing speech	3	1
Total responses:	349	100

*Sigma, the square root of the variance, is a statistical measure of variability approximately equal to the standard deviation.

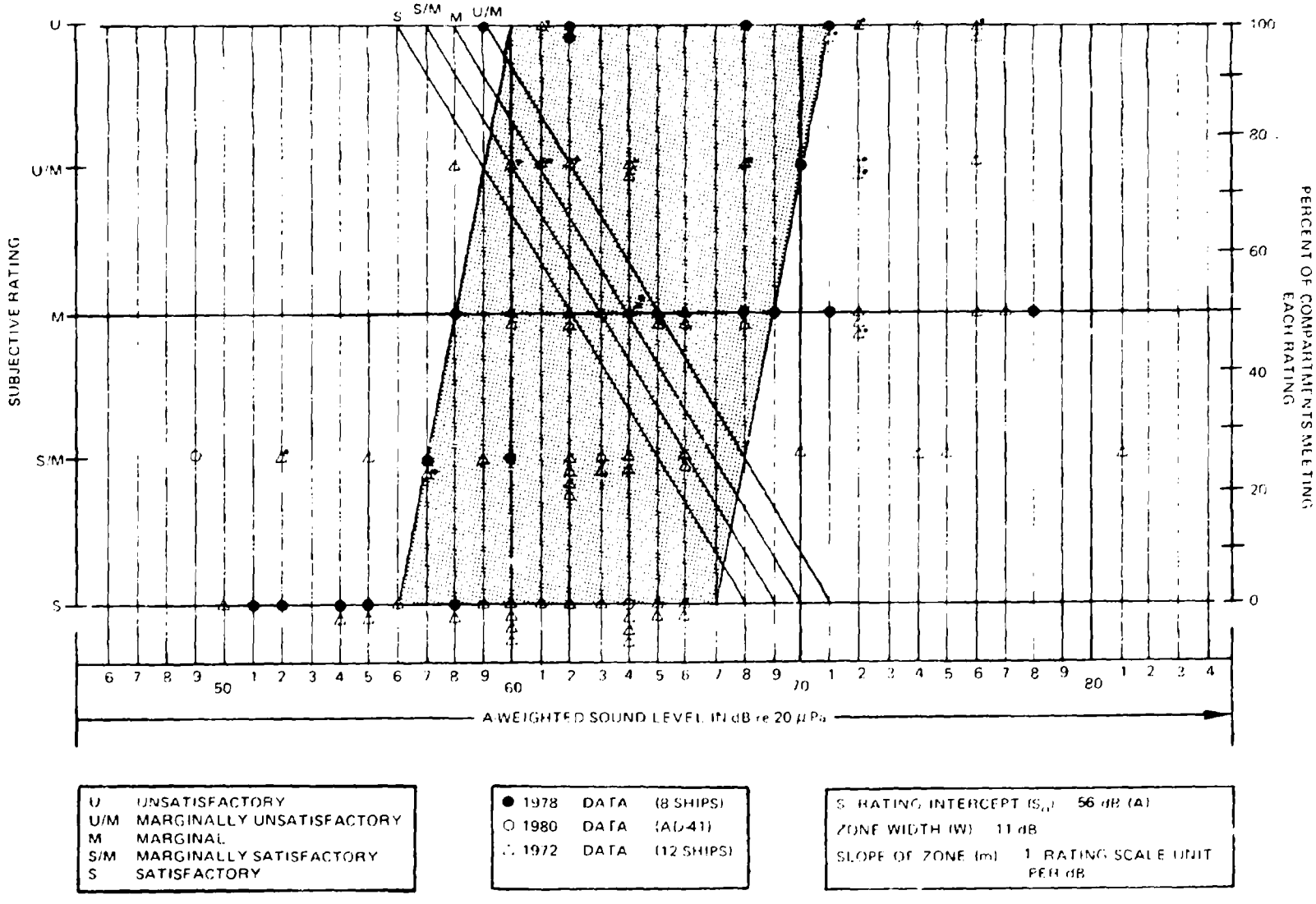

Figure 2. Subjective ratings of noise in large berthing compartments (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. Three additional points are not plotted: [89 dB(A), U], [92 dB(A), U], and [94 dB(A), S/M]. The 100-percent S/M sound level goal is 57 dB(A). Analysis based on 1978 data. A dot (•) indicates that transient noises probably influenced the evaluation. An asterisk (*) indicates an additional condition in a compartment already plotted.

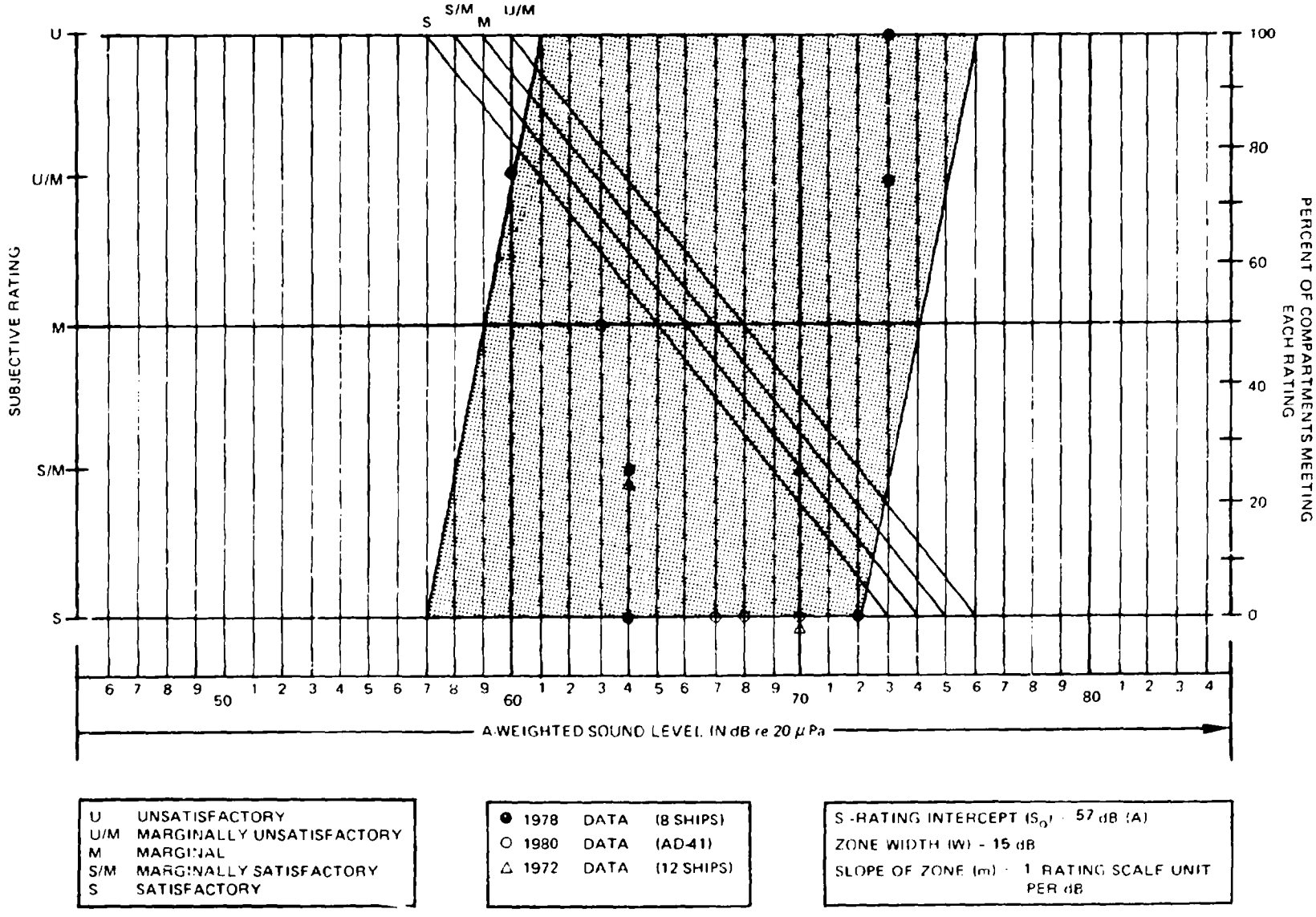

Figure 3. Subjective ratings of noise in lounges and recreation areas (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 58 dB(A). Analysis based on 1978 data.

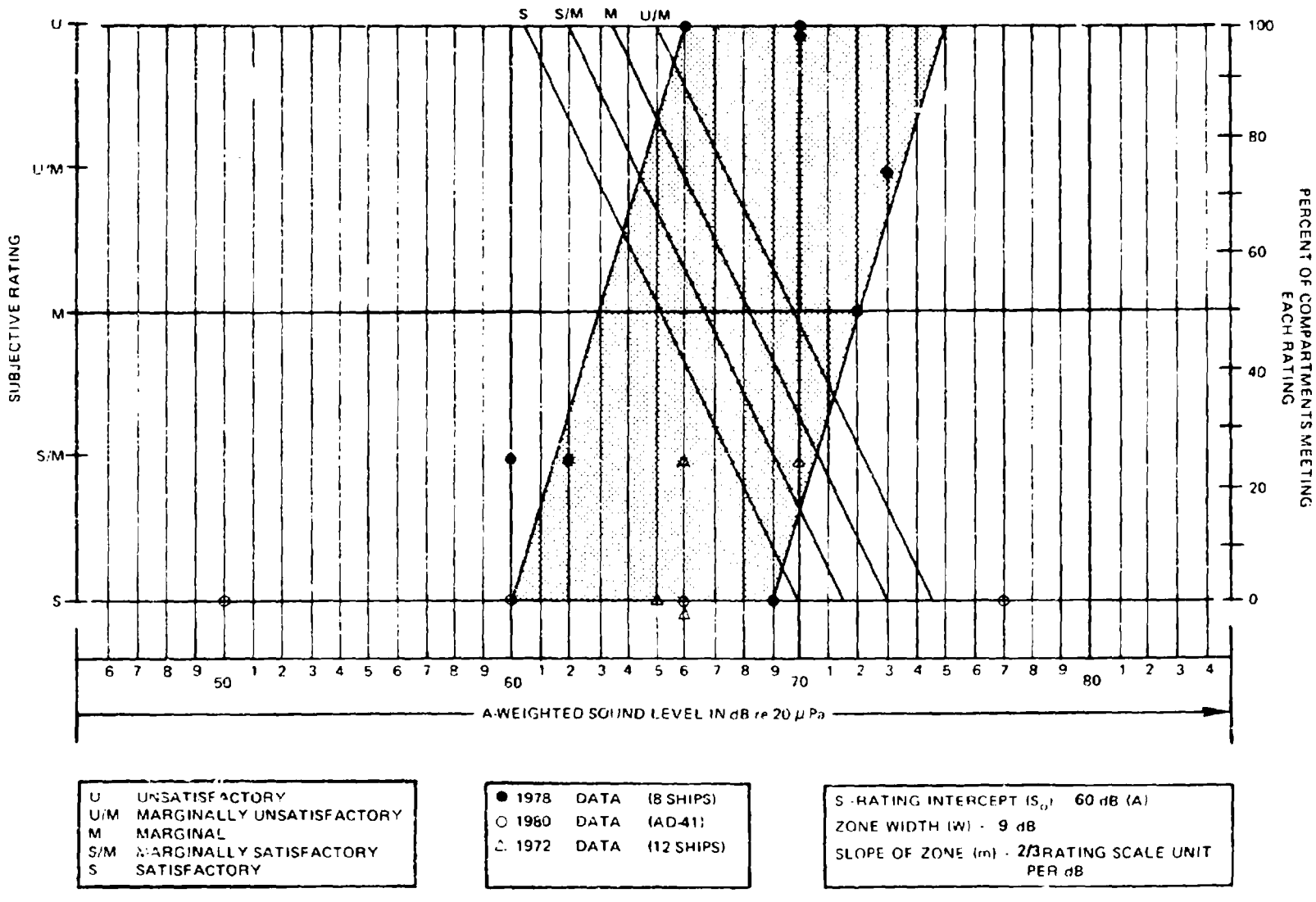

Figure 4. Subjective ratings of noise in mess areas (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 62 dB(A). Analysis based on 1978 data.

