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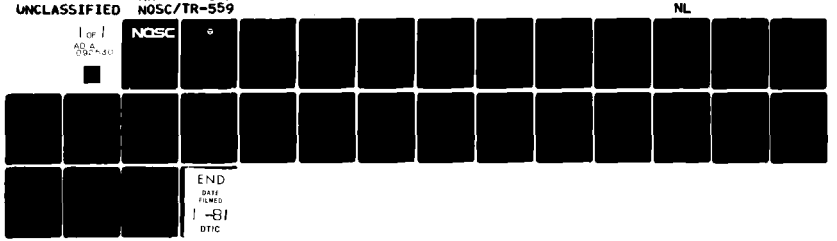

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Technical Report 559

REQUIREMENTS FOR SLEEP, SOLVING PROBLEMS, AND SPEECH COMMUNICATION IN SHIPBOARD COMPARTMENTS

A survey of US Navy personnel opinions

DR Lambert

20 May 1980

Prepared for
Naval Sea Systems Command
Office of Research and Development
Washington DC 20362

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FOREWORD

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

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This document reports opinions of personnel regarding requirements for sleep, solving problems, and speech communication in nonengineering compartments aboard eight US Navy ships. The ships were the CV 61, CV 64, DD 972, DD 976, DDG 13, FF 1063, LST 1185, and LST 1191. It is recommended that the activities necessary in the various types of shipboard compartments and the procedure for assigning ship spaces to airborne noise categories be documented more systematically.

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OBJECTIVE

To support evaluation of airborne noise criteria for Navy ships.

RESULTS

Noise criteria are based in part on the activities which must be performed in shipboard compartments. This document reports opinions of personnel regarding requirements for sleep, solving problems, and speech communication in nonengineering compartments aboard eight US Navy ships.

RECOMMENDATIONS

1. The procedure for assigning ship spaces to noise categories should be documented in the form of an engineering aid. The aid should be used as a medium for recording current experience in engineering design, noise control costs, and noise effects, and as a medium for communication among the various types of people concerned with shipboard noise, including, in particular, design engineers and research scientists.

2. The design aid should be developed from NAVSEA 3222's comprehensive general list of shipboard compartment types and recommended categories. For each compartment type, it should include a brief rationale of the bases for assignment to the preferred category or categories, and a statement of expected noise effects, if any. It should also include an indication of the consequences of higher noise levels when ship design history indicates they are likely to occur.

3. The design aid should include, as design goals, noise limits desirable from a noise effects standpoint; and should also include the engineering and cost information which determines the degree to which such goals are reflected in current noise category assignments.

4. The design aid should include a list of principal activities necessary in each compartment type. This list should be used, together with information on the effects of noise on each activity, as one of the bases for determining noise limit goals and the effects of actual category assignments.

5. The conclusions of this report provide opinions of a sample of shipboard personnel on the activities necessary in various shipboard compartments. Comment from the perspective of ship mission on the opinions reported here should be solicited, and more complete documentation of necessary shipboard activities affected by noise should be developed.

CONTENTS

TABLES

INTRODUCTION

This document presents data on the opinions of Navy personnel regarding requirements for sleep, solving problems, and face-to-face speech communication in nonengineering shipboard compartments.

The data have been collected in support of an evaluation of airborne noise criteria on Navy ships (see Bibliography of Related Documents). Their primary purpose is to aid interpretation of subjective judgments of noise effects which were obtained concurrently. This document has been prepared to make the data available for determining those activities on which airborne noise criteria should be based. Specific application of the data to airborne noise criteria will be discussed further in reference 1.

It has been common Navy practice to establish noise-limit categories so that critical parameters such as hearing capability, speech communication, work performance, or general habitability will not be degraded. Assignment of a compartment to one of these categories is then done on the basis of these critical parameters. For example, noise limits for categories A3 and A12 criteria are based on speech communication requirements, category B noise limits apply to "spaces where comfort of personnel in their quarters is the primary consideration and where communication considerations are secondary" (reference 2), and category C noise limits are based on requirements for especially quiet conditions. In order to assign a given compartment to a noise criteria category, one needs to know which parameters are important in that compartment.

