

Naval Submarine Medical Research Laboratory

NSMRL Special Report 90-2

28 September 1990



FIVE YEAR PLAN FOR

Fiscal Years 1991-1995

Edited by:

J. S. Bowman, LCDR, MSC, USN
and S. D. Monty

Released by:

R. G. Walter, CAPT, DC, USN
COMMANDING OFFICER

Naval Submarine Medical Research Laboratory
October 1990

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FIVE YEAR PLAN
1991-1995

for

NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY
SPECIAL REPORT 90-2

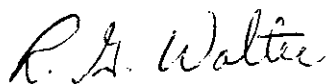
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FY 91 WORK UNITS LIST

REGULAR 1498s

63706N M000095 005	Evaluation of field clinical laboratory equipment for fleet Marine Force (Start Jan 90)
63706N M0095 005 5010	Submarine deployable computer based system for enhanced medical practice, performance, and quality (Formerly: Sea trials for computer-based medical diagnostic/patient management systems for use aboard SSN/SSBN submarines)
63706N M0096 002 5016	The effects of operational stressors on team performance during continuous/sustained naval submarine operations (Start 1 Apr 90)
63706N (NEW)	Performance enhancement for submarine systems using human factors principles and techniques
63706N (NEW)	Analysis of vision problems aboard submarines
65856N M0100 001 5001	Auditory sonar
65856N M0100 001	Digital signal processing for auditory sonar (Start 1 Oct 89)
65856N M0100 001 5003	Enhanced performance with visual sonar displays
63713N M0099.01A 5012	Medical problems associated with pressurized submarine rescue
63713N M0099 01C 5050	Development of a general hearing-conservation standard for diving operations (Start 1 Oct 89)
61153N MR04101 001 5014	Cell culture modeling of neurophysiological pathology and brain associative processes

INDEPENDENT RESEARCH WORK UNITS

61152N MR0401.001 5109	Event related potentials reflect different stages in learning to discriminate complex auditory stimuli
NEW	An evaluation of alternative symbolic designs for maritime tactical displays

NEW

Tactical information requirements and data base organization for a submarine approach officer's decision aid

REIMBURSABLES

61153N

RR4209 001 ONR 4424207

Auditory classification based on the identifiability of complex stimulus features

1GAV600(90)5-88001

Psychophysical procedures for auditory measures with naive subjects

PE0605131D DTAM04006

Effect of fire gas on decrement in mental performance of naval personnel

Coast Guard

Evaluation of navigation range lights

Naval Underwater
Systems Center

Human factors evaluation of non-penetrating periscope

CHART 1
AUDITORY AND VISUAL DISPLAYS

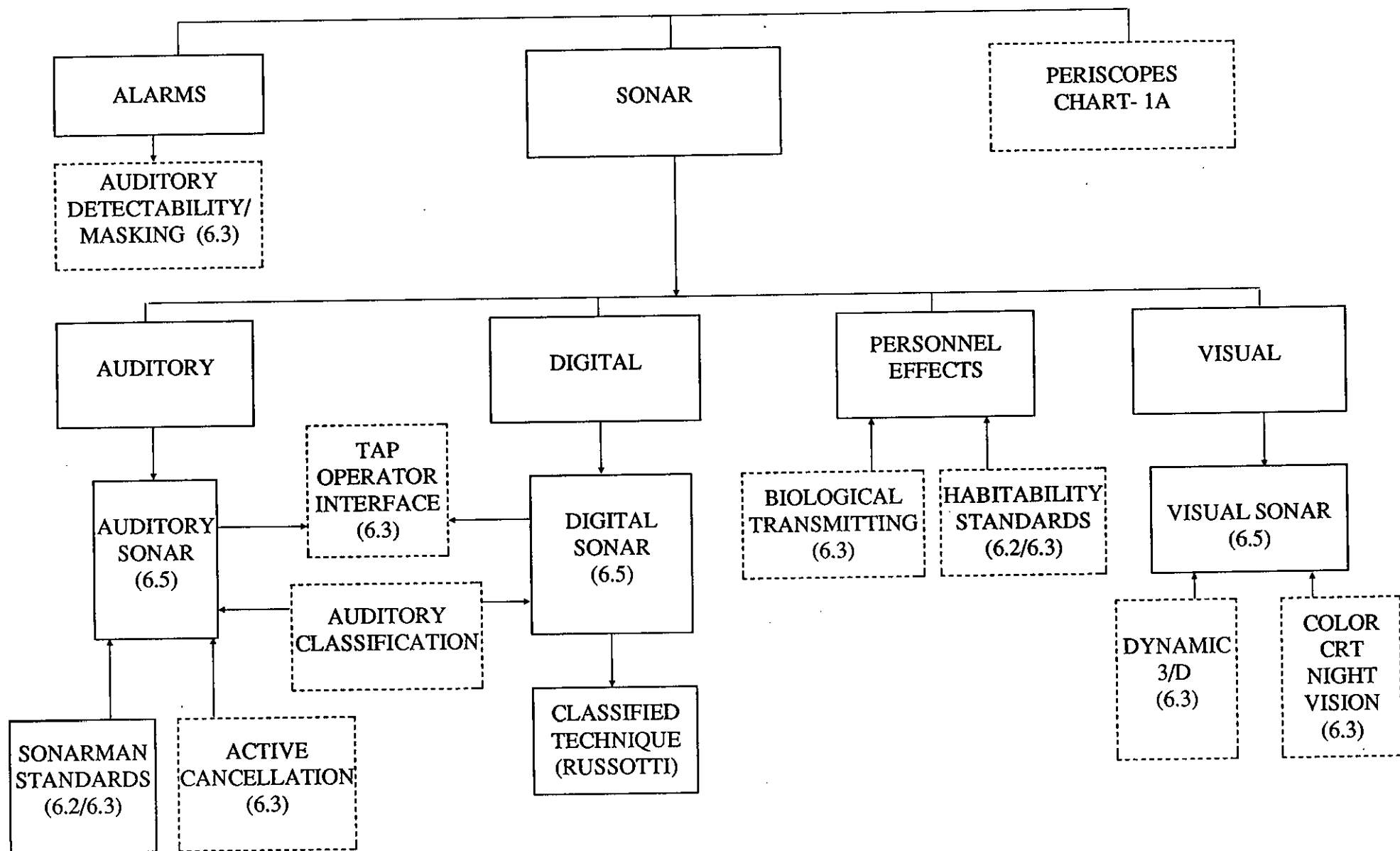


CHART 1A

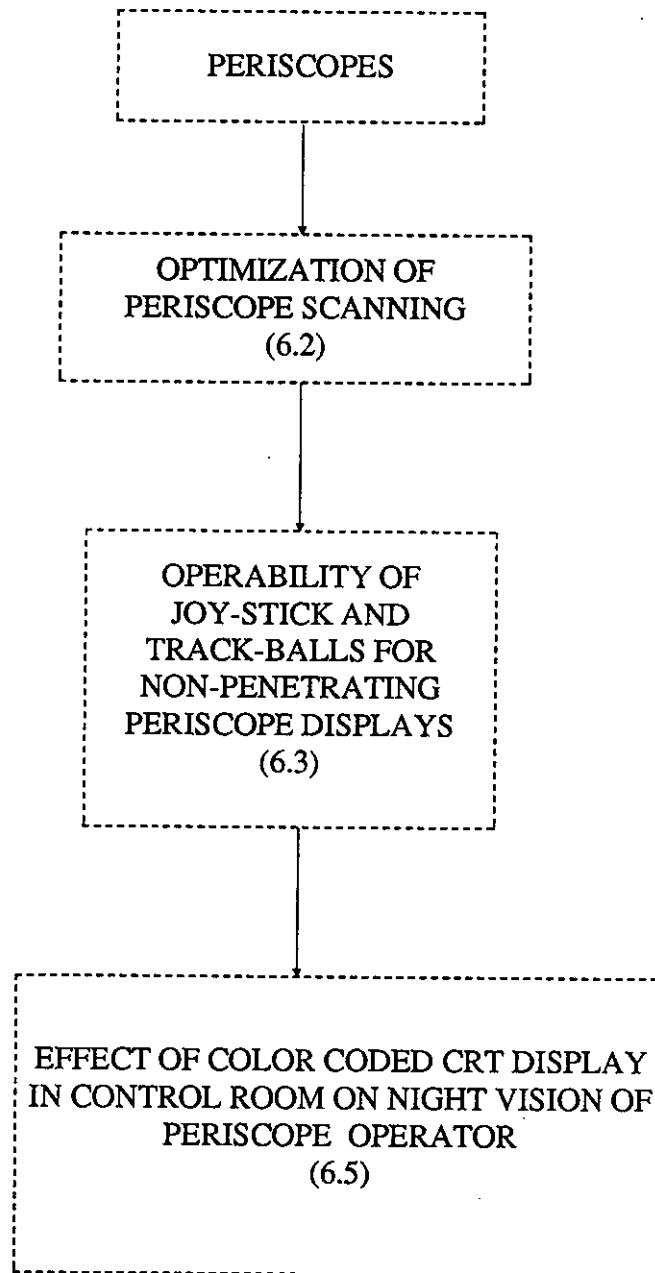
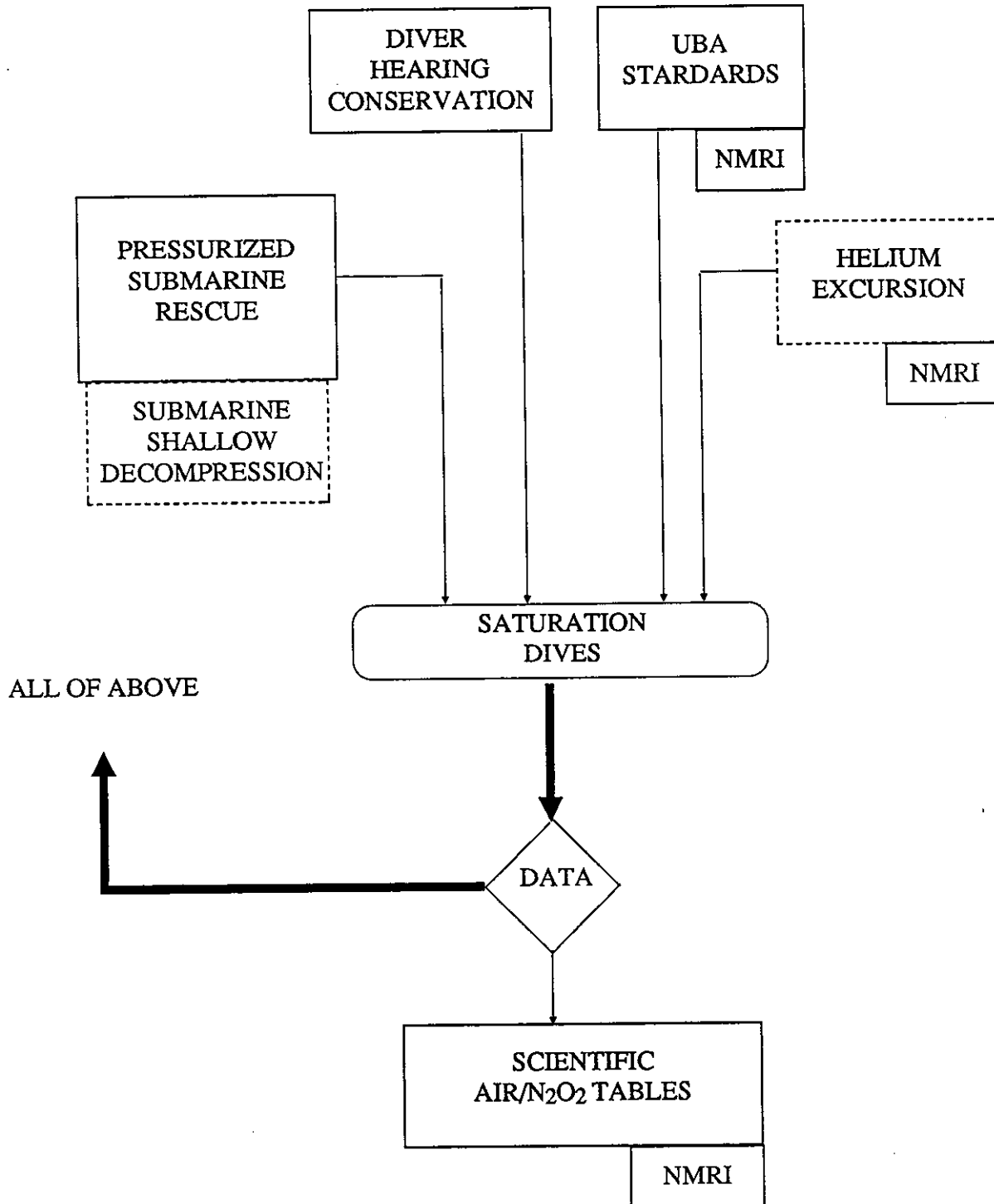


CHART 2
HYPERBARICS



II. NEW START (A):

1. Title: Auditory classification of sonar signals
2. Principal investigator: Thomas E. Hanna, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Submarine Systems Department
Phone Numbers:
Autovon: 241-2545
Commercial: (203) 449-2545
Other Laboratories involved: NUSC and SUBSCHOL

4. Navy need

To develop automated classification aids for passive sonar systems

Need identified in NAVSEA Technology Needs Guidance

5. Problem/Objective:

It is becoming increasingly important to classify transient sonar signals. Currently, this task is best performed by trained listeners. However, a trained listener is not able to attend simultaneously to the multiple sources of sonar information available at a given moment in time. A description of how trained listeners classify sonar signals could be used to develop algorithms for computer recognition of these sounds. This algorithm would allow a more complete analysis of sonar information than is currently possible. Moreover, the limited operator time available could be used for listening more carefully to the most important signals. Several methods of approaching this problem are under study, but none that attempt to model the mechanism that is best at the task - the human ear.