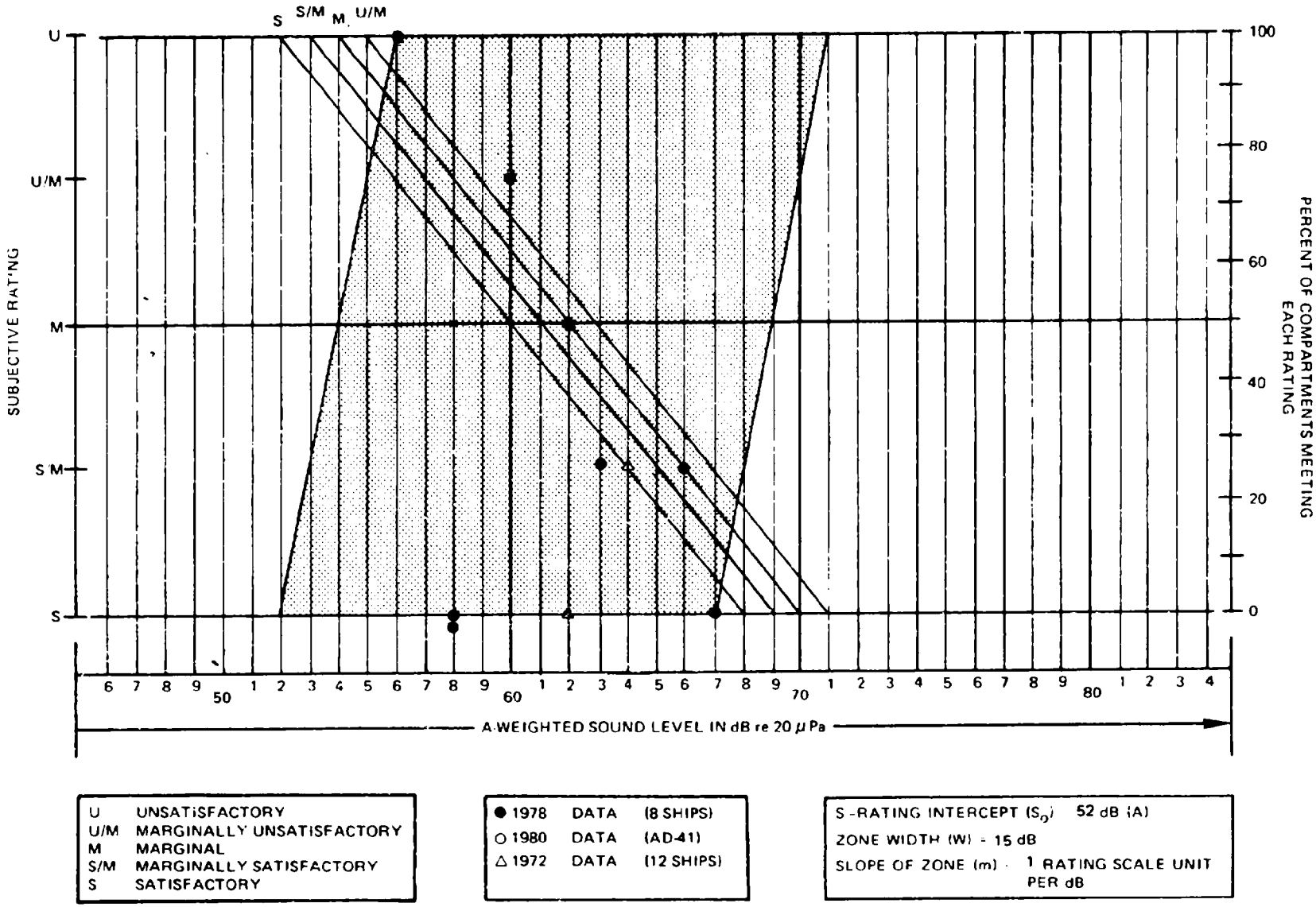

Figure 5. Subjective ratings of noise in officers' wardrooms (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 53 dB(A). Analysis based on 1978 data.

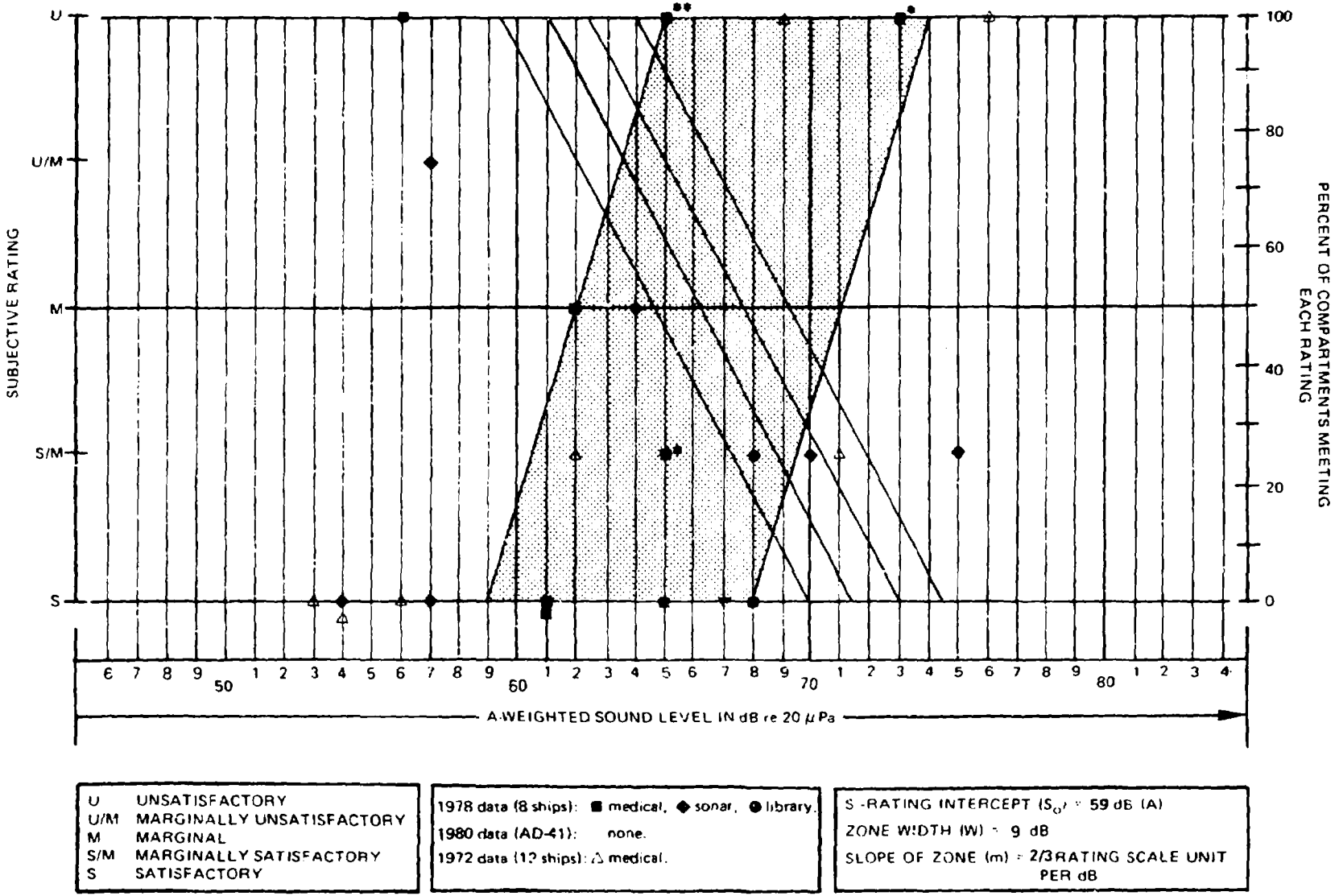

Figure 6. Subjective ratings of noise in medical, sonar, and library compartments (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. A variety of special tasks are performed in these compartments, making the combined analysis shown here somewhat inappropriate. The 100-percent S/M sound level goal is 61 dB(A). Analysis based on 1978 data. The single asterisk (*) indicates sick call; the double asterisk (**) indicates exam using a stethoscope; these three points represent the same compartment.

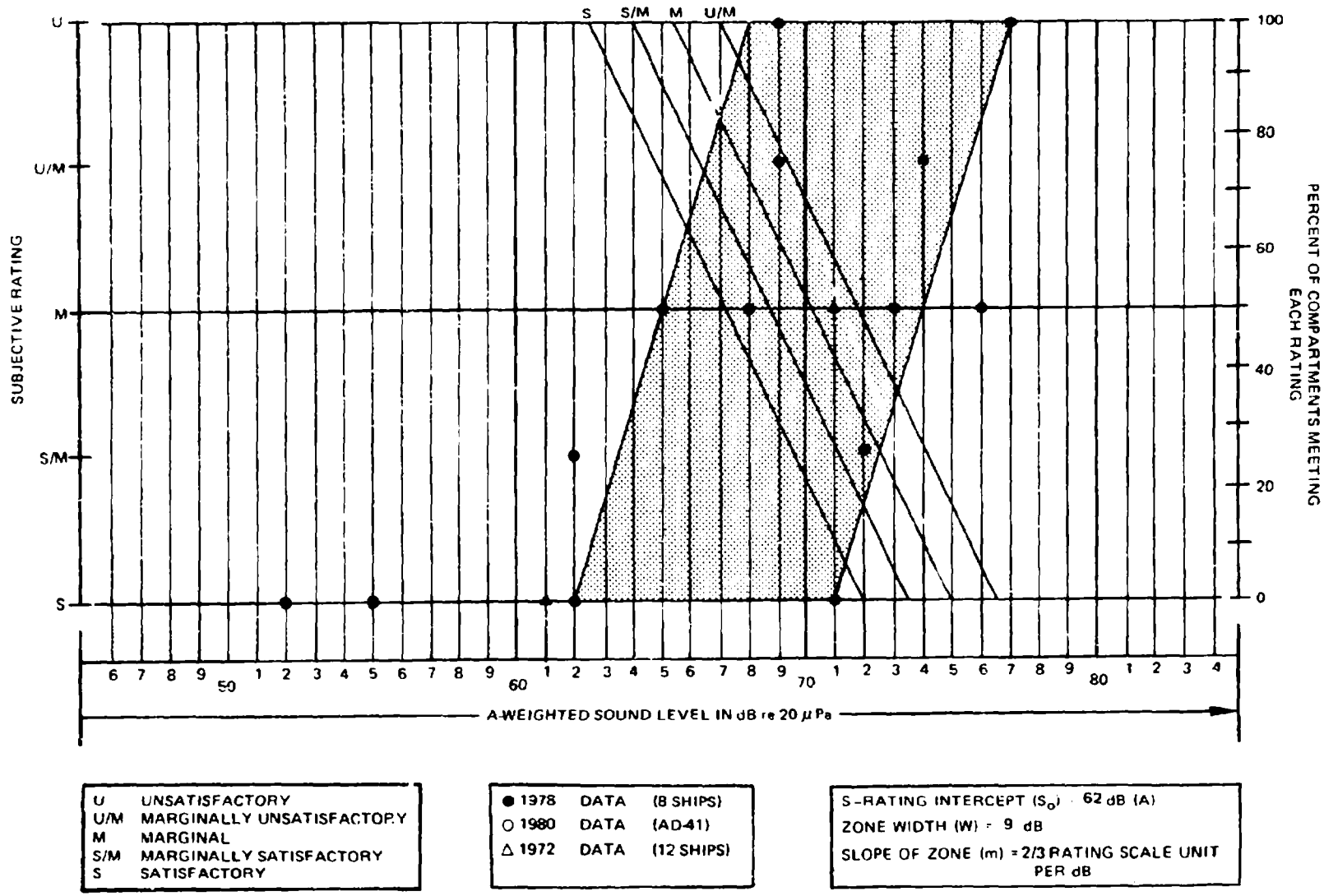

Figure 7. Subjective ratings of noise in command, control, and communication spaces, including pilot houses, bridges, logrooms, chartrooms, and CICs (left axis), and percent of those compartments meeting each rating (right axis) as a function of A-weighted level. The 100-percent S/M sound level goal is 64 dB(A). Analysis based on 1978 data.

