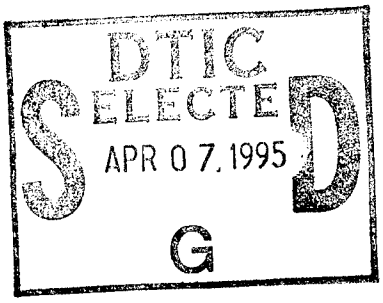
Naval Command,
Control and Ocean
Surveillance Center RDT&E Division San Diego, CA
92152-5001

Technical Document 2624
June 1994

Command History

Calendar Year 1993



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NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER
RDT&E DIVISION
San Diego, California 92152–5001

K. E. EVANS, CAPT, USN
Commanding Officer

R. T. SHEARER
Executive Director

ADMINISTRATIVE INFORMATION

This technical document was prepared in response to OPNAVINST 5750.12E. The document summarizes the major activities and achievements of the Naval Command, Control and Ocean Surveillance Center's RDT&E Division in 1993.

This document was prepared by the Technical Information Division using in-house funding.

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PREFACE

The Naval Command, Control and Ocean Surveillance Center, RDT&E Division, or NRaD, Command History for calendar year (CY) 93 is submitted in conformance with OPNAVINST 5750.12E. The history provides a permanent record of CY 93 activities at NRaD. Although the history covers one calendar year, certain information was available on only a fiscal year (FY) basis and is so noted in the text.

The history is divided into two main parts: (1) administrative developments and (2) technical developments. The first section gives an introduction to NRaD and describes developments in finance, organization, personnel, and facilities. The second section documents technical programs underway during 1993. Programs are organized by department.

Because the results of scientific work often develop out of many years' effort, programs are not always documented annually. Previous command histories provide extensive background articles on many major programs. When possible, background articles are prepared for new or previously untreated programs. By consulting command histories written over a period of several years, a reader can follow the broad thrusts of Division research and development.

Appendices to the history provide supplementary information to the main text. Appendix A lists military and civilian achievement awards given in CY 93. Appendix B lists patents awarded in FY 93. Appendices C and D provide lists of distinguished visitors hosted by NRaD and major conferences and meetings at NRaD, respectively.

While acronyms and abbreviations are defined when first used in the text, a glossary is included for reference.

ADMINISTRATIVE DEVELOPMENTS

INTRODUCTION TO NCCOSC RDT&E DIVISION

The Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (or NRaD) is a full–spectrum RDT&E laboratory serving the Navy, Marine Corps, and other Department of Defense and national sponsors within its mission, leadership assignments, and prescribed functions. NCCOSC is one of the Navy's four major warfare centers and reports directly to the Commander, Space and Naval Warfare Systems Command (SPAWAR) in Washington, DC. At NRaD we provide solutions to Navy, joint service, and national problems by generating and applying science and technology. We provide innovative alternatives to tomorrow's decision makers, enabling them to pursue new or expanded missions and capabilities.

We work closely with NCCOSC inservice engineering divisions to provide Fleet, joint, and national users and customers with complete life–cycle support. This support spans efforts that range from generating science and applying technology to creating new system concepts and upgrading older systems to perform previously unforeseen roles. We also work with SPAWAR, other Navy system commands, the Office of the Chief of Naval Operations, the Fleet, the Office of Naval Research, defense and national agencies, academia, and industry to produce quality products and services. Our roles include providing leadership for developing systems and solutions and functioning as a "smart buyer" to ensure that the government purchases quality products in an increasingly complex and technological marketplace.

At NRaD, we are strongly committed to our customers. We maintain close contact with them to ensure that our efforts remain relevant and meet the needs and threats of tomorrow; our goal is to ensure that Navy, joint commands, and defense and national agencies——the ultimate users and customers of our products——retain technological and operational superiority. We are also uniquely capable of serving operational users during national crises. Specifically, we support systems that we have helped introduce into today's forces by providing technical expertise and laboratory and test facilities not available to operational commands.

We continue to serve our sponsors in roles for which we have demonstrated expertise: management of Technology Blocks, creation and demonstration of technology, program formulation and initiation, Technical Direction Agent, Acquisition Executive Agent, Software Support Agent, system and subsystem prototyping, and the support of test and evaluation. We also actively license technology and support the transition of technology to industry.

NCCOSC and its RDT&E Division were created as part of the Base Realignment and Closure Act of 1991. NRaD was created from several predecessor organizations including the Naval Ocean Systems Center, the Communications and Navigation Technology Department of the Naval Air Development Center, the Navy Space Systems Activity, and the Fleet Combat Direction Support Activity.

Mission

NRaD's mission is to be the Navy's research, development, test and evaluation center for command, control and communication systems and ocean surveillance and the integration of those systems which overarch multiplatforms.

Leadership Assignments

NRaD leadership assignments are as follows:

Command, control, and communication systems
Command, control, and communication systems countermeasures
Ocean surveillance systems
Command, control, and communication modeling and analysis
Ocean engineering
Navigation support
Marine mammals
Integration of space communication and surveillance systems
Marine environmental quality assessment and remediation

Warminster Detachment

The NRaD Warminster detachment performs navigation support and communications functions.

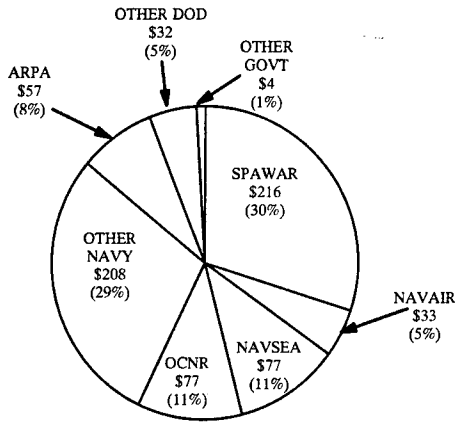
FINANCE

NRaD receives funding from sponsors that include the Space and Naval Warfare Systems Command (SPAWAR), the Naval Sea Systems Command (NAVSEA), the Naval Air Systems Command (NAVAIR), and the Office of the Chief of Naval Research (OCNR). The accompanying chart shows funding by sponsor for FY 1993.

In FY 93, NRaD received new orders totaling $704 million, an increase of $106 million from the $598 million received in FY 92.

FUNDING BY SPONSOR

FY 1993
ACTUAL $704*



*Includes Direct Cites $226 million

SPAWAR – SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR – NAVAL AIR SYSTEMS COMMAND
NAVSEA – NAVAL SEA SYSTEMS COMMAND
OCNR – OFFICE OF THE CHIEF OF NAVAL RESEARCH
ARPA – ADVANCED RESEARCH PROJECTS AGENCY

Direct Cites – Requests for Contractual Procurement (RCPs) and Military Interdepartmental Purchase Requests (MIPRs). Financed directly by sponsor rather than NRaD NIF account.

ORGANIZATIONAL CHANGES

NRaD is organized into five technical departments and several staff codes. The five technical departments include Navigation and Air C^3, Command and Control, Marine Sciences and Technology, Surveillance, and Communications. The following chart reflects NRaD organization as of 1 July 1993.

Organizational changes discussed here are limited to major changes affecting departments or divisions. NRaD notices, available from Code 0275, Computerized Production and Printing Branch, provide changes not covered here.

During 1993, two major reorganizations of support and technical codes took place.

Reorganization of Support Codes

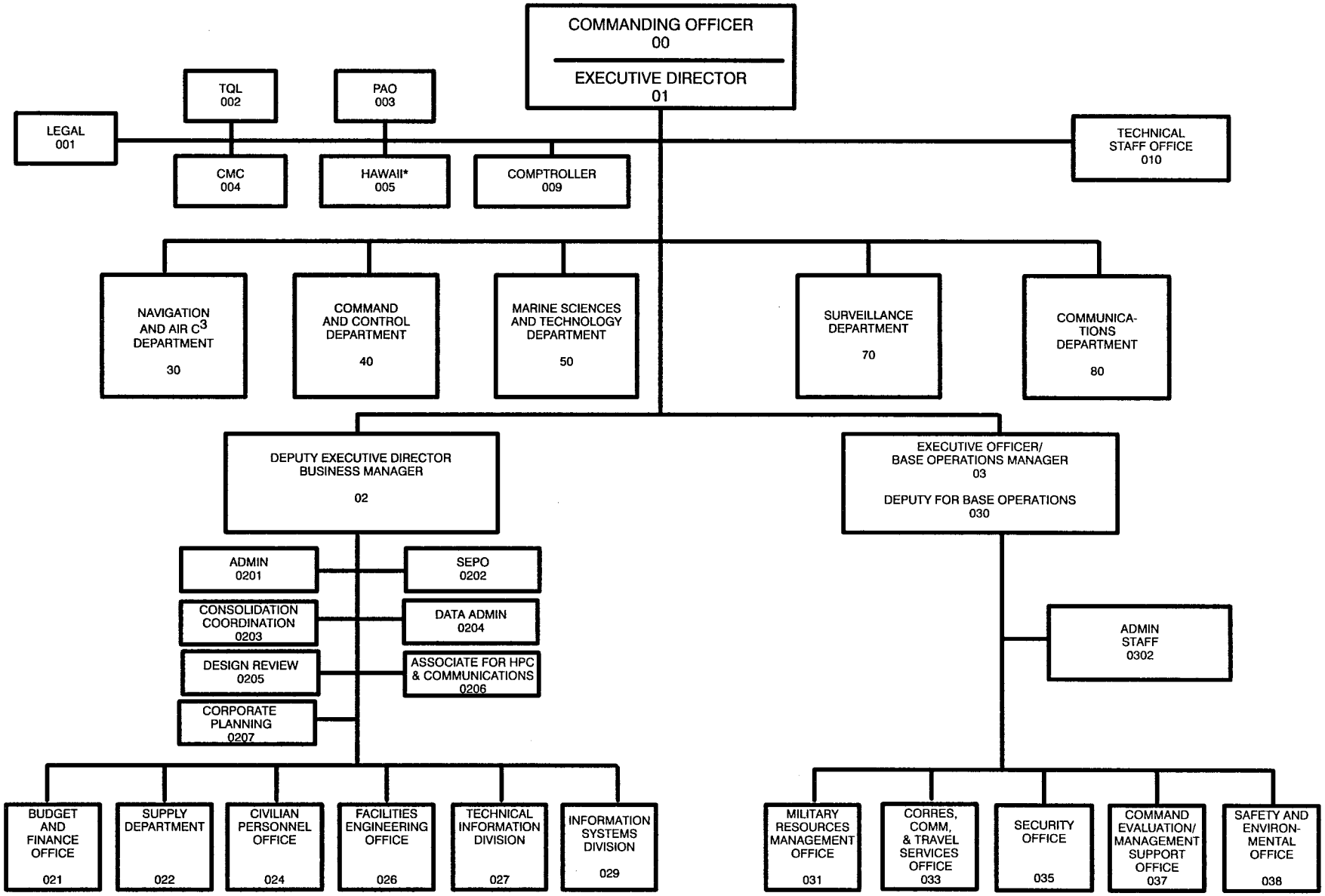
Effective 12 February 1993, NRaD Codes 006 through 20 and Code 91 (Computer Sciences and Resources Division) were reorganized in a major restructuring of support codes. The reorganization grouped support functions involving business management and allocation of resources, such as finance, budget, supply, contracts, and facilities, under the Deputy Executive Director. Functions involving base operations and compliance, such as security, safety, environmental, travel, mail, message, and command evaluation, were grouped under the Executive Officer. Code 91 was moved to give greater emphasis to Information Resources Management.

Specifically, the restructuring was intended to do the following:

1. Get control of costs. The restructuring will help NRaD exercise greater control over the General and Administrative (G&A) budget, allowing better and more cost-effective allocation of resources.
2. Establish clear lines of authority. Under the previous organization, the entire organization reported to a single block comprising the Commanding Officer, Executive Director, Executive Officer, and Deputy Executive Director; it was not always clear to which part of that block specific codes reported. By organizing codes under the Deputy Executive Director and Executive Officer, clear lines of authority were established.
3. Increase the authority of the Comptroller. Under the new organization, the Comptroller reports directly to the Commanding Officer and Executive Director, and is a member of the Executive Board.
4. Remove obstacles to effective action. The previous organization divided authority for particular functions among several different codes. Similar functions are now placed under a single manager.
5. Provide greater visibility to the G&A side of the house. Employees working on overhead funding may be able to convert to direct funding (based on their specific knowledge, skills, and ability to be trained for a function related to their present tasks). The reorganization will increase their visibility and their potential for conversion; each conversion will increase revenue and reduce costs.

(NOTE: The information above was taken from the NRaD Outlook, 12 February 1993.)

NCCOSC RDT&E DIVISION ORGANIZATION



*Hawaii Laboratory closed 30 September 1993.

1 July 1993

The codes involved in the reorganization are listed below, followed by their new code names (if changed) and new code numbers in parentheses.

Facilities Engineering Office, Code 006 (Code 026)

Command Evaluation Office, Code 007 (Command Evaluation/Management Support Office, Code 037)

Occupational Safety and Health Office, Code 007 (Safety and Environmental Office, Code 038)

Consolidation Coordination Staff, Code 013 (Code 0203)

Program Director for Research and Technology, Code 014 (Science and Technology Programs Office, Code 014)

Deputy Executive Director, Code 02 (Code 02)

Executive Officer, Code 03 (Executive Officer/Base Operations Manager, Code 03)

Central Staff, Code 09 (See NRaDNOTE 5400, 12 February 1993, for a complete listing of changes.)

Civilian Personnel Office, Code 14 (Code 024)

Security Office, Code 15 (Code 035)

Planning, Intelligence, and Analysis Office, Code 17 (See NRaDNOTE 5400, 12 February 1993, for a complete listing of changes.)

Supply Department, Code 20 (Code 022)

Engineering and Computer Sciences Department, Code 91, (Information Systems Division, Code 029)

NRaDNOTE 5400, 12 February 1993, gives a complete listing of changes.

Reorganization of Technical Codes

Effective 30 July 1993, the Communications Department, Code 80, and the Engineering and Computer Sciences Department, Code 90, were reorganized to meet changing program requirements and make more efficient use of available resources. Within Code 80, one division was moved. All Code 90 divisions were moved to other NRaD departments (Code 91 was moved in February as part of the reorganization of support codes.)

The codes involved in the reorganization are listed below, followed by their new code names (if changed) and new code numbers in parentheses.

Communications Development and Operations Division, Code 86 (HF/UHF Communications Branch, Code 861, transferred into the Satellite Communications Software Support Activity, Code 87; Technology Applications Branch, transferred into the Satellite Communications Division, Code 864)

Product Assurance Division, Code 92 (Code 88)

Design and Development Division, Code 93 (Code 89)

Ocean Engineering Division, Code 94 (Code 81)

Support Engineering Division, Code 95 (Code 81)

Technical Information Division, Code 96 (Code 027; under Code 02, Deputy Executive Director—see Reorganization of Support Codes above)

Test and Evaluation and Ranges Division, Code 98 (Code 58)

Software Test and Delivery Division, Code 99 (Combat Direction Systems Test Branch, Code 991, transferred into the Combat Direction Systems Division, Code 43; C^3 Systems Test Branch, Code 992, transferred into the Satellite Communications Software Support Activity, Code 87)

NRaDNOTE 5400, 30 July 1993, gives a complete listing of changes.

PERSONNEL

Navy Reorganization of R&D Activities

The Civilian Personnel Office (Code 024) completed major efforts in implementing the Secretary of the Navy directive to reorganize research and development activities. These efforts included the following:

- Completed functional transfer and entry into the Navy's Personnel Demonstration Project of 31 civilians from the Naval Electronic Systems Engineering Activity Detachment, Philadelphia, into NRaD.

- Completed the last phase of the closedown of NRaD, Hawaii Laboratory, on 30 September 1993. During this 9-month period, the remaining 81 civilian employees were separated by outplacement, retirements, resignations, and transfers.
- Completed extensive planning for the establishment of NISE East personnel programs and service for NISE East stand-up and conversion to the Navy's Demonstration Project on 9 January 1994.

Personnel Data System Conversion

Code 024 participated in the conversion of the Navy Civilian Personnel Data System from Burroughs hardware and software to Sperry Systems. This required establishment of FTS-2000 telecommunications services and the receipt and set-up of the new Sperry equipment, communication links, computer terminal, and software changes to operate the new system. This system was successfully converted on the target date of 15 November 1993.

Payroll System Conversion

Code 024 participated in the change of the payroll system from the Navy's CIVPAY system to a defense payroll system located in Denver, CO (Defense Finance and Accounting Service). The target date of 28 November 1993 was met by NRaD payroll and personnel staff. A Navy group achievement award was presented to a large group of civilian staff members for meeting this critical task.

Civilian Hiring Freeze

A total freeze on NRaD civilian hiring remained in effect for the full calendar year of 1993. This freeze continued severe restraints on exercising affirmative employment strategies.

Incentives and Early Retirements

In October 1993, NRaD received authority to offer up to 150 separation incentives and early retirements to 670 employees in 14 occupations. These employees must volunteer to retire or resign by 3 April 1994. Six employees accepted the offer to retire or resign and were separated in December 1993. Many more accepted this offer and will be separated in 1994.

Exception to Priority Placement Program

NRaD requested approval for an exception to the Department of Defense Priority Placement Program for 180 days. This was approved by the Navy's Office of Civilian Personnel Management beginning 13 October 1993. This exception permits NRaD management to reassign personnel within the Division without regard to the mandatory placement of DoD personnel into NRaD. This need resulted from the extensive reorganization of NCCOSC and reduction of resources.

FACILITIES

NRaD occupies more than 507 acres of land on the Point Loma peninsula, approximately 7 miles from downtown San Diego. Facilities are concentrated in three major areas: Topside, Bayside, and Seaside.

NRaD Topside, located on the ridge of Point Loma, includes the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance.

NRaD Bayside faces San Diego Bay, which provides the waterfront access and berthing capabilities vital to NRaD activities in ocean surveillance and marine sciences. McLean Laboratory and the Ocean Sciences Laboratory are located Bayside.

NRaD Seaside, located on the west slope of Point Loma, offers a protected, electromagnetically shielded site essential to RDT&E in command, control, communications, and intelligence (C^3I) and ocean surveillance.

Additional facilities include a detachment in Warminster PA; a laboratory at Kaneohe Bay, Oahu, Hawaii (see below); sea ranges at San Clemente; a test range at Morris Dam, CA (see below); a field station at La Posta, CA; and an arctic field station at Cape Prince of Wales, AK (see below).

San Diego

Construction of the Secure Assembly and Test Facility, FY 1991 Military Construction (MILCON) Project P–095, was completed on 3 August 1993, 12 weeks ahead of the contract completion date of 26 October. Located Topside, this facility will provide 80,000 square feet of laboratory and office space for compartmented programs and engineering services for all NRaD programs.

MILCON Project P-122, the Marine Sciences Pier located Bayside, was completed in July 1993 at a cost of $387,746.