Currently, assignment of compartments to noise-limit categories is based on modifying and updating lists in specifications of previous ship designs, which necessarily reflect compromises dictated by what was practicable and affordable in particular cases. Information concerning which parameters are important is being provided by individuals with shipboard experience, but appears not to have been systematically documented in the literature. A computer literature search of DTIC, NTIS, and Psychological Abstracts data bases for information on sleep, solving problems, and speech communication on Navy ships revealed almost no obviously relevant sources with unclassified titles.

Reference 3 reports a 1964 survey of five ships. The results of two questions are summarized in table 1. They imply indirectly that reading and writing are necessary in crew berthing and recreation areas. In addition, 17 of 20 officers surveyed aboard the DLG 17 indicated that they had to do necessary office work in their stateroom, although only six indicated that IN and OUT baskets were essential there. Corresponding results for the other four ships were not reported.

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[1] Lambert, DR, Airborne Noise Limits for Navy Ships (NOSC Technical Report in preparation).

[2] NAVSHIPS 0907-004-4010, Steady State Airborne Noise Criteria for Shipboard Spaces, by Louis A Herstein, Naval Ship Systems Command, Ship Silencing Division, 1 April 1970.

[3] Raymond Loewy/William Snaith, Inc, Habitability Control, NAVSEC Code 6131G Contract NOBS88489, New York, 30 July 1964.

SHIP	PERCENTAGE OF RESPONDENTS DISTURBED BY LACK OF QUIETNESS IN:		TOTAL ANALYZED RESPONSES
	BERTHING COMPARTMENT	RECREATION FACILITY	
LPD 2	40	56	178
DE 1033	29	50	102
DDG 6	44	39	164
DLG 17	47	51	280
CAG 1	60	54	208
TOTAL . . .	46	50	940

Table 1. Percentage of crew respondents on five ships indicating that lack of quietness disturbed reading and writing in berthing compartments and recreation facilities (data summarized from reference 3, 1964).

PROCEDURE

In the current NOSC study, opinions of personnel in specified compartments were sampled aboard eight US Navy ships while the ships were underway. 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 2, along with abbreviations used in this document. Several of the compartment types were combined into the groups indicated because the amount of data from them was very small. Medical, sonar, and library compartments, especially, had small sample sizes. Engineering spaces were not included in the survey.

Opinions were recorded by the personnel themselves on NOSC form 3960/14 (see appendix A). For each activity (sleep, solving problems, and speech communication), they responded "not necessary", "necessary" (N), or "very necessary" (V).

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 2. List of types of compartments surveyed, with abbreviations used in this document.

RESULTS

On the eight ships, data representing 124 individual compartments were obtained. The data consisted of a total of 362 individual response forms, 73 filled in by officers, 282 by enlisted personnel, and 7 by the NOSC civilian scientists. Of these response forms, 350 showed understandable responses to one or more of the items reported in this document.

For each activity, a score was determined for each individual compartment by computing the fraction of personnel in it who claimed a need for the activity. For this calculation, "N" and "V" responses were combined. These scores were averaged for each compartment type, sigmas were calculated, and pairwise one-way analyses of variance (ANOVA) performed for each possible pair of compartment types. These analyses are reported in appendix B. Table 3 is a summary listing the compartments in order according to decreasing mean scores. Table 3 and the tables in appendix B may be used to compare the need for each activity in the various compartment types.

To provide several different perspectives from which to interpret the data, all the responses from compartments of a given type were pooled together, and four additional statistical measures of the expressed need for each of the three activities calculated:

1. (N+V). Combined percentage of "necessary" (N) and "very necessary" (V) responses.
2. (V). Percentage of "very necessary" responses.
3. (GT 50). Percentage of compartments in which more than 50 percent of personnel responded "necessary".
4. (GT 0). Percentage of compartments in which at least one person responded, "necessary".

These analyses are reported in appendix C. Table 4 is a summary listing the rank orders of compartments according to each of these measures.

DISCUSSION

Inspection of the results of the analyses presented in tables 3 and 4 and in appendices B and C leads fairly readily to a consensus and to the conclusions presented in the next section.

In table 3, the three types of spaces in which the need for sleep is greatest are staterooms (mean score 0.99), berthing areas (0.88), and medical spaces (0.80). It is least in wardrooms (0.14), pilot house/chart rooms (0.15), and sonar/library compartments (0.25).