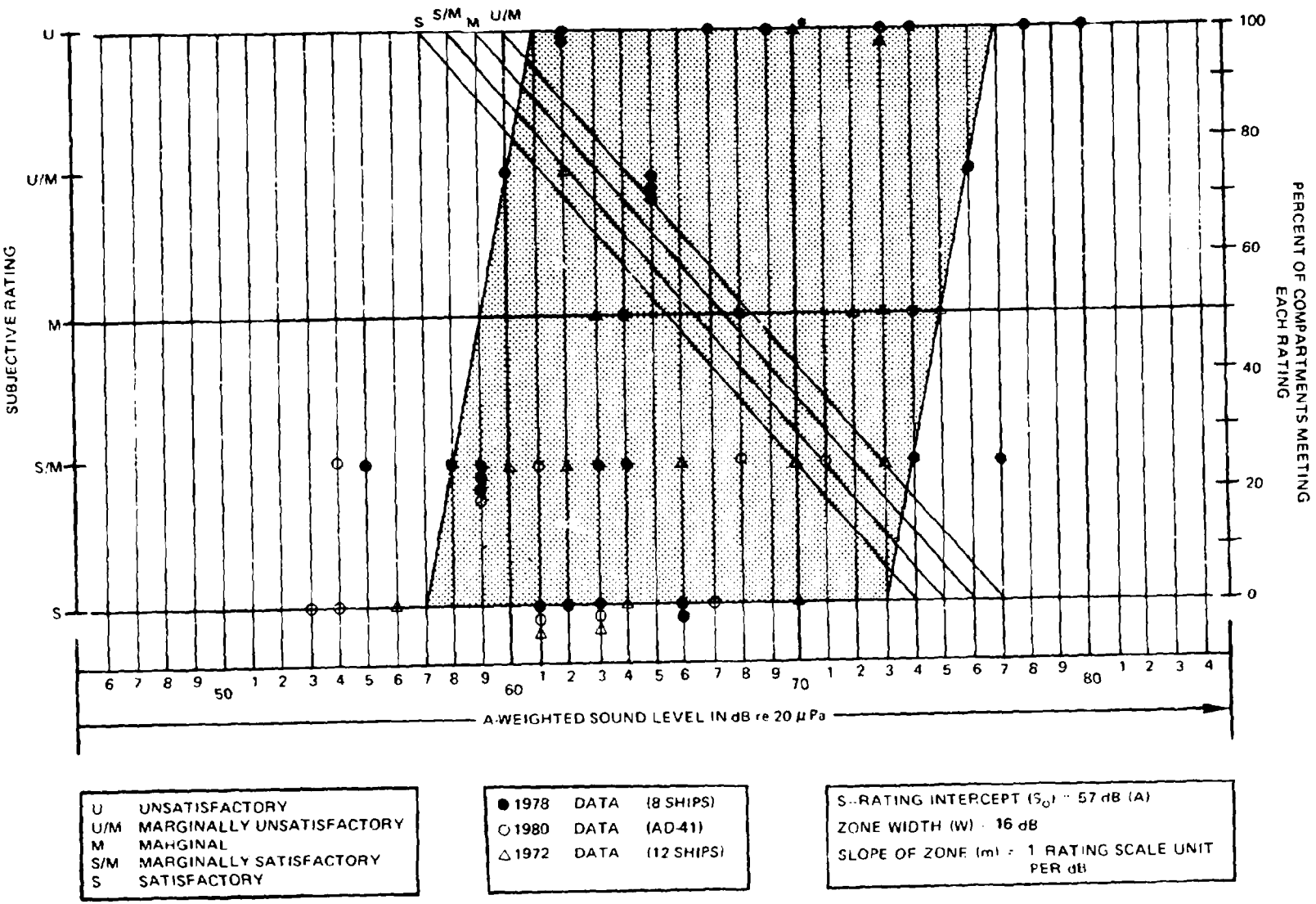

Figure 8. Subjective ratings of noise in offices (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 58 dB(A). Analysis based on 1978 data. An asterisk (*) indicates an additional condition for a compartment already plotted.

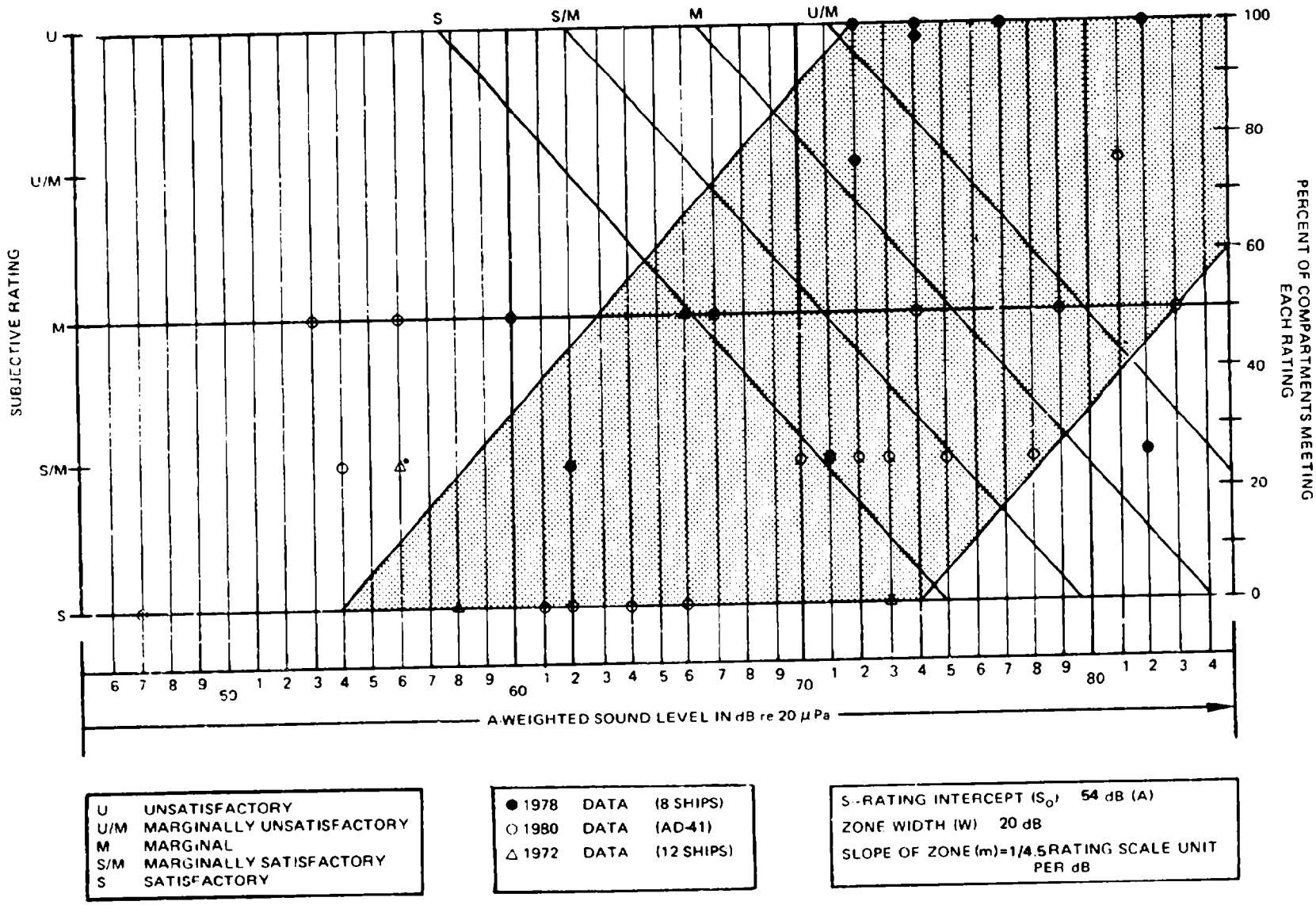

Figure 9. Subjective ratings of noise in workshops (left axis) and percent of those compartments meeting each rating (right axis) as a function of A-weighted sound level. The 100-percent S/M sound level goal is 62 dB(A). Analysis based on 1978 data. A dot (•) indicates that transient noises probably influenced the evaluation.

Compartment Type	Fraction of Compartments at or Below the Listed Sound Level (Rounded to Nearest 0.05)									Specified Percentage of Compartments is Below the Listed Sound Level [dB(A)]	
Sound Level [dB(A)]:	50	55	60	65	70	75	80	85	90	80%	90%
(SR) Staterooms	--	0.15	0.40	0.65	0.80	0.95	1.00	--	--	72	73
(B) Large berthing areas	--	0.20	0.40	0.60	0.75	0.95	1.00	--	--	71	73
(L) Lounges/reservation areas	--	0.00	0.20	0.20	0.40	1.00	--	--	--	73	73
(M) Mess areas	--	--	--	0.00	0.15	0.70	1.00	--	--	78	80
(W) Wardrooms	--	0.00	0.45	0.65	0.80	0.90	1.00	--	--	71	77
(H) Medical spaces	0.00	0.15	0.30	0.60	0.70	0.85	0.85	1.00	--	73	83
(C) Command, control and communication spaces	0.00	0.05	0.05	0.05	0.15	0.40	0.75	0.95	1.00	81	82
(O) Offices	--	0.00	0.15	0.55	0.75	0.95	1.00	--	--	71	74
(S) Workshops	--	0.00	0.10	0.30	0.30	0.70	0.90	1.00	--	78	80
(S/L) Sonar and library	--	0.00	0.15	0.45	1.00	--	--	--	--	68	70
(P/C) Pilot houses/bridges and chartrooms/log-rooms	0.00	0.15	0.15	0.60	0.60	1.00	--	--	--	72	75

Table 6. Distribution of measured sound levels in each compartment type (1978 data).

Ratings resulting from the author's analysis are also tabulated in tables B-1 through B-8 of appendix B. These tables correspond exactly to tables 1 through 8 of reference 13. The reader may analyze ratings as a function of C-level, any octave band level, noise rating (NR), or other sound pressure level measures by using these tables and the method of reference 7.

1980 AD-41 DESTROYER TENDER DATA

Sound level data for the AD-41 are reported in references 14 and 15. The subjective responses obtained via questionnaire are summarized in table B-9 of appendix B. The questionnaires were completed for 125 compartments by approximately 15 ship trials personnel: nine were Navy personnel and the remainder were civilian Government employees. One civilian employee rated approximately 50 compartments. The personnel reported their hearing acuity as follows:

Hearing	Number of Responses
Normal	10
Slight loss.	3
Substantial loss	1
Trouble hearing speech	1
Total responses:	15

Data from reference 14 and rating data are plotted along with the 1978 data in figures 1 through 9. Extensive data were obtained for shops (figure 9), and smaller amounts for staterooms, berthing compartments, lounge and recreation areas, mess areas, and offices. Unless otherwise stated (i.e., for shops), these data were not used in the analyses.

1972 DATA (12 SHIPS)

Figures 1 through 9 also show the data obtained in 1972, although, unless otherwise stated, they were not used in the analyses. Data were obtained for many berthing compartments, and often eight or more questionnaires were

obtained per compartment. Smaller amounts of data were obtained for other compartment types.

Analyses of the 1972 data for staterooms, large berthing compartments, and offices were conducted by using the method of reference 7. For staterooms and large berthing compartments, they produced the same parameter values as the analyses of the 1978 data, except that the upper boundaries of the zones were 1 dB and 3 dB higher, respectively. For offices, the lower boundary was 2 dB higher and the zone width was 3 dB narrower. These analyses thus support the 1978 data, and suggest that the method of reference 7 can yield repeatable results.

OTHER SUBJECTIVE MEASURES

On the 1978 questionnaires, personnel were asked to indicate interference with various activities by responding "no", "yes", or "severe". The results for sleep in staterooms, berthing areas, and "all other compartments" are reported in figures 10 through 12 for those cases in which the respondent indicated sleep was necessary. The results for speech communication in staterooms, berthing areas, offices, wardrooms, and control areas are reported in figures 13 through 17. Unlike the previous analyses in which one point represented one compartment, in this analysis one point represents one individual response.

An analysis was also performed of the 1972 raw three-point scale acceptability data for large berthing compartments. The average for each compartment was calculated and rounded off to the nearest whole number on a five-point scale. This yielded a satisfactory (actually "acceptable") rating intercept of 54 dB(A), a width of 19 dB, and a slope of one-half rating scale division per dB. This analysis indicates that 57 dB(A) is the sound level at which 100 percent of berthing compartments would be marginally satisfactory ("marginally acceptable").

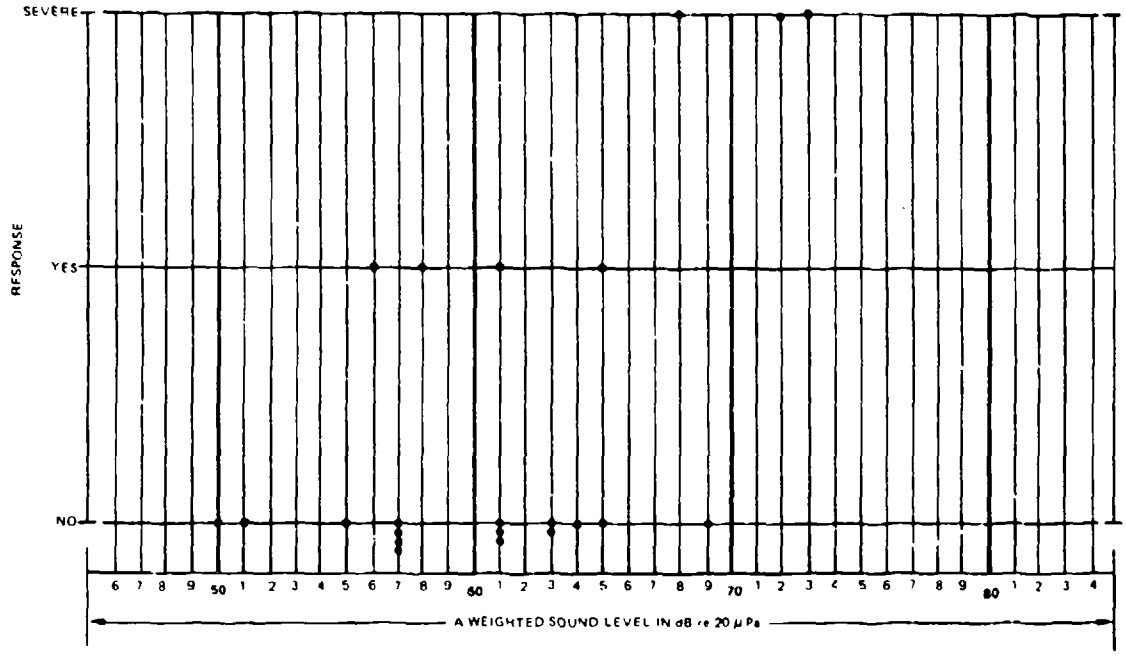

Figure 10. Responses of personnel concerning interference with sleep in staterooms (1978 data). The level above which "yes" interference reports begin is 55 dB(A); the level above which "severe" interference reports begin is 67 dB(A).