Hawaii Laboratory

The Hawaii Laboratory, located at the Marine Corps Air Station on Kaneohe Bay, Oahu, was closed 30 September 1993. The 20-acre facility provided a mid-ocean base for NRaD's Pacific fleet support activities and programs in C^3, marine biosystems, ocean bionics, ocean surveillance, ocean technology, teleoperator/remote presence systems, and ocean engineering. Animal handling, training, and research facilities were located in the bay, with support facilities located nearby. The lab was closed by the Base Closure and Realignment process of 1991. All functions were relocated to San Diego.

Morris Dam Facility

The Morris Dam facility near Azusa, California, included the Morris Dam Reservoir and adjacent land. This 640-acre area, leased from the Metropolitan Water District of Southern California, was used for the development and testing of inert torpedoes. Facilities include the propulsion laboratory and static test cells. The Morris Dam facility was closed and placed on inactive status in August 1993.

Arctic Field Station, Alaska

The arctic field station at Cape Prince of Wales was transferred to the Naval Undersea Weapons Center, Keyport, Washington, in March 1993.

TECHNICAL DEVELOPMENTS

NAVIGATION AND AIR C^3 DEPARTMENT

GLOBAL POSITIONING SYSTEM (GPS)

The NAVSTAR Global Positioning System (GPS) is a space-based radio navigation and positioning system that will provide extremely accurate three-dimensional position and velocity information as well as precise time to suitably equipped users worldwide. GPS consists of three major segments: space, control, and user equipment.

GPS will provide worldwide precision navigation and time to U.S. military forces and their allies. Military forces are required to know their position in order to enhance command and control, coordinate battle tactics and support, engage in strategic and tactical warfare, maneuver efficiently on the battlefield and at sea, provide accurate and timely fire support, and facilitate combat support operations. In addition, knowledge of exact positions and time is essential for reconnaissance and intelligence missions. A worldwide positioning and navigation system can increase both accuracy and availability of current weapon systems, thus increasing their effectiveness and acting as a force enhancement.

The GPS Program is a multiservice effort, as directed by the Department of Defense. The Air Force has been designated the executive service for program development. NCCOSC's RDT&E Division Detachment serves as the technical and field staff of the Navy GPS Program Office, providing both the Navy Deputy at the Joint Program Office and a significant portion of technical expertise in the development of the GPS User Equipment. The Detachment maintains simulation and modeling capability for equipment validation/certification, SSA test, and accuracy and error analysis in both basic and differential operations.

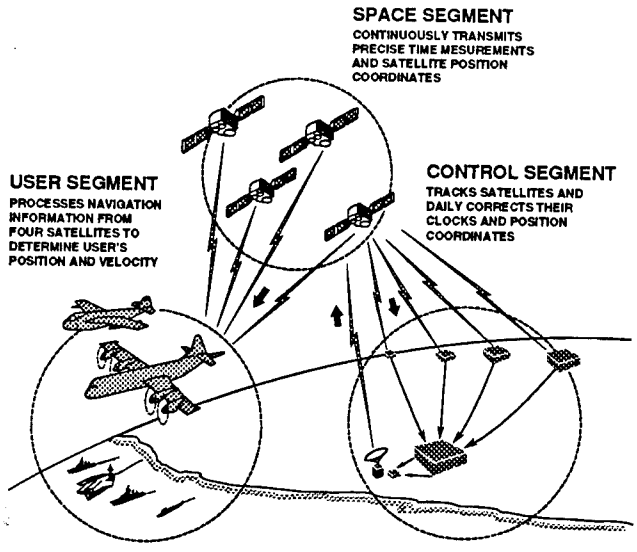
GPS/Electrically Suspended Gyro Navigator (ESGN)

Program accomplishments during CY 93 included the following:

Performed installation of the GPS/Electrically Suspended Gyro Navigator (ESGN) interface and the GPS/time interface on USS *La Jolla* (SSN 701).

Initiated installation of limited production development model GPS/ESGN interface on SSN 637 class submarine.

Performed troubleshooting and training for GPS/ESGN integration on USS *Finback* (SSN 670) at the Norfolk Naval Base in Norfolk, VA on 5 Aug.



AN/WRN-6 Equipment Suite

Program accomplishments in CY 93 included the following:

Successfully installed AN/WRN-6 equipment suites aboard four amphibious ships, in support of the AN/KSQ-1 DT IIA testing for the Naval Surface Warfare Center Coastal Systems Station, Panama City, FL. Following installation, personnel provided technical support of large-scale, at-sea amphibious exercises to validate operation and usability. Code 322 also trained ships' force personnel in the operation and maintenance of the GPS user equipment. At the completion of the at-sea exercises, they deinstalled the four AN/WRN-6 equipment suites and had the equipment shipped back to NRaD Warminster. All operations including installation, complicated at-sea amphibious exercises, and deinstallation, were successfully carried out in the very brief time window allocated.

successfully carried out in the very brief time window allocated.

Precision Lightweight GPS Receiver (PLGR)

Program accomplishments during CY 93 included the following:

Participated in the Precision Lightweight GPS Receiver (PLGR) Factory Acceptance Testing at Rockwell Collins, Cedar Rapids, IA on 6-9 July.

The first shipment of PLGRs arrived at NISE West for fleet distribution. Priority for early deliveries were to the EOD and Special Warfare Forces.

Global Positioning System Interface Unit (GPSIU)

The Global Positioning System Interface Unit (GPSIU) integrates GPS latitude and longitude information into the Position Locating Reporting System (PLRS) for use within the AN/KSQ-1 Amphibious Assault Direction System. The GPSIU was designed in-house and will enable GPS navigation information to be distributed to the PLRS.

Program accomplishments in CY 93 included the following:

Successfully delivered the first article GPSIU to the Navy as part of the Over-the-Horizon Amphibious Assault Command and Control (OTHAAC^2) System. Excellent feedback was received from the Navy sponsor at Panama City on the timeliness of the delivery.

Conducted field testing of first article J-6094/KSQ-1 (GPSIU) at Marine Corps Tactical Systems Support Activity (MCTSSA), Camp Pendleton, CA. Firmware version 00.00 was tested and certified.

Successfully completed GPSIU integration testing at MCTSSA, Camp Pendleton, CA.

Shipped six completed Navy GPSIU to CSS at Panama City, FL.

Participated in a major 1-month Navy and Marine amphibious assault exercise at Camp Pendleton, CA to aide in installing and testing the NRaD-developed GPSIUs. One aspect of the testing was to verify that the GPSIU will enhance the operational ability and accuracy of the PLRS when tracking Navy and Marine units. The GPSIU and PLRS equipment were monitored during beach assaults while riding aboard Landing Craft Air Cushion (LCAC) vehicles. Results of the test indicated that the GPSIU enhanced the performance of the PLRS significantly.

GPS Fiber-Optic Antenna Link (GPS FOAL)

The objectives of the GPS Fiber-Optic Antenna Link (FOAL) program are to (1) develop and demonstrate a shipboard fiber-optic antenna link for the AN/WRN-6(U)1 GPS and (2) assess other navy communication/navigation systems for their potential for conversion to fiber-optic antenna signal transmission. The FOAL will be developed by integrating off-the-shelf hardware and will be designed to work in a shipboard environment.

Program accomplishments during CY 93 included the following:

AEGIS cruiser USS *Yorktown* (CG 48) selected for demonstration of GPS FOAL. Shipboard installation is planned for mid-September, with NRaD testing to begin late September.

Successfully completed Land Based Checkout of the FOAL, in preparation for the planned at-sea test to begin late September, aboard USS *Yorktown*.

GPS Inertial Navigation Assembly (GINA)

Program accomplishments during CY 93 included the following:

Awarded the contract for the GPS Inertial Navigation Assembly (GINA) to Litton Industries.

Conducted dry runs on software developed in-house for laboratory test of the Litton Model LN-100G (GPS-Aided Inertial Navigation System (INS)), which uses zero-lock ring laser gyros. Following software debugging, in-house tests were conducted to characterize performance and identify performance deficiencies. Efforts to interface the LN-100G with an NRaD test station continued.

Standoff Land Attack Missile (SLAM) GPS

Program accomplishments during CY 93 included the following:

Installed navigation system to support the Standoff Land Attack Missile (SLAM) aboard USS *America* (CV 66).

Installed an NRaD-developed SLAM GPS initialization system aboard the USS *George Washington* (CVN 73) in Norfolk, VA. After completing the installation, ship's personnel were trained on the proper

operation of the system. Nearly every carrier has had one of these systems installed.

SURFACE SHIP RING LASER GYRO NAVIGATOR (RLGN)

The Ring Laser Gyro Navigator (RLGN) is the next-generation inertial navigation system under development for surface ships. NRaD is responsible for development and transition of the RLGN into the Fleet and for subsequent product improvements as TDA. NRaD also provides an extended performance capability, a significantly improved reliability, and a much lower life-cycle cost.

Program accomplishments during CY 93 included the following:

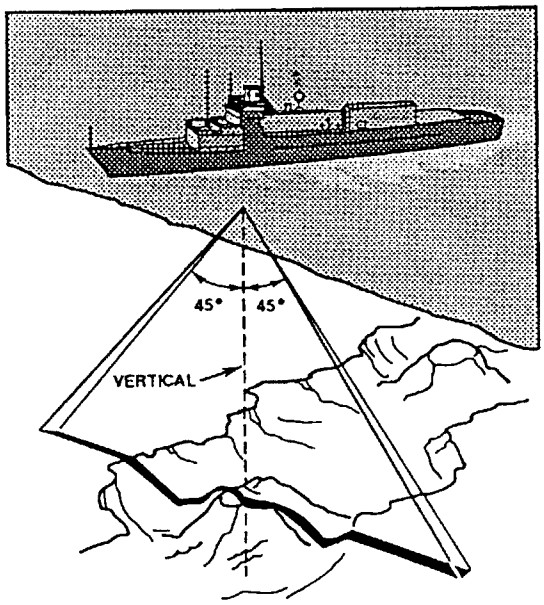
Completed at-sea evaluation of the Sperry Marine Mk 49 RLGN aboard the USNS *Vanguard* (T-AGM 19). The Mk 49 is being evaluated by the Navy as a potential replacement for the Electrically Suspended Gyro Navigator (ESGN) aboard Navy attack class submarines.

Completed preparation of the Mk 49 laboratory test plan. This test plan takes into account laboratory testing already completed, as well as testing conducted aboard the USNS *Vanguard.*

Developed preliminary Operational Requirements Document (ORD) for an RLGN for use aboard the Navy's attack class submarines and surface combatants. The ORD was delivered to COMNAVSEASYSCOM sponsor on 18 Nov 93.

OCEAN SURVEY PROGRAM (OSP)

NCCOSC's RDT&E Division Detachment is the technical agent for the Naval Oceanographic Office with total responsibility for the design, development, test, and evaluation of the complete shipboard mission equipment for the Ocean Survey Program (OSP). The mission survey system is a highly complex, integrated navigation, bathymetric, and data refinement system that produces high-accuracy charts of bathymetry, gravity, magnetics, and other geophysical parameters in support of the Trident Fleet Ballistic Missile Submarine Program. The system is operational on four deep-ocean survey ships: the USNS *Maury* (T-AGS 39), USNS *Tanner* (T-AGS 40), USNS *H. H. Hess* (T-AGS 38), and USNS *Wyman* (T-AGS 34).



Ocean survey program (OSP).

The OSP has a BRICKBAT 01 priority, the Navy's highest, and is in a continuous evolutionary phase to maintain the highest state-of-the-art in survey capability and productivity. The program is providing new challenges in ocean bottom characterization, shallow-water coastal surveys, and bistatic bathymetry to meet future requirements.

A 4500-square-foot Systems Integration Laboratory (SIL) supports in-house OSP hardware and software development. Three major laboratory areas are in operation for bathymetric refinement, multibeam sonar, and navigation system development.

USNS *Wyman* OSP System Upgrade

Program accomplishments in CY 93 included the following:

In April, the Ocean Survey Systems Development and Integration Division (Code 33) personnel met with representatives of the Military Sealift Command and the Naval Oceanographic Office (NAVOCEANO) to review the latest technical specifications for the planned USNS *Wyman* OSP System upgrade being generated by NRaD Warminster. This upgrade, previously accomplished on the USNS *Tanner* and USNS *Maury*, is extensive, involving major hardware, software, and documentation changes. Obsolete and unsupportable computers and associated peripherals are being replaced with state-of-the-art Hewlett-Packard (HP) computers and peripherals. The entire existing regulated power system will be replaced with

a system designed and developed by Code 33 engineers. It will undergo major revision. This system will be given an improved shallow-water capability that will allow operation to depths as shallow as 35 fathoms. The sonar system's athwartship bottom coverage will be increased from 90 degrees to 120 degrees and a backscatter system, that will record all acoustic data for each sonar return, will also be installed. This upgrade will improve OSP system productivity, reliability and maintainability, reduce hard copy data outputs, increase realtime and posttime shipboard data processing capabilities, and improve watch stander efficiency and effectiveness.

In September, the Configuration Change Notice (CCN) 34317 describing the major FY 94 OSP System upgrade to be integrated by Code 33 personnel aboard the USNS *Wyman* was issued. This CCN is the standalone technical specification, required by Code 33 engineers and *Wyman* NAVOCEANO shiprider personnel, to successfully accomplish the integration, test, and evaluation of this upgrade. The CCN also constitutes the basis for configuration control, documentation, and logistics management required for this upgrade.

In June, the first of two parts of the final technical specification for the USNS *Wyman* major survey system upgrade was issued. This specification provides the technical documentation required to integrate OSP System improvements and new multimission capabilities.

USNS *Tanner* OSP System Upgrade

Program accomplishments in CY 93 included the following:

Issued the final technical evaluation report describing the results of the FY 93 OSP System upgrade integration and testing done by Code 33 aboard the USNS *Tanner.*

USNS *Maury* OSP System Upgrade

Program accomplishments in CY 93 included the following:

Issued the final technical evaluation report describing the results of the FY 93 OSP System upgrade integration and testing accomplished by Code 33 aboard the USNS *Maury.*

Successfully completed the installation and dockside and at sea technical evaluation of the Phase I OSP System upgrade on the USNS *Maury.* This upgrade was extensive, involving major hardware, software, and documentation changes. Obsolete AN/UYK-20 computer systems and associated peripherals were replaced with state-of-the-art HP computers and peripherals. This upgrade will improve OSP system productivity, reliability, and maintainability, reduce hard copy data outputs, increase realtime and posttime shipboard data processing capabilities, and improve watch stander efficiency and effectiveness.

United Kingdom Ocean Survey Vessel/Ocean Survey Program Survey System (UK OSV/OSPSS)

The United Kingdom Ocean Survey Vessel/Ocean Survey Program System (UK OSV/OSPSS), involving SSP (SP-20), NAVOCEANO (N21), and the UK Director General Underwater Weapons (DGUW/ UW134), will result in the conversion of a ship to a deep-ocean bathymetric survey ship in 1994. The shipboard survey system will produce high-accuracy charts of bathymetry and collect other essential geophysical scientific data.

Code 33 is responsible for the survey system design, integration, and shipboard installation that would provide the vessel with a precise bathymetric charting and oceanographic data-collecting capability. NCCOSC involvement is to develop the survey system configuration scientific payload; integrate the scientific payload with the ship structure; design, develop, and procure the scientific systems and equipment; install, test, and evaluate the survey system performance, and provide system life-cycle support.

Program accomplishments during CY 93 included the following:

Completed the first major equipment delivery for the UK OSV/OSPSS Project. This deliverable included the OSV Gravity System (less sensors) and the NRaD-designed and developed Gravity Interface Simulation Program, including necessary documentation and hardware interface. This simulation program will allow the UK to test their gravity system interface for compliance with the OSPSS interface requirements.

Successfully completed the first of two stages of UK OSPSS System equipment acceptance testing conducted in the System Integration Laboratory (SIL). These tests were witnessed by LCDR Colin Brooks who represented the Captain Weapons Trials Assessment (CWTA). This first stage of testing consisted of verifying that all individual equipment to be installed aboard the UK OSV was operational. The second stage of testing, to be carried out during the second quarter of FY 94, will also be witnessed by CWTA and will consist of verifying proper UK OSPSS subsystem and overall system operation.

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)/ MULTIFUNCTIONAL INFORMATION DISTRIBUTION SYSTEM (MIDS)

The Joint Tactical Information Distribution System (JTIDS) is a high-capacity communications terminal that will provide aircraft and ship platforms with secure, jam-resistant voice and data communications. The Multifunctional Information Distribution System (MIDS) is an upgraded version of JTIDS that will be developed by a five-nation consortium. NRaD has two primary offices, one in the Command and Control Department and the other within the Navigation and Air C^3 Department, that perform significant JTIDS and MIDS engineering roles.

The Navigation and Air C^3 Department performs systems engineering tasks to provide military worth analyses, cost and operational effectiveness analyses, scenario modeling, network design and generation, relative navigation engineering/simulation, terminal integration, frequency assignment, training, and test support. Network development encompasses support of the Joint Program Office and NATO member nations.

Link-16/JTIDS

Program accomplishments in CY 93 included the following:

Provided Link-16/JTIDS crypto training for TECHEVAL/OPEVAL participants between 13 and 22 April. This includes all surface (USS *Antietam* (CG 54), Long Beach Naval Base , USS *Carl Vinson* (CVN 70) and USS *Arkansas* (CGN 41), NAS Alameda, Alameda, CA) and airborne (VAW-113, VF-11 and VF-31, NAS Miramar) platforms. The training was designed to assist all personnel involved with the crypto initialization of JTIDS terminals using existing COMSEC equipment. The training included (1) JTIDS equipment description, (2) definition of JTIDS crypto-related concepts and terms, (3) crypto loading equipment description, and (4) explanation of the crypto portion of the OPTASKLINK Message.

Conducted Link-16 System Introductory training at Eglin Air Force Base for representatives from the Joint Air Defense Operations Test and Evaluation Team. This test group will be testing multi-TADIL(A,B,J) interoperability message exchanges.

Multifunctional Information Distribution System (MIDS)

NRaD is the primary Navy systems engineer supporting both the MIDS terminal development within the international community and its application and implementation in the U.S. lead platform, the F/A18, and is responsible for integrating MIDS into the overarching JTIDS tactical C^3I structure to support battlespace dominance and power projection operations from littoral areas. NRaD also provides the primary technical interface to NATO for the utilization of the system in meeting combined operations requirements.

Program accomplishments in CY 93 included the following:

Completed analysis of Electronics Analysis Warfare threats to regional strategic strike (RSS) and battlefield air interdiction (BAI). Results and impact of jamming effects on UHF and L band communications were presented to the MIDS Cost and Operational Effectiveness (COEA) Study Team.

NAVIGATION SENSOR SYSTEM INTERFACE (NAVSSI)

The Navigation Sensor System Interface (NAVSSI) is designed to integrate shipboard navigation sensors and systems and to provide a single best source of navigation information to all users. NRaD is responsible for development and preplanned product improvement of the NAVSSI including incorporation of ship navigation planning aids, digital nautical charts, plotting capabilities, addition of navigation sources and users, and accuracy improvements.