The proposed work would address three questions towards solving the problem of classifying sonar signals. First, what are the perceptual categories used by listeners and how reliably do listeners use these categories? Second, how do these categorizations compare with those used by algorithms; can those categories be used to train better algorithms? Third, which acoustic features define the perceptual categories?

These results would be used by NUSC to develop classification algorithms.

6. Technical Approach:

NUSC has collected a library of transient signals. Trained sonar operators will be asked to listen to these signals and group them into categories of their own choosing. Reliability of each individual's judgments and consistency of categories across listeners will be used to define meaningful perceptual categories. Subjects will also do a bi-

nary categorization of each signal along a dimension which is currently being used to train a computer algorithm. The following questions will be answered: 1) can the perceptual categories be used to predict the rating judgments?, 2) is there information in human rating judgments that is not used by the computer algorithm?, 3) do the perceptual categories contain the information that the computer algorithm is missing?, and 4) can the computer algorithm perform better by training to the perceptual categories?

Attempts will be made to identify specific acoustic features which define the perceptual categories and rating judgments. The features used by current algorithms will be tested as well as any features suggested by listening to the categories. Prior research suggests that the amplitude envelope may be important; classification data will be collected using stimuli with only the signals' envelopes preserved to determine which categorizations can be made using the envelope. A second possibility is to use an analysis/synthesis technique to generate a modified stimulus set for classification. This technique is known to produce perceptually similar stimuli, but with simpler stimuli. It would be easier to identify features from this alternate signal set. Moreover, these signals can be modified to provide tests of the importance of certain features.

Finally, neural net algorithms will be developed that use models of auditory peripheral processing as input to the neural nets. The network will map input features onto perceptual judgments. This network would then serve as a preprocessor to identify important events to the sonar operator.

7. Assessment of risk:

This proposal is high-risk but with potentially high payoffs for Navy application and scientific contribution. Auditory modeling and parallel processing capabilities are now sufficiently mature to study such a complex problem.

8. Related activities:

The Battle-Management Technology Group, Code 5570, at the Naval Research Laboratory (NRL) is initiating a related project for passive sonar. The Advanced Resource Development Corporation has been granted a Phase II SBIR contract to use auditory features to classify active sonar returns. We would monitor their efforts and attempt collaboration, particularly with NRL, when feasible.

9. Transition approach:

We would be doing this project in conjunction with a current NUSC 6.3 program. Some transition could be initiated prior to project completion so that a working prototype could be taken to sea in FY96.

10. Resources required (Funding Category 6.2)

	FY92	FY93	FY94	FY95
Funding Required	225	230	215	210
Personnel required				
Onboard personnel				
Military Officers				
Military Enlisted	0.2	0.2	0.2	0.2
Civilian	0.4	0.4	0.4	0.4
Total	0.6	0.6	0.6	0.6
Additional personnel				
Military Officers				
Military Enlisted	0.2	0.2	0.2	0.2
Civilian Professional	1.0	1.0	1.0	1.0
Civilian Supporting	0.6	0.6	0.6	0.6
Total	1.8	1.8	1.8	1.8

11. Current references:

Hanna, T.E. (1990) Contributions of envelope information to classification of brief sounds, NSMRL Report (In Press).

Hanna, T.E. (1989) Auditory temporal features underlying sound source identification. Proposal to Office of Naval Research.

Shamma, S. (1988) Acoustic features of speech. Journal of Phonetics 16,p77.

Rumelhart, D. and McClelland, J. (1986). Parallel distributed processing: Exploration in the microstructure of cognition. Volumes 1 & 2. Cambridge, MA: Bradford Books/MIT Press.

SBIR Phase II proposal for signal feature analysis using neural networks and psychoacoustics by the Advanced Research Development Corporation.

II. NEW START (B):

1. Title: Auditory detectability of signals subject to masking
2. Principal investigator: Lynne Marshall, Ph.D.
3. Naval Submarine Medical Research Laboratory
Department: Submarine Systems Department
Phone Numbers:
 Autovon: 241-2545
 Commercial: (203) 449-2545
Other Organizations involved: MRC Applied Psychology Unit (Great Britain), COM-SUBDEVRON-12, and SSEP.

4. Navy need:

A variety of tasks performed by naval personnel require that auditory alarm signals be detectable in adverse acoustic environments. The proposed work will specify what signal-to-noise ratios are necessary to achieve detectability as influenced by the spectral properties of the signal and the extraneous interfering stimuli.

5. Problem/Objective:

To apply an algorithm for auditory alarm detectability to the design of alarm signals for submarines. Depending on the acoustic environment in a particular compartment, certain alarm signal spectra may be more or less effective. The work will provide guidance for constructing alarm signals that are detectable at lower levels than current alarms. A decrease in alarm levels can increase the usage of these warning devices by operators since lower levels are less aversive and interfere less with other auditory tasks.

6. Technical Approach:

Dr. Roy Patterson from the MRC Applied Psychology Unit in Great Britain has developed an algorithm to predict the detectability of signals in the presence of interfering stimuli, and has developed numerous alarm signals based on the predictions of his algorithm. This work was conducted for military applications, primarily to address problems encountered by helicopter pilots. The approach has proved extremely valuable for improving pilots' performance in tactical settings and has also been extended to more general settings, such as hospitals. Other applications are being pursued in conjunction with several NATO countries, including Canada, the Netherlands, and West Germany. Dr. Patterson has expressed interest in working with our Laboratory to explore applications of interest to us.

First, submarine personnel will be interviewed to identify candidate auditory alarm signals that are currently ineffective or annoying. Sonar operators have already indi-

cated problems with alarms in sonar as well as ship's alarms; additional information will be gathered on the use of alarms outside the sonar shack. Second, background noise levels will be recorded in the areas in which the alarm is to be used, and a signal synthesized that is appropriate for that background. Finally, the resulting alarm signal will be compared to current alarm signals, and recommendations will be made based on both laboratory and operational evaluations.

The validated model of auditory detectability in noise environments can be used by NUSC, COMSUBDEVRON-12, and the operational submarine forces as well as sonar system designers and engineers performing acoustic-quieting tasks.

7. Assessment of risk:

Improving alarms onboard submarines is a low-risk project.

8. Related activities:

As stated above, we would be interacting with Dr. Roy Patterson in Great Britain on this project.

9. Transition approach:

Results of this research would be used for specifications of alarms on submarines. The length of time before the new design reached the fleet would depend on when new equipment was designed and contracted. NAVSEA might also decide to modify the design specifications for equipment that is already in production, or even to retrofit some of the alarms on existing equipment.

10. Resources required (Funding Category 6.2):

	FY94	FY95	FY96	FY97
Funding required	275	290	290	290
Personnel required				
Onboard personnel				
Military Officer	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0
Civilian Professional	0.8	0.8	0.8	0.8
Civilian Supporting	0.0	0.0	0.0	0.0
Total	0.8	0.8	0.8	0.8

Additional personnel				
Military Officer	0.0	0.0	0.0	0.0
Military Enlisted	0.8	0.8	0.8	0.8
Civilian Professional	0.4	0.4	0.4	0.4
Civilian Supporting	0.4	0.4	0.4	0.4
Total	2.4	2.4	2.4	2.4

11. Current references:

Marshall, L., & Nash, M. (1989). Analog audio, digital audio, and alarms on the AN/BQQ-5 sonar system: Sonar technicians' ratings. NSMRL Report 1152 (Confidential).

Nash, M., & Marshall, L. (1990). Sonar technicians' ratings of shipboard and sonar alarms. NSMRL Report (In review).

Patterson, R. D. (1982). Guidelines for auditory warning signals on civil aircraft. Civil Aviation Authority. Paper 82017. London; Civil Aviation Authority.

Patterson, R. D. (1989). Guidelines for the design of auditory warning sounds. Proceedings of the British Institute of Acoustics 1989 Spring Conference, Vol II, Part 5, 17-24.

Patterson, R. D. (1990). Auditory warning sounds in the work environment. Phil. Trans. R. Soc. Lond. (In Press).

II. NEW START (C):

1. Title: Performance assessment for auditory sonar signals
2. Principal investigator: Lynne Marshall
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Submarine Systems Department
Phone Numbers:
Autovon: 241- 2545
commercial: (203) 449-2545
Other Organizations involved: SUBSCHOL

4. Navy need:

There is currently no objective means to determine whether waivers should be given to sonar technicians whose hearing loss exceeds the standards for their rate.

5. Problem/Objective:

Traditional pure-tone audiograms do not adequately assess the auditory skills required by submarine sonar operators. Once a sonar technicians's hearing loss has reached levels that may disqualify him according to today's standards, suprathreshold auditory tests (currently not available) should be administered to determine whether he should be retained or disqualified. This work unit is intended to develop tests to evaluate auditory sonar performance test abilities. Some of the tests may also be useful for sonar operator selection. The tests could be useful for some aspects of sonar system evaluation.

Expected users will be NAVSEA, SUBSCHOOL, MEDCOM, design engineers for sonar systems and for machine-recognition systems.

6. Technical Approach:

The work related to sonar retention will focus on the development of a group of tests that measure the ability to extract auditory patterns from a background noise. The patterns or complexes involved will constitute simulations of actual auditory-sonar contacts but may be modified to allow measurement of discrete spectral and temporal characteristics. Unlike traditional pure-tone audiometry, signals will be complex, will be imbedded in a background of noise, and will be at levels above those used for pure-tone audiometry. Discrimination and identification tasks will be included along with detection tasks. Because sonar-pattern perception and speech-pattern perception share many characteristics, techniques that have been effective in speech-perception research will be used to segment complex sonar contacts into discrete elements or features. Much of this work will use digitally synthesized signals.

In order to determine to what extent auditory skills can be predicted a priori (for sonar selection), standard psychoacoustic and speech-perception tasks will be included. If performance on a non-sonar psychoacoustic task is highly correlated with a learned sonar task, the non-sonar task may be used to predict future sonar skills, e.g., performance on a temporal modulation transfer function (TMTF) task (which measures detection of noise modulation depth as a function of modulation frequency) can be compared with the ability to accurately perform turn counts.

7. Assessment of risk:

Development of a test that gives a more valid assessment of auditory performance on sonar tasks than do pure tones is not high risk. However, the test development is time-consuming, requiring fairly lengthy testing time on a large number of subjects, so the greatest risk is that it could be difficult to get enough volunteer subjects to complete the project quickly.

Development of a test for selection of sonar operators who will have good auditory skills is much higher risk. If none of the non-sonar tasks correlate very highly with sonar performance (which is a possible outcome), then sonar retention criteria will not be improved.

8. Related activities:

Auditory assessment using the auditory skills required for a particular job has been implemented for tasks requiring auditory understanding of speech. Military applications are primarily for pilots. Assessment of non-speech auditory skills to our knowledge is not currently being systematically investigated by any other group.

9. Transition approach:

The sonar-retention test could be used by audiologists to provide objective data to physicians on whether a sonar technician should be given a medical waiver. There are two different approaches that could be used to implement the test into audiology clinics. The first would be simplest and less expensive from the audiologist's standpoint, but would require further development from us. It would involve transforming the laboratory psychoacoustic tasks into comparable clinical ones that could be administered using the equipment already present in audiology clinics. The second approach would be more expensive for audiology clinics, but would require no additional research from us. In this approach, miniature psychoacoustic test stations would be set up in each clinic.

In either case, the implementation, including training of Navy audiologists and the physicians, would take approximately three years.

10. Resources required (Funding Category 6.2):

	FY94	FY95	FY96	FY97	FY98
Funding required	306	366	431	446	466
Personnel required					
Onboard personnel					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0	0.0
Civilian Professional	0.2	0.4	0.4	0.4	0.4
Civilian Supporting	0.0	0.0	0.0	0.0	0.0
Total	0.2	0.4	0.4	0.4	0.4
Additional personnel					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	0.4	0.4	0.4	0.4	0.4
Civilian Professional	0.4	0.8	1.6	1.6	1.6
Civilian Supporting	0.8	0.8	0.8	0.8	0.8
Total	1.6	1.6	2.8	2.8	2.8

11. Current references:

Hanna, E.T., Russotti, J., and Marshall, L. (1988). Auditory sonar: the importance of high-quality channels in system design. NSMRL Report 1109.

Marshall, L. (1990). Identification of the bandwidth needed for auditory sonar. NSMRL Report (In review).

Marshall, L. and Carpenter, S. (1988). Hearing levels of 416 submarine sonar technicians. NSMRL Report 1123.

Van Rooij, J.C.G.M., Plomp, R., and Orlebeke, J.F. (1989). Auditive and cognitive factors in speech perception by elderly listeners. I: Development of a test battery. J. Acoust. Soc. Am., 86, 1294-1309.