The need for solving problems seems to be generally high in all compartments. The greatest score is in staterooms (0.94); the smallest score, 0.55 in berthing compartments, still indicates that on the average more than half of the personnel claim they need to solve problems there.

The need for face-to-face speech communication is also quite high everywhere. It is greatest in hospital spaces (1.00), staterooms (0.94), and control spaces (0.94); it is least, but not low, in lounges (0.63), mess areas (0.69), berthing compartments (0.70), and sonar/library spaces (0.72).

Casual comparison of the three activities reveals that the expressed need for speech communication is consistently high, and often greater than that for either sleep or solving problems. Furthermore, noise limits required for speech communication are better established,

	NEED FOR SLEEP			NEED FOR SOLVING PROBLEMS			NEED FOR SPEECH COMMUNICATION		
	COM-PARTMENT	MEAN	MEDIAN	COM-PARTMENT	MEAN	MEDIAN	COM-PARTMENT	MEAN	MEDIAN
1.	SR	0.99	1.00	SR	0.96	1.00	H	1.00	1.00
2.	B	0.88	1.00	S/L	0.87	0.80-1.00	SR	0.94	1.00
3.	H	0.80	1.00	C	0.85	1.00	C	0.94	1.00
4.	M	0.54	0.50	H	0.83	1.00	S	0.90	1.00
5.	L	0.50	0.33-0.67	P/C	0.81	0.67-1.00	P/C	0.90	1.00
6.	S	0.37	0-0.50	S	0.80	1.00	W	0.89	1.00
7.	C	0.30	0.25-0.33	O	0.73	0.75	O	0.84	1.00
8.	O	0.26	0.25	L	0.63	0.50-1.00	S/L	0.72	0.67-0.80
9.	S/L	0.25	0-0.25	M	0.59	0.50	B	0.70	0.75
10.	P/C	0.15	0	W	0.58	0.50-0.67	M	0.69	0.67-0.75
11.	W	0.14	0-0.17	B	0.55	0.67	L	0.63	0.67-0.83

Table 3. Compartments, mean scores, and medians arranged according to mean scores in order from highest to lowest.

ABBREVIATIONS:

(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.

ACTIVITY:	SLEEP				SOLVING PROBLEMS				SPEECH COMMUNICATION			
MEASURE:	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	N + V	V	GT 50	GT 0	N + V	V	GT 50	GT 0	N + V	V	GT 50	GT 0
STATEROOMS	1	1	1	1	1	1	3	*5	4	8	4	8
BERTHING	2	2	2	2	9	10	8	9	10	9	8	9
LOUNGE	5	4	5	5	7	6	9	10	8	10	7	10
MESS	4	5	6	3	10	7	11	*4	11	11	10	*7
WARDROOM	11	11	4	10	11	8	10	8	6	6	*3	*6
MEDICAL	3	3	3	4	6	11	5	*3	1	1	*2	*5
CONTROL	8	8	8	6	3	5	4	6	3	3	*1	*4
OFFICES	7	6	11	7	8	2	6	7	7	5	6	3
SHOPS	6	7	7	8	4	3	7	11	2	2	11	11
SONAR/LIBRARY	9	10	10	9	5	9	*2	*2	9	7	9	*2
PILOT/CHART	10	9	9	11	2	4	*1	*1	5	4	5	*1

*indicates arbitrary rank based on tied values.

N + V – Combined "necessary" and "very necessary" responses.

V – "Very necessary" responses.

GT 50 – Percentage of compartments in which more than 50 percent of responses were "N" or "V".

GT 0 – Percentage of compartments in which more than zero percent of responses were "N" or "V".

Table 4. Rank orders of compartments according to the four measures of table C1 of appendix C.

and probably lower, than those required for either of the other parameters. Although it may not be cost effective in practice, this supports a concept of using speech communication as the basis for noise limits for all of these compartments. This is particularly true in staterooms, where current limits are based on need for sleep, but where substantial need for all three parameters was consistently expressed. Workshops, where noise limits are currently quite high, also warrant further examination in view of the high expressed need for speech communication (0.90) in them.