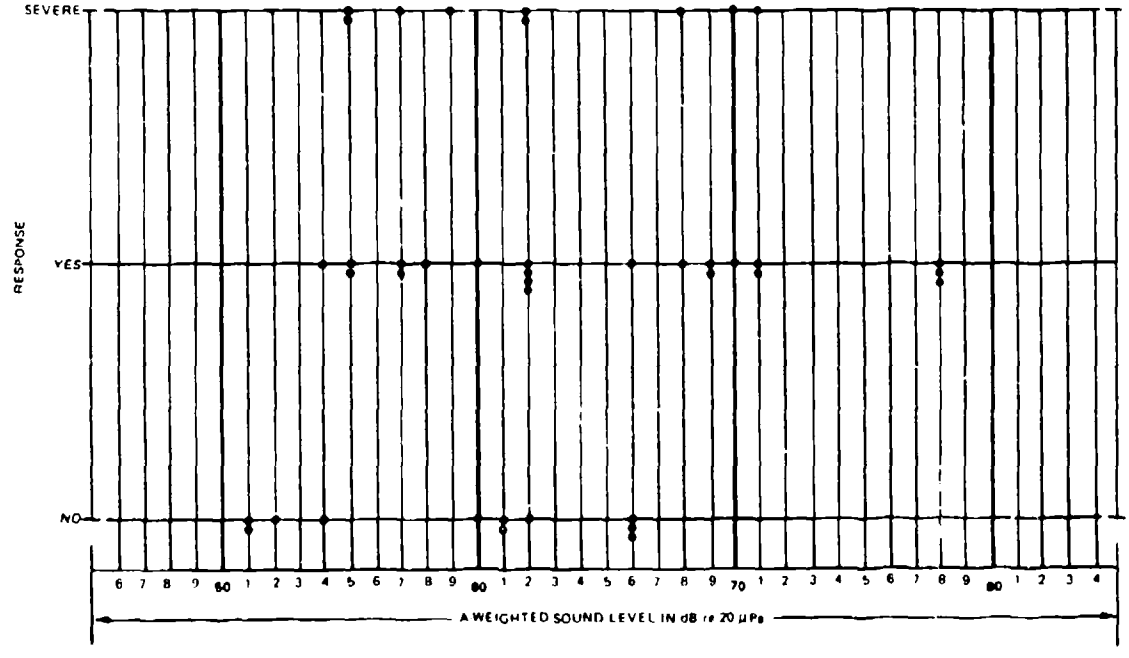

Figure 11. Responses of personnel concerning interference with sleep in large berthing compartments (1978 data). The level above which "yes" interference reports begin is 53 dB(A); the level above which "severe" interference reports begin is 54 dB(A).

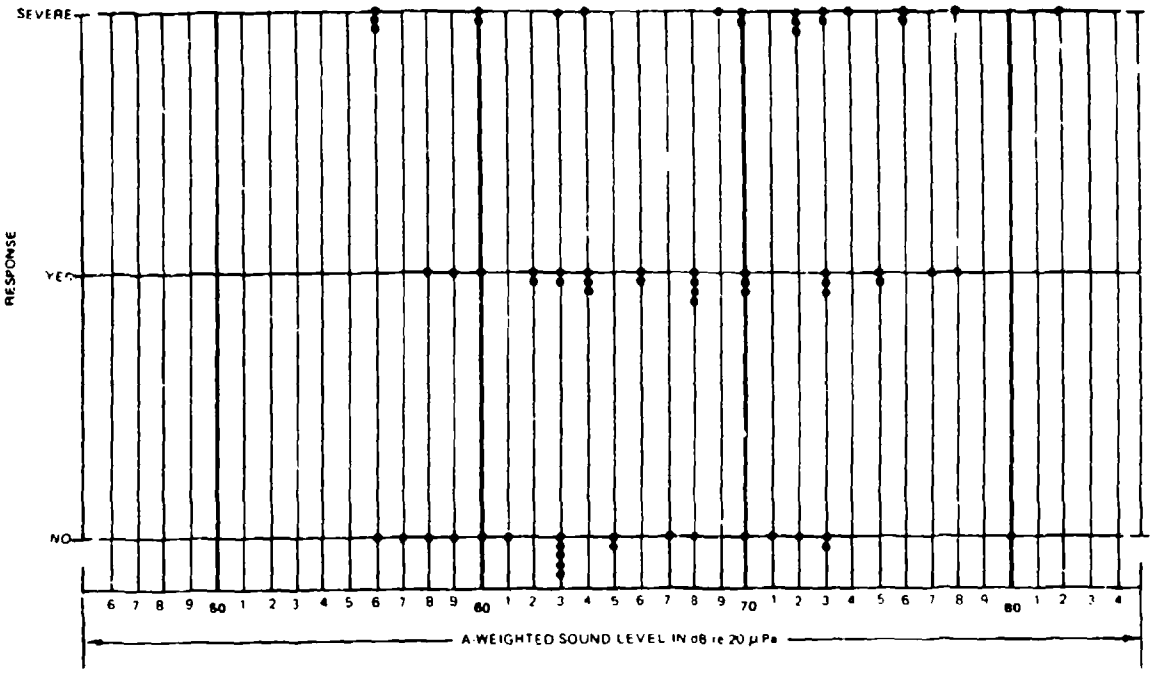

Figure 12. Responses of personnel concerning interference with sleep in "all other compartments" (except staterooms and large berthing compartments; 1978 data). A need to sleep was claimed by a few personnel in virtually every compartment type on the ship (reference 8). The level above which "severe" interference reports begin is 55 dB(A); however, no data were obtained for sound levels at or below 55 dB(A).

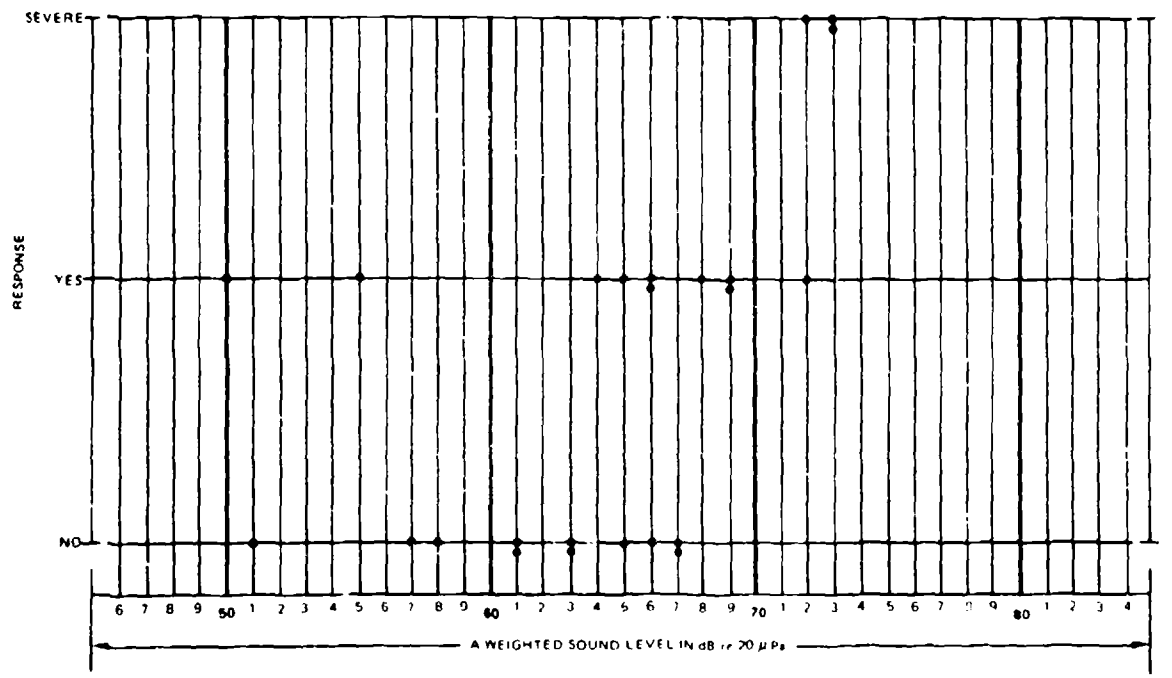

Figure 13. Responses of personnel concerning interference with normal conversation in staterooms (1978 data). The level above which consistent "yes" interference reports begin is 63 dB(A); the level above which "severe" interference reports begin is 71 dB(A).

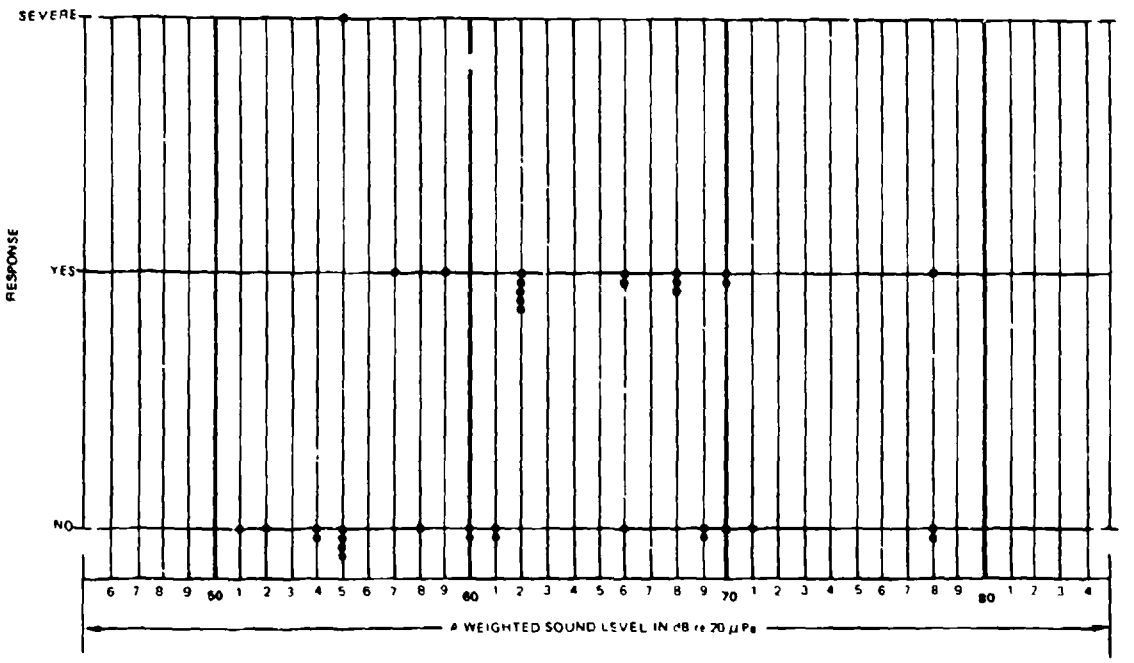

Figure 14. Responses of personnel concerning interference with normal conversation in large berthing compartments (1978 data). The level above which interference reports begin is 54 dB(A), with more consistent reports beginning above 61 dB(A).

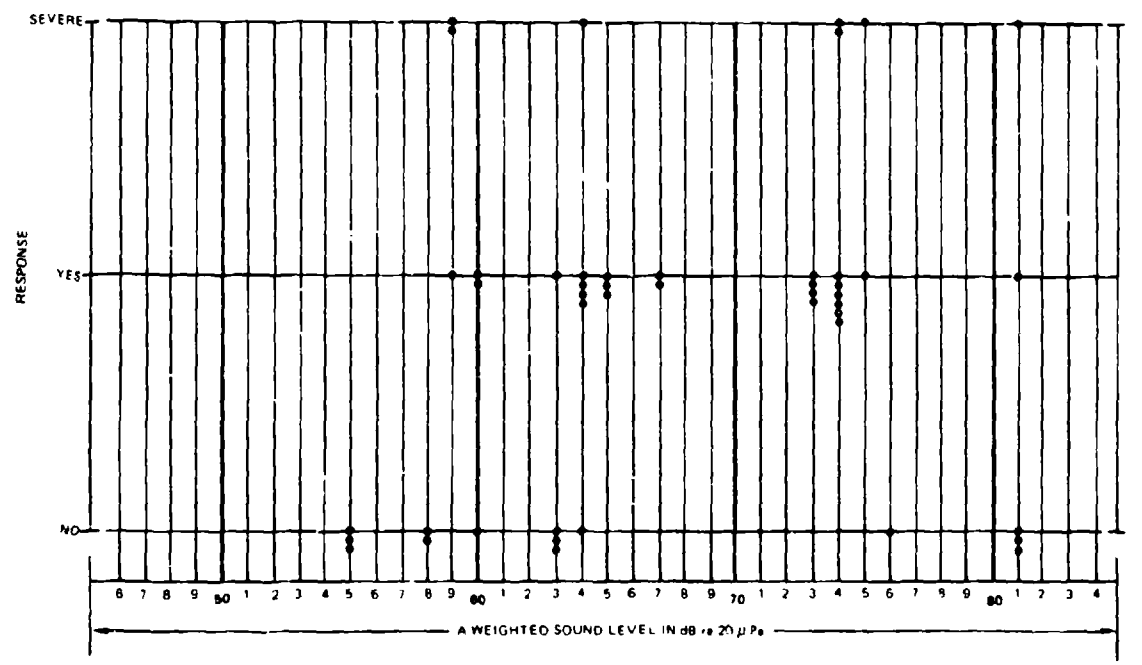

Figure 15. Responses of personnel concerning interference with normal conversation in offices (1978 data). The level above which interference reports begin is 58 dB(A).