Van Rooij, J.C.G.M. and Plomp, R. (1990). Auditive and cognitive factors in speech perception by elderly listeners. II: Multisonite analysis (In review).

II. NEW START (D):

1. Title: Cancellation of active sonar transmissions from auditory sonar signals
2. Principal Investigator: Thomas E. Hanna, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Submarine Systems
Phone Numbers:
 Autovon: 241-2545
 Commercial: (203) 449-2545
Other Organizations involved: NUSC, NAVSEA, Massachusetts Institute of Technology Lincoln Laboratory

4. Navy need:

To cancel active surface sonar transmission from submarine sonar operator's headphones.

This need was identified at several meetings on low-frequency active sonar including one held at NSMRL 6 June 1990.

5. Problem/Objective:

To develop a prototype unit that eliminates active sonar transmissions from the sonar operators' audio signal.

Auditory sonar performance is expected to be impaired to an increasing extent due to the use of active sonar, particularly by surface ships (e.g., SURTASS, AN/SQQ-89I). It has already been reported that, due to the sound levels, submarine sonar operators have had to take off their headsets when their boat has operated in areas where these newer types of sonar are being used. The loss of auditory information is critical to operator performance. The proposed work would recover a high-quality audio signal by cancelling the high-amplitude active transmission from the operator's audio signal. This problem is more difficult for auditory than for visual signals because the operator will be aurally more sensitive to any distortions introduced by the cancellation algorithm. Thus, simpler techniques that might work well visually would be inadequate, or even inapplicable. The techniques examined must be designed to reflect auditory sensitivity and perceptual capabilities.

6. Technical Approach:

Preliminary results suggest that an analysis/synthesis technique of signal modification developed at Massachusetts Institute of Technology's Lincoln Laboratory would provide a good method of eliminating active sonar transmissions. In the proposed work, Lincoln Laboratory would be primarily responsible for algorithm and hardware devel-

opment. NSMRL would generate system requirements and evaluate the prototype in consultation with NUSC and NAVSEA. Approximately eight months would be required for the development of system requirements and the refinement of the analysis/synthesis (or alternative) technique to meet these requirements. Preliminary evaluations would be performed on synthesized and recorded signals. Six months would be required to develop hardware specifications and design that would implement selected algorithms for a programmable field prototype that could be used in at-sea evaluations with the capability to vary algorithm parameters for best performance. Hardware procurement, assembly, and software development would require twelve months. At-sea testing would be done in ten months.

7. Assessment of risk:

There is only a low level of risk associated with this project. The Lincoln Laboratory technique is well suited to these signals. Pilot efforts have been fairly successful using a simplified version of their technique.

8. Related activities:

The application is unique with no other similar efforts. Lincoln Laboratory has done some related work with speech interference.

9. Transition approach:

The device could be added as a black box to current submarine systems.

10. Resources required (Funding category 6.3):

	FY92	FY93	FY94
Funding required	400	400	400
Personnel Required			
Military Officer	0.0	0.0	0.0
Military Enlisted	0.2	0.2	0.2
Civilian Professional	0.5	0.5	0.5
Civilian Supporting	0.4	0.4	0.4
Total	1.1	1.1	1.1

Costs include: 1) contract with Lincoln Laboratory and 2) development workstation (FY93).

11. Current references:

"An approach to co-channel talker interference suppression using a sinusoidal model for speech." IEEE Trans. on Acoustics, Speech, & Signal Processing (T. F. Quatieri & R. G. Danisewicz, 1990).

"Speech transformation based on a sinusoidal representation." IEEE Trans. on Acoustics, Speech, & Signal Processing, Vol ASSP-34 p. 1449-64 (T. F. Quatieri & R. J. McAulay, 1986).

"Speech analysis/synthesis based on a sinusoidal representation." IEEE Trans. on Acoustics, Speech, & Signal Processing, Vol ASSP-34, p. 744-54 (R. J. McAulay & T. F. Quatieri, 1986).

II. NEW START (E)

1. Title: Development of revised acoustic habitability standards for active sonar platforms
2. Principal investigator: Paul F. Smith
3. Laboratory: Naval submarine Medical Research Laboratory
Department: Submarine Systems
Phone Numbers:
 Autovon: 241-2557/3201
 commercial: (203) 449-2557/3201

4. Navy Need:

Modern active sonars radiate intense tones into own-ships spaces. The Navy needs to prevent hearing loss in Naval crew members aboard vessels equipped with active sonars. Noise level criteria for berthing spaces are needed that will ensure recovery from auditory threshold shifts incurred while on duty in noisy spaces.

Relevant official documents that support the Navy need are:

OPNAVINST 9640.1 Shipboard Habitability Program.

OPNAVINST 5100.23B CHAPTER 18. HEARING CONSERVATION AND NOISE ABATEMENT

CNO ltr 0191 ser 03/8C580210 of 2 May 88

COMNAVSEASYS COM ltr 9073 OPR 55N2 ser 55N/334 of 22 Dec. 88

The research proposed herein addresses the Navy need by establishing, through experiment, the maximum ambient noise level for tones that does not interfere with recovery from noise-induced temporary auditory threshold shift.

5. Problem/Objective:

Many Naval vessels are equipped with active sonars that have the potential for in-sonifying shipboard spaces with tonals in frequency ranges that could interfere with human health. These developments raised concerns related to acoustic habitability of spaces aboard those platforms. Among the questions that have been raised are what ambient noise levels are appropriate for berthing spaces to permit recovery from noise-induced temporary hearing loss incurred while on watch (as in the engineering spaces).

During experiments at NSMRL and NOSC that were done to establish present habitability standards for vessels equipped with active sonar, the sound of interest (pings)

was the only intense noise to which the subjects were exposed. That is, the situation of an engineman who is exposed to much higher sound levels while on watch was not considered. If engine-room watch standers had incurred temporary threshold shifts (TTS) while on watch it is questionable that they would have recovered if berthed in a space subject to intermittent around the clock noise levels of 85 dB. In addition to engine rooms several other areas aboard submarines and warships are high noise level areas within which crew members may incur TTS.

In short, while the NSMRL and NOSC studies showed that TTS would not grow beyond insignificant levels from around-the-clock exposure to noise levels experienced in berthing spaces aboard a certain class boat, those experiments did not show that those levels were sufficiently low to permit crew members' ears to recover from other (non-sonar) noise exposure.

Despite many years of research on the topic, there remains considerable debate in the literature as to what constitutes effective quiet for purposes of recovery from noise-induced temporary threshold shifts. Although many experiments on asymptotic threshold shift have demonstrated that recovery of behavioral thresholds to pre-noise-exposure levels does occur even after many days of noise-induced threshold elevation, it is strongly suspected that chronic temporary threshold shifts eventuate in permanent hearing damage. Thus, if temporary threshold shifts which exist from noise exposure experienced while on duty are not permitted to dissipate because of excessive noise levels in off-duty spaces, some permanent hearing loss may be expected to develop. Yet, there is no consensus among scientists concerning how quiet is quiet. From prior experience it is known that ambient levels as low as 55 to 65 dB that are thought by many to constitute "quiet" are economically and operationally infeasible for many shipboard spaces. Thus, one can not look to the existing literature for a solution to the present problem. Present berthing-space noise levels were established on the basis that recovery from temporary auditory threshold shift is not impaired by ambient broad-band noise as high as 75 dB(A).

6. TECHNICAL APPROACH:

A series of experiments will be conducted in which TTS will be induced by broad band noise (fifteen minutes at 104 dB(A)) and recovery will be measured under several levels of berthing-space pings up to an including present permissible level of 80 dB for 3.5 kHz tones at low duty cycles. Results will be compared with a control condition in which berthing-space noise will be less than 65 dB(A). Duty cycle of the pings will be the maximum expected to prevail aboard present vessels (about 5%).

7. Assessment of risk

Present berthing space noise (ping) levels may leave some of the crew at risk of incurring permanent noise-induced hearing loss. The failure to take recovery processes into account may leave the Navy open to claims from former members who happen to exhibit hearing deficits.

8. Related activities:

This research is related to work being conducted at NSMRL to establish acoustic habitability standards for low-frequency active sonar platforms. There are a number DOD and civilian laboratories that conduct research on the effects of long-term noise exposure. Among these are the Aerospace Medical Research Laboratory at Wright-patterson AFB, the U.S. Army Human Engineering Laboratory at Aberdeen Proving Ground, the Callier Center for Communications Disorders, U. Texas at Dallas, the Hearing Research laboratory, U. Minnesota, etc. Formal and informal relationships are maintained with such groups through the Acoustical Society of America and the NAS/NRC CHABA. Those resources may be called upon for consultation and for providing additional professional manpower when needed.

9. Transition approach:

This research updates previous research. The results will be immediately implemented through appropriate guidance to the fleet (BUMED notice, etc.)

10. Resources required (Funding Category 6.3)

	FY92	FY93	FY94
Funding required	461	332	244
Personel required			
Military Officer	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0
Civilian Professional	1.0	1.0	1.0
Additional Manpower			
Civilian Professional	1.0	1.0	1.0
Civilian Supporting	2.0	2.0	2.0
Total	3.0	3.0	3.0

11. Current references:

1. Hamernik, R.P., Henderson, D., Salvi, R. eds. (1982) New perspectives on noise-induced hearing loss. Raven Press, New York.

2. Salvi, R.J., Henderson, D., Hamernik, R.P., and Colletti, V. eds. (1986) Basic and applied aspects of noise-induced hearing loss. Plenum Press, New York.
3. Kryter, K.D. (1984) Physiological, psychological, and social effects of noise. NASA Reference Publication 1115
4. Cantrell, R.W., (1974) Prolonged exposure to intermittent noise: audiometric, biochemical, motor, psychological, and sleep effects. *Laryngoscope*, suppl. 1, vol. LXXXIV no. 10, pt 2. 1-55.

II. NEW START (F)

This new start is classified and will be submitted under separate cover.

PI: J. S. Russotti

II. NEW START (G)

1. Title: Dynamic Visual Sonar Displays
2. Principal Investigator: Dr. Joseph DiVita
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Behavioral Sciences Department
Phone numbers:
 Autovon: 241-2528
 Commercial: (203) 449-2528
4. Navy need:

The sonar operator has too much disparate information which he must analyze and integrate into a coherent representation of the ocean world around him. Narrow band analysis offers the greatest resolution; however, there are simply too many bearings and too many frequencies which the operator must simultaneously monitor, in order to detect and identify contacts. The performance of the sonar operator may be greatly enhanced by a display that presents all the essential data simultaneously. The information must be presented in a denser but still complete format, that is, in a display that offers the operator a global view, yet still allows the operator the ability to analyze specific characteristics of the data.

5. Problem/Objectives:

The proposed new start will demonstrate the effectiveness of a 3-Dimensional data cube that contains all the sonar information. The x,y, and z axis of the 3-Dimensional space of the data cube are frequency, bearing, and time, respectively. Thus the x-z planes of the cube will contain the frequency - time data displays at each of the bearings, the x-y planes will contain the frequency - bearing displays at each segment in time, and the y-z planes will contain the bearing - time displays at each of the frequencies. A two dimensional projection of the cube is presented to the operator. There is static mode and a moving mode in which to display information. In the static mode, the average of all pixel intensities of one line of sight is presented. In the moving mode, the planes of data along one of three lines of sight - time, frequency, or bearing - are sequentially viewed so that a dynamic representation of the data is achieved. Targets changing with respect to the dimension sequenced will appear to move, whereas noise will appear as dynamic random dots with no particular coherent motion. The sonar operator controls, with a mouse, the perspective projection of the cube, and is able to window and clip data in the cube.

6. Technical Approach:

The human visual system is exquisitely sensitive to motion. No use is made of the visual system's motion. Currently, the way data is presented on sonar displays, detec-

tion of targets exploits the visual system's ability to detect patterns. No use is made of the visual's system motion detection mechanisms.

The psychophysical parameters of perceiving motion in dynamic noise must first be investigated. The conditions under which motion of targets may be perceived in a background of random dynamic noise must be specified. Once these parameters are specified, a dynamic display, as outlined in the objective section, can be built. For example, It is very difficult to obtain a frequency signature of contacts with high bearing rate, that is, contacts that are changing their bearing relatively quickly; hence their tracks do not appear in any one LOFAR DISPLAY. However, if the LOFAR DISPLAYS at each bearing are "flipped" through as in animation, the signature of the high bearing rate contact will emerge through the dynamic presentation of the data.

7. Assessment of Risk

Advances in the world of computer graphic and animation are now making it feasible to achieve dynamic displays on desk top computers. Certainly the applicability of this technology to visual sonar displays needs to be exploited. Specifically, color CRT monitors now have refresh rates above the human flicker fusion threshold. This makes it possible to utilize the human visual system's motion detection capabilities in order to detect and classify contacts.

8. NA

9. Transition approach

From the onset of this project there is a well defined product, the creation of which is the goal of the project, i.e. the 3-D data cube. Once the psychophysical parameters of the visual system's capability to detect motion in dynamic noise are known, actual sonar data may be tested in the data cube.