The data reported in this document are based on a limited sample of subjective opinions of personnel in various compartments aboard eight US Navy ships. Opinions can vary substantially among individuals. In this case, variability may be the result of many factors, including the particular job the individual performs, his particular style of performing it, how he communicates with other people, and when and where he chooses to rest and sleep. An example of the kind of variability that can be expected in these data is illustrated by the score for need for sleep in berthing compartments. Although one would expect it to be 1.00, it is only 0.88 because five individuals, one in each of five compartments on four ships, indicated that sleep is not necessary in their berthing compartments. As a result, scores were 0.67 for the four compartments with three responses each. In the fifth compartment, only the one response was obtained, which resulted in a score of 0. Perhaps these few individuals did not understand the question properly; perhaps they need very little sleep; or perhaps they sleep elsewhere, a hypothesis which is supported by the score on need for sleep in other compartments. The results presented in this report should be interpreted with the caution due subjective data of limited sample size. One should focus on the major trends, and not place too much weight on specific numbers. One should also note that major trends usually reflect primarily the opinions of the numerical majority, in this case a ship's enlisted complement. Thus the opinions reflect personal desires which are not necessarily always in accordance with the ship's mission.

Nevertheless, some of the responses obtained are highly predictable and follow expectations. These lend credence to the data presented here, as well as to other data obtained in this survey which will be presented in reference 1. Several especially obvious cases are useful as controls. For example, it was expected that need for sleep would be rated highest in staterooms and berthing compartments, and that need for speech communication would be rated highest in control compartments. These expectations are supported by the data. In pilot rooms/chart rooms, the scores for solving problems and speech communication, although not 100 percent, are both still quite high, as expected.

CONCLUSIONS

The results of this survey of shipboard personnel opinions suggest the following conclusions.

1. The need for speech communication is great everywhere; it is greatest in medical and control compartments; it is least, but not low, in lounges, mess areas, and berthing compartments.

2. The need for solving problems is greatest in staterooms, sonar/library compartments, control compartments, and pilot house/chart rooms; it is least in berthing compartments, wardrooms, mess areas, and lounges.

3. The need for sleep is greatest in staterooms, berthing compartments, and medical compartments, as might be expected. It is least in pilot house/chart rooms, wardrooms, and sonar/library compartments.

4. There exist individuals who claim a need for all three activities in virtually every compartment type. Of the three activities, speech communication has the greatest overall expressed need and requires the lowest noise limit. Thus more widespread use of speech communication as a basis for noise limits seems appropriate, especially in staterooms and in workshops. If it were practicable to satisfy the expressed needs of all personnel, noise limit goals based on speech communication might be appropriate for all manned, nonengineering compartments.

5. A general feel for the robustness of each of these requirements may be obtained through a study of the tables in this document and its appendices. This may assist in making realistic compromises in establishing airborne noise criteria for any given compartment type.

RECOMMENDATIONS

The conclusions of this report provide opinions of a sample of shipboard personnel on the activities necessary in various shipboard compartments, and provide supplementary guidance for assignment of ship spaces to noise limit categories. In particular, it suggests that more emphasis be placed on the need for speech communication. Comment from the perspective of ship mission on the opinions reported here should be solicited, and more complete documentation of necessary shipboard activities affected by noise should be developed.

It is also recommended that the procedure for assigning ship spaces to noise categories be documented in the form of an engineering design aid. Since much of the information to be included in this aid is not currently available, the aid should be utilized initially in an incomplete form, and should undergo continual development as dictated by experience. It would thus serve as a medium for recording current experience in noise effects research, engineering design, and noise control costs, and as a medium for communication among the various types of people concerned with shipboard noise, including, in particular, research scientists and ship design engineers.

The design aid should be developed from the comprehensive general list of shipboard compartment types and recommended categories currently being prepared by NAVSEA 3222 for the General Ship Specifications. It should be in a simple tabular form suitable for use by ship designers and by noise-control engineers. For each compartment type, the following information should be listed:

1. Necessary activities (eg, sleep, solving problems, speech communication).
2. A noise criteria goal based on noise effects, with a brief rationale of the basis for this goal.
3. Major engineering limitations which typically govern the noise level in this compartment type, together with the typical noise levels which result.
4. Recommended typical compromise noise-limit category or categories based on the prevailing states of the art in noise-effects research and engineering design, together with a statement of expected noise effects, if any.
5. A list of parameters which should govern a decision to change its assignment to higher or lower noise-level categories in particular cases, together with the expected consequences of higher noise levels when ship design history indicates they are likely to occur.
6. Funding limitations which have typically governed the noise level, together with noise levels which have resulted.
7. A recommended compromise noise-limit category based on the prevailing funding policy, together with expected noise effects, if any.