Program accomplishments during CY 93 included the following:

Completed development of a NAVSSI module to allow NAVSSI availability at any Naval Tactical Control System-Afloat (NTCS-A) terminal. This is a major step required to fully integrate the NAVSSI into the Joint Maritime Command Information System (JMCIS) program.

COMMAND AND CONTROL DEPARTMENT

OPERATIONS SUPPORT SYSTEM (OSS)

The Operations Support System (OSS) is being developed to provide the Chief of Naval Operations (CNO) and Fleet Commanders in Chief (CINCs) with a single, integrated system to receive, process, display, and assess the readiness, warfighting capabilities, and disposition of U.S. and allied forces and to optimize the allocation of these resources. Effective management of naval resources requires ready access to an enormous amount of static and dynamic information regarding positional data, employment scheduling, readiness, casualty status, and standardized unit characteristics. Available data must include current positional information on hostile and neutral combatant and auxiliary naval forces plus all-flag merchant shipping and environmental data. The sheer volume of information necessitates the use of the latest automated tools for information processing and display, plus flexible, survivable, and efficient afloat-ashore connectivity.

Program accomplishments in CY 93 included the following:

Successfully passed Operational Test (OT). OPTEVFOR's recent OT Report judged the system "suitable" for interim use and for continued development through OSS Phase II OPEVAL in FY 95. Operator training and proficiency were highlighted as one of the most impressive aspects of the 4-week OPTEVFOR test.

Joint Staff selected OSS as the core for Block 1 of the Global Command and Control System (GCCS). The GCCS core will interface with Joint Sorts, include Unified Build (UB) capabilities, and include functionality from Naval Intelligence Processing System (NIPS), NTCS-A Imagery Exploitation Workstation (NIEW), and Navy Tactical Command System Afloat (NTCS-A).

Installed OSS software release 92-2 at CINCUSNAVEUR, London, UK.

COMBAT AIR FORCES WEATHER SOFTWARE PACKAGE (CAFWSP)

The Combat Air Forces Weather Software Package (CAFWSP) being developed by NRaD together with Computer Sciences Corporation has been selected by General Kelly, Director of Weather for the Air Force, to be a cornerstone in its Combat Weather System (CWS). The CAFWSP and another Air Force weather system, the Automated Weather Distribution System (AWDS), will be integrated using the Portable, Reusable, Integrated Software Modules (PRISM) concept, and then provided to GFE contractors who will use the system as a baseline for the Combat Weather System. The Combat Weather System is the Air Force's long-term tactical forecasting system that will give weather support forces the capability to deploy within hours, carry all necessary equipment and supplies with a limited amount of airlift, and be able to maintain themselves in the field for at least 30 days. General Kelly signed an action memo with Admiral Chesbrough, Oceanographer of the Navy, to extend cooperation of meteorological and oceanographic initiatives to improve environmental support to joint, interservice, and service operations.

ADVANCED COMBAT DIRECTION SYSTEM (ACDS)

The Advanced Combat Direction System (ACDS) is a major development program that will upgrade the current Navy Tactical Data System (NTDS) on aircraft carriers, LHDs, and selected cruisers. ACDS is being developed in two phases designated as Block 0 and Block 1. ACDS Block 0 is intended to provide for the installation of upgraded Navy-standard computers, displays, and peripheral hardware, and the rehosting and enhancement of existing Model 4 NTDS software to operate on this hardware. ACDS Block 1 is planned to provide a major software upgrade to Model 5 NTDS by using the same hardware as installed for Block 0. In addition to the Model 5 capability, principal software enhancements provided by the Block 1 computer program include increased surveillance ranges and capacities, automation of the track management process, integration of electronic surveillance measures (ESM) and nonorganic surveillance assets, enhanced ability to identify system tracks based on contributing

sensor sources, improved multiship gridlock achieved in concert with JTIDS, and system adaptability through operator-defined doctrine processes.

Program accomplishments in CY 93 included the following:

ACDS Block 0

Completed System Integration Testing (SIT) on the Advanced Combat Direction Systems Block 0 CV Cooperative Engagement Concept (CEC) in Dam Neck, VA. Over 12 separate modules were tested along with a high number of program modifications.

Delivered the ACDS level 8 Block 0 C48F.1 program version to the USS *Dwight D. Eisenhower* (CVN 69) at Portsmouth, VA. This is a major upgrade for the ship and will include intensive training of the ship's Combat Systems personnel.

Delivered the ACDS Level 8 Block 0 C48F.1 program version to the USS *Essex* (LHD 2) in Long Beach, CA. Initial problems with the Naval Tactical Command System Afloat (NTCS-A) interface were resolved and the delivery went well.

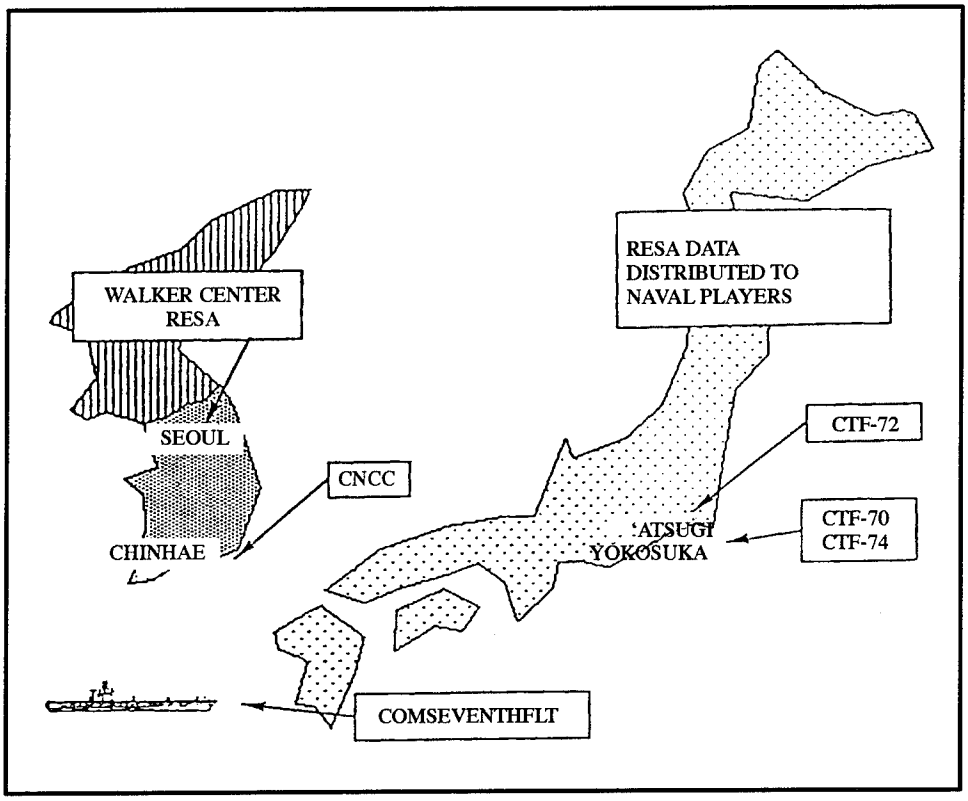
Delivered the ACDS Level 8 Block 0 G48K program version to the USS *Carl Vinson* (CVN 70) in Alameda, CA. This delivery is an upgrade to the ship's current program and a part of the overall Code 40 effort to groom USS *Carl Vinson* C^3 capabilities.

ACDS Block 1

Completed USS *Constellation* (CV 64), ACDS Block 1 crew training in the C60 Lab 118. Highly favorable comments were received from the training crew for the support provided during the 4-week training period.

ULCHI FOCUS LENS (UFL)

NCCOSC and contract support personnel contributed significantly to the success of the world's largest and most complex computer-aided joint service command and control exercise, Ulchi Focus Lens (UFL-93), which was conducted during August 1993. The exercise was sponsored by the U.S./Republic of Korea Combined Forces Command and and was intended to provide command and control training to the numerous joint and allied commanders responsible for the defense of the Republic of Korea.



Ulchi Focus Lens-93.

To provide a realistic and dynamic warfare environment and stimulate training, UFL used a variety of computer simulation models. The events occurring in the computer simulations were reported to the commanders in the training audience. The commanders interacted with each other using the normal command, control, communication, computer, and intelligence (C^4) systems. Plans and directives formulated by the training audience were interactively implemented in the computer models on a realtime basis. Approximately 12,000 personnel participated in UFL-93 from command locations throughout the Republic of Korea, Japan, and at sea.

The principal combat models used for UFL-93 were the U.S. Army Corps Battle Simulator for ground operations, the U.S. Air Force Air Warfare Simulator (AWSIM) for land-based air operations, and NCCOSC's Research, Evaluation, and Systems Analysis (RESA) simulation for maritime operations. RESA is developed and maintained by the NRaD Simulation and Human Systems Technology Division, Code 44.

For sufficient computing power to operate all of the simulation models needed, AWSIM, RESA, and an electronic combat model were operated at the Warrior Preparation Center, Einseidlerhof, Germany. They were remoted to interactive command centers at various sites in Korea via leased satellite systems and the Defense Simulations Internet, making the exercise truly global. U.S. 7th Fleet and Republic of Korea naval forces were controlled by several hundred U.S. naval reservists and Republic of Korea naval officers at RESA command centers at the Walker Center in Seoul, Korea. Opposing force naval play was conducted using four RESA command centers at Camp Casey, north of Seoul. One RESA command center for coordination of sea-based and land-based air operations was at Osan Air Base.

A key achievement of UFL-93 was to more fully integrate U.S. 7th Fleet commanders and staffs into the training effort. Key roles were played by Commander U.S. 7th Fleet onboard his flagship, USS *Blue Ridge* (LCC 19), Commander Task Force (CTF) 70 onboard USS *Independence* (CV 62), CTF 72 at Kami Seya, Japan, CTF 74 at Yokosuka, Japan, and the Joint Task Force Naval Component Commander at Chinhae, Korea.

This integration was accomplished largely by providing an exercise tactical picture to the Navy Tactical Command System-Afloat (NTCS-A) used by those commanders for command and control support. The tactical picture for NTCS-A was provided by using the RESA Message Generator to create streams of appropriately formatted messages to describe the apparent tactical situation as developed by the RESA warfare models. These data streams originated on the RESA host computer in Germany and were distributed to fleet participants via a complex architecture integrated with the Officer in Tactical Command Information Exchange System. This architecture was designed by NRaD Code 42040; installed/tested by NISE West and Allied Signal.

Operational support of the communications systems used to distribute the tactical picture to NTCS-A users during the exercise was supervised by PRC Incorporated. The tactical picture was also copied at the Reconfigurable Land Base Test Site in NRaD Building 600 and forwarded to the RESA Laboratory in Building 606 to complete a three-continent simulation link.

A significant advancement in computer simulation technology was used for the first time in UFL-93. The functional electronic interface of the ground, air, and maritime combat models used the Aggregate Level Simulation Protocol (ALSP). While RESA used ALSP in previous exercises to maintain simulation time in synchronization with a confederation of models, the UFL-93 ALSP interface allowed air-to-air combat between RESA simulated aircraft and aircraft simulated in other models. Another ALSP interface provided simulation of Tomahawk Land Attack Missile operations. These interfaces were developed under the leadership of the ALSP Naval Subgroup.

In spite of a number of network outages the continuity of the exercise was maintained through the efforts of NRaD and contractor support personnel in Germany.

Exercise support in Korea during the 7-day pre-exercise testing period and the 14-day exercise was provided by NRaD and contractor personnel.

UFL-93 fostered significant advances in the state-of-the-art of distributed simulation technology as well as providing an exceptional medium for conducting joint services command and control training. NRaD participation in the exercise contributed significantly to supporting the Navy in command and control system development, operations, and training.

HIGHLY DYNAMIC AIRCRAFT (HyDy)

The ARPA-sponsored project Highly Dynamic Aircraft in a Real and Synthetic Environment (HyDy) successfully tested the ground portion of Phase II integration, which will have real and synthetic targets being displayed at an F-14D Radar Intercept Officer

(RIO) position. The test completed at NAWC Weapons Division China Lake demonstrated the ability to take Tactical Air Combat Training Systems (TACTS) messages and translated that information to interact with Distributed Interactive Simulation (DIS) Protocol Data Unit (PDU) compliant simulators.

The NRaD Stealth was used as a visualization system during the HyDy vehicle demonstration at China Lake for the ARPA HyDy project. The NRaD Stealth provides a 3-D view of the world based on the interactions being promulgated by the DIS protocols standard. The NRaD Stealth is written in "C" and runs on an SGI Indigo platform using Gemini Visual Systems (GVS) software library to display and manipulate 3-D models and terrain that conform to Software Systems Multi-Gen Flight format.

LINK-11

The AN/USC-34 Link-11 system is the Fleet's standard Link-11 radio system, receiving Approval for Service Use in 1980. The AN/USQ-74 Programmable Data Terminal Set (PDTS), part of the USC-34, is hosted on the USN standard UYK-20 minicomputer and performs the modulator/demodulator and link protocol functions. The USQ-74 is also used with other radio systems on various platforms. Since the USQ-74 is software programmable, many improvements in signal processing techniques, operator display, and link performance monitor tests are feasible with the system. Changes to upwards of 100 units can be readily affected with a simple magnetic cartridge update. Link-11 improvements are now also feasible with new technology equipments.

Program accomplishments in CY 93 included the following:

Conducted Caribbean Link-11 Net Site surveys with NRaD NISE West personnel at the Dominican Republic and Grand Cayman Island Caribbean Basin Radar Network (CBRN) sites. A Radio Remote Control Interface Unit and a remotely controlled MX-512P Link-11 Data Terminal Set (DTS) are to be installed at these and other remote sites, feeding a master MX-512P DTS and attached Link-11 Display System (LEDS) at CARIBROC, Key West, FL using the Wireline/Satellite option of the MX-512P. CBRN sites were originally contracted to Westinghouse by U.S. Air Force, but documentation was not procured. By tracing cables and buzzing out selected radio and data cables, sufficient knowledge was gained to determine an acceptable method for integrating the MX-512P into the existing data multiplexer, RF-155DR HF radio and three GRC-171(V)2 UHF radios.

Successfully tested the Time-Locked Link-11 interface of the LEDS in the lab, demonstrating the ability of the modified LEDS program to transparently pass all data and interrupts between the Link-11 DTS on one interface and a host Combat Direction System (CDS) on a second interface.

Completed the Navy Link-11 interoperability certification test for the E-2C Group 0 version of the tactical software (P9), using the Air Tactical Data System (ATDS) lab in C60 linked to the Multiple Unit Link Test and Operational Training System (MULTOTS).

COMMAND AND CONTROL PROCESSOR (C^2P)

The Command and Control Processor (C^2P) is intended for use aboard major combatants (carriers and cruisers) to provide tactical data link service to the ship's Combat Direction System (CDS). The C^2P provides the ship's CDS data link service on Link-11, Link-4A, and the new Tactical Digital Information Link (TADIL) J/Link-16.

The C^2P is being developed in two configurations. One of the configurations, termed "(V0)," is intended to allow the introduction of the Joint Tactical Information Distribution System (JTIDS)/ Link-16 into ships with "Model 4" CDSs. The second version of C^2P, termed "(V1)," is intended to provide full TADIL J/Link-16 service on the ships scheduled to receive the new "Model 5" ACDS Block 1 CDS.

NRaD is the Technical Direction Agent (TDA) for the C^2P and is leading the Government acceptance test and product validation effort. NRaD is also the designated Software Support Activity (SSA) for the system.

Program accomplishments in CY 93 included the following:

Delivered, installed, and tested the latest C^2P operational program, Version M4V1B7, aboard the USS *Carl Vinson* and USS *Antietam*.

Installed the C^2P on the USS *Arkansas* and corrected problems associated with the navigation and disk interfaces.

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)

The Joint Tactical Information Distribution System (JTIDS) is a high-capacity communications terminal

that will provide aircraft and ship platforms with secure, jam-resistant voice and data communications.

Link-16

Link-16 is a high-capacity, antijam, secure, extended line-of-sight, digital communication (data and voice), navigation and identification system. It uses Time Division Multiple Access (TDMA) architecture, spread-spectrum, L-Band frequency hopping, and error correction coding and detection.

It is the next-generation tactical data link, built to support the command, control, communications and intelligence function in Navy battle group, multiservice and multinational operations. Link-16 equipment included JTIDS database and human-computer interface controls and displays.

Link-16 Developmental Testing

Program accomplishments in CY 93 included the following:

Completed an intensive 2 weeks of Link-16 Developmental Testing (DT-IIF). Testing was conducted in the Southern California (SOCAL) Operations Area with Joint Tactical Information Distribution System (JTIDS)-equipped vessels under the operational control of Commander Cruiser-Destroyer Group Three (COMCRUDESGRU THREE). The Battle Group was comprised of the USS *Carl Vinson* (CVN 70), the USS *Arkansas* (CGN 41), and the USS *Antietam* (CG 54). Testing also included JTIDS-equipped aircraft: VAW-110 E-2C Hawkeyes and VF-11 and -31 F-14D Tomcats. JTIDS support equipment, manned and operated by NRaD test staff, included the Multilink System Exerciser (MLSE) Van, embarked on the USS *Carl Vinson*, the E-2C Van at Naval Air Station Miramar, the JTIDS Van at Pedro Tower, the Systems Integration Facility (SIF) at building 600, and a Relay Van on San Clemente Island. The Relay Van provided excellent beyond line-of-sight JTIDS voice and data communications, creating a wide area tactical network for the Battle Group Commander. The SIF became the ashore operations center for JTIDS testing using a realtime SOCAL Link-16 tactical display. JTIDS voice was also used to pass operational testing and administrative traffic. Fleet participants were very impressed with Link-16's ease of operation and how it reduces the operational work load of the Link Supervisors. In addition, JTIDS secure voice was used in various real-world operations including an actual Search and Rescue (SAR) as well as Link-11 Management and other Battle Group tactical operations. JTIDS voice quickly became the most reliable voice system in the Battle Group and the coordination net of choice.

In addition, JTIDS voice was used to coordinate and execute multiple training exercises (e.g., Link-11 Fast Frequency changes). At one point during DT-IIF, Link-16 presented COMCRUDESGRU Three with the tactical picture during a major War at Sea exercise since poor connectivity made Link-11 virtually unusable. The friendly force identification feature of Link-16 provided the staff with a situational awareness that allowed them to observe the F-14Ds go "feet-dry," descend to the target, and rendezvous with their wingmen. The JTIDS-equipped aircraft were the only aircraft that were able to immediately rendezvous with their respective wingmen following the strike; again due to the enhanced situational awareness provided by Link-16, a stable and reliable tactical picture was presented to the staff. The extensive use of Data Forwarding throughout the DT-IIF test phase confirmed the Link-16 interoperability capability with existing TADILs. Connectivity with the SOCAL operational Link-11 net was almost continuous throughout the test phase. The Data Forwarder proved the capability to forward an operational Link-11 tactical picture to Link-16 and vice versa. Link-16 is proving itself to be a valuable, desired, and much needed asset to the existing Naval communications arsenal. JTIDS Link-16 system was recommended for preceding to Operational Testing OT-IID upon completion of development testing.