10. Resources required (Funding category: first year 6.1, second year 6.2, out years transition to 6.3 and 6.5.)

	FY93	FY94	FY95	FY96
Funding Required	300	325	350	375
Personnel Required				
Onboard personnel				
Military Officer	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0
Civilian Professional	0.8	0.8	0.8	0.8
Civilian Supporting	0.0	0.0	0.0	0.0
Total	0.8	0.8	0.8	0.8

Additional Personnel				
Military Officer	0.0	0.0	0.0	0.0
Military Enlisted	0.4	0.4	0.4	0.4
Civilian Professional	0.0	0.0	0.0	0.0
Civilian Supporting	1.2	1.2	1.2	1.2
Total	1.6	1.6	1.6	1.6

11. Current references: NA

II. NEW START (H)

1. Title: Human factors evaluation of non-penetrating periscope
2. Principal Investigator: Thomas P. Santoro, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Behavioral Sciences Department
Phone numbers:
 Autovon: 241-2445
 Commercial: (203) 449-2445

4. Navy need:

The Naval Sea Systems Command is developing a periscope (NHPP) which does not have an optical shaft penetrating the hull. Instead, the sensor information is displayed on CRT screens. The NHPP raises many human factors problems which must be resolved before optimal use of the NHPP can be achieved.

5. Problem/Objectives:

One problem is that of orientation: the operator of a conventional periscope can tell in which direction, relative to the submarine, he is looking simply by noting in which direction he is facing in the control room. There is no easy way of orienting the direction of the NHPP from the CRT display. Another problem is that it is not known if the best way to scan with the periscope is continuously or in a stepwise scan. Another problem is to determine which sensor or combination of sensors is best for a given target detection or recognition task. The objectives of this research will be to find solutions to these types of problems.

6. Technical Approach:

Periscope scenes will be simulated, and observers will search for targets on the display. They will scan by moving a trackball or joystick. To investigate the problem of orientation, the relative or true bearing of each target will be indicated in several ways, and, once the target is acquired, the speed and accuracy of the operator in determining its position will be measured. In addition to objective measures, we will obtain subjective ratings of the various methods. To investigate the scanning problem, the ability of operators to detect targets will be compared using continuous and stepwise scanning. Comparisons will similarly be made to determine the best combination of sensors under various conditions. Initial subjects will be laboratory personnel, but the final subjects will be submarine officers.

Specific recommendations will be made as to the best method of indicating orientation, of scanning, of combinations or sensors, and so on.

7. Assessment of Risk

There is no risk in these studies.

8. Related activities:

The Naval Aerospace Medical Research Laboratory and the Air Force Armstrong Aerospace Medical Research Laboratory are studying the use of multisensor displays in the closed cockpit where the pilot has no direct sight of the outside. We propose to pursue contacts at those laboratories.

9. Transition approach:

The development of the NHPP is being directed by NUSC/New London. Our results would be communicated to them for the purpose of incorporating our recommendations into the final design of the new periscope.

10. Resources required (Funding category: first year 6.1, second year 6.2, out years transition to 6.3 and 6.5.)

	FY93	FY94	FY95	FY96	FY97
Funding Required	250	275	300	290	290
Personnel Required					
Onboard personnel					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0	0.0
Civilian Professional	1.6	1.6	1.6	1.6	1.6
Civilian Supporting	0.8	0.8	0.8	0.8	0.8
Total	2.4	2.4	2.4	2.4	2.4
Additional Personnel					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0	0.0
Civilian Professional	0.0	0.0	0.0	0.0	0.0
Civilian Supporting	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	0.0

11. Current references: NA

II. NEW START (I):

1. Title: The Effects of Smoking and Tobacco Deprivation on Visual Functions: Implications for Military Operations
2. Principal Investigator: C. Schlichting, PhD.
3. Laboratory: Naval Submarine Medical research Laboratory
Department: Behavioral Sciences Department
Phone Numbers:
Autovan 241-2529
Commercial: (203) 449-2529
4. Navy need:

Naval operations are performed in a variety of different environments. These frequently include darkness or other low visibility situations that place extreme demands on the visual system. Piloting a plane, scanning the horizon for ships or planes at night and monitoring visual displays in lowlight conditions are three examples. Current Navy statistics show that 43% of Naval personnel are smokers and that the percentage of smokers is even higher on surface ships (50%). Together with the reduced capacity to perform physical work and other health effects, smoking may have both short and long term effects on several aspects of visual perception critical to navy operations. The literature however, reveals contradictory results which may be due to whether or not individuals were permitted to continue to use tobacco during testing. A recent Army sponsored review suggests that the tests of smoker, nonsmoker and deprived smoker differences on dark adaptation, ocular accommodation and convergence "could provide major payoffs of improved soldier and unit performance" (Dyer, 1986, p. 159).

The effects on visual functions appear to be the result of nicotine, and/or increased levels of carbon monoxide in the blood of smokers. Macular changes may also be induced. Night vision and accomodation are two functions that appear to be most affected. A less common, but equally important effect of extreme use of tobacco is the development of tobacco amblyopia. With this disorder individuals show demonstrable loss of central visual acuity and ability to discriminate colors. This major loss of visual function has additional implications for performance of military tasks requiring normal visual acuity. With cessation of the use of tobacco some recovery is found.

The results for the immediate effects of smoking on dark adaptation yield diverse effects. Sheard (1946) and McFarland (1970) both found poorer ability to dark adapt immediately following smoking. Several other authors have reported improved dark adaptation following smoking while still others found no effect. It is conceivable that in certain types of tasks tobacco users may actually show better performance.

The differences that are reported between smokers and nonsmokers occur even in young smokers. Such an effect was found by Luria and McKay (1979). Young smokers showed significantly worse dark adaptation than either young or older non smokers. One possible explanation for this result is ocular accommodation. At the close viewing distance used in this study it is conceivable that younger smokers were unable to accommodate for the viewing distance and therefore their performance was worse. This possible explanation is supported by work of Roberts and Adams (1980) who found smoking reduced the ability to accommodate for close viewing. Young and Erickson (1980) however, found that smokers take twice as long to dark adapt as nonsmokers. These differences in both absolute level of dark adaptation obtained and speed of dark adaptation are large enough to be important for any military operation in which dark adaptation or ability to focus are critical.

It remains to be determined however, whether many effects are the result of immediately preceeding smoking, smoking deprivation, or a longterm effect of smoking. Similarly if these effects are due to short term effects the time course of these effects is important; how long must an individual refrain from smoking for performance to improve becomes a critical question. If these effects are the result of long term smoking it would become important to select only nonsmokers for visual based tasks in lowlight or redlight conditions.

5. Objective:

The proposed work will determine whether effects on dark adaptation and other visual functions reported in previous studies are due to immediate preceding smoking or smoking deprivation, or are the result of long term and possibly irreversible changes in the the visual system. The implications of these findings for personnel selection and operational procedures will be determined.

6. Technical Approach:

Tobacco deprived and non-deprived users and nonusers will perform ocular accommodation, vigilance, visual acuity, contrast sensitivity, color discrimination and dark adaptation tasks. Aged matched user and nonuser populations will be employed. The data will be analyzed to determine what performance differences occur in ocular accommodation and visual functions in young smokers as a result of smoking and smoking deprivation and whether performance on specific tasks is better or worse than that of tobacco nonusers. @LIST = Anticipated Product: Specific recommendations for use of tobacco products during military operations; selection criteria for critical personnel performing demanding visual tasks.

7. Assessment of Risk:

There are no known problems that would inhibit research success. This is not a high risk project.

8. Related Activities:

This Laboratory has recently performed related work for the US Coast Guard pertinent to the design of new beacons.

9. Transition Approach:

Guidelines for tobacco use/nonuse could be promulgated to the Fleet immediately.

10. Resources required (Funding Category 6.2)

	FY92	FY93
Funding Required	115	115
Personnel required		
Military Officers	0.2	0.2
Military Enlisted	0.0	0.0
Civilian professional	0.8	0.8
Civilian Support	0.8	0.8
Total	1.8	1.8
Additional personnel:	None	
No major equipment will be purchased.		

11. References:

Dyer, F. Smoking and soldier performance: a literature review. USAARL Report No. 86-13.

Luria, S. and McKay, C.L. 1979. Visual processes of smokers and nonsmokers. Archives of Environmental Health. 34:449-454.

McFarland, R.A. 1970. The effects of small quantities of carbon monoxide on vision. Annals of the New York Academy of Sciences. 174: 301-312.

Roberts, J.D. and Adams, A.J. 1969. The short term effects of smoking on ocular accommodation and pupil size. Journal of the American Optometric Association. 40:528-530.

Sheard, C. 1946. The effects of smoking on dark adaptation of rods and cones. Federation Proceedings. 5:94.

Young, H.R. and Erickson, J.A. 1980. Effects of combat vehicle interior light colors on dark adaptation and detection by night vision devices. US Army Tank-Automotive Research and Development Command Laboratory Technical Report No. 12485. 1-24. Warren MI.

NEW START (J):

1. Title: Development of a portable test to determine fitness for duty.
2. Principal Investigator: C. Schlichting, PhD.
3. Laboratory: Naval Submarine Medical research Laboratory
Behavioral Sciences Department
Commercial (203) 449-2529
Autovon 241-2529
4. Navy need:

There are many internal and external factors that may affect performance to the point where individuals are no longer capable of safely and effectively performing their jobs. These include, but are not limited to, alcohol use, sleep deprivation, physical fatigue, heat stress, illicit drug use, and prescribed or over-the-counter pharmaceutical preparations. There are many circumstances in which missions could easily be jeopardized by inadequate performance on the part of one or more individuals.

Currently there is no objective means of determining whether an individual is capable of performing his/her job. There is a need for a test that could be rapidly and reliably administered in different environments. Such a test could greatly enhance the safety and effectiveness of personnel in critical positions. As required by the particular mission or job category, tests could be administered before duty commenced and also during performance of duty as conditions that might cause deterioration in performance worsened. Impaired persons could be removed from duty before personnel were injured or hardware damaged by faulty decisions or performance. This type of test could also be used to measure the effectiveness of protection against chemical or biological warfare.

Development of this form of testing has several advantages. It can provide an objective determination of an individual's fitness for duty. It does not require that the underlying cause of performance decrements be specified. Additionally results of the test would be immediately available. The test chosen however, must be reliable, valid, and sensitive; test results must be easily interpreted.

There are currently no performance, motor or physiological tests of fitness for duty testing available to the tri-services. Particularly there are no tests available for small handheld computers that could be used in multiple environments.

5. Objective:

To develop a test of fitness for duty to be used in various military environments that can be easily and rapidly administered using a lightweight battery operated hand held computer.

6. Technical Approach:

The proposed work will evaluate several computer administered tests of physiological, perceptual, cognitive, information processing and motor function for possible adoption. If necessary, new tests will be developed. Validity, reliability and specificity of the proposed test or tests for specific tasks will be determined. Ease of administration, time required for completion and interpretation will also be heavily weighted in the evaluation. Ideally one rapidly administered test will be sufficient for most situations.

Tests that have been shown to be sensitive to various neurotoxicological insults will be evaluated first. These include compensatory tracking, mathematical processing, digit symbol substitution, pattern comparison, Manikin and measures of heart rate and peripheral blood flow.

Initially dose-response curves will be assessed for two substances known to affect performance, alcohol ingestion and the use of antihistamines. Blood or urine tests will be performed to determine physiologically active levels of these substances. After selection of tests population means and standard deviations for unimpaired performance will be developed for each test on the appropriate military populations. The applicability of performance and physiological testing for other specific stressors such as chemical warfare or heat stress can be determined as the need develops.

Anticipated Product: Specific recommendations for tests to be used to determine fitness for duty under given conditions will be developed. As an end product portable, reliable and valid versions will be produced.

7. Assessment of Risk:

There are no known problems that would inhibit research success. Although the payoff would be high, this is not a high risk project.

8. Related Activities:

Research on the AGAARD-Stress and UTC-PAB batteries is related but these tests have not been evaluated or developed as measures of fitness for duty. Additionally standardized versions of these tests are not available nor are versions available for small handheld computers. These two batteries do not include compensatory tracking or measures of heart rate and peripheral blood flow. A commercial version of a tracking task implemented on an IBM compatible PC is currently being pilot tested in the transportation industry for personnel screening.

9. Transition Approach:

The research funding category is 6.2 with probable transition to 6.3 or 6.4 for development of the actual test device in outyears.

10. Resources required (Funding Category 6.2)

	FY92	FY93	FY94
Funding Required	250	250	250
Personnel required			
Military Officers	0.8	0.8	0.8
Military Enlisted	0.0	0.0	0.0
Civilian professional	0.8	0.8	0.8
Civilian Support	0.8	0.8	0.8
Total	2.4	2.4	2.4
Additional personnel:			
Military Officers	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0
Civilian professional	0.0	0.0	0.0
Civilian Support	0.8	0.8	0.8
Total	0.8	0.8	0.8

Portable computers must be purchased to obtain performance and physiological data. The commercial version of the tracking task will be purchased and evaluated. Clinical laboratory tests will be needed to measure blood or urine levels of related biochemical compounds.

11. References: NA

II. NEW START (K)

1. Title: Effect of color-coded CRT displays in the control room on night vision sensitivity.
2. Principal Investigator: S. M. Luria, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory,
Department: Behavioral Sciences Department
Phone numbers:
Autovon: 241-2527
Commercial: (203) 449-2527
4. Navy need:

An increasing number of color-coded CRT displays will soon be found on submarines. Those in the control room will be significantly brighter than the back-and-white displays they will replace. The latter can be dimmed to a considerable extent and still present their information to the operator. Color-coded displays cannot be dimmed too much without losing the color and, thus, the information the colors convey. The brighter displays will produce considerably more light in the control room which is typically "rigged for black" when the submarine is at periscope depth at night. The extent to which such CRTs will affect the dark adaptation of the crew should be determined.