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1. Lambert, DR, Airborne Noise Limits for Navy Ships (NOSC Technical Report in preparation).

2. NAVSHIPS 0907-004-4010, Steady State Airborne Noise Criteria for Shipboard Spaces, by Louis A Herstein, Naval Ship Systems Command, Ship Silencing Division, 1 April 1970.

3. Raymond Loewy/William Snaith, Inc, Habitability Control, NAVSEC Code 6131G Contract NOBS88489, New York, 30 July 1964.

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3. NOSC TD 243, Airborne Noise Levels on Merchant Ships, by DR Lambert, 30 April 1979.
4. NOSC TD 296, A Simple Method for Predicting Subjective Response to Noise on Navy Ships, by DR Lambert (in preparation).
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6. Lambert, DR, Airborne Noise Limits for Navy Ships (in preparation).

APPENDIX A: EXCERPTS FROM DATA FORMS

Opinions were recorded by the personnel themselves on form 11ND NOSC 3960/14. The earlier revision of this form (Rev 5-78) was used for six ships; the later revision (Rev 3-79) for two. As a result, there are slight differences in the meaning of the date from the two forms. The context in which the questions are answered differs somewhat. The term "sleep" is used on the earlier form, while the term "rest/sleep" is used on the later one. On the earlier form, the term "speech communication" is divided into "speaking" and "listening." In the analysis, speech communication was considered necessary if either speaking or listening was so marked; otherwise, these differences were ignored.

The following is an excerpt from question 6 of form 11ND NOSC 3960/14 (Rev 3-79), which was used for two of the ships.

6. Indicate how necessary each of the following is to the usual activities (job, sleep, recreation, etc) in this room . . . .

	Necessary? No	Yes	Very
Communication (normal conversation)	—	—	—
Solving problems/studying/reading	—	—	—
Rest/sleep	—	—	—

The following is an excerpt from question 5 of FORM 11ND NOSC 3960/14 (Rev 5-78), which was used for six of the ships.

5. Indicate how necessary each of the following is to the usual activities (job, sleep, recreation, etc) in this room during normal cruising . . . .

	Necessary? No	Yes	Very	
Talk to others (face to face)	—	—	—	} (These two combined
Listen to others (face to face)	—	—	—	} for analysis here.)
Solving problems	—	—	—	
Sleep	—	—	—	

APPENDIX B: ANALYSIS OF INDIVIDUAL COMPARTMENT SCORES.

For each activity, a score was determined for each individual compartment by computing the fraction of personnel in it who claimed a need for the activity (tables B1, B2, and B3). For this calculation, "N" and "V" responses were combined. These scores were averaged for each compartment type, sigmas were calculated, and pairwise one-way analyses of variance (ANOVA) were performed for each possible pair of compartment types. The resulting means and sigmas are reported in tables B4, B5, and B6, as is the level of significance of the difference between the means of each pair of compartment types.

For every 100 pairwise ANOVA tests performed, chance would be expected to yield five significant results at the 0.05 level, one of which would reach the 0.01 level. In this case, for all three parameters, we would expect a total of 5.75 tests to be significant at the 0.05 level, with 1.15 reaching the 0.01 level. Figures B4, B5, and B6 show 41 tests significant at the 0.05 level, with 24 reaching the 0.01 level – a number clearly well above that expected by chance.

In table B4, the three types of spaces in which the need for sleep is greatest are staterooms, berthing areas, and hospital spaces. The mean score for sleep was 0.99 in staterooms and 0.88 in berthing compartments. These are not significantly different from each other, as is indicated in the lower half of the table by the lack of an asterisk notation (* or **) at the intersection of the SR row and the B column. Similarly, they do not differ significantly from medical spaces. However, staterooms and berthing areas do each differ significantly from each of the other types of spaces listed.