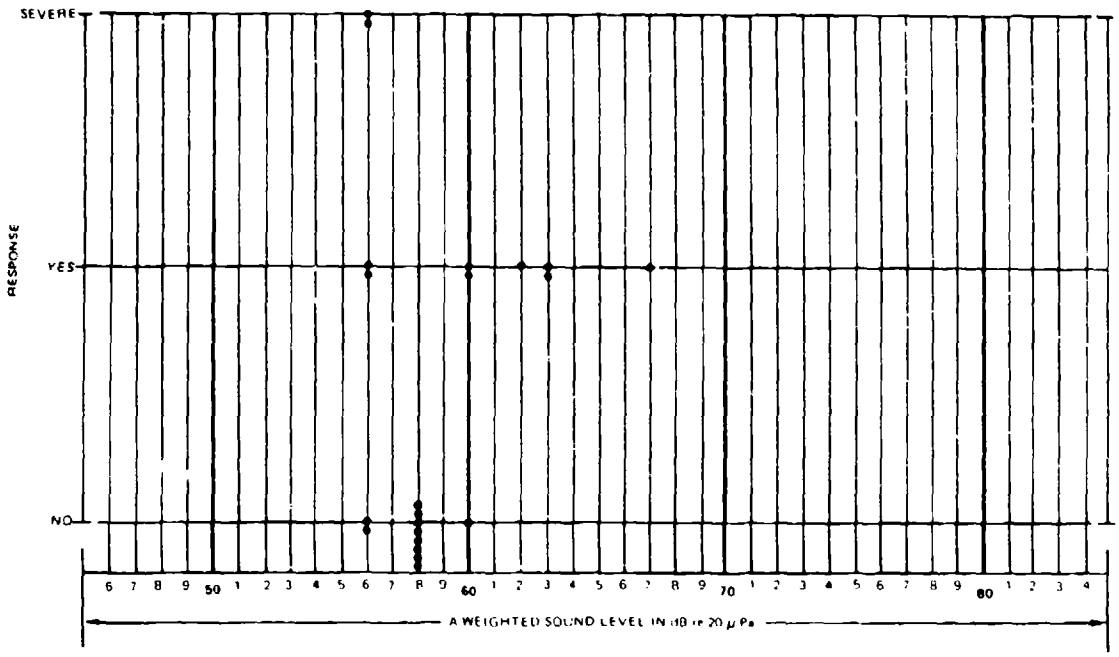

Figure 16. Responses of personnel concerning interference with normal conversation in officers' wardrooms (1978 data). The level above which interference reports begin is 55 dB(A); however, no data were obtained for sound levels at or below 55 dB(A).

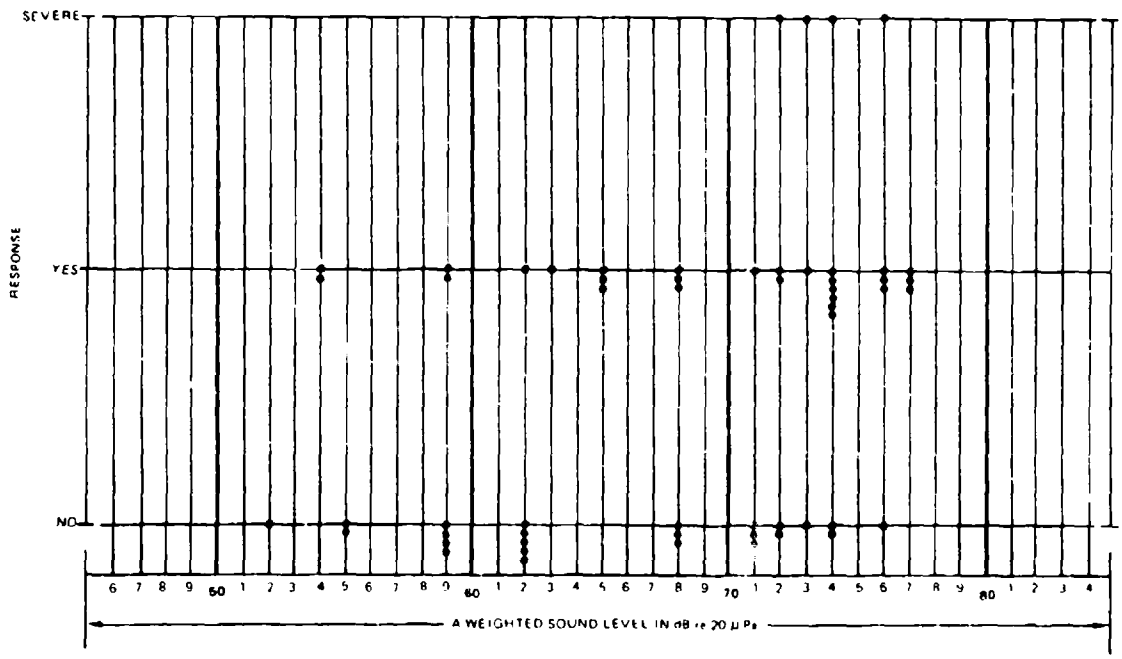

Figure 17. Responses of personnel concerning interference with normal conversation in command, control, and communication spaces (1978 data). The level above which "yes" interference reports begin is 53 dB(A); the level above which "severe" interference reports begin is 71 dB(A).

DISCUSSION

The graphs of figures 1 through 9 provide guidance for setting noise limits. Given a particular noise limit and compartment type, the reader may use figures 1 through 9 to generate analyses parallel to those given below for staterooms. And with more specific information on the cost of noise control, he may perform a more complete cost-benefit analysis. For example, information on the major noise sources in the compartments would give a better idea of the kind of noise control needed.

Although most of the analyses are based only on the 1978 (eight ships) data, they are usually adequate to accommodate the 1980 (AD-41) and 1972 (12 ships) data as well.

Most of the sound levels observed on the AD-41 were rated as satisfactory, even those high enough to be well into the transition zones defined by the analyses of the 1978 data. Consequently, the AD-41 data yield relatively little information about the transition zones. The sparsity of M, U/M, and U ratings, which resulted from the general lack of interference reports (table B-9 of appendix B), shows that the AD-41 is considered to be a quiet ship by these personnel. This suggests that, overall, the efforts to establish and enforce noise limits on this ship during its design and construction have been successful.

NOISE LEVEL GOAL

In the author's opinion, it would be reasonable to accept marginally satisfactory ratings, but to avoid marginal ratings. Since this may not always be practical, it is best viewed as a goal based on noise effects consideration. Such a goal provides a lower bound on the noise limit required for a given compartment type; reducing the sound level below this point will have little further beneficial effect on the responses of personnel. For the purpose of this document, the 100-percent S/M noise level goal is defined as that sound level at which 100 percent of the compartments are predicted to meet a rating of S/M or better.

Table 7 lists S/M noise limit goals for the various compartment types. It also presents estimates of compartment ratings, based on figures 1 through 9, for the Navy noise limits contained in reference 5. And it presents estimates of the degree to which current Navy ship compartments meet those noise limits and the S/M noise limit goals.

These analyses involve choices based on the analyst's subjective judgment. However, an important feature of these graphs is that the user is not bound by these choices. The user can readily assess the approximations used in fitting the lines to the data, including any points which fall outside the boundaries of the selected lines. The user can also readily assess the impact of any new data which might become available. Thus the user is free to apply his own experience, available information, and the prevailing philosophy to select other bases for determining a noise limit. Figures 1 through 9 may be used to assess the impact of higher noise levels on the responses of personnel. Or the method described in reference 7 may be used to derive new graphs.

If an initial selection of 100-percent S/M ratings leads to impractically low noise limits, the user may select a different rating believed to be acceptable, and derive noise limits based on it. For example, a goal of 80-percent S/M might be preferred because it would be a function of zone width and might therefore better accommodate cases in which the zone width is large.

VARIABILITY

It is evident from the results that the data contain considerable variability. Sound levels measured within a given space varied somewhat because of room acoustics, especially when the space was large. One would also expect a small amount of variability because of differences in measurement techniques and noise spectra. However, the major sources of variability are in the subjective response data. They are inherent in the fact that we are dealing with people, and people differ in the amount of noise they can or will tolerate. For example, people's sensitivities to noise may differ; they may have different expectations for the particular environment or

Reference Figure No	Compartment Type		Current Navy Noise Categories	Current Navy Noise Limits [dB(A)]	Fraction of Surveyed Compartments Meeting Current Navy Limit	If All Co Fraction S
1	(SR)	Staterooms	B	70	0.85	-
2	(B)	Large berthing compartments	B	70	0.83	-
3	(L)	Lounges/recreation areas	B	70	0.50	0.19
4	(M)	Mess areas	B	70	0.75	-
5	(W)	Wardrooms	A-12 A-3 or B	60 70	0.50 1.00	0.50 -
6	(H/S/L)	Medical (C), Sonar (C), and Library (B)	C or B	65 70	0.75 1.00	0.48 -
7	(C/P/C)	Command, Control, and Communication spaces, including CIC (A-12), Pilot houses (A-12)/bridges, and Chartroom (A-3)/logrooms	A-12 or A-3	60 70	0.14 0.57	1.00 0.22
8	(O)	Offices	A-12 or A-3 or B	60 70	0.21 0.76	0.25
9	(S)	Work Shops	E	82	1.00	-

If All Compartments Were at Current Navy Limit, Fraction (Predicted From Graphs) Rated: S	S/M	M	U/M	U	Sound Level Goal: (100% Meet S/M [dB(A)])	Current Limit Minus Goal (dB)	Fraction of Surveyed Compartments Meeting Sound Level Goal
-	-	-	-	1.00	63	7	0.50
-	-	-	0.10	0.90	57	13	0.28
0.19	0.06	0.06	0.06	0.63	58	12	0.00
-	0.16	0.16	0.16	0.52	62	8	0.25
0.50	0.06	0.06	0.06	0.32	53	7	0.00
-	-	-	0.06	0.94		17	
0.48	0.14	0.14	0.14	0.10	61	4	0.42
-	0.14	0.14	0.14	0.58		9	
1.00	-	-	-	-	64	-4	0.29
0.22	0.15	0.15	0.15	0.33		6	
0.25	0.05	0.05	0.05	0.60	58	2	0.07
						12	
-	-	0.12	0.25	0.63	62	20	0.20

Table 7. Summary of noise limit information for various shipboard compartment types.

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situation; they may perform different activities or functions; or their responses may be consciously or subconsciously biased. This variability forces us to make a choice of what percentage of the people to satisfy. And, in general, the more people one wishes to satisfy, the more it will cost. Very roughly, the 100-percent S/M sound level goal represents satisfying about 80 percent of the personnel, since not all personnel responses are accommodated by the compartment ratings, and about 10 percent of the compartment ratings are ignored in establishing the transition zone.

The analyses presented in this document assume steady-state noise. The noise levels measured during the 1978 survey were usually relatively steady, the major sources being ventilation systems, air-conditioning units, and propulsion machinery. Numerous sources of annoying transient noises were also reported by ships' personnel or observed, especially in large berthing compartments and in compartments directly below flight operations on aircraft carriers. These included people (general traffic, loud talking, footsteps, portable radios, ship's entertainment system, and TV), alarms and bells (especially the bos'n's whistle), chipping and hammering, guns, sonar, and, on aircraft carriers, aircraft, catapults, and arresting gear equipment. Efforts were made to make measurements when transients were not occurring, and personnel were asked to rate the steady noise actually present when the measurements were being made. During analysis, it was found that some personnel did indicate dissatisfaction with transient sounds. When personnel had obviously misinterpreted instructions and allowed memory of transient noises to influence their ratings, the responses were omitted from the analysis. Other ratings, principally some of those in large berthing compartments, which are likely to have been influenced somewhat by transients, are labeled in the figures.

STATEROOMS

The data may be interpreted in a manner which will now be illustrated for staterooms. The Navy's present category B noise limit (for general habitability and sleep) is 70 dB(A), as is the category A3 limit for conversation at 3 feet. In figure 1, the S, S/M, M, and U/M lines predict the

percentage of compartments at the selected sound level which will meet each subjective rating (see "Generation and Use of Figures 1 Through 9" section). If all Navy shipboard staterooms were exactly 70 dB(A), the lines predict that a survey like the one NOSC conducted would indicate 100 percent of the spaces as unsatisfactory (table 7). If the level were lowered by 7 dB to the S/M goal of 63 dB(A), 100 percent of the spaces would be rated as marginally satisfactory or better. Therefore, in the author's opinion, the 70-dB(A) limit is too high from a noise effects standpoint; cost permitting, 63 dB(A) would be a more appropriate noise limit for staterooms.

The cost of meeting the S/M noise limit goal of 63 dB(A) in existing staterooms is dependent on the number of compartments needing noise control and the amount of noise reduction they need. Figure 1 (1978 data only) shows that 10 cases of the total of 20 exceed 63 dB(A). One may therefore estimate that approximately 50 percent of the existing staterooms in these ship classes would require quieting to meet this goal. They exceed 63 dB(A) by amounts ranging from 1 to 10 dB. This gives an indication of the amount of noise reduction required.