5. Objective:

To measure the effects on night vision sensitivity of having to work in a compartment with various numbers of CRTs with colored displays.

6. Technical Approach:

The night vision threshold will be measured for each subject. He will then be exposed to a compartment containing color-coded CRTs, after which his night vision sensitivity will again be measured. The number, size, and brightness of the CRTs will be systematically varied, as will the duration of exposure. The subject's sensitivity will be compared to its initial state in each case.

The extent to which night vision sensitivity will suffer as a result of exposure to various combinations of color-coded CRTs in the control room will be specified. The extent to which an observer's eyes must be shielded in order to maintain dark adaptation will be determined.

7. Risk: None.

8. Related Activities:

The most closely related work has been our own on visibility through the periscope.

9. Transition Approach:

The findings will be immediately applicable by the designers of the control room or the control room personnel.

10. Resources required:

	FY92	FY93
Funding Required	172.5	150.7
Personnel required		
Onboard personnel		
Military Officer	0.0	0.0
Military Enlisted	0.0	0.0
Civilian Professional	0.4	0.4
Civilian Supporting	0.5	0.5
Total	0.9	0.9
Additional personnel		
Military Officer	0.0	0.0
Military Enlisted	0.0	0.0
Civilian Professional	0.4	0.4
Civilian Supporting	0.0	0.0
Total	0.4	0.4

11. References:

S.M. Luria and J.A.S. Kinney, The interruption of dark adaptation. NSMRL Rep. No. 347, 1961.

S.M. Luria, J.A.S. Kinney, C.L. Schlichting, and A.P. Ryan, The limiting effects of astigmatism on visual performance through periscopes. NSMRL Rep. No. 905, 1979.

II. NEW START (L)

1. Title: Validation of a sonarman selection test.
2. Principal Investigators: S. M. Luria, Ph.D. and Christine Schlichting, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory,
Department: Behavioral Sciences Department
Phone numbers:
 Autovon: 241-2527
 Commercial: (203) 449-2527

4. Navy need:

When NSMRL was founded, its original goal was to develop a selection test for sonarmen. Fifty years later, the need still exists-- in view of the high costs of sonar school-- to be able to select those men who will make the most competent sonarmen. Ten years ago NSMRL developed a sonarman selection test battery which was subjected to a preliminary validation. In 1984, a cross-validation study was begun. We now propose to conclude that study.

5. Objective:

To develop a selection test for sonar school candidates

6. Technical Approach:

1984 an entering class of about 100 men at the sonar school, San Diego, took the NSMRL Sonarman Selection Battery. Their scores on this test battery will be correlated with the ratings of sonarmen by their peers, supervisors, and officers and with the career milestones (promotions, medals, awards, etc.) of those men who are still in the Navy. If possible, the records of those men who have resigned from the Navy will also be considered.

Eventual Product: A selection test for sonar school candidates

7. Risk: None

8. Related activities:

Selection tests are a pervasive feature of the military scene.

9. Transition Approach:

If these results are positive, a definitive study should be carried out leading to a valid selection test.

10. Resources:

	FY92
Funding required:	121.1
Personnel required	
Military Officer	0.0
Military Enlisted	0.0
Civilian Professional	0.6
Civilian Supporting	0.3
Total	0.9
Additional personnel	
Military Officer	0.0
Military Enlisted	0.0
Civilian Professional	0.0
Civilian Supporting	0.0
Total	0.0

11. Reference:

J.A.S. Kinney, D.F. Neri, A.P. Ryan, and C. L. Schlichting, Predicting proficiency on visual sonar displays: validation of a test battery. NSMRL Rep. No. 994, Jan. 1983.

II. NEW START (M)

1. Title: Comparison of operability of different joysticks and trackballs

2. Principal Investigator: S. M. Luria, Ph.D.

3. Laboratory: Naval Submarine Medical Research Laboratory,
Behavioral Sciences Department

Phone:

Autovon 241-2527

Commercial (203) 449-2527

4. Need:

A large number and variety of joysticks and trackballs are commercially available. Eleven such joysticks were demonstrated to the committee set up to develop the new non-penetrating periscope. All have different human factors characteristics-- the pressure required, the excursion of the cursor in response to a given movement of the stick, the movements required for diagonal movement of the cursor, etc. Operators manipulate a joystick for long periods of time. Yet the accuracy of control and the amount of fatigue produced by each stick have not been measured.

5. Objective:

To compare the ease and accuracy of operation of a selection of joysticks and trackballs.

6. Technical Approach:

Subjects will view CRT displays requiring specific cursor adjustments such as would be required to lock on and track a target. Accuracy and speed will be measured, and subjects will rate the degree of fatigue at the end of each session.

Product: Determination of optimal joystick for various tasks

7. Risk: None

8. Related activities:

All human factors studies of speed and accuracy of eye-hand coordination are related.

9. Transition Approach:

The information would be available for designers incorporating joysticks in their equipment.

10. Resources required:

	FY92
Funding required	132.0
Personnel required	
Onboard personnel	
Military Officer	0.0
Military Enlisted	0.0
Civilian Professional	0.6
Civilian Supporting	0.1
Total	0.7
Additional personnel	
Military Officer	0.0
Military Enlisted	0.0
Civilian Professional	0.0
Civilian Supporting	0.4
Total	0.4

11.References: NA

II. NEW START (N)

1. Title: Naval Medical Informatics Center -- NAMIC
2. Principal Investigator: D. M. Stetson, CAPT
3. Laboratory and Department: Naval Submarine Medical Research Laboratory
Behavioral Sciences Department
Phone:
 AV 241-2523
 COMM (203) 449-2523
4. Navy need:
 1. Improved patient care and reduced administrative burdens on providers within existing assets.
 2. Centralized focus for medical informatics in the Navy.
 3. Focus for medical software development and testing.
5. Objective:

Improve practice quality for providers, enhance patient care, reduce medico-legal risks, and improve patient understanding and compliance regarding their care by bringing state of the art computer capabilities to the service of medical professionals.
6. Technical Approach:

Through evaluation of existing medical software, management of contracts to create new software products meeting specific requirements and in-house development and testing of hardware/software systems, the project will create an integrated medical care provider oriented medical practice supports system. The approach will emphasize:

 - 1) Gathering, refining and validating user requirements.
 - 2) Formal, dynamic system specification.
 - 3) Rapid prototyping with expert review and usability testing.
 - 4) Formal hardware/software quality assurance techniques.
 - 5) Modular programming and integration under uniform interface.
 - 6) Mainstream language to facilitate transition and maintenance.

Expected products: Full featured, integrated, micro-computer based multi-media system which supports medical provider needs by intelligently evaluating user inputs and stored information to instantly offer the user access to a wealth of medical reference material, expert system based diagnostic assistance and patient care review, and complete medical record keeping. Features will include:

- 1) Utilization of artificial intelligence and plain language recognition permitting background operation to minimize system demands on the user and allowing a single system to serve users with different skill levels working in facilities with different capabilities and limitations.
- 2) Multi-media capabilities including high resolution still and animated graphics, TV images and simultaneous sound.
- 3) Extensive library of text, images and sound providing information on medical conditions and procedures.
- 4) Voice recognition for data input and spoken responses.
- 5) Dynamic, interactive continuing medical education.
- 6) Patient tailored output including interactive patient education.
- 7) Complete patient record documentation.
- 8) Data exchange capability with other federal medical computer systems.

A system featuring intelligent review of user input and offering tailored diagnostic assistance, patient care review and patient education material will be completed in 2-3 years; a fully functioning system with full voice and medical language recognition will be complete in 5 years.

7. Assessment of risk:

With the exception of medical language and voice recognition the likelihood of success is very high. Much of the needed technology is available, requiring only focused integration and testing.

Intelligent recognition of medical language and of voice are greater risks, reduced somewhat by the widespread availability of microcomputers with enormous computing power and several academic centers and industrial concerns devoting effort to these areas.

8. Related Activities:

NSMRL: Subscreen psychologic testing program; usability testing program. Auditory sonar program (enhancing speech recognition).

NHRC: Cooperation in MEPSS development, DNBI database, NOHIMS database.

CONTRACTORS:

APL: Cooperation in MEPSS development, neural network expertise, experience in language and voice recognition.

OTHERS (involved in knowledge base development): NW Research Associates, Seattle; Medical College of Pennsylvania, Philadelphia; University of Missouri-Columbia School of Medicine, St. Louis; Cyometrics, Bel Air, MD; University of Leeds, Leeds, England; Southern Illinois University; Harvard University Medical School, Boston; and others.

ANTICIPATED INTERACTION. None of the other people in this field are developing products aimed at assisting the physician or non-physician medical provider practicing in isolated situations, small clinics or the general outpatient setting of hospitals. However, each of them is a useful resource for specific products and expertise. The availability of these related activities substantially lowers the risk of this effort.

9. Transition Approach:

Everything envisioned under this proposal can be immediately applied to physician and non-physician providers in the fleet, isolated practice and general outpatient practice. Everything envisioned under this proposal has immediate industrial applicability (at the medical clinic level). Transition for cooperative development will be easy, and licensing opportunities are very real.

10. Resources Required (Category: 6.3)

	FY92	FY93	FY94	FY95	FY96
Funding Required	802.5	802.5	802.5	802.5	802.5
Personnel required					
Onboard personnel					
Military Officers	1.0	1.0	1.0	1.0	1.0
Military Enlisted	2.0	2.0	2.0	2.0	2.0
Civilian Professional	3.0	3.0	3.0	3.0	3.0
Civilian Supporting	2.0	2.0	2.0	2.0	2.0
Total	8.0	8.0	8.0	8.0	8.0

Additional personnel: None

Equipment: computer equipment/software/maintenance

11. Current references:

Lee K., Hauptmann A., Rudnick A., "The Spoken Word", in BYTE, July 1990.

Kowarski D., "A Low-Cost Personal Computer-Based Radiology Diagnostic Expert Wywtem and Image and Text Database", Proceedings of the Third Annual IEEE Symposium on Computer-Based Medical Systems, June 1990.

Morelli R.A., Bronzino J.D., Goethe J.W., Hartmann-Voss K., "Incorporating a Language/Action Design Perspective into a Computer-Based Psychiatric Alerting System", Proceedings of Thirteenth Annual Symposium on Computer Applications in Medical Care, November 1989.

Mahon M.J., "The PC: A Tool for Integrated Information Management", in Proceedings of the American Society for Information Science Mid-Year Meeting, May 1990.

Kelly-Bootle S., "The human-appliance interface", in Computer Language 7:117-22, January 1990.

II. NEW START (O):

This new start is classified and will be submitted under separate cover.

PI: P. Smith

II. NEW START (P):

1. Title: Biological effects of transmitting sonars.
2. Principal Investigator: A. B. Callahan, Ph.D.
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Biomedical Sciences Department
Phone Numbers:
Commercial: (203)449-2539
Autovon: 241-2539
Other Organizations involved: None
4. Navy needs:

Currently employed transmitting sonars aboard Naval vessels vary widely in their output characteristics and intended use. Ultra-sonic sonars such as the AN/SQQ-14, AN/SQQ-30 and AN/SQQ-32 countermine series are used for mine detection and classification, whereas sonars with outputs in the audible frequency range such as AN/SQS-23, AN/SQS-26, AN/SQS-53 and AN/BQQ-5 are used for long range detection and classification of sub-surface vessel activities. The sonars also differ in their transmitting power capability as well as employing differing operational frequencies. Collectively, the transmitting sonars used by Naval vessels are capable of injecting signals composed of a myriad of combinations of amplitudes and frequency components into their aqueous environs. There has been little investigation of the possible hazardous effects of exposures of divers to these sonar transmissions.

5. Problem/Objective:

The paucity of relevant information was recognized by NAVMINEWARCOM, and NSAP was requested by them to fund a study aimed at providing guidelines concerning safe diving distances from mine hunting sonars, and the potential biohazards associated with underwater exposure of EOD divers to ultrasonic sonar transmissions. The NSAP tasking was given to NSMRL (NSAP Task CMWC-1-86, Safe Diving Distances). Research commenced 1 OCT 86 and a final report was submitted to the NSAP office, White Oak, MD, 27 SEP 87. Unfortunately, the data collected and extrapolated under the NSAP tasking only begins the process of elucidating the potential bio-hazards associated with underwater exposure to sonar transmissions. The NSAP funded research concerned itself only with ultrasonic mine hunting sonars which operate at a much higher range of frequencies than those employed by more common subhunt sonars. Also, the tasking required that we determine conservative safe diving distance recommendations as they apply to EOD operations. These operations usually take place at considerable distances from the transmitting sonar transducers, with exposure time limited by the duration of the mine de-activation task. The ultrasonic nature of the countermining warfare sonars enabled prudent standards for exposure limits to be determined using predictive modeling techniques. These were derived from extrapolations from the vast library of information con-

cerning the effects of exposure to clinical diagnostic and therapeutic ultrasound. The NSAP work provides little guidance directly applicable to the potentially hazardous effects of underwater exposures to high amplitude audible (low) frequency sonar transmissions. No corresponding data base of biomedical effects at these relatively low frequencies exists apart from that concerned with hearing conservation. Finally, even for ultrasonic sonars, our direct work yielded little information or predictive guidance concerning the possible bio-effects from an additive effect of repeated acute or continuous chronic high amplitude ensonification, or from possible interactions between ensonification and the changing levels of gas saturation which would be anticipated in ascending or descending divers. As long as divers are presented in the water when active sonar is in use there is a cause for concern for their safety and well being. These concerns extend beyond EOD divers to other military divers working in areas where sonar is in use, or where tests are being conducted. Additionally, the Navy must also be concerned for the safety of civilian sport or salvage divers who may be inadvertently subjected to high power active sonar ensonification. The answers to the questions encompassing diver safety in waters where active sonar is in use are of such paramount and universal importance that it is surprising to find such a scarcity of relevant information.