COMPARTMENT TYPE	COMPARTMENT SCORES ON NEED FOR SLEEP (percentage)									
Staterooms	100	100	100	83	100	100	100	100	100	100
	100	100	100	100	100	100	100	100	–	–
Berthing	100	100	100	67	100	100	100	100	100	100
	67	100	100	67	67	100	100	0	100	–
Lounge	67	100	33	0	–	–	–	–	–	–
Mess	33	100	0	50	50	33	100	67	–	–
Wardroom	17	0	25	0	33	0	0	33	–	–
Medical	100	0	100	100	100	–	–	–	–	–
Control	0	67	14	67	0	33	0	33	0	67
	25	50	50	0	0	67	–	–	–	–
Offices	0	67	33	40	0	33	0	0	0	50
	0	0	50	33	0	50	0	100	0	25
	67	–	–	–	–	–	–	–	–	–
Shops	0	50	0	0	100	0	50	67	0	100
Sonar/Library	25	0	25	0	0	100	–	–	–	–
Pilot/Chart	33	0	0	0	67	0	0	50	–	–

Table B1. Individual compartment scores on need for sleep.

COMPARTMENT TYPE	COMPARTMENT SCORES ON NEED FOR SOLVING PROBLEMS (percentage)									
Staterooms	100	100	100	83	100	100	100	100	100	100
	100	100	100	100	100	50	100	100		
Berthing	33	100	60	33	100	100	67	0	50	67
	67	67	67	100	33	0	0	0	100	
Lounge	50	100	100	0						
Mess	25	100	50	50	50	67	100	33		
Wardroom	100	100	50	67	33	0	50	67		
Medical	100	50	100	67	100					
Control	67	67	100	67	100	100	60	100	100	100
	100	100	100	0	100	100				
Offices	100	100	100	80	75	67	100	50	67	100
	50	0	100	100	67	60	0	100	50	75
	100									
Shops	100	100	100	100	0	100	67	100	67	67
Sonar/Library	80	67	75	100	100	100				
Pilot/Chart	67	67	50	67	100	100	100	100		

Table B2. Individual compartment scores on need for solving problems.

COMPARTMENT TYPE	COMPARTMENT SCORES ON NEED FOR SPEECH COMMUNICATION (percentage)									
Staterooms	100	100	100	83	100	100	100	100	100	100
	100	100	100	100	100	100	100	0	–	–
Berthing	67	100	60	33	100	100	100	100	100	100
	33	33	75	100	0	67	67	0	100	–
Lounge	67	100	83	0	–	–	–	–	–	–
Mess	25	50	75	100	67	100	100	33	–	–
Wardroom	100	100	75	67	67	100	100	100	–	–
Medical	100	100	100	100	100	100	–	–	–	–
Control	100	100	100	67	100	100	100	100	100	100
	100	100	67	100	100	67	–	–	–	–
Offices	100	67	67	67	80	100	100	100	100	100
	50	100	50	100	67	100	50	100	100	75
	100	–	–	–	–	–	–	–	–	–
Shops	100	100	100	100	0	100	100	100	100	100
Sonar/Library	80	100	50	100	67	33	–	–	–	–
Pilot/Chart	100	100	100	100	67	100	100	50	–	–

Table B3. Individual compartment scores on need for speech communication.

COMPARTMENT	SR	B	L	M	W	H	C	O	S	S/L	P/C
MEAN SCORE	0.99	0.88	0.50	0.54	0.14	0.80	0.30	0.26	0.37	0.25	0.15
SIGMA	0.04	0.25	0.37	0.57	0.14	0.40	0.27	0.29	0.40	0.35	0.26
N	18	19	4	8	8	5	16	21	10	6	8

COMPARTMENT	F-RATIO									
SR	3.50	26.9**	31.6**	510**	3.61	107**	106**	39.9**	69.9**	155**
B		5.80*	8.07**	59.0**	0.27	41.4**	49.4**	16.8**	21.7**	40.0**
L			0.03	4.93	1.03	1.37	1.90	0.28	0.92	2.40
M				9.37**	1.40	3.50	4.74*	0.89	2.22	5.19*
W					15.5**	2.22	1.29	2.17	0.60	0.22
H						9.22**	11.0**	3.38	4.79	9.57*
C							0.13	0.27	0.09	0.80
O								0.67	0.006	0.37
S									0.31	1.08
S/L										0.13
P/C	—									

* – Significant at 0.05 level.

** – Significant at 0.01 level.

Table B4. Need for sleep in shipboard compartments. Mean compartment scores and F-ratios from pairwise ANOVA tests. Score for each compartment is total fraction of "necessary" and "very necessary" responses. The overall F-ratio, $F(10, 112) = 14.06$, is significant at the 0.01 level.