Figure 1 may also be used to predict the benefit in subjective rating to be derived from other proposed amounts of noise reduction. In this case, the transition zone is steep and narrow (m is large and W is small), and located just below the present noise limit, so that a small change in sound level produces a relatively large change in subjective rating. For example, if the level were lowered by 5 dB to 65 dB(A), unsatisfactory ratings would be eliminated, 100 percent of staterooms would be rated as U/M or better, 80 percent M or better, 60 percent S/M or better, and 40 percent S.

Now consider the reports of interference with sleep and normal conversation. Personnel considered both necessary in staterooms (reference 10), which suggests that both should be considered in establishing the noise limit. Figure 10 shows that a noise limit of 63 dB(A) would not eliminate sleep interference reports ("yes" responses) altogether, since the sound level above which such reports begin is 55 dB(A). But it should eliminate consistent "severe" interference reports, which begin above 57 dB(A).

The conversation interference reports correlate very closely with the overall S/U ratings. Figure 13 shows that a noise limit of 63 dB(A) would just barely eliminate reports of interference with normal conversation; in fact, it is equal to the level above which such reports begin. This is just 2 dB below the level of 65 dB(A) required for communication in a normal voice at 3 feet (reference 2). The present category B limit of 70 dB(A) is just 1 dB below the level of 71 dB(A), above which consistent "severe" speech interference reports begin; 71 dB(A) is the level required for communication in a raised voice at 3 feet (reference 2).

LARGE BERTHING COMPARTMENTS

For large berthing compartments (figure 2), the 100-percent S/M goal is 57 dB(A). There is considerable variability, reflected in the zone width of 11 dB. Therefore, in contrast to staterooms, a large reduction in sound level is required to cause a substantial improvement in rating. However, if sound levels are above 57 dB(A), even a few dB of reduction will have some beneficial effect.

An analysis of the raw 1972 three-point scale acceptability rating data for large berthing compartments also yielded an S/M (actually "marginally acceptable") noise limit goal of 57 dB(A). The satisfactory (acceptable) rating intercept was 54 dB(A), the width was 19 dB, and the slope was one-half rating scale division per dB.

Figure 11 indicates that the level above which consistent reports of sleep interference begin is 53 dB(A).

Figure 14 indicates that the level above which consistent reports of interference with normal conversation begin is 61 dB(A).

In large berthing compartments, there was a relatively large number of complaints about transient noises. This suggests that overall satisfaction may be greater in these compartments if steady noise levels are kept high enough to mask some of the transients.

WARDROOMS

For wardrooms (figure 5), there are only eight data points. A linear regression analysis which ignored the stipulation that low sound levels be generally more desirable than high ones would yield the opposite interpretation: that low sound levels are actually less desirable than moderate sound levels. This could be the case if the ratings reflected annoying transient sounds which were masked by higher-level steady noise. However, a more likely possibility is that an awareness of a need for different activities which require lower noise levels is driving the responses in this particular room: for example, it may be necessary to hold conferences around a large table. Figure 16 indicates that for wardrooms, the level above which consistent reports of interference with normal conversation begin is 59 dB(A). This is consistent with a need to hold conferences around a large table, since 59 dB(A) permits communication at 6 feet in a normal voice, and at 12 feet in a raised voice (reference ?).

SONAR, MEDICAL, AND LIBRARY COMPARTMENTS

Sonar, medical, and sometimes library compartments are considered Category C spaces. References 1 and 5 recommend a noise limit of 65 dB(A) for Category C spaces. An estimated S/M noise limit goal of 61 dB(A) can be derived by applying the analysis method to the combined data (figure 6). However, even when they are combined into a single group, the quantity and consistency of the data in figure 6 are not adequate for establishing a trend with any certainty. Furthermore, it is somewhat inappropriate to group these data together, not only because libraries are not always classified as Category C, but also because responses to noise in these compartments are highly dependent on the specific task, and the tasks differ. For example, in one medical space a noise level of 65 dB was rated as satisfactory for a medical corpsman who handled sick calls, but as very unsatisfactory by a doctor who conducted examinations using a stethoscope. As another example, sonar personnel operating the same equipment had very different responses to noise: some stated that listening to auditory sonar signals was essential;

others, that visual displays were sufficient. Among the former, some reported that noise interfered, others that it did not. More detailed investigation of such task differences is necessary before meaningful noise limits for these spaces can be determined.

SHOPS

The analysis for shops in figure 9 includes all three data bases (1978, 1980, and 1972 data). The resulting parameter values are S_0 = 54 dB(A), W = 20 dB, and m = 1/4.5 rating scale units per dB.

All the shops of the 1978 survey meet the current 82-dB(A) noise limit. If all shops were exactly 82 dB(A), then 63 percent would receive ratings of unsatisfactory (table 7). To eliminate unsatisfactory ratings in shops as a group would require lowering the sound level by 11 dB to 71 dB(A). This would require 1 to 10 dB of noise reduction in 70 percent of the compartments surveyed. To reach the 100-percent S/M noise limit goal would require lowering the sound level by another 9 dB to 62 dB(A). This would require noise reduction in 80 percent of the compartments in amounts of 9 to 20 dB. The relatively low S/M goal may be accounted for by the need for conversation expressed by personnel in 90 percent of the shops (reference 10).

Alternative noise limits one might want to consider include a 100-percent M goal of 66.5 dB(A), a 100-percent U/M goal of 71 dB(A), an 80-percent S/M goal of 65 dB(A), and a 50-percent S/M goal of 71 dB(A).

The wide, shallow-sloped transition zone for shops indicates a very great amount of variability, and that the overall average rating is quite insensitive to changes in sound level. This suggests that the noise requirements of shops could be better accommodated if shops could be divided into two or more noise-limit categories based on differences in speech communication and other work requirements.

OTHER COMPARTMENTS

Figures 3, 4, 7, and 8 show the results for recreation and lounge areas, mess areas, command and control spaces, and offices, respectively.

In each compartment type, there were a few personnel who reported sleep was necessary (reference 10). Inspection of figure 12 suggests not only that personnel claim they need to sleep in many different areas of the ship, but also that some personnel would report interference with sleep even if noise levels were lowered to 56 dB(A).

In every compartment type, a large percentage of personnel indicated that speech communication was necessary (reference 10). Figure 15 indicates that for offices, the level above which consistent reports of interference with normal conversation begin is 63 dB(A).

CONCLUSIONS

Graphs (figures 1 through 9) have been presented in this document which may be used to predict responses of personnel to selected noise levels in various compartment types. The graphs were derived from ship compartment noise level data and personnel opinion data.

Compartment types with similar graph parameters could be combined under common noise categories, especially if similar activities are required in the compartments. Comparison of figures 1 through 9 suggests that three noise limits 5 dB apart could be utilized as follows. A noise limit goal of 63 dB(A) is appropriate for staterooms, mess areas, and command, control, and communication spaces; of these, staterooms are the most critical since the transition zone is steep and narrow. A goal of 57 dB(A) is appropriate for large berthing compartments, lounge and recreation areas, and offices. A goal of 53 dB(A) is appropriate for wardrooms. A 63-dB(A) noise limit goal is also indicated for shops, but this level is clearly not realistic, and the degradation above this level is very gradual. A 57-dB(A) noise limit goal is also indicated for combined medical, sonar, and library compartments, but this may be inappropriate because of the wide divergency of tasks in these compartments; more detailed study is required.

There is considerable variability in the responses of personnel to noise. This is partly the result of measurement technique. But it is also largely because we are dealing with people whose tasks vary, and who vary in their response to noise. Thus one may not be able to identify a general, sharply defined A-weighted noise limit below which everyone is satisfied. But, given a large number of compartments at a given sound level, one can estimate the percentage which will meet a given rating. If one then selects a particular rating and specifies what percentage of the compartments are to meet it, he can then use the graphs in this document to estimate the sound level necessary to achieve that objective. Other factors may then be considered, and if cost or technology makes higher levels necessary, the graphs may be used to estimate the effect of these levels on personnel response.

Additional data for constructing graphs of the type of figures 1 through 9 and for determining the number of spaces which meet noise limits may be obtained as follows. Sound level data could be obtained during acceptance trials of new ships, such as the CV 67, LAJ 5, CGN 38, FFG-7, and AD-41 classes, or from ship trials noise control reports. Subjective data may be obtained by distributing the noise data form used in the 1980 AD-41 survey (appendix A) to personnel assigned to a ship after they have had sufficient experience aboard.

The information potentially obtainable from the raw subjective response data collected in NOSC's 1972, 1978, and 1980 surveys has by no means been exhausted, as an examination of questionnaires in appendix B indicates. More information on whether low frequencies are significant in determining subjective response might be derived through analyses of subjective ratings versus C-level and low-frequency octave band levels by using this document and references 7 and 13. Similar analyses could help determine whether A-level or noise rating (NR) better predicts response to noise, and whether A-level, a 4-band speech interference level (SIL), or a 3-band preferred speech interference level (PSIL) best predicts response to noise in spaces where speech intelligibility is known to be the primary concern.

The data could also be used to further evaluate the suitability of grouping various compartment types, such as those with similar rating curves and similar activities profiles (reference 10), under the same noise category. Additional analyses of the raw rating data for acceptability, annoyance, and comfort could also be performed to provide comparisons with the S/U rating scale results which involve fewer subjective judgments.

The major sources encountered in this study could be identified by further analysis of the data collected by NOSC Code 5134. These data could also be analyzed for effects resulting from room volume and room absorption.

Differences in noise levels during underway and "cold iron" conditions may be determined by comparing the appropriate data listed in reference 13. This information could be useful in determining whether noise sources are propulsion-related, and for evaluating cold iron data from similar ships.

RECOMMENDATIONS

It is recommended that the author's "100 percent of compartments marginally satisfactory" sound level goals in table 7 be used as lower bounds for noise limits in setting ship design goals. But it must be recognized that these goals may often be unattainable in practice because of high power requirements and constraints on size, weight, cost, and schedules. Consequently, the noise limits actually specified in ship specifications may often be higher. In such cases, the designer should refer to figures 1 through 9 to assess the impact of higher levels on personnel response.

Explicit definition of the compartment types assigned to the various noise categories, such as that presented in reference 5, is needed. Further analysis of the existing data could be performed for such compartment groups. Additional research is also needed to determine whether shops can be divided into two or more noise limit categories based on differences in speech communication and other work requirements. For compartment groups finally selected, it is recommended that graphs of the type presented in figures 1 through 9 of this document be generated by using the method of reference 7 to correlate sound level data and subjective data.

Further study is recommended of the tasks in sonar, medical, and possibly library compartments. The data collected in this study are clearly not adequate to establish trends for setting Category C noise limits, mostly because of the wide variations in tasks performed in these compartments.

It is recommended that the major noise sources in the various compartments be identified to provide a better idea of the kind of noise control needed.

Further investigation is recommended of low-frequency, tonal, intermittent, and impulse/impact and other transient noise sources and how their effects can be reduced. Specifications for measurement and control of transient noises on ships need to be developed, particularly for large berthing compartments and compartments affected by air operations on carriers.

More research is recommended to determine the effect of noise on performance under conditions of unusually great demand when any additional load created by the noise may render a person's capacity to process information inadequate to handle the task requirements. Investigations should include long-term vigilance tasks and complex tasks.

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RELATED DOCUMENTS

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APPENDIX A

Forms and Questionnaires

1. Noise Survey Inquiry form used in Preliminary NOSC 1978 surveys.
2. Noise Survey Data form used in NOSC 1978 surveys.
3. Noise Survey Questionnaire form used in NOSC 1978 surveys.
4. Noise Data Form used in NOSC AD-41 survey.
5. Opinion of Noise Level form used in NOSC 1972 surveys.

NOISE SURVEY INQUIRY (Preliminary NOSC 1978 survey)

SHIP _____

DATE ___/___/___

NAME _____ RANK/RATE _____ ASSIGNED WORK CENTER _____

NAVSEA has tasked the Naval Ocean Systems Center to evaluate noise criteria in certain ship spaces. The purpose of this questionnaire is to identify spaces (other than engineering spaces) aboard this ship where noise may be interfering with job performance or causing annoyance.

For each space you regularly spend time in, check whether NOISE causes interference or annoyance. If it does, also indicate the source of the noise.

Type of Space	Number/Name of Space	Job interference No	Yes	Severe	Annoyance No	Yes	Severe	Source of Noise &/or Comment
Berthing	___/___							
Mess	___/___							
Recreational	___/___							
Wardroom	___/___							
Hospital	___/___							
Sonar	___/___							
CIC	___/___							
Other	___/___							
Other	___/___							

Place an asterisk (*) in front of the name of the space above in which noise causes the greatest problem.

THANK YOU.

Please return completed form to: Commander, Naval Ocean Systems Center
Code 5121, San Diego, CA 92152

NAVMAT-NOSC 3960/13 (Rev. 5-78)

NOISE SURVEY DATA (NOSC 1978 survey)

SHIP STATUS CODE:
c = cold iron (dockside) u = underway
e = engine up (dockside) h = high speed

SHIP _____

DATE ___/___/___

COMPARTMENT NAME _____

COMPARTMENT NO. _____

Compartment Size: length_____ width_____ height_____ Volume____cu. ft.