The research effort will examine the effects of exposure to sonar transmissions emanating from all active sonars currently in use as well as those to be deployed in the near future by the U.S. Navy, in order to develop safe distance diving standards from the sonars. In addition, it will determine the nature of the bio-hazards which could be encountered when divers are exposed to the sonar transmissions.

6. Technical Approach:

In general, two main systematic approaches will be used. One approach, using human diver subjects, will focus on the effects of acute sonar ensonification and the ensuing degree of threat to Navy and civilian divers. This research will be primarily directed toward elucidation of the biological risks which are anticipated as a matter of standard operating procedures and will answer questions that directly concern diver health and mission readiness. The second approach will focus on the assessment of bio-effects produced by acute, repeated acute and chronic high amplitude ensonification of laboratory specimens including animal-derived tissue and blood samples as well as cultured cell specimens. While the first approach will yield expedient answers to questions concerning safe diving practices in typical operating scenarios, the tissue and cellular experimentation will allow us to determine the predicted absolute limits at which hazardous bioeffects of sonar ensonification would be anticipated.

The technique to be used for assessing the damaging potential of sonar ensonification on human divers will employ standard hearing conservation methodology, and stress telemetric techniques. Because the cochlea is believed to be the most sensitive organ to high amplitude vibration, an assessment of the predictive indices of hearing loss by underwater sonar stimulation is probably the most sensitive and conservative measure of physiological damage possible. In the hearing conservation studies, divers will be exposed to sonar frequency stimulation at reversed-incremental distances from the source transduc-

ers at varying depths. Temporary auditory threshold shifts will be compared to those obtained at 1 ATM air to determine if damage risk criteria obtained at 1 ATM also hold true for submerged divers. In other experiments divers will be telemetrically monitored for changes in respiration, heart-rate, blood pressure and changes in blood oxygen saturation as a measure of stress as a function of distance from outputting sonar transducers. Additionally, blood and urine samples will be chemically analyzed for catecholamines and other stress related neurohumors. Finally, the results of these experiments will be analyzed and integrated in order to establish conservative safe diving guidelines for general operational use.

In order to develop an understanding of the relationships between underwater acoustic exposure conditions and the production of physiological damage it is necessary to use small, appropriate and easily maintained specimens which can be subjected to ensonification levels high enough to produce biological effects and damage. Biological effects will be assessed as a function of frequency and amplitude of the ensonifying stimulus as well as the degree of gas saturation induced by fluctuating atmospheric pressure. These studies will be conducted so as to allow the investigation of both the primary effects of the frequency of the stimulation, its amplitude, and the equivalent atmospheric pressure of the medium as well as the interactions among the three variables. All ensonification exposures will be conducted using a portable ensonification bioeffects testing facility which will allow manipulation of stimulation frequency and amplitude, and which can be ported into a hyperbaric chamber for control of atmospheric pressure. Following the sonic exposures we will examine the preparations for disruptions or damage which may have been caused by acoustic stressors (e.g., transient cavitation, acoustic microstreaming, rectified diffusion, etc) using electron microscopic and other ultrastructural analysis techniques as well as tests of physiological functioning developed at this laboratory.

7. Assessment of risk: None

8. Related activities: None

9. Transition approach:

Results of the research should be directly applicable to the evaluation of the biological risk associated with exposure to high amplitude sonar ensonification. The results will also have carryover implications for other operational questions concerning diving suit and equipment design and applicability of high amplitude acoustic fields for defense against swimmer attack.

10. Resources required (6.3)

	FY92	FY93	FY94	FY95	FY96
FUNDING					
Personnel/Overhead	190	200	260	275	290
Contracts	220	160	105	70	70
Automatic Data Processing	50	30	10	10	10
Equipment	175	75	20	20	20
Supplies	10	15	15	15	15
Travel (Data Collection)	25	40	10	10	10
Travel (Consultants)	10	10	10	10	10
Travel (Subjects)	10	10	0	0	0
Ensonification Laboratory	50	25	10	10	10
GRAND TOTAL	740	565	440	420	435
CONTRACTS					
Acoustic Attenuation Modeling	110				
Acoustic Attenuation Computer	0	50			
Transducer Development	80	40	35		
Electron Microscopy	10	20	20	20	20
External Pathology	0	10	20	20	20
Animal Services	20	20	20	20	20
Consultants	0	10	10	10	10
EQUIPMENT					
Telemetry Apparatus (5X)	100				
Ensonification Laboratory	50	50			
General Purpose	25	25	20	20	20
Personnel Required					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	1.6	1.6	1.6	1.6	1.6
Civilian	1.2	1.2	1.2	1.2	1.2
Additional Personnel					
Civilian Professional (GS13/14)	0.8	0.8	0.8	0.8	0.8

11. References:

1. NAVSEAINSTRUCTION 3150.2, OPR OOC32 dtd 10 Mar 1989
2. LTR CDR, NAVSEA to Distribution, 10560, OPR: OOC31A, Ser OOC/3247 dtd 4 May 1989
3. LTR CO, NMRDC/CO, NSMRL, 3900, NMRDC-401, dtd 28 Aug 1984.

II. NEW START (Q):

1. Title: Effects of Multiple Stressors on Physical and Mental Performance in Fire Contaminated Compartments
2. Principal Investigator: Claude A. Harvey, CAPT, MC, USN; Co-Investigator: Dr. Arthur B. Callahan
3. Laboratory: Naval Submarine Medical Research Laboratory
Department: Biomedical Sciences
Phone Numbers:
 Autovon: 241-3410
 Commercial: (203) 449-3410
4. Navy need:

There are three major requirements to which this work is addressed. The first is established under the cognizance of ADDDRE(T&E). The U.S. Congress has passed legislation (Chapter 139 of Title 10, Section 910 of the United States Code) requiring vulnerability and lethality testing of selected major weapons systems prior to full scale production. The primary emphasis of the Live Fire Testing program is on realistic testing as a source of personnel casualty, vulnerability and lethality information which takes into account the susceptibility to attack and vulnerability of the combat system. The Assistant Deputy Director Defense Research and Engineering (Test and Evaluation) (ADDDRE(T&E)) has provided the funds for preliminary studies in this area at NSMRL. AD-DDRE(T&E) also sponsored a work-shop on live fire Test-Crew Casualty Assessment at NSMRL on 18-19 Oct. 1988.

The second requirement for this program is established by the Ship Survivability Program with OP-03C2 as NAVOP Coordinator for Survivability. A specific goal of this program is to develop methods to deal with major interior ship conflagrations, to integrate newly developed items, including new fire retardant materials for damage control and firefighting. The final goal of this program is to provide for advanced damage control and firefighting concepts for new ship designs. OP-03 sponsored and funded a Workshop on the Effects of Combined Fire Products on Human Physiological and Psychological Performance at NSMRL on 16-18 Nov. 1987. A NAPDD for Active Firefighting Initiatives (NAPDD #218-03) has been approved and promulgated for this program.

The third requirement for information derived from this program is established under a Tentative Operational Requirement for Damage Control Management Systems (promulgated 9/14/88 by OP-098). Included among the capabilities derived by this TOR are the need to diagnose problems in order to minimize, localize, and limit casualties; monitor and verify casualties; and monitor and verify casualty resolution. In the context of this TOR, a casualty refers to combat operational systems, e.g., missile

launch, propulsion, communication as well as considering the crew component as a specialized combat operational system.

5. Problem/Objective:

The output of this study will document the dose thresholds at which several commonly encountered fire-produced stressors, alone and in combinations, produce decrements in mental and physical performance. Stressors include exposures to elevated carbon monoxide, low oxygen, elevated carbon dioxide, heat and work loads. Performance of unprotected individuals and individuals in survival or fire fighting equipment will be investigated selecting the appropriate stressors for the degree of protection.

This research seeks to assess the physiological and psychological (mental acuity) effects incurred by damage control and firefighting personnel when exposed to the multiple stressors expected in operational combat scenarios. It is intended that a quantitative assessment technique will be developed which will incorporate environmental stressors and physiological responses to these stressors into a predicted value for personnel response capability. There are a variety of potentially applicable modeling techniques which can be applied to this task. Among these are the Coburn-Foster-Kane model, the Fractional Effective Dose Model and the N-Gas Model. All of these models are suitable to accommodate a variety of environmental stressors and physiological responses. However, there is insufficient data in the literature on the physiological effects of multiple stressors with which to exercise the models.

6. Technical Approach: The research program has been planned for three phases:

Phase 1 is concerned with the establishment of presumptive baseline values for performance decrement, as a function of dose for each stressor and the selection of proper performance tests to reflect decrements of decision-making and mental acuity. Literature searches provide much of this information. A parallel effort will develop models for predicting decrements in mental acuity and physical performance based on physiological responses to multiple stressors. After the determination of presumptive baseline values, human pilot studies will be performed for validation and refinement of the research protocol for each stressor.

Phase 2 will consist of full scale studies using human volunteers. The research protocol will use a "step-up" approach of exposure to mixed stressors, as recommended by the 1988 Workshop scientific panel. In this approach, exposure to an additional stressor will be administered additively in an ascending concentration to the previously determined concentration of stressor (or stressors), which produced minimal performance decrement.

This proposal does not include examination of additional fire gas products such as HCN and HCL but further experiments could be performed on animals and the results extrapolated to the human model.

Phase 3 is concerned with gathering data and the application and validation of the research results in operational scenarios. This will be accomplished through a joint effort with the Naval Research Laboratory (NRL). These studies will be performed at the large-scale fire test facility at Mobile, Alabama, where the capability exists for monitoring human performance and pertinent environmental parameters (fire gas concentration, smoke, heat, mass loss and rate of build-up) useful in predicting physiological responses and performance, particularly for individuals wearing protective equipment. This phase of the work will be primarily under the direction of NRL. A joint report on the final results of this research program will be made with NRL.

7. Assessment of risk:

The limits for ship survivability and combat systems operations during fires are obviously affected by human performance. The tolerable limits of fire by-products as they infiltrate into vital shipboard spaces affects several areas: combat systems design; sensor settings for new compartment monitoring systems; equipment for appropriate personnel protection; permissible flammable materials (fire loading) included on combat platforms; life support systems; fire sensor design; human tolerance standards; and damage control/firefighting protocols. Models to predict human physiological responses and performance are difficult but not impossible to develop and test. The investment of time, money and resources in this program seems fully justifiable within the goals of ADDRE(T&E), OP-03C2, and OP-098.

8. Related activities:

This area is not being addressed by civilian sector, which is more concerned with fire by-product lethality and time to escape, rather than with continuing or reestablishing operations as quickly as possible. Cooperative efforts with NRL are discussed under "Technical approach."

9. Transition Approach:

The information can be used immediately in evaluating the vulnerability of present and future combat systems. Stay times, protection requirements, sensor design/settings, and damage control techniques can incorporate pertinent information immediately for systems under design and within several months to a few years for operational systems.

10. Resources required: The research seems appropriate for the 6.3 funding category.

	FY92	FY93	FY94	FY95	FY96
Funding required	308	323	340	357	103
Personnel required					
Onboard personnel					
Military Officer	0.5	0.5	0.5	0.5	0.4
Military Enlisted	0.4	0.4	0.4	0.4	0.0
Civilian Professional	0.5	0.5	0.5	0.5	0.4
Civilian Supporting	1.0	1.0	1.0	1.0	0.2
Total	2.4	2.4	2.4	2.4	1.0
Additional personnel					
Military Officer	0.0	0.0	0.0	0.0	0.0
Military Enlisted	0.0	0.0	0.0	0.0	0.0
Civilian Professional	0.5	0.5	0.5	0.5	0.5
Civilian Supporting	0.5	0.5	0.5	0.5	0.5
Total	1.0	1.0	1.0	1.0	1.0

11. Current References:

1. Proceedings of the Live Fire Test Crew Casualty Assessment Workshop. Office of the Director, Defense Research and Engineering (LFT), Washington, D.C., 1988.
2. Fire and Smoke: Understanding the Hazards. Committee on Fire Toxicology, Commission on Life Sciences, NAS-NRC, National Academy Press, Washington, D.C., 1986.
3. Complex Mixtures: Methods for In Vivo Testing. Board on Environmental Studies, Commission on Life Sciences, NAS-NRC, National Academy Press, Washington, D.C., 1988.
4. Purser, DA. Modelling Toxic Fire Hazards in Fires. In "International Progress in Fire Safety." Proceedings of the Fire Retardant Chemicals Association Meetings, 101-130, 1987.
5. Tikuisis, P., Meatal, HD, Gell, BJ, Lewis, WF, Cox, KN, and Kane, DM. A Critical Analysis of the Use of the CFK Equation in Predicting COHb Formation. Am Ind Hyg Assoc J, 48(3): 208-218, 1987.