COMPARTMENT	SR	B	L	M	W	H	C	O	S	S/L	P/C
MEAN SCORE	0.96	0.55	0.63	0.59	0.58	0.83	0.85	0.73	0.80	0.87	0.81
SIGMA	0.12	0.36	0.41	0.26	0.31	0.21	0.27	0.30	0.31	0.14	0.19
N	18	19	4	8	8	5	16	21	10	6	8

COMPARTMENT	F-RATIO									
SR	20.5**	7.93*	22.5**	18.5**	2.87	2.46	8.67**	3.69	2.34	5.34*
B	0.13	0.09	0.05	2.65	7.27*	2.96	3.32	4.22	3.58	
L	0.02	0.03	0.75	1.61	0.35	1.97	1.45	0.96		
M	0.004	2.53	4.61*	4.75*	0.50	4.76*	3.19			
W	2.12	4.38*	1.31	1.96	3.76	2.74				
H	1.87	0.37	0.75	1.71	1.11					
C	1.43	0.18	0.03	0.11						
O	0.31	1.07	0.45							
S	0.24	0.009								
S/L	0.32									
P/C	--									

* – Significant at 0.05 level.

** – Significant at 0.01 level.

Table B5. Need for solving problems in shipboard compartments. Mean compartment scores and F-ratios from pairwise ANOVA tests. Score for each compartment is total fraction of "necessary" and "very necessary" responses. The overall F-ratio, F(10, 113) = 2.89, is significant at the 0.01 level.

COMPARTMENT	SR	B	L	M	W	H	C	O	S	S/L	P/C
MEAN SCORE	0.94	0.70	0.63	0.69	0.89	1.00	0.94	0.84	0.90	0.72	0.90
SIGMA	0.23	0.34	0.38	0.28	0.15	0.00	0.13	0.19	0.30	0.25	0.18
N	18	19	4	8	8	6	16	21	10	6	8

COMPARTMENT	F-RATIO									
SR	5.51*	4.12	5.08*	0.28	0.44	0.002	1.70	0.11	3.58	0.16
B	0.15	0.01	1.98	4.19	6.41*	2.54	2.21	0.00	2.12	
L	0.09	2.42	4.69	6.72*	2.74	1.76	0.17	2.31		
M	2.67	6.17	8.04	2.69	2.07	0.03	2.64			
W	3.01	0.71	0.29	0.01	2.18	0.01				
H	1.26	3.63	0.58	6.58*	1.62					
C	2.68	0.18	6.78*	0.38						
O	0.36	1.66	0.40							
S	1.39	0								
S/L	2.08									
P/C	--									

* – Significant at 0.05 level.

** – Significant at 0.01 level.

Table B6. Need for speech communication in shipboard compartments. Mean compartment scores and F-ratios from pairwise ANOVA tests. Score for each compartment is total fraction of "necessary" and "very necessary" responses. The overall F-ratio, $F(10, 113) = 2.16$, is significant at the 0.05 level.

APPENDIX C: ANALYSIS OF FOUR OTHER MEASURES.

To provide several different perspectives from which to interpret the data, all the individual responses from compartments of a given type were pooled together, and four additional statistical measures of the expressed need for each of the three activities calculated:

1. (N+V). Combined percentage of "necessary" (N) and "very necessary" (V) responses.

2. (V). Percentage of "very necessary" responses.

3. (GT 50). Percentage of compartments in which more than 50 percent of personnel responded "necessary".

4. (GT 0). Percentage of compartments in which at least one person responded "necessary".

Measure 1, above, is a typical "yes-no" measure calculated by totaling all individual responses from the compartments of the specified type. Like measure 4 discussed below, it probably is too sensitive to unusual, spurious, and insincere responses to be useful as an indicator by itself.

Measure 2 is less sensitive, counting only "very necessary" responses as affirmative. This measure was included as an indicator of the degree to which measure 1 reflected non-essential or social benefit rather than substantial need.

Measure 3 is also relatively insensitive. It caters to the majority of individuals in each compartment: more than one-half of the personnel must reply "necessary" or "very necessary" to register an affirmative rating for the compartment. This is a useful measure when all personnel in the compartment have about the same need, so that it is the subjective nature of their judgments which causes variability. But when the needs of the personnel actually differ, this measure completely ignores the needs of the minority even when they are vital.