Conducted the Link-16/JTIDS Developmental Test DT-IIG. DT-IIG on a not-to-interfere basis with routine battle group (BG) training evolutions. Results of the tests showed numerous combat system integration problems aboard the various ships among the BG. By the end of the week, high-level negotiations were accomplished that elicited concurrence from COMCRUDESGRU THREE to take some systems off line to clean up the BG's tactical picture. From that point things went smoothly.

E2-C JTIDS Van Support

Program accomplishments in CY 93 included the following:

Provided E2-C JTIDS Van support for the Joint Air Defense Operations/Joint Engagement Zone (JADO/JEZ) Field Test 2 exercise at Nellis Air Force Base Las Vegas, NV. This Field Test was the second in a series of three activities designed to evaluate JEZ Airspace Management options based on positive hostile identification. The E2-C Van was used for ground JTIDS checks of VF-11/31 F-14Ds and VAW-113 E2-C's. In addition, the van was used for

Mode 4 IFF checks and various air platform communication checks prior to launch.

SECURE TACTICAL DATA NETWORK-4 (STDN-4)

NRaD was a major participant in a joint-service demonstration of the Secure Tactical Data Network phase 4 (STDN-4) 23 August – 16 September. During the Navy-led demonstration, more than 25 Navy, Air Force, Marine, Army, and other government agency sites participated, meeting more than 70 joint objectives to make the effort an overwhelming success.

The STDN-4 demonstration accomplished an impressive list of tasks that had never been done before, including:

1. First network linking Commander, Joint Task Force (CJTF), Commander-in-Chief, and component commanders over super-high-frequency (SHF) link
2. First use of common imagery server to support entire task force
3. First use of common weather server to support entire task force
4. First demonstration of common tactical picture across entire task force
5. First demonstration of multilevel secure local area network over SHF over entire task force
6. First demonstration of collaborative planning tools across CJTF using SHF connectivity
7. First time Navy Tactical Command System-Afloat has been connected to other services' packet switched networks.

Demonstration sessions at NRaD's new Building 40 and aboard USS *Coronado* (AGF 11) were attended by a constant stream of distinguished visitors, including the principals overseeing command, control, and communications programs for the DoD and all the services.

Significant NRaD participation involved the CRONUS distributed computing environment and the Reconfigurable Land-Based Test Site (RLBTS).

CRONUS Distributed Computing Environment

The CRONUS distributed computing environment was incorporated into the STDN-4 demonstration.

CRONUS has been developed at NRaD, as a joint service effort with Rome Lab, CECOM, and BBN. This technology is being used to demonstrate collaborative planning between CJTF/COMTHIRDFLT and CINCPAC, CINCPACFLT, and NRaD using TARGET (a product of ARPA) and CASES.

Reconfigurable Land-Based Test Site (RLBTS)

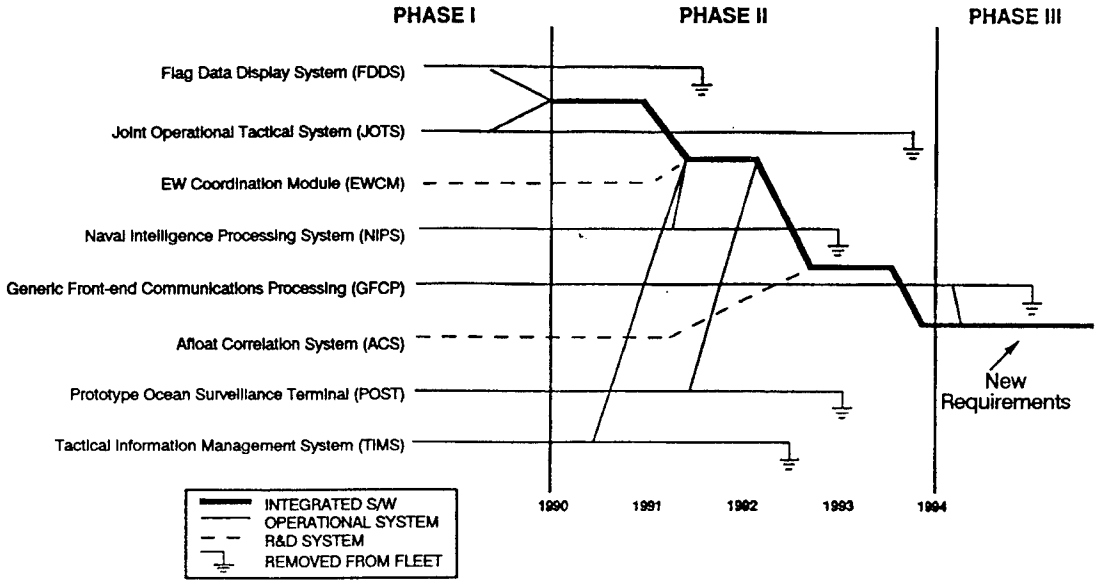
Over-the-Horizon Targeting (OTH-T) program system engineers working in the Reconfigurable Land-Based Test Site (RLBTS) provided lab support in the STDN-4 effort. RLBTS was configured as the Naval Force Commander (NAVFOR) with Commander, Carrier Group One, RADM Prueher and his staff operating the consoles in the lab. OTH-T program support engineers operated the REPEAT data extraction and replay processors in order to inject the synthetic portions of the scenario over the secure tactical data network from the RLBTS lab. Connectivity between the exercise Commander, Joint Task Force (CJTF) , all the service force commanders (Army, Air Force, Navy, Marines), as well as between supporting staffs (CINCS and other supporting Commands) has been established at the application level. The tactical SHF LAN has been connected to the Pacific Crisis Management System (PAC CMS) metropolitan area network, and to the Defense Simulation Internet (DSI).

NAVY TACTICAL COMMAND SYSTEM-AFLOAT (NTCS-A)

The Navy Tactical Command System-Afloat (NTCS-A) is the primary Navy command and control system afloat. NTCS-A integrates the functional capabilities of several command, control, communications, and intelligence (C^3I) systems into a single system that supports C^3I requirements for both unit-level and flag-level commanders.

Program Objectives

The objective of the NTCS-A program is to develop and field an integrated, automated command and control system for the support of afloat naval commanders, i.e., officer in tactical command (OTC), composite warfare commander (CWC), and commanding officer (CO). This system will provide the ability to receive, process, display, and manipulate data in near realtime on the readiness and warfighting capabilities of friendly (U.S. and allied) forces in support of the full range of Navy missions.



NTCS-A evolutionary development process.

System Description

The NTCS-A program started with two major C^2 programs, the Flag Data Display System (FDDS) and the Joint Operational Tactical System (JOTS). As the remaining baseline systems evolve during Phases II and III into the NTCS-A/JOTS II software, only the NTCS-A will remain. Thus, the operational requirements of the two programs have been satisfied by a single engineering solution, i.e., both programs use (1) Navy standard Desktop Tactical Computer 2 (DTC-2) workstations, (2) identical computer programs, (3) common configuration management and training, and (4) the same Software Support Activity (SSA) and In-Service Engineering Agent (ISEA).

The NTCS-A/JOTS II software/system will receive, process, correlate, store, and present information from multiple sensors and sources to support the OTC, CWC, and COs in executing their command responsibilities.

NRaD Roles

NRaD has participated in all aspects of evolving Navy C^3I development since the early 1960s and supported early NTCS-A program prototyping efforts. Today, NRaD is a central figure in support of the NTCS-A program, with major roles in development, system integration, system engineering, and field support, and is responsible for software life-cycle support.

Background

The submarine, once viewed almost exclusively as an ASW platform, has now taken on missions such as covert strike, special warfare support, and battle group support operations. These new mission areas have generated new command and control requirements.

Since the advent of the Tomahawk missile, the submarine has had limited data communications. Using its Combat Control System (CCS) Mk I, the attack submarine has the capability to receive, store, and display over-the-horizon targeting information via satellite.

Interoperability problems between the CCS Mk I and other Navy tactical command, control, communications, and intelligence systems forced the submarine to rely on a shore targeting terminal to reformat information so the CCS Mk I system could process it. This processing took time, and the delays incurred frequently limited the value of the information. Modifications to the CCS Mk I to make it support new mission areas were both costly and time consuming.

To improve submarine interoperability with other forces, the Program Executive Office for Submarine Combat Systems began to investigate installing NTCS-A systems on submarines (SSNs) in 1992. With assistance from SPAWAR 323 and the NRaD Over-The-Horizon Targeting program staff, successful tests of NTCS-A systems were conducted first at the Naval Undersea Warfare Center Newport Division

submarine combat systems laboratory and then onboard the submarine USS *Miami* (SSN 735). These tests showed that the NTCS-A installation on the SSN allowed it to receive information directly from the battle group in a much more timely fashion than before. NTCS-A made it possible for the submarine to receive and display graphic overlay information.

Operators also noted that NTCS-A was significantly faster and easier to operate than the CCS Mk I, and the NTCS-A color displays were more effective. Based on these results, plans were made to install NTCS-A systems on submarines starting in FY 94.

In the meantime, Commander, Submarine Force, U.S. Pacific Fleet, asked if a limited number of installations could be done to support near-term SSN battle group deployments. NRaD Code 4204 developed and installed a temporary NTCS-A package for USS *Birmingham* (SSN 695) in early 1993.

Birmingham's commanding officer reported that the NTCS-A system provided a significant enhancement to his ability to support battle group operations during its historic first deployment to the Persian Gulf. Since the *Birmingham*, about 10 SSNs in the Atlantic and Pacific Fleets have received NTCS-A installation.

NTCS-A installation on submarines played a role in another new submarine mission area in support of special forces. USS *William H. Bates* (SSN 680) supported the Commander of the Joint Special Operations Task Force (JSOTF) during exercise Tandem Thrust 93. *Bates* was able to use its NTCS-A system to communicate directly with COMJSOTF and the Joint Task Force Commander during its special warfare mission. Using a new application, *Bates* was also able to receive weather information directly, a first for SSNs.

The submarine community is continuing to explore new technologies to help support its new mission areas. The addition of NTCS-A technology allowed them rapidly to become part of the new "from the sea" maritime strategy.

Program accomplishments in CY 93 included the following:

Installed Version 2.0 systems on the USS *Blue Ridge* and at COMUSNAVCENT in Bahrain. Version 2.0 is the latest update to the Navy's primary afloat command and control system. This upgrade includes the introduction of TAC 3 computers, improved common support software, called the unified build, and new application programs that provide new and improved support to command. These are the most recent installations in the Fleet. NTCS-A is installed at over 200 installations, many of them will be upgraded to Version 2. The USS *Blue Ridge* is the flag ship for COMSEVENTHFLT.

Provided NTCS-A support for Tandem Thrust 93. Initial software installation and checkout on the USS *Blue Ridge* (LCC 19) was completed with NTCS-A, OSS, and the Contingency Theater Auto Planning System (CTAPS). Technical support was provided to PACAF in Hawaii to ensure CTAPS interoperability with *Blue Ridge*.

Installed NTCS-A 2.0 interim capability at the Naval Strike Warfare Center, Fallon, Nevada. This interim system (preliminary to a full installation in FY 94) consisted of three TAC-3 computers providing a NIPS Central Data Base Server and four operator work positions. The system will be used for C^2 and mission planning training by all air wings as part of their normal workup and training cycle.

MAP GENERATOR PROTOTYPE

The NRaD Map Generator Prototype is a transition effort of the ONT block-funded Map Generator program. The system will overlay digital maps, air corridors, and other graphic objects on the existing OJ-535 tactical situation displays.

Program accomplishments in CY 93 included the following:

Completed a site survey on the USS *Constellation* (CV 64) in preparation for the installation of the NRaD Map Generator Prototype hardware.

SHIPBOARD TRACKING AND TELEMETRY SYSTEM (STTS)

In support of exercise Kernal Raider 93, NRaD installed three NRaD-developed Shipboard Tracking and Telemetry Systems (STTS) on exercise participants (USS *Conquest* (MSO 488), USS *Implicit* (MSO 455), and USS *Gallant*) (MSO 489). GPS-derived position reports from STTS were relayed to Tactical Training Group Pacific (TTGP) where they were automatically sent to the Enhanced Naval Wargame System (ENWGS), the NTCS-A LAN at TTGP, and on the OTCIXS broadcast to afloat units. This was the first time STTS has been used to provide near realtime Blue Force position reports over OTCIXS - STTS, providing position reports at 5-minute intervals.

E-2C GROUP II

NRaD is the designated Software Support Activity (SSA) for the E-2C Group II Air Tactical Data System

(ATDS) software system. The Group II ATDS has a Software Support Date of 1 January 1993 and is currently undergoing fleet introduction. NRaD Code 48 has been actively involved in the development of the Group II software in the areas of IV&V and software acceptance testing.

In CY 93, the E-2C Group II configuration passed OPEVAL.

FLEET MOBILE OPERATIONAL COMMAND CENTER (FMOCC)

In November 1992, the Navy decided to remove the USS *La Salle* (AGF 3) from the Persian Gulf, leaving U.S. Naval Forces Central Command without a flagship. In 3 months, the NRaD Fleet Mobile Operational Command Center (FMOCC) Team conducted an ashore installation of the FMOCC from concept to operational deployment. This effort resulted in Central Command having the most advanced command, control, communications, computers, and intelligence (C^4I) capability available. Without this capability, central command could not have performed the mission.

MARINE SCIENCES AND TECHNOLOGY DEPARTMENT

MARINE MAMMALS

Program accomplishments in CY 93 included the following:

Completed assistance to Fleet Marine Mammal Systems participating in Kernal Raider Exercise. Three Marine Mammal Systems participated and successfully conducted assigned operations to expected performance levels.

Supported Fleet Marine Mammal Systems that participated in Operation Bell Thunder. All the Fleet systems attached to Explosive Ordnance Disposal Unit Three did very well in this exercise. The Mk 7 was aboard and operated from the USS *Ft. McHenry* (LSD 43) for 6 days during the exercise. This was the first time a marine mammal was deployed from a ship in an exercise.

Successfully transported all animals scheduled to transition from the NRaD Hawaii Detachment to San Diego.

CONE PENETROMETER SYSTEM

Technology transfer/transition plans were made in May for the Cone Penetrometer Program. The newly formed Naval Facilities Engineering Support Center (NFESC) [combining the Civil Engineering Laboratory (CEL) and the Navy Energy and Environmental Support Activity (NEESA)] in Port Hueneme will become an active partner in this technology transfer process. The cone penetrometer is a high-visibility product that needs rapid acquisition/transition.

The Penetrometer system began validation studies at NAS North Island in June. After final installation of equipment and check out, the first test with sensor and data acquisition systems were made.

The system was then demonstrated in July to RADM Walker, CNO (N45), Director, Environment, Safety and Health, Dr. G. Moy, Assistant DUSD for Environmental Security, Mr. Paul Yeroshak, Deputy for Environmental Restoration and Compliance Policy, ASN(I&E), and Mr. Bill Quade NAVFAC Code 40, Director for Environment, Health and Safety. The participants were pleased and impressed with the progress in the program. After the demonstration, the system was driven to the North Island NAS fuel farm and commenced its shake-down test and evaluation. Results of the initial "pushes" looked very positive, as the system detected a previously unknown plume of spilled or leaking petroleum product.

A transition and acquisition plan for the petroleum cone penetrometer system was developed and followed by discussions between NAVFACENGCOM, Code 52, and NEESA on policy, responsibility, and implementation of acquisition and transition of the system.

SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM (SCAPS)

The Site Characterization and Analysis Penetrometer System (SCAPS) is a Tri-Service technology effort led by the U.S. Army. Initial integration of a fiber-optic-based laser-induced fluorescence sensor for petroleum, oil, lubricant (POL) contaminants into a standard geotechnic cone penetrometer was a collaborative effort with U.S. Army Waterways Experiment Station (WES) and NRaD. Technical success generated high sponsor interest for rapid maturation and introduction of the technology to POL-contaminated Hazardous Waste Sites. Acquisition and dual-use of SCAPS for continued technological development and regulatory acceptance and preliminary site characterization as a strategy was adopted.

NRaD will design, develop, test, and evaluate, document and produce, field and support, and incrementally improve the SCAPS in coordination with a Tri-Service consortium.

Program accomplishments in CY 93 included the following:

Completed a very successful 2-week test and evaluation of SCAPS EDM-1 at NAS, North Island (NASNI). This was part of the phase 2 shake down and initial deployment. After several weeks of negotiations with the County of San Diego, NRaD was granted a permit to penetrate ground water (on a revised/reduced fee). The crew put 22 "permitted" holes in the ground to depths of 23 feet, and six others for calibration

purposes. The crew obtained good data, or good "hits," correlating with recognized fuel spill areas. There were a few problems as expected, but all were corrected on site. The crew did an outstanding job. A system demonstration was held for regulators and NAVFAC Southwest Division personnel. They watched the complete system in operation, demonstrating the rapid on-site visualization of petroleum contamination. The demonstration went very well.

Completed phase 3 tests of the SCAPS system at the NASNI fuel farm. This validation study compared penetrometer sensor profiles with soil cores and well samples to support EPA and regulatory acceptance of the SCAPS system.

In conjunction with Naval Facilities Engineering Support Center (NFESC), Port Hueneme, NRaD provided an information brief and a SCAPS demonstration for EFD/Southwest Division Remediation Program Managers at their facility. About 15 Remedial Program Managers attended and expressed high interest in deploying SCAPS to their respective sites. Subsequent followup indicates over 300 potential sites have been identified and will be researched. Plans were finalized for deployment of SCAPS to Naval Station, San Diego (i.e., 32nd Street), to screen the "lodge" site for POL contaminants. This will be the first official field deployment (NASNI fuel farm was a scheduled three-phase "checkout").

MOBILE DETECTION, ASSESSMENT, AND RESPONSE SYSTEM (MDARS)

The Mobile Detection, Assessment, and Response System (MDARS) program provides technical support for the Tri-Service DoD MDARS Security Robotics program.

Program accomplishments in CY 93 included the following:

Shipped Version 1.0 of the Multiple Robot Host Architecture (MRHA) software systems.

Completed "semi-formal" software testing for release of version 1.1 of the MRHA systems.

MOBILE INSHORE UNDERSEA WARFARE SYSTEM UPGRADE (MIUW-SU)

The Early User Assessment (EUA) of the Mobile Inshore Undersea Warfare System Upgrade (MIUW-SU) program was conducted at NRaD from 1 August through 16 August. Personnel from Naval Reserve MIUW Unit 112, St. Louis, MO, and Inshore Undersea Warfare (IUW) Groups One and Two were ordered to NRaD for 2 weeks of reserve annual training to assist in evaluating the upgraded system. The project is sponsored by Director, Expeditionary Warfare Division (OPNAV N852G), and managed by the Office of Special Technology. The intent of the project is to provide integrated and upgraded MIUW equipment and capabilities using primarily off-the-shelf equipment. The mission of the MIUW units is to provide surface and subsurface surveillance in littoral areas worldwide. Secondary mission capabilities include command, control, communications and intelligence functions.