II. NEW START (R):

1. Title: Submarine/Shallow Decompression Problems
2. Principal Investigator: C. L. Shake; P.K. Weathersby

A. Submarine Rescue Maintenance Research Need:

With delivery of a usable Pressurized Submarine Rescue Manual slated for the end of 1991, the level of effort on that task can decrease, but not disappear. Follow-on work is necessary, especially on aspects of fleet implementation of laboratory tested procedures. For example, how are Trimix decompression procedures to be accomplished on ASR-21 and -22 without a mass spectrometer to monitor gas composition? What changes in procedures for gas switches and monitoring will be required by use of the (still undelivered) DSRV-DDC mating assembly? What combination of upward excursion and slow decompression is most suitable for SSN-637 MOSUB forward compartment use as a saturation chamber? What training program should be developed for medical and operational personnel on AVALON, MYSTIC, ORTOLON and PIGEON?

Approach: About two saturation dives per year will be devoted to this effort. The present cooperative arrangements with operational saturation diving commands will be expanded. Staffs of those commands will join in the planning, as well as the execution, of future saturation dives. As appropriate, one dive per year will be an "away game" conducted on ORTOLON, PIGEON, an SSN, or an Allied platform. Problems arising from those exercises will be subject, if necessary, to additional laboratory research before further field testing.

Products: Major revision to Submarine Rescue Manual every two years - Cadre of trained personnel in Submarine Rescue Operations

B. Mainline Saturation Diving Research Need:

Human hyperbaric research is typically limited by subject number. Binary outcome studies like decompression table testing and UBA rig failure studies obtain only a single bit of data per subject. For those and other dry, shallow (350 fsw max), and low-tech projects, NSMRL has a proven cost effective saturation capability. We can off-load some of the NEDU and NMRI burden in selected areas, and allow them to concentrate on deeper exposures and those requiring immersion.

Approach: Conduct 2-4 saturation dives per year. Collaborate with NEDU, NMRI to plan protocol for maximum productivity. Plan for each to test decompression (e.g. helium upward excursions), pulmonary (e.g. resistive breathing and/or oxygen toxicity), hearing conservation, and others as appropriate.

Products: - 6 to 16 man-dives per year depending on length, complexity - accelerated data collection for many work units.

C. Submarine Force Decompression Problems Need:

The submarine force requires human pressure exposures to depth equivalents of 50 fsw or less but for periods of several hours to 1-2 days. Examples include sonar dome work, alongside underwater repair, and tests of compartment and prototype integrity. The exposures are typically outside the purview of the Diving Manual, and indeed are outside the range of tested decompression schedules. We can perform the tests required to fill those gaps.

Approach: Using local divers and other active duty personnel, conduct chamber dives in the necessary pressure-time envelope. Some 30 to 150 per year can be expected, depending on dive duration and subject availability. From 50 to 200+ man-dives are needed per schedule. Then, combine the data with other appropriate exposures using maximum likelihood and probabilistic decompression models.

Products: - Improved "Low Pressure Air Exposure Tables" - Surface decompression procedures for submarine hull work (using chamber on tender, surface interval might be 10-15 min). - Improved "Exceptional Exposure Air Tables"

Costs: (FY92 through FY97) \$620K per year (1990 \$) for 6 years 7.8 man years per year in-house, and \$80K/yr TAD included \$ could decrease slightly if other diving funding increases \$ could increase if diver hearing conservation work decreases, or if collaborative research requires more than 2 trips/yr/project. Sponsor: OP-23 under P.E. 63713N.

II. NEW START (S):

1. TITLE: Molecular biology of stress protein induction as a factor in accelerated wound healing

2. Principal Investigator: A. A. Messier, Ph.D.

3. Laboratory: Naval Submarine Medical Research Laboratory

Department: Biomedical Sciences Department

Phone Numbers:

Commercial: (203)449-2537

Autovon: 241-2537

Other Organizations involved:

NMRI

University of Connecticut - Department of Molecular Biology

Department of Physiology

University of Rhode Island - Department of Chemistry and Biochemistry

4. Navy needs:

The Chief of Naval Research, in a document outlining FY-93-97 Naval Research Planning and Programming Guidance, emphasized a number of priority research topics (3910 RPDP-3-93, Ser 10P4, 8 Mar 1990). One of the identified topics which reflects a promising research opportunity and is responsive to Navy needs is a study which focuses on the molecular and cellular tissue processes that influence accelerated wound healing.

We propose to examine the cellular processes by which cells respond to acute injury and develop experimental approaches which will accelerate wound repair. This work will provide an improved capability to produce innovative medical protocols to treat wounded Navy and Marine Corps personnel.

5. Problem/Objective:

In vivo and in vitro studies of mammalian cells which have been exposed to wide variety of stressors such as ischemia, oxidative stress, cardiac hypertrophy, fever, inflammation, and cell injury (wounding) have been shown to respond by inhibiting the synthesis of normal proteins and by beginning the synthesis of a subset of protein which are collectively called "stress proteins".

It has been hypothesized that abnormal or nonfunctional proteins may be the trigger for induction of stress proteins. Recent work has demonstrated that soluble factors (proteinases) are released from damaged tissue and that these factors may stimulate wound healing. A similar factor may also be released from scraped skin cells that lead to increased levels of the cellular oncogenes, c-fos and c-myc. The c-fos oncogenes are also induced in oxidative and heat stressed cells. The implication is

that there may be a signaling mechanism common to both cell growth (accelerated wound repair) and cell death.

The objective of this work is to examine the cellular mechanisms by which cells respond to acute injury and to develop experimental approaches to accelerate wound repair. This work will provide an improved capability to produce innovative medical protocols for the treatment of injured Navy and Marine Corps personnel.

6. Technical Approach:

To more directly examine the mechanism of cell injury and repair in wounding, human fibroblasts and keratinocytes will be maintained in serum-free culture. Under these defined culture conditions, a number of known cellular stressors will be applied: 1) cell scraping - will release soluble factors (proteinases) from damaged cells, 2) heat shock (43°C for 15 min) - will release a subset of stress proteins, and 3) chemical and physical oxidative stressors (xanthine/xanthine oxidase or hyperbaric oxygen exposure) - will generate free radicals which have been postulated to play a central role in cell injury. The injured/wounded cell response to these varied stressors will be assayed by molecular biological approaches: 1) An antisense RNA method will be used to investigate the central hypothesis that stress proteins may be induced in order to facilitate the degradation of damaged/partially denatured proteins. 2) Specific assays of the protooncogenes, c-fos and c-myc, by Northern blot analysis will assess the role of these so-called "wounding factors" as possible mitogens of new cell growth repair. Together, these studies will demonstrate or lead to identifying factors which are released by damaged cells that trigger the proliferation of additional wound-healing factors or accelerate wound healing.

Performers: Collaboration with other Naval laboratories interested in the same phenomena would be welcomed. Collaboration with Drs. Crivello and Hightower at the University of Connecticut is essential because they have unique capabilities for antisense RNA, and specific mammalian vectors for the proposed studies. Dr. Fisher of the University of Rhode Island provides essential in vitro primary cell isolation and microscopic expertise.

Other Approaches: In vivo approaches were considered to model wound healing. However in vitro techniques can best demonstrate the existence of endogenous factors that are released by damaged cells.

7. Assessment of Risk:

Establishing an understanding of the cellular mechanism of the role of stress proteins in cell healing is an important concept, but we need to satisfactorily document the presence of stress proteins and fully understand the significance of stress proteins in wound healing. The application of a significant new technology along with the clear import and relevance of this work to Navy medicine should warrant support.

8. Related Activities:

Dr. Lawrence Hightower is widely known as an expert in the molecular biology of stress protein and is one of the principal investigators for this proposal.

9. Transition Approach:

Understanding the role of stress protein in wound healing will transition to improved prediction, diagnostic, and treatment modalities. Navy-related medical problems including fever, inflammation, infection with pathogens, tissue trauma and ischemia, and hypo- and hyperthermic injury could all be approached by developing monoclonal antibody tests. Countermeasures for enhancement/maintenance of performance during sustained operations could be developed as a result of these studies. A specific example of a 6.2 transition product would be the development of a "fingerprint" of specific stress proteins produced by injured cells which would be developed to predict assess, and treat the wound site. As a time estimate, these treatment modalities could be developed within five years.

10. Resources Required: (6.1 Funds)

	FY92	FY93	FY94
Funding Required	180	200	200
Personnel Required			
Military Officer	0.2	0.2	0.2
Military Enlisted	0.2	0.2	0.2
Civilian Professional	2.0	2.0	2.0
Civilian Support	0.2	0.2	0.2
TOTAL	2.6	2.6	2.6
Additional			
Military Officer	0.8	0.8	0.8
Military Enlisted			
Civilian Professional			
Civilian Supporting	0.8	0.8	0.8
TOTAL	1.6	1.6	1.6
Equipment			
Coulter Counter	10.0		
Water Bath (Heat)	3.0		
Water Bath (Cold)	3.0		
Densitometer	5.0		
Freezer	5.0		
Laminar Hood		5.0	
Sterilizer		5.0	
Computer		5.0	

11. Current References:

1. Currie, R.W., and White F. P. Trauma-induced protein in rat tissues: A Physiological role for a "heat shock" protein? *Science* 214: 72-73, 1981.
2. Tsuboi, K., Yamamoto, S., Maki, M., Ohshio, G., Tobe, T. and Hatanaka, M. Soluble factors including proteinases released from damaged cells may trigger the wound healing process. *Bioch Biophys Res Comm* 168: 1163-1170, 1990.
3. Colotta, F., Polentarutti, M., Staffico, M., Fincato, G. and Mantovanti, A. Heat shock induces the transcriptional activation of c-fos protooncogene. *Bioch Biophys Res Com* 168: 1013-1019, 1990.
4. Beckman, R., Mizzen, L., and Welch, W. Interaction of hsp 70 with newly synthesized protein: Implications for protein folding and assembly. *Science* 248: 850-854, 1990.
5. Edington, B., Whelan, S., and Hightower, L. Additional support for the abnormal protein hypothesis of induction. *J Cell Physiol* 139: 219-228, 1989.II. NEW START (S):

III. EQUIPMENT AND FACILITIES:

A. <u>Equipment: (\$000)</u>	FY91	FY92	FY93	FY94
Work Unit Equipment				
New (over 15K)	58.9	62.8		
General Purpose Equipment				
New	53.0			
Replacement				
Grand Total of Equipment	111.9	62.8		

Identification and Justification of Work Unit Equipment over 15K

FY 91	Rugged controller (2)	23,900
	GPXII color work station	15,000
	Optical disk and software	20,000
	Total	58,900
FY92	10KW amplifier	21,800
	Signal generators	24,000
	Rugged controller	17,000
	Total	62,800

Identification and Justification of General Purpose Equipment over 15K

FY 91	Diversified air system, quincy	53,000
	air compressor	
	Total	53,000

B. Facilities:

1. Military Construction (MILCON): N/A

2. Special Projects: All three NSMRL buildings (141, 148, 156) have been rated as substandard by NAVFACENGCOM. As outlined below, the proposed special projects are aimed at increasing building usability and functionality, and increasing the life expectancy of the facilities. Projects listed below are prioritized within each fiscal year.

- FY91 (1) CR2-87 Renovation of Library (Bldg 141): \$100K const. 9012-9108.
 (2) CR6-87 Renovation of Heads - Bldg 148: \$44K const. 9011-9104.
 (3) RC2-90 Replace Windows - Bldg 156: \$9K A/E. 9010-9103.
 (4) RC1-90 Electrical Upgrade - Bldg 148: \$6.5K A/E. 9010-9107.

(5) CR4-87 Non-electrical Improvements - Bldg 156: \$20K A/E. 9010-9108.

FY92 (1) RC2-90 Replace Windows - Bldg 156: \$150K const. 9204-9208.
 (2) RC1-90 Electrical Upgrade - Bldg 148: \$47K const. 9112-9204.
 (3) CR4-87 Non-electrical Improvements - Bldg 156: \$245K const. Backlog.
 (4) RC1-92 Replace Windows - Bldgs 141 & 148: \$15K A/E. 9111-9205.
 (5) RC2-92 Replace Carpet/Flooring - Bldg 141: \$5K A/E. 9111-9204. . .

FY93 (1) CR4-87 Non-electrical Improvements - Bldg 156: \$250K const. 9212-9309.
 (2) RC1-92 PHASE I Replace Windows - Bldgs 141 & 148: \$110K const. (Bldg 148) 9303-9307.
 (3) RC2-92 Replace Carpet/Flooring - Bldg 141: \$47K const. Backlog.
 (4) AC1-93 Central AC/Ceilings - Bldg 148: \$11K A/E. 9211-9305.

FY94 (1) RC1-92 PHASE II Replace Windows - Bldgs 141 & 148: \$160K const. (Bldg 141) 9403-9408.
 (2) RC2-92 Replace Carpet/Flooring - Bldg 141: \$47K const. 9312-9404.
 (3) AC1-93 Central AC/Ceilings - Bldg 148: \$150K const. Backlog.
 (4) AC1-94 Central AC - Bldg 141: \$15K A/E. 9312-9407.