Measure 4, on the other hand, is an overly sensitive measure which caters to individual needs in each compartment: a single "necessary" response is sufficient to register an affirmative compartment rating.

These four measures of expressed need for each of the three activities are reported in table C1. The mean and standard deviations of the distributions are also given for each of the four measures. The mean, an average over compartment types, is useful as a reference value: a compartment type in which personnel have greater than average need for a particular activity will have a percentage of affirmative responses greater than this mean. The mean expressed need for speech communication is greater than that for either sleep or problem solving on each of the four measures.

These four measures allow one to get a feel both for how vital the need for these activities is, and for the reliability of the data. As an example, let us consider the claim of personnel that sleep is necessary in two compartment types: staterooms and offices. Parallel arguments could be made regarding this claim for most of the other compartments.

Measure 1 indicates that 97 percent of personnel in staterooms claim that a need for sleep exists, while only 26 percent of personnel in offices make this claim. This is supported by measure 2: 50% claim sleep is very necessary in staterooms versus 14% in offices. So we may conclude that more personnel sleep in staterooms than in offices, as one would expect. However, we may also conclude from measure 4 that there are individuals in about half of the offices who claim they need to sleep in them. But measure 3 indicates that while in every stateroom more than half of the personnel claim sleep to be necessary, this is the case in only 10% of the offices; so, generally, the majority of personnel in offices do not need to sleep there.

ACTIVITY:	SLEEP				SOLVING PROBLEMS				SPEECH COMMUNICATION			
MEASURE:	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	N + V	V	GT 50	GT 0	N + V	V	GT 50	GT 0	N + V	V	GT 50	GT 0
Staterooms	97	50	100	100	94	32	94	100	94	25	94	94
Berthing	90	34	95	95	58	83	53	79	71	20	68	90
Lounge	46	18	50	75	80	20	50	76	75	17	75	75
Mess	52	14	38	88	54	15	38	100	67	11	63	100
Wardroom	15	0	50	50	15	15	50	88	89	37	100	100
Medical	89	22	80	80	80	0	80	100	100	60	100	100
Control	26	7	20	60	85	21	93	93	96	47	100	100
Offices	26	14	10	52	76	32	76	91	85	45	86	100
Shops	29	13	30	50	83	29	70	70	96	52	70	70
Sonar/library	20	0	17	50	81	10	100	100	74	26	67	100
Pilot/chart	18	5	13	38	86	23	100	100	91	46	88	100
MEAN	46	16	46	67	72	19	73	91	85	35	83	94
SIGMA	32	15	33	21	22	10	23	11	12	16	15	11
2 X SIGMA	63	30	66	42	45	21	45	22	23	32	29	22
MEAN + SIGMA	78	31	78*	88	94	29	96	+	97	51	97*	+
MEAN + 2 SIGMA	+	46	+	+	+	39*	+	+	+	67	+	+
MEAN - SIGMA	15*	1	13	46	50	8*	50	79*	74*	19	68	83
MEAN - 2 SIGMA	-	-	-	25	27	-	28	68*	62	3	53*	74*

+ Indicates greater than 100%.

- Indicates less than 0%.

* Calculated before rounding.

Table C1. Four additional statistical measures of percentage of affirmative responses regarding the need for sleep, solving problems, and speech communication in various compartment types. Calculation of means and standard deviations was performed before rounding. See text for further details.

(Offices, of course, may serve different functions. But examination of the data for uniformity of the need for these three activities revealed no obvious basis for dividing them into subgroups.)

There are two ways of viewing these results, both of which may have some validity. On the one hand, there may well be some spurious comments in the sample. In this case, one should focus on the main trends in the data (measures 2 and 3) and ignore weaker responses or those made by only a few personnel (measures 1 and 4). On the other hand, shipboard personnel often work very long hours as the result of work requirements and watch schedules. Some do need to be able to rest when the workload permits, in offices or wherever else they may be. From this viewpoint, noise criteria for offices should consider the need for sleep.

It is readily apparent from measure 4 that there are a few personnel in virtually every compartment type surveyed who feel all three of the activities reviewed here are necessary. Thus, if it were practical to accommodate these personnel, one would base the criteria for all of those compartments, staterooms included, on the activity requiring the lowest sound level. This would generally be speech communication.

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