SKETCH CODES:

M Measurement location
L Loudspeaker location
R Recording location
P Photo
E Entrance
W Working Personnel
X Other Personnel

(Scratch out one fwd)

fwd

fwd

ABSORPTION CODE:

0 Hard/reflecting (metal/concrete/plaster/paint/thin mats)
1 Medium (wood paneling/thermal insulation/light drapes/thin carpet)
2 Soft/absorptive (acoustical tile/thick carpet/carpet & pad)

Usual no. of personnel in space--------- ___

No. and types of soft furniture--------- ___

_____

Lagging (therm insul, sq ft) 0-30 30-60 60-___

ABSORPTION OF:

Overhead 0 1 2
Deck 0 1 2
Bulkhead (fwd) 0 1 2
Bulkhead (aft) 0 1 2
Bulkhead (stb) 0 1 2
Bulkhead (prt) 0 1 2

NOISE SOURCES:

V1 Ventilation _____ E1 Equip 1 _____

V2 Ventilation _____ E2 Equip 2 _____

V3 Ventilation _____ E3 Equip 3 _____

L1 Loudspeaker _____ O1 Other _____

L2 Loudspeaker _____ O2 Other _____

L3 Loudspeaker _____ O3 Other _____

P Propulsion _____

11ND-NOSC 3960/15 (Revised 5/78) (OVER)

NOISE SURVEY DATA

SURVEYOR (SU) 1._____ 2._____ 3._____ INSTRUMENTATION (IN) 1._____ 2._____ 3._____ Category ___ Vol _____ cu ft COMPARTMENT _____ SHIP _____

Date	SPL (dB) (A)	(C)	Mic Loc	Ship Stat	Noise Sources (see over)	SU#	IN#	Comp. Surv#	Rec Made?	Octave Band (lab analysis) 31	63	125	250	500	1k	2k	4k	8k
1.					V P E1 E2 E3 I O													
2.					V P E1 E2 E3 I O													
3.					V P E1 E2 E3 I O													
4.					V P E1 E2 E3 I O													
5.					V P E1 E2 E3 I O													
6.					V P E1 E2 E3 I O													
7.					V P E1 E2 E3 I O													
8.					V P E1 E2 E3 I O													
9.					V P E1 E2 E3 I O													
10.					V P E1 E2 E3 I O													
11.					V P E1 E2 E3 I O													
12.					V P E1 E2 E3 I O													

COMMENTS: _____

Please return completed form to: Commander, Naval Ocean Systems Center
Code 5121, San Diego, CA 92152

11ND-NOSC 3960/15 (Revised 5/78) (BACK)

NOISE SURVEY QUESTIONNAIRE (NOSC 1978 survey)

SHIP _____ COMPARTMENT NOW IN _____

DATE ___/___/___ SURVEY # _____

NAVSEA has tasked the Naval Ocean Systems Center to evaluate noise criteria in certain ship spaces. The purpose of this questionnaire is to evaluate the effect of the noise in this compartment on job performance. Your responses are for unofficial survey use only. The results will be reported in statistical form, and your name will not appear in any reports.

NAME_____ RANK/RATE_____ ASSIGNED WORK CENTER_____

Hearing: normal__ slight loss__ substantial loss__ trouble hearing speech__

_____ years on ships
_____ years on this ship
_____ years assigned to this space

Enter this space ___ times per day.
Usually in this space _____ hours per day
In this space _____ hours so far today

1. Compared to living conditions ashore in general, how noisy would you say this room is now? (circle one)

very quiet = 1
quiet = 2
average = 3
noisy = 4
very noisy = 5

2. Compared to living conditions ashore in general, how noisy is this room during normal cruising?

very quiet = 1
quiet = 2
moderate = 3
noisy = 4
very noisy = 5

3. Compared to normal cruising conditions, how noisy is this room now?

much quieter = 1
quieter = 2
same = 3
noisier = 4
much noisier = 5

4. During normal cruising, the noise in this room is:

not bothersome = 1
slightly bothersome = 2
moderately bothersome = 3
quite bothersome = 4
very bothersome = 5

5. Indicate how necessary each of the following is to the usual activities (job, sleep, recreation, etc.) in this room during normal cruising. Also indicate whether the NOISE in this room interferes with these activities.

	Necessary?			Noise Interferes?		
	No	Yes	Very	No	Yes	Severe
talk to others (face to face)	—	—	—	—	—	—
listen to others (face to face)	—	—	—	—	—	—
talk to others (face to face raised voice)	—	—	—	—	—	—
listen to others (face to face raised voice)	—	—	—	—	—	—

11ND NOSC 3960/14 (Rev. 5-78) (OVER)

	Necessary?			Noise Interferes?		
	No	Yes	Very	No	Yes	Severe
talk (telephone)	—	—	—	—	—	—
listen (telephone)	—	—	—	—	—	—
talk (intercom)	—	—	—	—	—	—
listen (intercom)	—	—	—	—	—	—
listen to sonar sounds	—	—	—	—	—	—
listen to machinery sounds	—	—	—	—	—	—
listen to radio/TV/recorder	—	—	—	—	—	—
listen to movie	—	—	—	—	—	—
reading	—	—	—	—	—	—
calculating	—	—	—	—	—	—
solving problems	—	—	—	—	—	—
cleaning	—	—	—	—	—	—
recreation	—	—	—	—	—	—
relaxation	—	—	—	—	—	—
sleep	—	—	—	—	—	—
Other major activity _____	—	—	—	—	—	—
Other major activity _____	—	—	—	—	—	—

6. What are the chief sources (e.g., fan, blower, etc.) of the noises that annoy you or interfere with your work? What do they sound like (hum, whistle, tone; how often? how long?).

Noise Source	Describe the sound.	Is it necessary to be able to hear it? No	Yes	Can you suggest a practical way to reduce it?
_____	_____	—	—	_____
_____	_____	—	—	_____
_____	_____	—	—	_____
_____	_____	—	—	_____

7. Under most circumstances, how much are you bothered by noise? (circle one)

much less easily than others = 1
less easily than others = 2
about the same as others = 3
more easily than others = 4
much more easily than others = 5

8. Check each of the following which would probably bother you if you were to hear it at home in the evening:

truck noise __ city traffic noise __
a firecracker __ a door being slammed __
a jack hammer __ a dog barking continuously __
very loud music __ an electric table fan (12") __
motorcycle noise __ the sound of chalk squeaking on a blackboard __

Count the number of items you just checked and write the total here ---→ ____

Please return completed form to: Commander, Naval Ocean Systems Center
Code 5121, San Diego, CA 92152

11ND NOSC 3960/14 (Rev. 5-78) (BACK) THANK YOU.

NOISE DATA FORM (NOSC 1980 AD41 survey)

The purpose of this form is to find out the effect of noise on work performance

Provide the information requested below for compartments where you spend much of your time, and which you are able to visit during the full power run. FILL IN A SEPARATE FORM FOR EACH COMPARTMENT DURING THE FULL POWER RUN WHILE YOU ARE ACTUALLY IN THE COMPARTMENT. For example, you might fill out one form for your work station, another for your berthing compartment, and a third for your mess area.

YOUR RANK/RATE/TITLE _____ ASSIGNED WORK STATION _____

Hearing: normal__ slight loss__ substantial loss__ trouble hearing speech__

How long have you been working aboard ships at sea? ___ years

COMPARTMENT: NAME _____ NUMBER ____-____-____

1. How much does the noise in this compartment now bother you? (circle one):

zero slightly moderately much very much

2. How much would the noise in this compartment now interfere with the usual activities in it? Circle one response for each activity which applies:

normal conversation	zero	slightly	moderately	much	very much
hearing warning signals	zero	slightly	moderately	much	very much
hearing radio, TV, etc.	zero	slightly	moderately	much	very much
solving problems/studying/reading	zero	slightly	moderately	much	very much
recreation/relaxation/light reading	zero	slightly	moderately	much	very much
rest/sleep	zero	slightly	moderately	much	very much
other (fill in): _____	zero	slightly	moderately	much	very much

THANK YOU. Return completed form to _____

NOSC 5121 3960/14 (Mod 4-80) 0445u

OPINION OF NOISE LEVEL (NOSC 1972 surveys)

Please fill in the following information:

Ship Name & Number_____ Compartment No.___

Compartment Name_____ Date____ Time_____

Rank/Rate_____ Time on Board this Ship_____

(1) CHECK ONE RATING IN EACH ROW. THESE RATINGS APPLY TO THIS ROOM AT THIS TIME. THE NOISE LEVEL IN THIS COMPARTMENT IS:

(a) Comfortable____ Marginal____ Uncomfortable____

(b) Quiet____ Slightly Noisy____ Noisy____ Very Noisy____

(c) Low____ Moderate____ Loud____ Very Loud____

(d) Acceptable____ Marginal____ Not Acceptable____

(e) Not Annoying____ Annoying____ Very Annoying____

(2) Have personnel complained about noise level or requested improvement? YES____ NO____

(3) Would you say the current noise level in this room is similar to normal conditions? YES____ NO____

(4) If NO, is this room normally: MORE NOISY____ LESS NOISY____ VARIABLE____

(5) Please check one rating for each row (where applicable). Where statement does not apply, leave blank.

I can:	No Difficulty	Slight Difficulty	Moderate Difficulty	Considerable Difficulty	Extreme Difficulty
hear others with:					
talk with:					
phone with:					
work with:					
sleep with:					

(6) List the noise sources_____

_____

11ND NUC 3910/6 (7-72) Return to Naval Undersea Center (NUC), San Diego, California 92132, Code 5054

DO NOT WRITE ON THIS SIDE - TO BE FILLED IN BY SURVEYOR

Activity Conducting Survey _____ Surveyor _____

Space Noise Category (Circle One) A B C D E

LEVEL		MICROPHONE POSITION WITH MICROPHONE HELD AT HEAD HEIGHT								
dB C	dB A	31.5	63	125	250	500	1000	2000	4000	8000

Compartment Dimensions _____

Compartment Treatment

a) Acoustical: No. of bulkheads ___ Overhead ___

b) Thermal: No. of bulkheads ___ Overhead ___

c) Deck: Tile ___ Carpeting ___ Rubber mats ___

d) No. of bunks in compartment ___

Instrumentation _____

Noise Sources

Blowers: Air Distribution System ___

Electronic Equipment Cooling ___

Teletypewriters ___ Card Sorters ___

Input-Output Printers ___

Transformers ___

Rotating Equipment (Specify) _____

Reciprocating Equipment (Specify) _____

Other _____

_____

DO NOT WRITE ON THIS SIDE

APPENDIX B

Tables of 1978 and 1980 Rating Data

Tables B-1 through B-8 list author's ratings for compartments of the eight ships. These tables correspond exactly to tables 1 through 8 of reference 13, which contain corresponding A, C, and octave band levels. Using these data, analyses similar to those done here for rating versus A-level could be done for rating versus C-level, octave band level, noise rating (NR), four-band speech interference level (SIL), three-band preferred speech interference level (PSIL), and other ratings.

Compart. Name & Number		Author's Rating	(A)
Wardroom 1	03-39-0	M/U	60
ORD Workshop	03-74-6Q	U	82
ORD Workshop	03-74-6Q	U	82
Capt.'s Office	03-79-3Q	U	58
Capt.'s Office	03-79-3Q	S	61
Capt.'s Office	03-79-3Q	U	86
Capt.'s Office	03-79-3Q	S	90
Capt.'s Office	03-79-3Q	U	--
Officer's Berth	03-84-4L	S/M	48
Air Dpt. Office	03-99-6Q	M/U	60
CIC	03-109-2C	M	76
V1 Div. Office	03-124-5A	U	69
Nav.'s Office	03-127-13Q	S	66
Officer's SR	03-149-03L	--	56
CPO Berthing	03-162-0L	U	59
V3 Berthing	03-212-0L	--	65
Aft Crew Berth.	03-236-1L	S	--
Train. Off.	03-236-4Q	--	75
SR	03-32-1L	S	56
Officer's SR	02-37-1L	--	--
Officer's SR	02-42-1L	S/M	55
01 Berthing	01-21-0L	U	62
Crews Berth.	01-29-0L	--	61
V3 Div. Off.	01-132-2Q	S/M	77
Hang. Dk Con.	01-134-2Q	S/M	72
Sick Bay Hall	2-97-2Q	S	68
Sick Bay Off.	2-97-6L	S	61
Engr. Logroom	2-132-0Q	S	63
1st Lt's Off.	2-150-1L	S	62
Wardroom II	2-162-0L	S	67
Library	2-207-1L	S/M	68

Table B-1. Underway airborne noise data for USS RANGER (CV-61).