FY95 (1) AC1-93 Central AC/Ceilings - Bldg 148: \$150K const. 9412-9507.
 (2) AC1-94 Central AC - Bldg 141: \$175K const. 9502-9509.

Issues:

a)CR2-86 Reconstruction of Anechoic Chamber - Bldg 141, is designed and estimated to cost in excess of \$450K. This project will remain shelved until both a clear need is demonstrated, and a source of funding (which will not jeopardize other facilities programs) is identified.

b)Upon completion of some facilities improvement project A/E designs (ie. window replacement projects), it may be determined that funding will be provided by the host activity (SUBASE-NLON). This would permit earlier funding of projects in backlog status, as noted above.

C. INFORMATION SYSTEMS FIVE-YEAR PLAN

1. ADP Environment

Late FY89 saw the completion of installation and start-up of the NSMRL local area network. This net is really three separate thin-wire Ethernet LAN's, one in each Lab building, connected by fiberoptic repeaters and a passive fiberoptic star router. Initially two VAX's and four PC nodes were established along with terminal servers in each building. Only the minimal TELNET and FTP Ethernet functions were installed in the first start. PC users began experimenting with moving files on and off the VAX's and performing remote logins. Terminal users now had the convenience of starting sessions on either VAX without depending on routing through the VAX 750 as our DECNET point to point configuration required. In comparison to the old DECNET, the speed and convenience of Ethernet were welcome improvements.

The VAX 11/750 and the 11/730 were joined by two major new server nodes in FY90; the microVAX II real-time graphics station and the SUN SPARC SERVER 330 scientific processing station. The microVAX was upgraded to 16mb ram and a 600 mb disk drive. A real-time clock and digital I/O port were also procured to complete its experiment control functionality in conjunction with the RAMTEK graphics coprocessor system. The SPARC, NSMRL's first venture into UNIX, came on-line very easily and benchmarked out on Lab Fortran programs at 3+ million floating point instructions per second (mflops) as advertized. Our benchmark of the blood-gas exchange model program came in at about 25 times faster than its speed on the VAX 750. In addition to Fortran and C applications, the SPSSX statistics package has been recently moved to the SUN from the VAX to take advantage of its processing power. Lab personnel are gradually testing the UNIX waters and making the move across the network to the SUN.

In the latter part of FY 90, the LAN is in the process of adding PC nodes and dealing with their communications needs. From the original 4 PC nodes, there will be about 20 MSDOS machines on the thinwire net by the end of the fiscal year. Most are for scientific applications, several have real-time data acquisition and experiment control hardware. There is now a desk-top publishing station. The Fiscal and Supply group has 5 PC's on order. A DECSTATION 2000 RISC machine running DEC's version of UNIX, ULTRIX, is now on the net and planned for a UNIX client-server hookup with the SPARC. The need to establish some type of client-server relationship among the PC's is growing as they become the dominant node type. Former terminal users accustomed to VAX MAIL and shared data bases are looking for the same services from their PCs. A variety of PC LAN software is available and needs evaluation on our network. One PC on order now will include a UNIX OS package to give us an evaluation of its potential for networking PC's. This package is available from the DESKTOP III contract showing UNIX's new acceptance in the PC community. We need to carefully evaluate the alternatives for PC services as we progress with our LAN development.

2. Research Activities

The installation of the SUN SPARC Server on the ethernet marked a new peak in computing power available for NSMRL research. Reduced instruction set computers (RISC) now are the clear leaders in all measures of computation performance-per-dollar in the industry. The SUN was quickly joined by a second RISC platform in early 1990, the DECSTATION 2000 graphics workstation. Like the SPARC server, this network node runs a flavor of the UNIX operating system, ULTRIX, in its case. Fast becoming the OS of choice for networks as well as for its RISC compatibility, UNIX offers full support of the industry standard client-server network protocol. The DECSTATION and SPARC will soon be connected over the ethernet in full client-server configuration. The two systems will serve as models for future expansion of scientific computing.

1) SYSTEMS ON HAND

<u>SYSTEM</u>	<u>ACTIVITY</u>
SPARC SERVER	general purpose scientific programming, statistics
DECSTATION 2000	support for SPSSX graphics package
MICROVAX II	color graphics, real time monitoring, vision testing
COMPAC 386	data acquisition, real time monitor, vision testing
COMPUADD 386(5)	data acquisition, general scientific computing
Zenith 386	laptop computing for medical diagnosis testing
Zenith 248	mass spectrometer work station
PDP 11/23+	data acquisition, real time monitoring, auditory testing
PDP 11/73	data analysis, statistics, waveform synthesis

2) OBSOLETE SYSTEMS

<u>SYSTEM</u>	<u>ACTIVITY</u>
MINC 11/23	data acquisition, real time monitoring, visual testing
PDP 11/34	data acquisition, real time monitoring, auditory testing

<u>SYSTEM</u>	<u>ACTIVITY</u>
PDP 11/04	data acquisition, real time monitoring, visual testing
Zenith 120	medical diagnosis testing
RAINBOW PC-100	data analysis, statistics
IBM PC/AT (3)	medical diagnosis testing
Zenith 248	medical diagnosis testing
Zenith 184 (6)	medical diagnosis testing (laptop)
Data General I	medical diagnosis testing (laptop)
Grid Systems (2)	medical diagnosis testing (laptop)

3) IMMEDIATE PROCUREMENT

<u>SYSTEM</u>	<u>ASDP NO</u>	<u>ACTIVITY</u>
Instr control workstation	90-31	auditory testing in remote locations
Digital sonar workstation	90-26	experiments in digital signal processing of sonar audio
Program development workstations (4)	90-13 90-10 90-17 90-27	general purpose programming

4) LONG RANGE

<u>SYSTEM</u>	<u>ACTIVITY</u>
PAL PDP11 REPLACEMENT	auditory testing, acoustic signal processing
HEWLETT-PACKARD COMPUTER	exemplar submarine systems computer

VAX NODE
REPLACE-
MENT(S)

statistical analysis, data base management

3. Research Support

Fiscal operations were reviewed by outside agencies and steps were taken to transfer automated functions to them over the next 2 years. Parallel in-house and outside operations should begin in FY91 with complete turnover to follow in FY 92. Five personal computers to facilitate these operations were ordered in FY90.

The networking of those machines will provide a starting point for further expansion of the net for other administration functions. New PC's for both the XO and CO are on order for FY90 and will eventually be tied into the ADMIN net.

1) ON HAND

<u>SYSTEM</u>	<u>ACTIVITY</u>
Compuadd 386	desk-top publishing
Zenith 248 (5)	word processing, administrative functions
ETHERNET	Lab-wide TCP/IP 10 Mbit network

2) OBSOLETE

<u>SYSTEM</u>	<u>ACTIVITY</u>
VAX 11/750	general scientific and administrative applications
VAX 11/730	graphics, real time monitoring
PRO 350	graphics, word processing, data base
HP-85/87 (4)	analysis, computations
RAINBOW 100	budget/finance, purchasing and inventory

3) IMMEDIATE PROCUREMENT

<u>SYSTEM</u>	<u>ASDP NO</u>	<u>ACTIVITY</u>
Technical Systems PC	90-21	word processing, DB
Exec Officer PC	90-18	word processing, DB
Comm Officer PC	90-11	word processing, DB
PM/CAL Work-station	90-15	equipment maintenance
Info Services	90-22	on-line medical info

4) LONG RANGE

additional software packages for new workstation applications

VAX node replacement(s)

4. Miscellaneous

The transition to networking is progressing well with two new major nodes on line along with numerous PC being added almost daily. The expansion path to true client-server networking is becoming clear and the first trial implementation should occur in the coming fiscal year.

Reorganization of the Computer Applications Division is still under consideration along with the hiring of additional personnel.

5. Current Year Procurement:

a) Systems costing greater than \$5000:

<u>ASDP #</u>	<u>COST (\$000'S)</u>	<u>DESCRIPTION</u>
90-19	36.5 (general purpose funds)	Neuroscan package software

Packaged software for experiments on visual, auditory, cognitive, and somatosensory evoked potentials. Also includes Brain Electric Source Analysis program for localizing sites of cortical activity during evoked potential experiments.

90-26 10.0 (work unit Auditory experiment station
 funds)

Expansion of existing workstation to replace obsolete DEC PDP11 system still in use. This system will provide backup, concurrent program development, and allow testing of additional subjects.

90-34 24.2 (work unit GPX II Graphics Workstation
 funds)

Visual Sonar research in collaboration with Johns Hopkins Applied Physics Lab SPAR/SPAN program will involve implementation of APL software on visual simulator at NSMRL.

90-30 20.4 (work unit Optical disk and software
 funds)

Further work with APL software and data requires availability of high capacity optical storage device to drive displays of sonar bearing time and frequency displays.

91-xx 15.0 (work unit Tactical display simulator
 funds)

New system to compliment existing device used in studies of tactical display symbology for NATO maritime units.

91-xx 5.6 (work unit ILS software for SPARC Server
 funds)

Signal processing software package now available on the VAX 11/750 will be transferred to the faster Sun SPARC Server network node. The vendor charges the difference between the cost of the new package and what had been paid for the existing one.

91-xx 14.0 (work unit Auditory sonar lab expansion
 funds)

New hardware/software for data acquisition and experiment control of auditory sonar research. Additional test stations for backup and to allow program development concurrent with experimentation.

A90605E 15.0 (general pur- Enet expansion, yr 4
 pose funds)

TCP/IP Ethernet software applications for existing PC/AT machines to network with server nodes and provide transparent client/server resources such as database and e-mail to PC's.

91-xx 7.0 (overhead Graphic Arts PC
funds)

Single user workstation with graphics software and plotter compatible with NSMRL/NMRDC standard word processing package, Word Perfect, and standard publishing package, Ventura Publishing.

b) Systems or enhancements costing less than \$5,000:

91-XX 3.0 (overhead Research Library PC
funds)

91-xx 3.0 [work unit data analysis workstation
funds)

6.Summary of Total IS-Related Costs (\$000)

	FY91	FY92	FY93	FY94	FY95
NEW ADP	28.0	60.0	40.0	35.0	35.0
EXP/RPL ADP	83.6	50.0	40.0	35.0	35.0
OTHER EQ/SOFT	42.1	35.0	35.0	30.0	30.0
SUPPLIES	10.0	10.5	11.0	11.5	12.0
CONTRACTS	50.0	52.5	55.0	57.5	60.0
TRAVEL	5.0	5.5	6.0	6.5	7
ADP STUDIES	12.0	13.0	14.0	15.0	15.0
SALARIES	246.5	258.0	264.5	271.0	277.5
TOTAL	477.2	484.5	465.5	461.5	471.5

V. Laboratory Organization

There have been no major proposed changes in the organization or management of the laboratory that may affect program execution.

VI. FISCAL SUMMARY: (\$000)

Program Element	Task Title	FY90	FY91	FY92	FY93	FY94	FY95
61152N	Independent Research	57	0	0	0	0	0
61153N	Cell Culture Modeling	126	136	150	0	0	0
63706N	Computerized Diagnosis	400	275	0	0	0	0
	Contact Lenses	0	58	120	0	0	0
	Human Performance	0	97	294	300	300	0
	Clinical Laboratory	125	120	120	120	120	0
	SUSOPS	75	150	314	338	321	350
63713N	Submarine Rescue	386	434	0	0	0	0
	Hearing Conservation	204	211	418	411	313	325
65856N	Auditory Sonar	432	481	480	610	640	670
	Visual Sonar	231	251	251	220	220	231
	Digital Sonar	426	471	471	570	570	570
<u>Total Direct</u>		2462	2684	2618	2569	2484	2146
1GAV60	VA: Psychophysical Procedures	51	24	0	0	0	0
61153N	ONR: Auditory Classification	59	0	0	0	0	0
0605131D	Fire Gases	100	0	0	0	0	0
NAVSEA	Fire Gases (Travel)	5	0	0	0	0	0
USMC	Snow Goggles	10	0	0	0	0	0
USCG	Navigation Lights	39	0	0	0	0	0
NMPC-68	Body Fat	15	0	0	0	0	0
NUSC	Non-hull Penetrating Periscope	30	25	0	0	0	0
ASN/RDA	Anti-submarine Warfare	0	750	650	650	0	0
NMRI	Diving	40	0	0	0	0	0
<u>Total Reimbursables</u>		349	799	650	650	0	0
<u>Grand Total</u>		2811	3483	3268	3219	2484	2146

VII. Personnel Summary

Direct Tasks	FY90	FY91	FY92	FY93	FY94
A. Military Officer	8	8	10	10	10
B. Military Enlisted	9	10	11	12	12
C. Civilian Professional	17	19	21	23	25
D. Civilian Supporting	7	10	13	16	19
E. Contracted (Note 1)	3	0	0	0	0
Subtotal	41	47	55	61	66
Administrative	FY90	FY91	FY92	FY93	FY94
A. Military Officer	4	4	4	4	4
B. Military Enlisted	5	4	4	3	3
C. Civilian Professional	1	1	1	1	1
D. Civilian Supporting	15	15	15	15	15
Subtotal	25	24	24	23	23
Total (Note 2)	66	71	79	84	89

Note 1: GeoCenter Technicians not included in subtotals or total.

Note 2: Personnel onboard. Increases in military personnel reflect anticipated filling of vacant billets.

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