The current MIUW system is based in an 8-foot by 20-foot transportable AN/TSQ-108A-V3 Radar Sonar Surveillance Center (RSSC) van used as a command center. The sensors located in and on the RSCC include an SPS-64 radar and AN/SQR-17A sonar buoy processor. Lookouts use binoculars or electronic imaging equipment for visual identification of targets and stand exposed watches. Five MIUW units, including MIUW Unit 112, used this type of equipment configuration while deployed during Desert Storm and Desert Shield. The Navy decided to provide an upgrade to the MIUW system based on this experience as well as the availability of much more capable off-the-shelf sensors and displays.

The MIUW-SU program will dramatically improve the capabilities of the MIUW community. It consists of an upgraded RSCC van, three Remote Sensor Platforms (RSPs), and lightweight underwater sensor strings.

The RSPs come in two different configurations, a Mobile Sensor Platform (MSP) and a Portable Sensor Platform (PSP). The MSP is a sensor platform built onto a High-Mobility Multipurpose Wheeled Vehicle (HMMWV or "Humvee") to permit rapid deployment and maximum site flexibility. The PSP is a sensor platform mounted on a stationary 24-foot tripod designed to be quickly erected and left in position for the duration of the mission. The remote sensors include a Thermal Imaging Sensor (TIS) and a Visual Imaging Sensor (VIS) co-located on a computer-controlled pan-and-tilt mechanism, a Furuno radar, and an electronic support measures (ESM) system. Telemetry is provided by either microwave or fiber-optic cable.

A modular approach was taken in the design of the sensors and telemetry. Both the MSP and PSPs can be easily reconfigured, mixing and matching sensors or telemetry systems, to adapt the equipment to a particular operational mission.

The AN/TSQ-108A-V2 RSCC van has been upgraded to a V3 configuration. The new RSSC contains

improved sensor processing hardware including an upgraded AN/SQR-17A(V)3 acoustic processor, an upgraded AN/ALR-66(V) ESM system, communications gear, and a Graphical Data Fusion System (GDFS) for state-of-the-art command and control display.

The GDFS is a processor/display that fuses all sensor platform information and overlays it onto a digitized map. An operator can see the geographic picture, his own location, the location of the sensors, and the output of the sensors on a single large screen display.

A typical display could be a map of San Diego Harbor with overlays of 20 surface targets, four subsurface targets, a TIS picture of one of the surface targets, and selected ESM lines. The display is kept manageable through the use of pull-down windows for sensor control and display, target icons based on classification, and selectable zones of target acquisition and non-interest.

Array and omni-sensor underwater sensor strings are in development and will be configured for easy deployment from a small boat. Combined with the upgraded acoustic processor and the GDFS, MIUW units will have an operationally effective shallow-water surveillance capability.

During the EUA period, MIUW Unit 112 set up both the current system and the upgrade system at Battery Humphreys. Training of the 61-person unit on the features and operation of the system upgrade was completed in 4 days. The training included both classroom and hands-on instruction. Personnel were cross-trained on all the major subsystems. Once the training sessions were completed, the unit began to run 24-hour watches and participate in operational exercises.

Personnel from NRaD and MIUW Group 1 planned and coordinated several mission scenarios using a variety of target types ranging from large ships to fast boats, helicopters, and swimmers. In addition, the MIUW-SU system was used to assist U.S. Customs agents in tracking border maritime traffic.

MIUW Unit 112 returned to St. Louis highly enthused about the planned upgrade. Unit Commanding Officer CDR Richard Robey reported everyone was pleased to have had an opportunity to critique the system and offer suggestions for improvement.

The program requirements officer (N852G) CAPT Kevin McCleskey was onboard for the first three days of the EUA. He was impressed by both system upgrade equipment and the dedicated efforts of NCCOSC personnel to plan and effectively manage the 2-week training period.

UNMANNED GROUND VEHICLE (UGV)

The objective of the Unmanned Ground Vehicle (UGV) program is to produce telerobotic mobile ground systems for use in the battlefield by Marine Corps and Army personnel. Three Teleoperated Vehicles (TOVs) systems were developed by the Naval Ocean Systems Center (NOSC) (NRaD predecessor), each consisting of a remotely controlled vehicle and control station. Each TOV can be controlled through a 30-km, fiber-optic tether and can be equipped with one to three mission modules to include a reconnaissance, surveillance, target acquisition (RSTA) module; a 50-caliber machine gun, self-defense module; and/or a nuclear, biological, chemical (NBC) reconnaissance model.

Program accomplishments in CY 93 included the following:

Accepted the final set of Surrogate Teleoperated Vehicles from the contractor. The contract was completed pending a final audit by the Defense Contacting and Management Agency.

Completed the disassembly of TOV #1. All nonstandard equipment was removed and the vehicle returned to the troop carrier configuration.

STATIC RANDOM ACCESS MEMORY (SRAM)

Tests at Brookhaven National Lab were conducted to determine the vulnerability of fully depleted, ultrathin silicon-on-sapphire (SOS) circuitry to high-energy heavy ions. These tests were carried out on Static Random Access Memory (SRAM) circuits fabricated at the Microelectronics Fabrication Facility at Battery Ashburn. Results showed extremely low sensitivity to single-event-upset (SEU) with no errors detected at the highest radiation levels available from the tandem Van de Graff accelerator at Brookhaven. Resistance to heavy ion bombardment is critical to satellite and missile electronics.

WATERSIDE SECURITY SYSTEM (WSS)

The Waterside Security System (WSS) program began its research and development cycle with a commercial product demonstration at the Naval Submarine Base, Bangor, Washington, in 1985. The demonstration tested off-the-shelf equipment to enhance security from waterborne threats.

Following that demonstration program, WSS Program Manager Carmela Keeney, head of Code 532, guided

the program under a compressed schedule. The program completed its DT-IIB testing and operational assessment in 1992, and received approval from Naval Sea Systems Command to proceed with Low Rate Initial Production.

The WSS program was developed at the NRaD Hawaii Laboratory. The program and staff were transferred to San Diego from Hawaii in August 1992.

Program accomplishments in CY 93 included the following:

The WSS Command, Control, Communication, and Display system successfully passed the First Article Acceptance Test.

Installed a WSS testbed on Pier 160 Bayside. Future plans for the program include developing a transportable version of WSS that can be used by crises response teams who deploy on short notice.

SITE SPECIFIC EXPERIMENT (SSE)

Program accomplishments in CY 93 included the following (tasks were completed in support of the Surveillance Department, Code 70):

Participated in the Site Specific Experiment (SSE) test deployment cruise (in support of Code 70) aboard the *Sea Turtle* on 1-3 June 93. During the cruise, two horizontal seafloor acoustic arrays and two lightweight vertical arrays were successfully deployed and recovered. Precision positioning of dummy seafloor arrays were obtained using the Datasonics and Trackpoint II acoustic navigation systems together. The test successfully demonstrated that the SSE array can be deployed, measured, and recovered.

Completed the task of fabricating and pressure testing, to 2000 psi, 26 fiber-optic couplers (wavelength division multiplexers and tap couplers). All couplers passed testing for delivery to Code 70 in support of the SSE and Distributed Surveillance Technology Project (DSTP) programs.

Constructed arrays (in support of Project Spinnaker) at the Code 541 array laboratory for the SSE. Excellent results were achieved with the array's basic production electronics, with only two of roughly 150 manufactured PCBs having serious defects detected in extensive testing.

Successfully recovered the Spinnaker proof-of-concept arrays (these arrays were deployed off the coast of San Clemente Island as the main acoustic detection system of the SSE in September). The Scripps Institute R/V *Sproul* was maneuvered to the array site using GPS navigation with a realtime chart display. Freed by an acoustic release, the arrays surfaced within 1/4 nmi of the ship. Electrical continuity was maintained throughout the recovery (the arrays are completely powered by internal batteries). The fiber-optic trunk cable was terminated and returned to the sea for a longevity test. There were no signs of abrasion visible on the array elements or nodes, but the Al-Fe contact points on the anchors showed signs of corrosion.

SHALLOW-WATER ENVIRONMENTAL CELL EXPERIMENT (SWELLEX)

The Shallow-Water Environmental Cell Experiment 1 (SWellEx 1) was successfully concluded. Conducted in the waters off Point Loma, the experiment gathered baseline environmental data and provided an overall organizational test for the upcoming experiments to develop, deploy, and test shallow-water systems/ concepts. Code 50 personnel acted as planners, coordinators, schedulers, participants, and evaluators of the joint experiment. SWellEx 1 accomplishments include the following: R/P FLIP deployment and use, REVERB array deployment and use, planar array deployment and use, extensive source tows and deployments, 160 conductivity-temperature-depth (CTD) profiles, 100 expendable bathythermograph (XBT) profiles, differential GPS navigation to 5 meters, and extensive propagation data collection.

VARIABILITY OF COASTAL ATMOSPHERIC REFRACTIVITY (VOCAR)

The Variability of Coastal Atmospheric Refractivity (VOCAR) Intensive Observation Period (IOP) took place in the southern California bight in September. Receiver sites at Point Loma and NAWCWPNS Point Mugu monitored VHF/UHF signals transmitted from San Clemente Island and the Los Angeles basin. Seven coastal and island radiosonde sites and the R/V *Point Sur* made weather balloon launches every 4 hours from 0500 to 2100 PDT to characterize the meteorological conditions (personnel from the Naval Oceanography Command Facility San Diego and Marine Corps Weather Support Group Camp Pendleton assisted in these measurements); aircraft operated for NRaD, NAWCWPNS, and NRL DC made airborne measurements throughout the bight. NRaD (Code 54) was the lead activity in conducting VOCAR jointly with NAWCWPNS, NRL Monterey, and Naval Postgraduate School (NPS); additional participants were NRL DC, NOAA/WPL, Johns Hopkins/APL, and Penn State/ARL.

MARINE AEROSOL PROPERTIES AND THERMAL IMAGER PERFORMANCE (MAPTIP)

The objectives of the Marine Aerosol Properties and Thermal Imager Performance (MAPTIP) experiment are to validate marine aerosol models, collect data on aerosol properties in the marine atmospheric surface layer (lowest 10 m), and assess marine boundary layer effects on thermal imaging systems.

In CY 93, NRaD completed a month-long data collection effort in the field program phase. MAPTIP involved eight NATO countries and was conducted off the coast of the Netherlands.

CERAMICS

(NOTE: NRaD Code 9402, Marine Materials Technical Staff, was disestablished effective 1 August 1993 and reestablished as Code 5402. Accomplishments reported after that date are listed below; accomplishments prior to 1 August 1993 can be found in the history for Code 90. An introduction to the ceramics program at NRaD is also found in the history for Code 90. See the document index for specific page references.)

Program accomplishments in CY 93 included the following:

Completed successful pressure test of a 25-inch diameter alumina ceramic hemispherical end closure. Testing included a single pressurization to 10,000 psi with a 1-hour hold, followed by 500 cycles to 9000 psi. The assembly survived the test with no structural degradation. Results will appear in NRaD TR 1584.

GENERALIZED EMULATION MICROCIRCUIT (GEM)

The Generalized Emulation Microcircuit (GEM) Program produces replacement integrated circuits (ICs) for unavailable military device requirements using modern technology (1.5-micron bipolar complementary metal-oxide semiconductor (BiCMOS) Gate Array technology).

Program accomplishments in CY 93 included the following:

Received the fabricated part designed by NRaD from David Sarnoff Research Center. This part emulates an old transitor-transistor logic circuit—a generic logic part used in all kinds of systems in the 70s. Although the functional part of this circuit is formed from bipolar transistors, the input has to live in the environment of 25 years ago. The actual fabrication involves CMOS, bipolar, and Schottky diodes in the same circuit. The design was sent out in November 1992. It was packaged, tested, and it met government specifications in terms of functionality and AC/DC characteristics over military temperature range. This is an example of success of the GEM concept and its utility for providing otherwise unavailable parts.

Analyzed recent GEM design achievements on the 900067 device (required by Alameda Naval Aviation Depot for a S-3 display) and upgrade of the GEM design library. Test results from contract house and board insertion of the 900067 were reviewed. With modifications, the test was successful.

TECHNOLOGY REINVESTMENT PROGRAM (TRP)

A Technology Reinvestment Program (TRP) proposal, in which NRaD is a participant, has been selected for funding by ARPA. The partnership also includes GM Hughes Electronics, Boeing, GTE Labs, Ortel, United Technologies Photonics, Amoco Laser, and MIT Lincoln Labs. The objective of the project is to develop affordable high-performance analog optoelectronic (OE) modules (laser transmitters, optical waveguide modulators and switches, optoelectronic integrated circuit receivers) for commercial and military applications. NRaD's primary role is to define performance requirements for Navy applications of OE analog modules, conduct applications studies, and provide a test environment for the developed products.

FIBER-OPTIC MICROCABLE (FOMC)

Fiber-optic microcable (FOMC) technology was developed and transitioned from NRaD to industry under the Navy Manufacturing Technology Program in FY 91. FOMC applications include undersea weapon command control links, undersea remotely operated vehicle communication links, communication links for expendable mine-hunting devices, and ruggedized optical fiber for incorporation into larger fiber-optic cables. Expendable FOMC, tiny enough to permit long lengths to be packaged in compact canisters, strong enough to permit reliable payout underwater at high rates of speed, and inexpensive enough to be discarded after each mission, is a potential means for high-bandwidth communications for several future Navy underwater systems. Development of FOMC required significant advances in the state-of-the-art in diverse areas including UV-curable polymer formulation, manufacturing processes, computerized coiling, measurement, and quality assurance. Over a development period encompassing nearly a decade, from

conception to transfer into commercial practice (covered by three patents), the UV-cured FOMC concept evolved into a manufacturable product able to withstand the rigors of being wound into spools and reliably deployed from undersea weapons and remote-controlled undersea vehicles.

Several diverse underwater Navy systems are expected to incorporate FOMC. The commercial availability of the material might appeal to Army and Air Force system designers as well. Commercial, nonmilitary markets include the undersea petroleum industry, local-area networks, cable television, and TELECOM, as the material serves not only as an expendable communications link but also as an excellent optical submember for incorporation into a composite cable.

Program accomplishments in CY 93 included the following:

Completed hydrostatic pressure certification of fiber-optic microcable components for use in Jules Verne project for Graham Hawkes Associates. The FOMC will provide a realtime, high-bandwdith data link for a deep-diving underwater vehicle to explore the Mariana Trench off Japan. It is critical that FOMC operate satisfactorily to depths exceeding 37,000 feet (about 20,000 psi), which requires hydrostatic testing to this level in order to provide a small factor of safety. The fiber-optic penetrator developed for the Tether Deployment Module and the FOMC provided under the Navy Manufacturing Technology Program have both passed this screening. No measurable attenuation change in the FOMC was detected up to 16,000 psi, with only insignificant increases to 20,000 psi. No permanent attenuation increases were observed in the FOMC as a result of the exposure. The penetrator held 20,000 psi overnight with no signs of leakage or damage. It was recommended to Graham Hawkes Associates that they proceed with procurement of the required FOMC coils and optoelectronic hardware, which they will purchase from NRaD.

Completed the Tether Development Project (TDP). This caps a 5-year effort to secure data on life expectancy of several commercially available cables with diameters ranging from 0.032 inch up to 0.076 inch in varying ocean depths and bottom terrains. "Life" was defined as the ability to pass light. A final report (SECRET) fully documenting the effort was also completed.

ADVANCED UNMANNED SEARCH SYSTEM (AUSS)

The Advanced Unmanned Search System (AUSS), developed under the Navy's Deep Ocean Technology (DOT) program, is designed to meet the Navy's requirement for an improved search capability identified under operational requirements. Extensive analysis and engineering efforts since 1972 have resulted in development of a prototype system based on a free-swimming sensor vehicle with an acoustic communications link for command and control and telemetry of data to the surface.

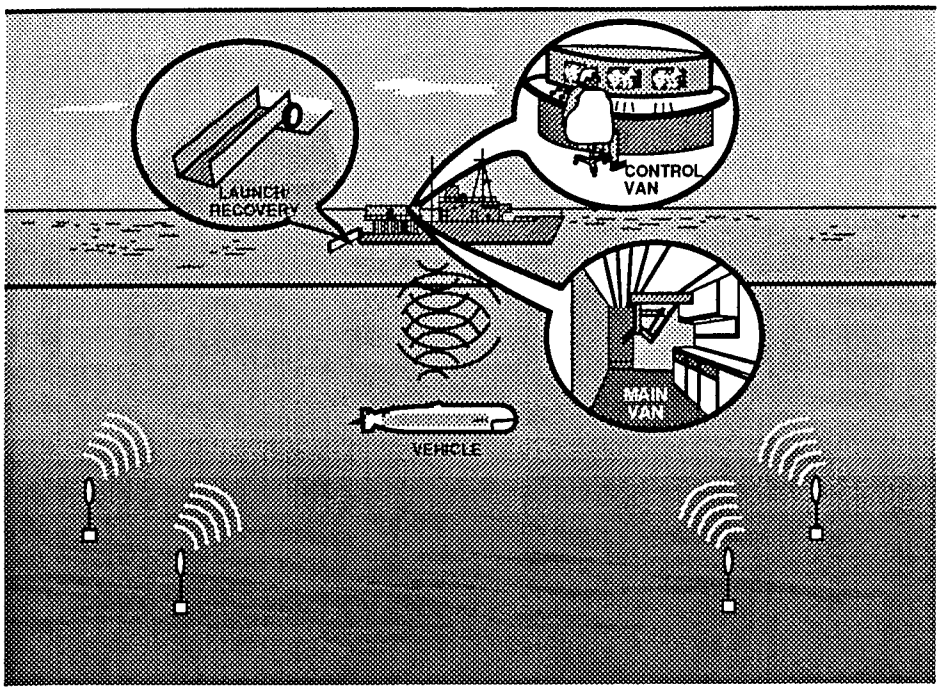
AUSS incorporates the concept of state-of-the-art sensors integrated into a supervisory controlled autonomous vehicle with new search tactics. AUSS performance evaluation will form the basis for acquisition of the Navy's next-generation search system, replacing the slower towed-sensor platforms currently operated by the Navy and its contractors.

Program accomplishments in CY 93 included the following:

Received funding from NAVSEA 00C to begin efforts to transition the AUSS into an operational system working in conjunction with a government contractor.

Planned transfer of AUSS. NAVSEA 00C (Supervisor of Salvage Office) and Oceaneering Technology, Inc. (OTECH) met at NRaD to plan transfer of the AUSS to the Navy Supervisor of Salvage. Topics included formulation of a plan to present to OP-N873 and technical development/reliability issues.

Trained OTECH personnel. A three-man team from OTECH came onboard for an intensive training period designed to equip OTECH operating personnel with the ability to operate the system for the Navy Supervisor of Salvage. Concomitant with the technical training was an effort to firmly establish the transition plan for review by OP-N873 prior to formal transfer of the system to the Navy Supervisor of Salvage.



Artist's concept of the AUSS.

ADVANCED DEPLOYABLE ARRAY (AdDA)

The ocean engineering team supported the Code 70 Advanced Deployable Array (AdDA) project through design and fabrication of wet-end hardware in Souda Bay, Greece.