Rating: S satisfactory
S/M marginally satisfactory
M marginal
U/M marginally unsatisfactory
U unsatisfactory

Compart. Name & Number		Author's Rating	(A)
SR	03-84-0L	-	69
SR	03-84-0L	S/M	66
SR	03-84-0L	-	77-80
SR	03-84-0L	-	73
SR	03-84-0L	-	65
SR	03-84-0L	-	82-85
OPS Office	03-100-0Q	U	64
OPS Office	03-100-0Q	S/M	60
OPS Office	03-100-0Q	S/M	64
OPS Office	03-100-0Q	S/M	74&86
Train. Off.	03-123-4Q	U	71
Train. Off.	03-123-4Q	U	70
Train. Off.	03-123-4Q	U	62
HRMO Chapl Off.	03-157-4Q	M/U	68
HRMO Off.	03-157-6Q	M/U	65
Library	03-159-6L	-	66
Library	03-159-6L	-	65
Library	03-159-6L	-	83
Library	03-159-6L	U	92
Crews Berthing	02-21-0L	-	73
Crews Berthing	02-21-0L	-	66
Crews Berthing	02-21-0L	-	89
CIC	02-39-0C	M/U	69
CIC	02-39-0C	M/U	72
CIC	02-39-0C	M/U	76
V3 Berthing	01-29-0L	S/M	60
V3 Berthing	01-29-0L	-	60
V3 Berthing	01-29-0L	-	71
1st Lt.'s Off.	01-84-4Q	M/U	65
Mainten. Contr.	1-49-2Q	-	74
Mainten. Contr.	1-49-2Q	M	68
Mainten. Contr.	1-49-2Q	-	67

Table B-2. Underway airborne noise data for USS CONSTELLATION (CV-64).

Compart. Name & Number		Author's Rating	(A)
Hangar Dk Contr	1-119-2Q	U	77
Hanger Dk Contr	1-119-2Q	-	69
Crews' Mess	2-49-0L	M/U	73
Crews' Mess	2-49-0L	-	78
Crews' Mess	2-49-0L	-	75
Wardroom 2	2-54-1Q	S/M	63
Wardroom 2	2-54-1Q	-	60
Wardroom 2	2-54-1Q	-	62
Medical Ward	2-106-0L	U	56
Chaplains Qtrs.	2-124-6L	U	68
Wardroom	2-157-2L	M	62
Wardroom	2-157-2L	-	65
Crew's Mess	2-186-0L	U	70
Crew's Mess	2-186-0L	-	75
Photo Lab	3-98-1Q	U	72
Photo Lab	3-98-1Q	-	69
Photo Lab	3-98-1Q	-	78
Photo Lab	3-98-1Q	U	75
Photo Lab	3-98-1Q	-	90
Photo Lab	3-98-1Q	-	64
Photo Lab	3-98-1Q	-	68
CPO Berthing	3-106-0L	U	71
CPO Berthing	3-106-0L	-	64
CPO Berthing	3-106-0L	-	57
CPO Berthing	3-167-0L	U/M	70
CPO Berthing	3-167-0L	-	58
CPO Berthing	3-167-0L	-	57
CPO Mess	3-177-0L	U	66
CPO Mess	3-177-0L	-	64
CPO Mess	3-177-0L	-	74
P2/P3 Berthing	3-205-01L	S	62
P2/P3 Berthing	3-205-01L	S	58
P2/P3 Berthing	3-205-01L	S	66

Table B-2. (Continued)

Compart. Name & Number		Author's Rating	(A)
Radar 1	03-154-02Q	-	76
Radar 1	03-154-02Q	U	74
Radar 1	03-154-02Q	-	72
CIC	02-139-0C	M	68
CIC	02-139-0C	-	69
CIC	02-139-0C	-	65
Sonar Control	02-139-2C	M/U	57
Sonar Control	02-139-2C	-	61
Sonar Control	02-139-2C	-	62
Trans. Room	02-234-1	U	84
Trans. Room	02-234-1	-	86
Trans. Room	02-234-1	-	81
Trans. Room	02-234-1	-	80
Trans. Room	02-234-1	-	84
Data Proc. Cen.	01-138-0C	U	74
Data Proc. Cen.	01-138-0C	-	75
Data Proc. Cen.	01-138-0C	-	71
Data Proc. Cen.	01-138-0C	-	72
Wardroom	01-274-2	S/M	66
Wardroom	01-274-2	-	71
Wardroom	01-274-2	-	65
Stateroom 3	01-346-1L	U	72
Crew's Rec. Rm.	1-205-1	S	72
Crew's Rec. Rm.	1-205-1	-	70
Crew's Rec. Rm.	1-205-1	-	72
Weapons Berth	2-149-0L	S	54
Weapons Berth	2-149-0L	-	60
Weapons Berth	2-149-0L	-	57
1st Div. Berth	3-146-0	M	58
1st Div. Berth	3-146-0	-	58
1st Div. Berth	3-146-0	-	58

Table B-3. Underway airborne noise data for USS OLDENDORF (DD-972).

Compart. Name & Number		Author's Rating	(A)
OPS Berthing	3-346-01L	M/S	57
OPS Berthing	3-346-01L	-	53
OPS Berthing	3-346-01L	-	60
Mid ship qtrdk.		-	
Crew's Mess		U	70
Crew's Mess		-	71
Crew's Mess		-	68

Table B-3. (Continued)

Compart. Name & Number		Author's Rating	(A)
Radar Room	03-154-02Q	-	82
Radar Room	03-154-02Q	-	81
Radar Room	03-154-02Q	S/M	82
Sonar Control	02-139-2C	-	63
Sonar Control	02-139-2C	M	64
Sonar Control	02-139-2C	-	66
Data Proc. Cen.	01-138-0C	S/M	74
Data Proc. Cen.	01-138-0C	-	75
Data Proc. Cen.	01-138-0C	-	72
Data Proc. Cen.	01-138-0C	-	73
Wardroom	01-291-2L	U	56
Wardroom	01-291-2L	-	57
Wardroom	01-291-2L	-	56
Stateroom #6	01-358-1L	M/U	65
Stateroom #6	01-358-1L	-	66
Stateroom #6	01-358-1L	-	63
CPO Berthing	1-224-0L	M	71
CPO Berthing	1-224-01	M	61
CPO Lounge	1-248-1L	S/M	64
CPO Lounge	1-248-1L	S/M	66
CPO Mess	1-260-1L	S/M	60
Nav.'s Statrm.	01-356-2L	S	61
Nav.'s Statrm.	01-356-2L	-	54
Nav.'s Statrm.	01-356-2L	-	57
Nav.'s Statrm.	01-365-2L	-	63
Sick Bay	1-382-0L	S	61
Sick Bay	1-382-0L	-	61
Sick Bay	1-382-0L	-	57
Barber Shop	1-414-1	S	64
Barber Shop	1-414-1	-	65
Bos'n #3	1-434-0A	M	60

Table B-4. Underway airborne noise data for USS MERRILL (DD-976).

Compart. Name & Number	Author's Rating	(A)
Cent Centrl Stn. 2-272-0C	S/M	62
Cent Centrl Stn. 2-272-0C	-	62
Cent Centrl Stn. 2-272-0C	-	60

Table B-4. (Continued)

Compart. Name & Number		Author's Rating	(A)
Pilot house	02-	-	72
Chartroom	02-59-2C	M	65
CO Sea Cabin	02-60-1	S	46
CIC	02-	S	52
Missile Fire Control:			
(Lg. Rm. 1)	02-123-0C	-	73
(Sm. Rm. 2)	02-123-0C	-	68
Offcr. WC/Shwr.	01-67-1L	-	70
Radio Central	01-	-	77
Sec Voice Area	01-	-	69
Trans. Rm.	01-	-	79
Shredder Rm.	01-73-1Q	-	80
ASROC DK Outside		S	70
Ord Shp/Com Sto	01-111-0Q	S/M	71
Wardroom	1-51-0L	S	58
Wardroom Galley	1-51-1Q	-	77
Offcr. WC/Shwr	1-55-2L	-	58
Radar Room #1	1-121-0Q	-	68
Radar Room #1	1-121-0Q	-	74
Radar Room #1	1-121-0Q	-	76
Radar Room #1	1-121-0Q	-	84
Radar Room #1	1-75-2Q	-	75
Jr. Offcrs. SR	1-115-2L	U	73
Sickbay	1-116-1L	U	73
"		U	65
Sickbay	1-116-1L	-	69
"		-	66
Engr. Off. SR	1-122-2L	U	72
Supply Off. SR	1-131-2L	S	67
Berthing 2-15 to	23-0L	S	52
Officer SR	2-43-2L	S	57
Berthing 2-163 to	183-2L	U	68

Table B-5. Underway airborne noise data for USS HOEL (DDG-13).

Compart. Name & Number		Author's Rating	(A)
Sonar Control	3-39-1C	S/M	70
ASW Control Rm.	3-39-C	-	68
Sonar Eq. Rm. #2	3-39-2Q	-	74

Table B-5. (Continued)

Compart. Name & Number		Author's Rating	(A)
Pilot House	02-46-0C	S	71
Pilot House	02-46-0C	-	64-71 is range of A-levels in pilot house
Sonar Control	01-70-01C	S	57
Sonar Control	01-70-01C	-	60/57
ET Shop	1-70-0Q	S/M	62
Radar	1-70-1Q	U	77
OPS Officer SR	1-79-1L	-	68
OPS Officer SR	1-79-1L	U/M	69
"		-	A-levels; 68 cntrfwd at desk; 66 stbd fwd at bunk; 70 stbd aft.
Weap. Offcr. SR	1-101-2L	S/M	63
XO SR	1-103-1L	M	64
Wardroom	1-109-0L	S	58
"		-	A-levels: 55-59
Sick Bay	1-118-0L	M	62
Sick Bay	1-118-0L	-	61
"		-	A-levels: 60-64
Crew Berthing	2-29-0L	-	55
Crew Berthing	2-29-0L	S	55
Crew Berthing	2-29-0L	-	55
"		-	A-level of alarm: 65 dB
DC Central	2-54-0Q	S/M	59
Supply Office	2-54-01L	S/M	63
Ships Office	2-61-2Q	U	73
"		-	A-levels: 71-75
Disbursing Off.	2-61-3Q	S/M	58
"		-	A-levels: uniform
Mess Decks	2-107-0L	S	69
"		-	A-levels: 70 cntr fwd; 65 cntr aft
Chfs. Qtrs/Lng.	2-121-01L	-	59
"		-	A-levels: uniform
Chfs. Qtrs/Lng.	2-121-01L	S	63
48 Torpedo Room	2-147-0M	U/M	60 (used as crew's lounge)

Table B-6. Underway airborne noise data for USS REASONER (FF-1063).

Compart. Name & Number		Author's Rating	(A)
Gun Plot	3-41-0C	U/M	72
Weap Berthing	3-45-0L	S	51
Electr Central	3-59-0C	U	74
"		-	A-levels: 63-74
Electr Central	3-59-0C	-	64
Crew Berthing	3-59-2L	U	62
"		-	A-levels: 60-63
Sub Supply	3-116-2Q	M	64
Supply Sup Cen.	4-107-1A	S	66

Table 8-6. (Continued)

Compart. Name & Number		Author's Rating	(A)
Pilot House	03-73-0C	-	68
Pilot House	03-73-0C	S	62-
		-	78
Pilot House	03-73-0C	-	75
CIC	03-79-2C	U/M	74
CIC	03-79-2C	-	73
CIC	03-79-2C	-	83
CIC	03-79-2C	-	70
Chart Room	03-79-3C	S	55
OPS Officer SR	02-73-2L	S	57
OPS Officer SR	02-73-2L	S	58
Troop CO SR	02-73-4L	S	50
Troop CO SR	02-73-4L	S	51
"			
Radio Central	01-82-2C	U	78
Secure TTY Rm		U	78
Ship's Office	1-81-2Q	U	67
Log Room	1-89-4Q	M/U	65
Log Room	1-89-4Q	-	58
Sick Bay	2-133-2L	-	-
Engr Main Ctrl	4-129-0E	M	73
Engine room		-	106
Engine room		-	101
Crew Lounge	4-132-2L	U	73

Table B-7. Underway airborne noise data for USS SCHENECTADY (LST-1185).

Compart. Name & Number		Author's Rating	(A)
CIC	03-79-2C	U	72
CIC	03-79-2C	U	69
OPS Officer SR	02-70-0L	S	50
OPS Office	02-115-2Q	S/M	55
OPS Office	02-115-2Q	-	60
Radio Room	01-89-2C	U/M	76
Radio Room	01-89-2C	-	81
CPO Mess	01-89-5L	S/M	62
Crew's Mess	1-73-1L	M	80
Crew's Mess	1-73-1L	M	72
Ship's Office	1-81-2Q	U	62
Ship's Office	1-81-2Q	U	64
Log Room	1-89-2L	S/M	59
Log Room	1-89-2L	-	62
Sickbay	2-133-2L	S	65
Sickbay	2-133-2L	-	69
Sickbay	2-133-2L	-	70
OPS Berthing	3-169-1L	M	69
OPS Berthing	3-169-1L	-	69
2nd Div. Berth	3-169-2L	M	68
2nd Div. Berth	3-169-2L	M	78
2nd Div. Berth	3-169-2L	-	75
Crew Lounge	4-129-4L	U/M	73
Crew Lounge	4-129-4L	-	70
Crew Lounge	4-129-4L	-	73

Table B-8. Underway airborne noise data for USS RACINE (LST-1191).