The support ship arrived in Souda Bay in September. The new engine was installed and "checked out." Personnel completed dockside checkouts of deployment equipment. All systems for the acoustic measurement system and nonacoustic measurement system were made functional and ready to operate. Testing is expected to proceed according to the revised test schedule.

MULTIBEAM

Program accomplishments in CY 93 included the following:

Completed Multibeam Detection/Classification ATD, a sea test aboard the USS *Flying Fish* (SSN 673). Three different single circuit board solutions were evaluated, each using a different neural network chip. All three boards performed realtime multiple-channel signal detection and classification during the entire exercise. Unexpected biologic activity initially produced unacceptable numbers of false contacts. Retraining the neural network at sea eliminated this problem.

Completed results from phase two testing were completed using blue target signals in shallow water. Signal detection and classification values were consistent with the original program goals.

FLYING PLUG

The Flying Plug is an ONR-funded effort to establish a working design for an expendable small vehicle that could be used to trail a fiber-optic microcable, home on a cooperative "socket," and plug in to transfer data back to the originating point. Applications include dumping recorded data from a prepositioned sensor array and underwater "telephone booths" for communications.

In CY 93, initial tests of the Flying Plug vehicle and associated test socket were conducted off the Bayside pier.

WAVELENGTH DIVISION MULTIPLEXING (WDM)

NRaD has received from the Jet Propulsion Lab a request for 10 fused fiber Wavelength Division Multiplexing (WDM) couplers for radiation hardness testing. Jet Propulsion Lab had received two NRaD WDMs through a NATO fiber optics working group earlier this year. Initial hardness testing produced favorable results, but more extensive testing at facilities at Cal Tech and Princeton University are planned, hence the need for additional couplers. The couplers are "packaged" in an exposed configuration,

where the fused fibers are epoxied onto a substrate. This open configuration allows for direct irradiation of the waveguide section of the coupler.

MISSILE MOTOR RAILCAR TRANSPORTER (MMRT)

Program accomplishments in CY 93 included the following:

Completed the software framework of the controller upgrade, which will enable remote localization and monitoring of the railcar missile transporter. The bulk of the software effort is tied to the base station, which will display in graphical form the location and status of the railcars.

Completed the graphical interface and communications portions of the software for the demonstration version of the Global Positioning System (GPS)/Cellular Tracking System upgrade to the MMRT controller.

Successfully demonstrated the feasibility of the GPS/Cellular Tracking System upgrade to program sponsor.

Initiated testing of MMRT GPS/Cellular Tracking System prototype at Magna, Utah. Preliminary test results indicated that automatic dial-up and transmission of position data to the San Diego prototype base station were successfully achieved.

RANGE ELECTRONIC WARFARE SIMULATOR (REWS)

As of 12 August 93, the maintenance and operation of the Range Electronic Warfare Simulator (REWS) was transferred to Fleet Area Control and Surveillance Facility, Naval Air Station, North Island. Transfer of plant account material was completed, ending 7 years of electronic warfare (EW) training by NRaD to the Fleet.

TRANSDUCER EVALUATION CENTER (TRANSDEC) ACTIVITIES

The Transducer Evaluation Center (TRANSDEC) is a sonar transducer calibration pool that is anechoic at all frequencies.

(NOTE: NRaD Code 58, Test and Evaluation and Ranges Division, was established on 1 August 1993. TRANSDEC activities reported prior to this date are listed in the history for Code 90, Engineering and Computer Sciences Department. See the index for specific page references.)

TRANSDEC activities completed after 1 August included the following:

Calibrated one to two TR-255/WQM Test Transducers for the following ships: USS *Jarrett* (FFG 33), USS *Lake Champlain* (CG 57), USS *California* (CGN 36), USS *Vincennes* (CG 49), USS *Puller* (FFG 23), USS *Wadsworth* (FFG 9). These types of transducers are used by the sonar technicians aboard ship to check out the operation of their sonar systems.

SURVEILLANCE DEPARTMENT

SURVEILLANCE TOWED ARRAY SENSOR SYSTEM (SURTASS)/LOW-FREQUENCY ACTIVE (LFA)

NRaD has been involved in all stages of Surveillance Towed Array Sensor System (SURTASS) development, testing, and technical evaluation since 1973. NRaD has continued to provide technical direction to all SURTASS upgrades. Technical direction, test, and evaluation of the Low-Frequency Active (LFA) System has been performed, including DT-I testing and DT-IIA testing. The system has now successfully transitioned into full-scale engineering development. The successful introduction of SURTASS into the Fleet and continuing improvements have required dedicated efforts of a large team of NRaD employees. Forty-two employees were commended for their contributions to the ongoing development and operations of SURTASS and its latest upgrade, SURTASS/LFA.

LOW-FREQUENCY ACTIVE (LFA)

The Low-Frequency Active (LFA) System has been in development since 1980, initially as the Active Adjunct Undersea Surveillance (AAUS) Exploratory Development Program. NRaD developed the first AAUS at-sea testbed, conducted several active surveillance sea tests, and demonstrated feasibility of the LFA concept. Under a companion 6.2 program, NRaD extended the technology for low-frequency, high-power projector arrays that are fundamental to LFA feasibility.

NRaD provides system engineering for the development efforts and conducts development, operational, acceptance, and certification tests as Technical Development Agent (TDA).

The LFA-11 sea test off Halifax was completed in September.

Following the test, the *Cory Chouest* was off-loaded in Norfolk in preparation for an overhaul in LaRose, LA. During the overhaul, her electronics suite will be upgraded to the TX configuration. After completion of the overhaul she will transit to SOCAL for LFA installation and shakedown and participation in Magellan II.

ADVANCED DEPLOYABLE SYSTEM (ADS)

The Advanced Deployable System (ADS) will provide a rapidly deployable surveillance capability for regional conflict scenarios.

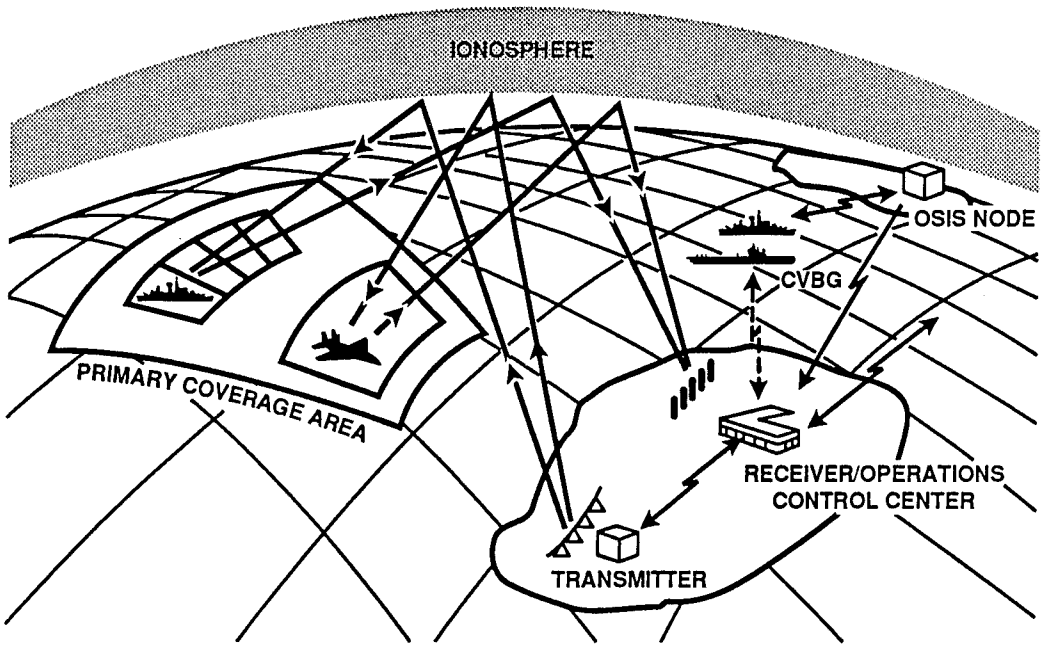
In August, the Advanced Deployable System (ADS) team completed the Test Plan for the September RDT&E Operation; all copies were mailed on 23 August. This document describes in detail the placement of all receiving arrays and the desired target tracks. A companion data analysis plan was also prepared.

In November, the ADS team completed System Design Review (SDR) meetings at each of the four ADS contractor facilities. Each contractor has put forth concepts that are the result of significant analysis and thought, and NRaD now has the lead to synthesize an overall system concept and the performance assessment that goes with it. This overall system concept will initially be a key input to the ADS Cost and Operational Effectiveness Analysis (COEA), and will later support Milestone I documentation.

RELOCATABLE OVER-THE-HORIZON RADAR (ROTHR)

The Relocatable Over-the-Horizon Radar (ROTHR) is a ground-based, bistatic radar system designed to provide long-range detection, tracking, and reporting of air and surface targets operating in its area of coverage.

The ROTHR transmitter emits FM radio energy in the high-frequency (HF) range, between 5 and 28 MHz. The transmitted energy is refracted in the ionosphere back onto the earth's surface in the area of interest. The surface of the earth and the targets in the area of interest reflect some of this energy back through the ionosphere to a separate receive site, where it is processed to generate target track information. This information has varying degrees of accuracy due to the changes and uncertainties of the ionosphere caused by factors such as the time of day, season, sun spot number, and other solar activity.



The ROTHR concept.

Program accomplishments in CY 93 included the following:

Began ROTHR acceptance testing for Production System No. 1 on 22 February, at Northwest, Va. NRaD personnel performed testing and data collection on site. Following the Government Acceptance testing, the system was turned over to the Naval Space Command to begin operational testing on low observables for CINCLANT. NRaD was involved in the data collection and analysis.

Initiated the Operational Counter Drug Evaluation and Assessment for ROTHR. The evaluation ran from 15 May to 30 September in 1-week segments, with a specific agency and recommended sub-regional focus assigned for each week. CJTF-4 coordinated the evaluation and assessment, with support from the ROTHR community and CARRIBROC.

Supported the operational evaluation of ROTHR as an asset for drug interdiction. Also supported the interoperability between the radar in Virginia, CARRIBROC, and JTF-4.

INTEGRATED UNDERSEA SURVEILLANCE SYSTEM (IUSS)

Program accomplishments in CY 93 included the following:

Conducted the IUSS Block 3.0 software installation in the Pacific the week of 15 November.

Successfully installed the IUSS Block 3.0 in the Atlantic during the week of 6 December. This completed both oceans for this latest software build. This is likely to be the last major software installation for SOSUS due to funding cuts.

OPERATIONS SUPPORT SYSTEM (OSS)

In September, Version 92-2 of the Operations Support System (OSS) was installed in the Surveillance Test and Integration Center (STIC) as part of the development of the Data Fusion Testbed. This testbed, being developed in STIC, jointly with STIC, Theatre Acoustic Warfare (ThAW), and Major Bid and Proposal (MB&P) funding, will be used to expand fusion capabilities to include multiple sensor sources for surveillance.

SPOTLIGHT ATD

NRaD has had the lead role in defining Surveillance Direction System (SDS) and the functions required to integrate undersea surveillance data from all Integrated Undersea Surveillance System (IUSS) sensors into a cohesive antisubmarine warfare (ASW) picture. The SPOTLIGHT program is a continuation of this role, providing SDS in the future with advanced technology. The program began in March 1991; SPOTLIGHT was scheduled to be completed by the end of 1993.

The objectives of the SPOTLIGHT Advanced Technology Demonstration (ATD) were (1) to adapt signal and display processing technology to the SDS evaluation function, (2) to adapt a nonlinear correlator/tracker and tactical forecast capability to the data-handling and correlation function of SDS, (3) to develop a resource optimization function for SDS, and (4) to demonstrate their utility to Integrated Surveillance System (ISS) operations. The objective of the SPOTLIGHT program is to develop an automated SDS-like system with advanced technology that will feed into a future SDS program.

In early FY 92, initial versions of the SPOTLIGHT software were delivered to the NRaD STIC. Scenario data were collected earlier in the year from recent fleet exercises and used for testing and integration. Development and integration of the appropriate technology for each SPOTLIGHT function was accomplished in FY 93. Also, the definition of the interfaces to SPOTLIGHT and of the integrated SPOTLIGHT system were accomplished.

In 1993, the SPOTLIGHT ATD Demonstration was conducted on the East Coast at NRL on 13 and 14 September and the West Coast in STIC on 15 and 16 September. Three technologies were demonstrated that reduce the time-late in delivery of tactical acoustic data from IUSS to users and reduce the manning required at the IUSS evaluation centers. The technologies include improved OMI, sensor data integration for nonlinear tracking and correlation, and resource optimization.

The operational demonstration of SPOTLIGHT at the Dam Neck Validation Center (DSVC) began on 1 December with operator training, with the demonstration continuing through the month. The SPOTLIGHT ATD successfully concluded with this demonstration, and transition of the technology is scheduled for implementation in the Surveillance Direction System.

SOUND SURVEILLANCE UNDERWATER SYSTEM (SOSUS)

The Sound Surveillance Underwater System (SOSUS) Block 3.0 software upgrade was successfully completed for the Pacific on 22 November. The Atlantic installation began 6 December.

SHALLOW-WATER EVALUATION CELL EXPERIMENT (SWELLEX)

In August, the first major experiment took place in the NRaD Southern California Shallow-Water Testbed. SWellEX-1 was the first in a series of Shallow-Water Evaluation Cell (SWell) experiments intended to explore methods of passive acoustic submarine detection in strongly bottom-limited areas. The SWell concept places emphasis on accurate environmental characterization of several test areas near San Diego, precision propagation modeling to better interpret results, and interlaboratory sharing of this knowledge to foster more cost and mission effective joint experimentation. The SWellEX series is sponsored by the ONR Wide Area Undersea Surveillance Tech Base program at NRaD and by companion "6.2" programs at the other labs. The tests are designed to address various acoustic and nonacoustic diesel-electric detection system concepts and designs.

Organizations participating in SWellEX-1 included NRaD, NAWC, NRL, MPL/SIO, McDonnell Douglas, Western Instruments, Lockheed, and Polar Associates; with about 40 scientists and engineers and their various experiments. Supporting the testing were the Research Platform FLIP, USNS *Sioux*, Research Vessel *Gordon Sproul*, TRB-10, and several small craft. The test area for SWellEX-1 was about 7 nmi WSW of the Point Loma Lighthouse.

A deployment rehearsal for SWellEx-2 took place in August, 13 miles off of Point Loma, in 4000 feet of water. The deployment platform was the NRaD barge *Sea Turtle*. A dummy array consisting of a 600-m vertical slack line array, and a 150-m horizontal array, dummy electro-optical multiplexer nodes, as well as 4000 m of fiber-optic trunk cable, were successfully deployed and retrieved.

The SWellEx-2 acoustic experiment was conducted in the Santa Catalina Basin in 1200-m water in September. An experimental array consisting of two 600-m VLAs and two 150-m HLAs fabricated with slack line technology, two electro-optic telemetry nodes, and 13 km of fiber-optic trunk cable terminated at San Clemente Island, was successfully deployed on 22 September, and data were recorded through 29 September. Code 733 Branch Head, Dale Barbour, joint sponsor of the experiment under the CS3A Block Program, participated in both deployment from the NRaD barge *Sea Turtle* as well as data collection on SCI.

ADVANCED DEPLOYABLE ARRAY (AdDA)

Program accomplishments in CY 93 included the following:

Successfully completed the September RDT&E Operation (SRO) with retrieval of both AdDA arrays. Many hours of environmental and contact data were recorded. Significant amounts of contact data were

collected for both the acoustic and non-acoustic AdDA strings. On-board operators were able to view portions of the dataset thanks to a limited realtime processing and display capability.

Held a "pre-Quicklook" meeting for the September RDT&E Operation participants at NRaD on 27 October. Significant amounts of contact data were "in the can" for every sensor that was deployed. NRaD has the lead to analyze the AdDA data and to integrate data processing results from all sensors.

CLUSTER CERES

CERES is a passive bistatic geolocation technique used for accurately locating radar transmitters in the vicinity of land and providing a radar map of the area.

In CY 93, Cluster CERES was installed on an operational platform and underwent local operational testing in close proximity to Pearl Harbor.

CLUSTER ARGUS

Cluster Argus is a submarine electromagnetic surveillance system that provides wide-band extended frequency coverage capability and high probability of signal intercept for the extended frequency range.

In CY 93, Cluster Argus was deinstalled from USS *Phoenix* (SSN 702) on 18 June. The mission planned for *Phoenix* was changed and, as a result, the Argus system was removed because it no longer met the mission profile. At present, no Argus systems are installed on operational platforms.

RADAR CROSS SECTION (RCS) SHIP MEASUREMENTS

NRaD has been conducting radar cross section (RCS) ship measurements since the early 1970s. The current program for using precise high-resolution radar ship measurement was started in 1984. The objective of the program is to conduct full-scale ship RCS measurements and RCS diagnostics from various parts of the ship target. Analysis is conducted based on these RCS ship measurements to understand the U.S. Naval ship vulnerabilities to threat radars.

Radar scattering data (phase and amplitude) are collected over a wide band of frequencies as the ship maneuvers in the space illuminated by the radar. Normally these data are stored on magnetic tape in the form of in-phase (I) and quadrature-phase (Q) digital samples. The tape is later transported from the radar site to the radar signal processing laboratory at NRaD, where the desired data products are produced. All data are calibrated against known standard targets.

Program accomplishments in CY 93 included the following:

Completed the RCS measurements of the USS *Wadsworth* (FFG 9) on 22 April. Testing and data collection went as planned. The NAVSEA sponsor, Code 05T4, was in attendance through the measurement and early data reduction phase. The sponsor was very pleased with the complete operation.

Performed successful RCS measurements on the USS *John Young* (DD 973) on 29 June. Twenty runs (files) were collected of the ship's EM signature. Sixteen data tapes were produced, and the data was processed. Approximately 14 Code 75 personnel were involved on the 29th to conduct the measurement and process the preliminary data. This test was the 24th in the program series with NAVSEA 05T.

TOMAHAWK

Tomahawk Surveillance System Project (TSS) personnel participated in a Tomahawk firing test on 12 September 1993. The Tomahawk was fired from the USS *Arkansas* (CGN 41) (which was approximately 100 miles northwest of St. Nicholas Island) and terminated at the North Range of China Lake. The TSS portion of the test was highly successful. Preliminary test data was delivered to the sponsor.

TACTICAL RELATED APPLICATIONS (TRAP) BROADCAST SYSTEM

The Tactical Related Applications (TRAP) broadcast is a worldwide broadcast to disseminate high-interest reports in near-realtime to tactical commanders with Tactical Receive Equipment (TRE). The TRAP equipment receives these reports from a number of sources, reformats and compresses the data, and transmits them to the TREs via UHF satellite communication satellites. Some TRAP sites also serve as relay sites to relay the data from one satellite to another, thus making the TRAP broadcast worldwide.

Program accomplishments in CY 93 included the following:

Completed installation of the TRAP Update 3.0 deployment in May at the Mission Support Operations Center (MOSC) in Washington, DC. The updated software load and a few minor hardware changes were completed on 19 May and the site came back up on the new system.

Successfully deployed TRAP Update 3.0 at Winter Harbor. The installation was completed in June.

Completed the TRAP Update 3.0 deployment at Imperial Beach in June.

Completed the TRAP Update 3.0 deployment at Edzell.

Completed the last TRAP Update 3.0 installation at Adak. Once all the sites were on the new software, three major new capabilities were activated, one at a time over 3 days. Fifteen-minute Extended TRAP Status Message (ETSM) reporting was turned on 28 July and operated properly. Reporting of Time of Entry data was activated on 29 July and provided detailed information on TRAP timeliness. Priority queuing was activated on 30 July to allow TRAP to give precedence to high-priority reports.

MULTIMISSION ADVANCED TACTICAL TERMINAL (MATT)

The Multimission Advanced Tactical Terminal (MATT) is a receiver system providing the user the capability to simultaneously receive, decrypt, filter, correlate, and distribute data contained on up to four UHF broadcasts.

In CY 93, VAQ-209 installed a MATT in one squadron aircraft and participated in the Radiant Oak Concept Demonstration. VAQ-209 successfully launched the first operational improved warhead High-speed Anti-radiation Missile (HARM) against a ship at sea using over-the-horizon targeting data from national systems delivered directly to the AE-6B cockpit in near realtime (NRT). Radiant Oak is a CNO and Navy Space Command initiative to demonstrate the benefit to situational awareness and mission effectiveness of delivering national systems in NRT targeting data directly to the cockpit in support of power projection at sea. MATT was used to receive and filter over-the-horizon targeting data from the Tactical Related Applications (TRAP) and the TADIXS-B broadcasts. The target was a 100-foot COMTHIRDFLT coastal patrol craft configured with a target acquisition and target tracking radar that simulated a common threat surface to air naval missile system. The exercise took place at the Point Mugu operations area, approximately 100 nmi at sea.

MULTICHIP MODULE (MCM)

NRaD (Code 76) and the National Security Agency (V482) are jointly developing the Hayfield Multi-Chip Module (MCM) under the direction of the Operation Support Office (OSO Code 421). The Hayfield MCM is a multichannel COMSEC device in the form of an integrated circuit suitable for use in embedded COMSEC applications. It is reprogrammable with different crypto algorithms, allows for over-the-air rekey, minimizes security risks at the tactical warfighter level, and improves tamper resistance. The Hayfield MCM will be used as a building block for embedded COMSEC decryption for all TRE-related receivers. On 16 November 1993 a KGR-96 algorithm and maintenance key was loaded into a prototype MCM and successfully decrypted a maintenance key encrypted TRAP broadcast.

POLAR EQUATORIAL NEAR-VERTICAL-INCIDENCE EXPERIMENT (PENEX)

The objective of the Polar Equatorial Near-Vertical-Incidence Experiment (PENEX), initiated in 1991, is to measure and collect calibrated HF skywave signal-strength data for the purpose of benchmarking the absolute accuracy of the signal-to-noise ratio models in the Medusa Program. Three global regions are of interest: Auroral and Polar Cap, Transequatorial, and Near-Vertical Incidence Skywave (NVIS). Critical elements of this program are the specification of a test methodology and the design of transmitting and receiving hardware to accomplish the measurements. This program is a joint effort between the Ionospheric Branch (Code 542) and the Signals Exploitation Branch (Code 772).

The PENEX transmitter in Alaska began formal operations in May 93.

CENTERBOARD

NRaD successfully completed CLASSIC CENTER-BOARD Technical Evaluation Phase II, 30 Nov - 9 Dec 93.

CRYPTOLOGIC SYSTEMS

As of 30 September, NRaD (Code 772) became the designated Software Support Activity (SSA) for all afloat cryptologic systems sponsored by the Naval Electronic Combat Surveillance Systems (NECSS) (PMW 163). Formal transition of responsibilities from other activities will occur during FY 94.

SHIP'S SIGNAL EXPLOITATION EQUIPMENT (SSEE)

As a result of NCCOSC teamwork, the Ship's Signal Exploitation Equipment (SSEE) Phase II, the first Open System for Afloat Cryptology, successfully passed operational evaluation (OPEVAL) onboard the USS *Yorktown* (CG 47).

This is a significant milestone in that 9 months ago SSEE Phase II was a mere concept conceived by the Naval Electronic Combat Surveillance Systems Program (PMW-163) at Space and Naval Warfare Systems Command, and Commander, Naval Security Group (CNSG) to satisfy Navy operational cryptologic requirements.

SPAWAR PMW-163, NRaD, and Naval Electronic Systems Engineering Center Charleston capitalized on the CNSG prototype Classic Trump. They collectively evolved a manual tactical cryptologic exploitation capability (SSEE Phase I) into an automated, effective, and affordable open system for a variety of ship classes.

As the Independent Validation and Verification (IV&V) agent to PMW-163, NRaD facilitated completion of SSEE Phase II through TECHEVAL AND OPEVAL at NRaD and Charleston.

CTTC Dave Leazer, Code 7703, spent several weeks at Charleston confirming the software was ready for sea onboard *Yorktown*. As the resident operational expert, he identified all outstanding software and hardware problems and ensured that they were resolved.

As Project Manager, Lenny Coppenrath, Code 772, directed the various government and contractor resources to accommodate this "fast track" system. The first and foremost task was to get an SSEE system at NRaD in March 1993. With the cooperation of SPAWAR, Charleston and the NRaD Intelligence Office, the system was installed in the Code 77 Sensitive Compartmented Information Facility.

Charleston's role was hardware IV&V and system installations at NRaD, USS *Yorktown*, and their own facility. They were indispensable in ensuring system maintenance and availability for the TECHEVAL/ OPEVAL period.

The use of commercial off–the-shelf/government off-the-shelf nondevelopment items and the inclusion of a TAC-3 computer in the SSEE Phase II architecture serve as the foundation for migrating cryptologic systems to the Joint Maritime Command Information System (JMCIS). Currently, NRaD Code 77 has development efforts directed to ensure full JMCIS compatibility.

Code 77 envisions the elimination of traditional "stovepipe" cryptologic systems by standardizing the Human Computer Interface and maintaining the open system approach.

CERCIS

The CERCIS Program is a DoD-sponsored program to provide the next-generation replacement of the Southern California Offshore Range Environment/ SIGINT Universal Recognition Facility (SCORE/ SURF) operational capabilities developed by NRaD. Program initiation was in 1991 with NRaD taking the lead for DoD to design, develop, and implement the components of CERCIS that will meet all Navy requirements and supercede the existing SCORE/ SURF functionality currently on site.

Program accomplishments in CY 93 included the following:

Delivered Increment 2 of CERCIS software to NSA 5 days early. CERCIS team members supported the integration and testing.

Provided the first installment of Increment 3 of CERCIS software to NSA electronically via the Lab 114 PLATFORM communications network in September. Software development for CERCIS (a replacement for SCORE/SURF) continued to be on schedule.

VERTICAL LAUNCH ASROC (VLA) PROGRAM

The Vertical Launch ASROC (VLA) is a rocket-propelled, ASW weapon designed for deployment on ships equipped with the Mk 41 Vertical Launching System (VLS) and the Mk 116 Mod 6/7/8 ASW Control System (ASWCS).

VLA provides the capability for rapid response, all-weather delivery of an Mk 46 Mod 5 warshot torpedo against threat submarines in any direction at intermediate ranges.

The VLS consists of an armored, high-capacity, environmentally controlled and sheltered magazine of modular design, and it employs missiles in vertically oriented canisters within the ship. It can handle, store, prepare for launch, and launch missiles upon command from the appropriate weapon control system.

NRaD was tasked by the Naval Sea Systems Command (PMS-416) as the TDA for the VLA during its

full-scale engineering development. During the production cycle, NRaD is the acquisition engineering agent.

Program accomplishments in CY 93 included the following:

Delivery of Digital Autopilot and Control (DAC) and Thrust Vector Control (TVC) units were made in May. With all VLA missile components in stock, assembly of four exercise missiles started to support test firings from the CG 70.

USS *Lake Erie* (CG 70) conducted two VLA missile firings on the Kuaui Range in September as part of the SQQ89/ASWCS Combat System Ship Qualification Test. This was the first time VLA was fired from an AEGIS platform using the ASWCS Mod 7 fire control. Both missiles fired successfully and one torpedo made the first successful VLA target localization run against the Mod 30 Mobile target. One torpedo failed to initialize after water entry due to malfunction of the arming wire pull mechanism.

The NRaD part of the CG 70 CSSQT VLA report was completed in late September. Both missiles flew properly and successfully demonstrated that using the PC-based missile simulation (developed at NRaD) allows rapid analysis with minimal expertise. The Mk 46 seawater battery assembly needed further analysis. On the first CG 70 VLA firing, the lanyard was not pulled from the Mk 46 battery and therefore the torpedo did not run. The battery lanyard galled (friction welded) to the battery post when the arming wire was pulled. Six battery assemblies from the Yorktown IMA were pull tested along with the assembly from the CG 70 firing. All units passed the pull test specified on the battery assembly drawing. All of the assemblies from the Yorktown Intermediate Maintenance Activity (IMA) pulled at lower values than the CG 70 assembly. It is not surprising that the CG 70 assembly pulled out rather than breaking the arming wire as it had done on the CG 70 firing, because the wire had been backed out to inspect it. No definite conclusions were reached, but analysis was still in process in late November.

COMMUNICATIONS DEPARTMENT

RADIANT TIN

NRaD Code 81 personnel began a task with Code 444 to transfer Radiant Tin compressed image software over HF radio. This will involve over-the-air link from Marine radios and KY-99's to HF radios in Building 600 and video terminals in NUSTF.

TACINTEL

Installation and checkout of SHFTAMS demonstration equipment was completed on the USS *Coronado* for TACINTEL Direct Access demonstration between the *Coronado* and the TACINTEL Link Control Facility (TLCF) at Wahiawa, Hawaii.

LOW-LEVEL SERIAL SWITCH (LLSS)

The third Low-Level Serial Switch (LLSS) was shipped to Wallops Island, VA in support of the AEGIS program. The LLSS team completed the project on schedule and within budget. The project included several design changes over the first two switches, and it will substantially improve the operational support of the AEGIS program. The LLSS team traveled to the AEGIS site following delivery of the hardware to provide engineering support in system integration and complete checkout of both hardware and software. All three switches were trunked together and controlled successfully with the new software program.

HIGH-SPEED HF

A 4800-bps full-duplex channel was operated over existing shipboard high-frequency radio equipment between USS *Duluth* (LPD 6) and USS *Peleliu* (LHA 5) during a recent FLTEX in SOCAL waters. This channel supported voice, video, fax, and data (VVFD) terminal text and image exchanges using Harris 5254C single-tone serial modems and KG-84's at ground wave distances out to 75 miles. The feasibility of extending this full-duplex link to shore was tested and verified using standard Marine Corps HF radios.

SURENET

On 17 November, personnel from Codes 811 and 824 and CNR Inc., performed radiated tests between buildings 40 and 410 using the SURENET terminals in an HF system including serial (single-tone) modems and KY-84A cryptos. Data passed included large data files and images. The system operates as full duplex using both upper and lower sidebands independently. Thus, the system can send data both direction simultaneously.

RADIATION HAZARD MEASUREMENTS (RHM)

Radiation Hazard Measurements (RHM) at H. E. Holt (Exmouth, Australia) were completed successfully in May. The NRaD lead team found some areas previously not identified as hazardous. For example, there are two rooms of capacitors used in tuning. Only one of the rooms is energized at a time. They found that the unused room was still hazardous. Now both capacitor rooms will be off limits when the transmitter is operating.

SUBMARINE MESSAGE BUFFER

The Submarine Message Buffer will provide automated routing of messages to various workstations within the submarine, a significant improvement in efficiency over previous manual, paper-intensive procedures. The Message Buffer also provides information storage capability and is an aid in the timing of message receipt. The system was developed from commercial, over-the-counter equipment. Over 80 percent of the software upgrades were government reused software, resulting in major savings in cost and development time.

In CY 93, the Submarine Message Buffer program passed DoD Milestone 3, approving production and installation into the Fleet.

LINK-16

The cooperative efforts of Codes 83 and 45 for submarine Link-16 was brought to a very successful

close. The results of the task were presented to SPAWAR PMW-153, CDR Hartigan. All of the issues that the SPAWAR PMW-153 had regarding implementing JTIDS were answered. The presentation was well-received and CDR Hartigan indicated that this was everything he expected from the task.

UHF SATCOM DAMA

The UHF SATCOM DAMA program provides design and analysis for UHF SATCOM systems, including existing fleet broadcast and demand-assigned multiple-access (DAMA) systems. The program also addresses secure and cryptographic interfaces and assists in designing and specifying new-generation systems.

The DAMA test team successfully completed Phase IV THIRDFLT Testing from 3-7 May at four sites: the Navy UHF Satellite Test Facility (NUSTF), Advanced Electronics School (AESD), the USS *Coronado* (AGF 11), and the USS *New Orleans* (LPH 11). Some software problems were discovered, but nothing that precluded completion of the test. Ship, NUSTF, and AESD personnel participated in the test procedures.

WAR BREAKER

The War Breaker team (Code 841) processed sub-bands of the ERIM Rail Synthetic Aperture Radar (SAR) foliage data and achieved a greater than 100 times reduction in false alarms. Although probably not achievable in the real world, this result may well help set an upper processing bound for real-world data.

SHF ANTENNA

A new 15-foot-diameter SHF antenna was delivered to NRaD on 6 December. The antenna was assembled and erected on the roof of Bldg. 33, Wing 2. NRaD and VERTEX personnel completed the installation of the antenna controller and beacon receiver, and mechanical alignment of the reflector for the new SHF SATCOM antenna. The system has successfully tracked the Defense Satellite Communications System, Eastern Pacific (DSCS EPAC) primary and spare satellites. Having two SHF antennas allows simultaneous access to multiple satellites and expands capabilities considerably. The first application of this is in the multinational Communications Systems Network Interoperability (CSNI) program.

TACTICAL DATA INFORMATION EXCHANGE SUBSYSTEM (TADIXS)

The Tactical Data Information Exchange Subsystem (TADIXS) is designed to support the exchange of over-the-horizon targeting (OTH-T) information between shore and Fleet-based computer systems (collectively referred to as tactical data processors [TDPs]) for Navy cruise missile operations. The current ON-143/(V)6 software contains the TADIXS and Officer-in-Tactical Command Information Exchange Subsystem (OTCIXS) programs, and the submarine version additionally hosts the special-interest and general-service Submarine Satellite Information Exchange Subsystem (SSIXS) subscriber program, the FLT SECURE voice, and TACBUOY programs. This program supports both the KG-35/36 and KG-84A crypto, with the next upgrade to include KG-84C. The TADIXS/OTCIXS programs provide inter- and intra-Battle Group communications and are designated as the return path for ship-to-shore OTH-T communications.

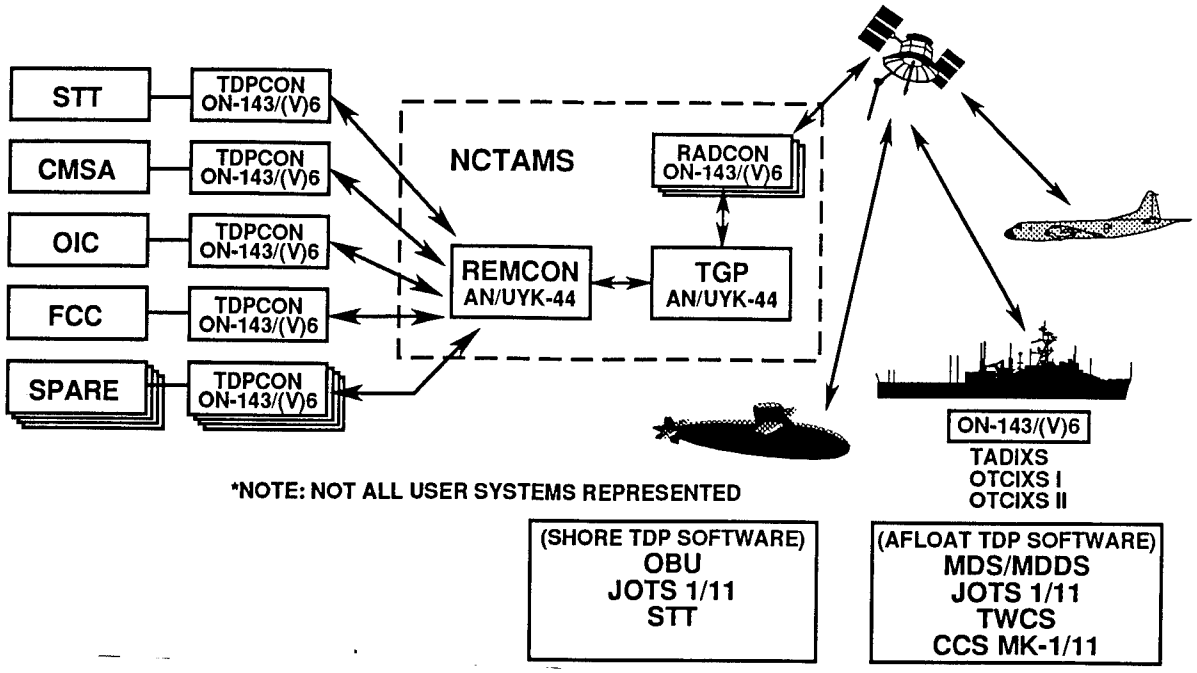
TADIXS Phase IV will replace the currently operational Phase III shore system. Phase IV will provide worldwide integrated connectivity among the OTH-T community, using dedicated landlines and satellite links, through a series of computer-controlled switching nodes called TADIXS Gateway Facilities (TGFs).

Phase IV consists of four computer programs hosted on two ON-143/(V)6s and two UYK-44s. The TADIXS Gateway Processor (TGP) and Remote Controller (REMCON) programs are hosted on the UYK-44 and the Tactical Data Processor Controller (TDPCON) and Radio Controller (RADCON) on the ON-143/(V)6.

Phase IV provides improved message routing and accountability and a demand-assigned multiple-access (DAMA) capability for the OTCIXS user. Additional benefits include reduced satellite channel loading through the use of dedicated landlines for data transmission and equipment redundancy.

Program accomplishments in CY 93 included the following:

Successfully completed the TADIXS Phase IV preliminary Pre-Fleet Acceptance Test (PFAT) 72-hour stress test on 22 May. A day of reconfiguration occurred followed by the four-gateway system test. This test was successfully completed on 26 May with one scheduled broadcast discrepancy under analysis.



TADIXS Phase IV.

Completed the TADIXS Phase IV PMW-323 PFAT 17 June with no problems. This test consisted of a first week of discrete testing on the five-gateway configuration, and in the second week, a 72-hour PFAT on the PACFLT three-gateway configuration.

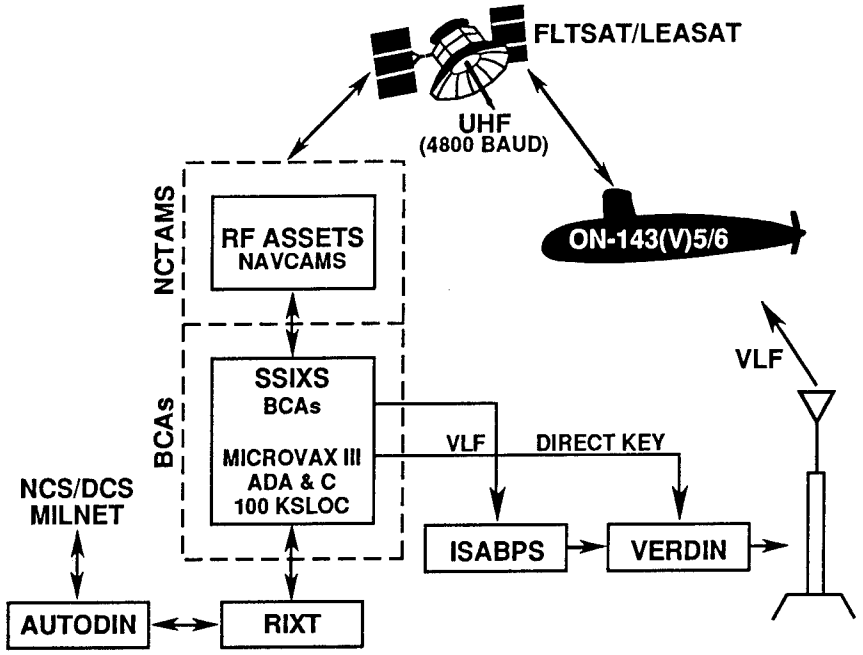
Successfully ran the TADIXS Phase IV Stress Test in August at NUSTF. TADIXS Phase IV transition began in Stockton on 7 September and EASTPAC on 11 September.

UNMANNED AERIAL VEHICLE (UAV) DEMONSTRATION

NRaD successfully exchanged message traffic with the Army Missile Command in Huntsville, AL, which simulated Army Short Range Unmanned Aerial Vehicle (UAV) targeting information. The messages were sent via telephone lines using STU-3 terminals in data mode. The Army generated the messages in USMTF format from their UAV Mission Planning and Control Station based on typical UAV targeting information. Upon receipt at NRaD, the messages were routed via Message Distribution Terminal to the Navy Tactical Command System Afloat (NTCS-A) console for display and plotting. The NTCS-A console is representative of tactical displays found on the LHA/LHD platforms to be used in the exercise.

SUBMARINE SATELLITE INFORMATION EXCHANGE SUBSYSTEM (SSIXS)

The Submarine Satellite Information Exchange Subsystem (SSIXS) is a DEC Ada program hosted by a MICROVAX III CPU. It is a UHF system that provides the submarine commander with the capability to exchange encrypted general-service and special-interest text message traffic between SSNs and SSBNs and the shore Broadcast Control Authorities (BCAs). Messages are transmitted from shore via satellite at scheduled intervals, called "group broadcasts." Between group broadcasts, submarines may transmit messages to the BCA or request messages held in queue, "query/response." These two modes of operation, group broadcast and query/response, permit the submarine commander to maintain either an active or passive posture.



Submarine Satellite Information Exchange System (SSIXS).

The Royal Navy SSIXS Rehost unit successfully completed certification and was shipped to the Royal Navy in December. This system contains the UYK-20 emulator that replicates a UYK-20 and is hosted on a VME board in a DTC-2 chassis.

MOVING TARGET SIMULATOR (MTS)

The NRaD radar Moving Target Simulator (MTS) was delivered to 4T21, Engineering Branch, Gun Systems, PHD NSWC (Port Hueneme Division, Naval Surface Warfare Center). The MTS is designed to provide a delayed, Doppler-shifted, operator-specified and calibrated response to the AN/SPG-60 pulsed-Doppler radar. It can be used for baseline performance evaluation ranging from hardware measurements such as Minimum Discernible Signal (MDS) and sub-clutter visibility to system software verification, training, and electronic counter-countermeasures (ECCM) techniques evaluation. The operator can specify a variety of canned target range/velocity profiles.

ENGINEERING AND COMPUTER SCIENCES DEPARTMENT

Code 91, Computer Sciences and Resources Division, of the Engineering and Computer Sciences Department, was disestablished effective 14 February 1993, and reestablished as Code 029, Information Systems Division, under Code 02, Deputy Executive Director.

Codes 92 through 99 were disestablished effective 1 August 1993. In most cases, the Department's technical programs were transferred to other NRaD departments. The accomplishments listed below were completed before 1 August. Program accomplishments reported after 1 August can be found in the histories of the appropriate department; the programs and the new code are noted in the text below. Additional discussion of the organizational changes can be found in the Administrative section of this document under Organizational Changes. Consult the index for specific page references.

TRANSDUCER EVALUATION CENTER (TRANSDEC) ACTIVITIES

The Transducer Evaluation Center (TRANSDEC) is a sonar transducer calibration pool that is anechoic at all frequencies. TRANSDEC activities during CY 93 included the following:

(NOTE: NRaD Code 98, Test and Evaluation and Ranges Division, was disestablished and transferred to Code 50, the Marine Sciences and Technology Department, and reestablished as Code 58, Test and Evaluation and Ranges Division. TRANSDEC activities reported after the reestablishment date of 1 August 1993 are listed in the history for Code 50.)

Performed acoustic calibration of 16 hydrophones for the AdDA VLA project.

Performed acoustic measurements on a high-frequency diced crystal array engineering prototype for Marine Physical Lab (MPL), UCSD.

Performed acoustic measurements on an engineering prototype hydrophone for SAIC in support of the BARSTUR Hydrophone Replacement Program.

Performed acoustic measurements to evaluate the operation of a Precision Transponder for the MPL.

Performed acoustic calibration of a computer-controlled General Noise and Tonal System (GNATS) for McLaughlin Research, San Diego. Systems of this type are installed aboard submarines and used for fleet training exercises.

Performed calibration of four AN/AQS-13 hydrophone units for the Naval Air Depot, North Island.

Performed acoustic measurements on a contractor-developed engineering prototype hydrophone for replacement hydrophones on the BARSTUR Test Range.

Performed acoustic evaluation of a prototype Low-Frequency Sound Source for the Systems Design Branch.

Calibrated two hydrophones that are the sensing elements in the Advanced Deployable Array (AdDA VLA Project).

Calibrated three Sound Measuring Sets for the Fleet Test Engineering Branch, Code 985.

Calibrated two TR-205/WQM Sonar Transducers for the Mobile Technical Unit (MOTU-5), San Diego.

Performed acoustic measurements on a prototype (portable tracking range) transponder being developed by a contractor under contract to the Japanese Defense Agency.

Supported the Electronic Systems Design and Development Branch, Code 934, and the Arctic Submarine Laboratory in performing acoustic measurements on an engineering prototype wide band hydrophone used in the Spectra II Project.

Performed acoustic testing of a TR-338/BQS sonar transducer for the Acoustic Analysis Branch, Code 711. This transducer is being subjected to a Composite Unit Accelerated Life Test (CUALT) to help identify any design and construction inadequacies. The above type transducer is used in the submarine service for high-resolution echo ranging.

Supported MPL performing acoustic measurements to evaluate the operation of a precision transponder and performed acoustic measurements on a contractor-developed (portable acoustic tracking range) transponder.

FLEET OPERATIONAL READINESS ACCURACY CHECK SITE (FORACS)

(NOTE: NRaD Code 9804, FORACS/SCOT Project Office, was disestablished effective 1 August 1993 and transferred to Code 50, the Marine Sciences and Technology Department, and reestablished as Code 5804, FORACS/SCOT Project Office. Accomplishments reported prior to 1 August are listed below.)

Installed Version 3.1.1 of Electronic Support Test System (ESMTS) at FORACS III.

Installed and successfully completed testing of version 3.0 of Automatic Position Tracking System (APTS) at FORACS V.

Installed and successfully completed testing of Digital Signal Processor Acoustic Target (DSPAT) prototype system at FORACS V.

Completed on-site check out and personnel training for the Certification of FORACS I. Provided operational training to APL/UW on the HP 9020 computer.

Completed test to certify underwater asynchronous acoustic tracking system at FORACS I, San Clemente Island. Certification performed in conjunction with NUWC, San Diego Det and NAVSEA (SEA 60T2).

Delivered Planned Maintenance System (PMS) documentation for Voice Communications System (VCS) to all FORACS ranges.

Installed APTS and ESMTS (Version 3.1.1) PMS at FORACS V.

Delivered revised PMS changes to all ranges. Delivered changes to the Data Analysis Operator's Manual and Version 4.5 software to all ranges.

Shipped COMPAQ System to FORACS V to complete installation of APTS version 3.0.

Delivered VCS to FORACS V.

Delivered HP 9020 computer to APL/UW for computer upgrade development.

SYSTEM CONSOLIDATED OPERABILITY TEST (SCOT)

(NOTE: NRaD Code 9804, FORACS/SCOT Project Office, was disestablished effective 1 August 1993 and transferred to Code 50, the Marine Sciences and Technology Department, and reestablished as Code 5804, FORACS/SCOT Project Office. Accomplishments reported prior to 1 August are listed below.)

Completed SCOT on USS *John Paul Jones* (DDG 53) at Bath, MA.

Performed SCOT on USS *Elliot* (DD 967). This was a redo as the previous SCOT was invalid due to ship power problems.

SPECTRA II SONAR

CY 93 accomplishments included the following:

Completed fabrication of the Spectra II Sonar. The transducers were developed by NRL and the electronic design, fabrication of the printed circuit board, electronic assembly, and check-out was completed in-house by NRaD. The unit is going to TRANSDEC for testing and upon completion of tests and test report, a decision will be made as to disposition. The hardware was built for the Arctic Lab.

SURFACE SHIP TORPEDO DEFENSE (SSTD)

CY 93 accomplishments included the following:

Conducted an at-sea operation with the Swim Out Launcher (SOL) in support of the SSTD program. Operations were conducted at San Clemente Island SCORE Range, using the IX-506 in conjunction with Fleet assets.

FIRE CONTROL

CY 93 accomplishments included the following:

Successfully completed testing of TSP Mk 331 Mod 3 power supply to verify Mk 50 compatibility. Test proved that power supply is adequate.

Provided on-site technical direction at NSWC, Dahlgren for installation of EC-49 into Torpedo Setting Panel Mk 331 Mod 3.

Made final delivery of UFCS Mk 116 Mod 0-4 documentation to NUWC Det Norfolk, VA, in accordance with Center's Transition Plan.

SSE SUPPORT

(NOTE: NRaD Code 982, Operations Branch, was disestablished effective 1 August 1993 and transferred to Code 50, the Marine Sciences and Technology Department, and reestablished as Code 584, Operations Branch. Accomplishments reported prior to 1 August are listed below.)

Assisted Code 50 in the successful deployment and recovery of an SSE Underwater Array. Assets employed were the TRB-10 and YFNX-30.

MULTIACCESS DATA DEVICE (MADD)

(NOTE: NRaD Code 95, Support Engineering Division, was disestablished effective 1 August 1993 and transferred to Code 80, the Communications Department, and reestablished as Code 81, Support Engineering Division. Accomplishments reported prior to 1 August are listed below.)

Began work on the CRADA with Multiaccess Data Devices. This task is to evaluate a proprietary polymer developed by MADD to isolate commercial off-the-shelf (COTS) equipment to withstand shipboard environments. This material may provide COTS suppliers an inexpensive method to protect their equipment from shipboard shock and vibration.

Completed the testing portion of the CRADA with Multiaccess Data Devices. Proprietary polymer protected the Sun SPARC 10 during full-level MIL-STD-167 vibration tests, but the disk drive was inoperable after the high-impact shock tests.

CERAMICS

(NOTE: NRaD Code 9402, Marine Materials Technical Staff, was disestablished effective 1 August 1993 and transferred to Code 50, the Marine Sciences and Technology Department, and reestablished as Code 5402, Marine Materials Technical Staff. Accomplishments reported prior to 1 August are listed below; accomplishments reported after 1 August can be found in the history for Code 50, see the document index for specific page references.)

The Office of Marine Materials at NRaD is developing the application of nonmetallic materials for use in pressure hulls for deep-submergence use. These hulls can be used to house electronics, batteries, or anything else that requires a dry, 1-atmosphere environment on deep-submergence vehicles.

The materials that have been and are being investigated include ceramics such as alumina and beryllia, and ceramic-metal matrix (cermet) materials such as boron carbide/aluminum and silicon carbide/aluminum. These materials offer significant advantages for deep-submergence pressure housing including low weight-to-displacement ratios (0.4 to 0.6) and excellent corrosion resistance at costs lower than those of titanium housings. Housings of sizes ranging from 6 inches in diameter by 9 inches in length to 20 inches in diameter by 90 inches in length have been successfully designed and tested for 20,000-foot service depth. Currently housings up to 32 inches in diameter by 113 inches in length are being fabricated.

The marine materials office is fully capable of addressing all aspects of design and testing of nonmetallic pressure hulls. These aspects include design of housings using computer-aided analysis tools for stress and buckling, specification of materials, procurement, assembly, test, evaluation, and documentation.

Aspects currently being investigated include reliable design analysis methods, establishment of design criteria, investigation of inexpensive nondestructive evaluation techniques, reliable methods of joining cylinders and hemispheres, and extension of number of cycles to failure by investigation of new materials.

CY 93 program accomplishments completed prior to 1 August included the following:

Completed assembly and began pressure testing of twenty 12-inch-diameter alumina ceramic cylinders as part of the advanced ceramics program.

INDEPENDENT RESEARCH (IR)/ INDEPENDENT EXPLORATORY DEVELOPMENT (IED)

New and innovative ideas proposed by NRaD scientists and engineers are supported and encouraged by the Executive Director through the use of discretionary funding provided by the Independent Research (IR) and Independent Exploratory Development (IED) programs. These programs support initial research and development in many areas of interest to the Navy, including command control, communications, ocean surveillance, and navigation.

At the beginning of FY 93, Dr. W. T. Rasmussen, Code 014, was Program Director for Research and Technology at NRaD, with responsibilities that included developing and maintaining both the IR and the IED programs. The FY 93 IR program was administered by Dr. A. Gordon, Code 0141, Deputy Program Director for Research, and the FY 93 IED program was administered by Dr. K. J. Campbell, Code 0142, Deputy Program Director for Exploratory Development. Drs. Gordon and Campbell coordinated their efforts in project selection, in reporting, and in review to ensure a balanced and integrated program of innovative science and technology.

In February 1993, Dr. Rasmussen became Head, Technical Staff Office, Code 010. Dr. Campbell became Head, Science and Technology Programs Office, Code 014, and continued to administer the IED program until the end of FY 93. Funding for the IED program terminated at the end of FY 93; therefore, there will not be an FY 94 IED program. Dr. Gordon became Deputy for Science, Code 0141, and continues to administer the IR program.

The FY 93 IR program began with the Executive Director's February 1992 call for proposals that emphasized Information Understanding, Ocean Surveillance, Antijam/Low Probability of Intercept Communications, Supercomputer Research/Scientific Visualization, Human Factors, Navigation, and Solid State Materials and Devices. Scientists and engineers responded with 85 written proposals. Of those, 21 were withdrawn or disqualified, and the remaining 64 were each heard in hour-long proposal meetings held throughout the spring and summer of 1992. Each proposal was presented orally before a different ad hoc committee chosen for its specific technical expertise. Members of those committees included Dr. Gordon, Dr. G. M. Dillard (Code 0141), line management, NRaD technical experts, faculty members from local universities, and visiting professors on the ONR-ASEE Summer Faculty Research Program. Based on administrative and peer review, 26 projects were selected for funding, comprising a $2,371 K Independent Research Program.

The FY 93 call for IED proposals in May 1992 emphasized the areas of Supercomputer Applications, Software Engineering, Undersea Surveillance, Antijam/Low Probability of Intercept Communications, Human Factors Technology, and Navigation. Scientists and engineers submitted proposals and after coordination with department heads and oral presentations by principal investigators, 12 projects were funded for a total of $902 K.

The FY 93 NRaD IR/IED program is documented in TD 2604, "IR-IED '93: Annual Report," dated October 1993. TD 2604 provides information on active projects, terminated projects, and lists of patents, publications, and presentations. The bulk of the report contains short descriptions of FY 93 IR and IED projects that highlight their objectives and accomplishments. In addition, three IR projects and two IED projects were selected for more in-depth treatment.

The featured IR projects are

> "A Simple 3-D Gaussian Beam Sound Propagation Model for Shallow Water," by Dr. Homer Bucker. The author describes a propagation model that has been developed for calculating acoustic fields in shallow water where the variation of bottom depth in range has a significant effect. Bucker's algorithm traces beams in appropriate directions and determines when there is a close approach of a beam to a receiver.

"Projection Pursuit Discriminant Analysis," by Brian Duston. The author describes the projection pursuit method of data analysis that is used to analyze high-dimensional data sets by looking at low-dimensional projections of the data. Duston's algorithm conducts a search to find the projection that displays the greatest degree of class separation so that discrimination between classes can be made.

"Low-Pressure, Low-Temperature Growth of $YBa_2Cu_3O_7$ Superconducting Thin Films," by Dr. T. E. Jones, Dr. W. C. McGinnis, and Dr. C. T. Blue. The authors discuss the development of techniques to grow in situ thin films of high-T_c superconductors and describe how $YBa_2Cu_3O_7$ thin films have been grown on single-crystal MgO substrates by using a low-pressure multitarget ion beam sputtering technique.

The featured IED projects are

"Vision-Based Autonomous Robot Navigation: Target Tracking, Trailing, and Obstacle Avoidance," by Dr. Michael Blackburn, Hoa G. Nguyen, and Theresa Tran. The authors detail the gains for artificial vision applications by examining and emulating how biological species accomplish similar tasks.

"Application of the Possibilistic Approach to Correlation and Tracking (PACT) Algorithm to Undersea-Surveillance Data Fusion," by Fred Kramer and Dr. I. R. Goodman. The authors describe the PACT algorithm, which is an extension of the Total Probability Rule that uses fuzzy sets to model both linguistic and numeric categorical information.

APPENDICES

APPENDIX A

MILITARY AND CIVILIAN AWARDS

COMMAND AWARDS

Small Business Administration 8(a) Award

ARMY AWARDS

Group Special Act Award
U.S. Army Belvoir R&D Center for contributions to the Mobile Detection Assessment Response System (MDARS)

Gary Gilbreath
Tracy Heath-Pastore
Richard Laird
Richard Smurlo
Steve Timmer
Teresa Tran

NAVY AWARDS

Legion of Merit

CAPT James D. Fontana, USN

Meritorious Service Medal

LCDR Ronald C. Bethmann, USN

Good Conduct Medals

DP1 Lorenzo A. Barraza, USN
AT1 Timothy J. Hodge, USN
OTA1 Timothy T. Hurtle, USN
OTAC Daniel E. Kylander, USN
BM3 Allen K. Pitts, USN
DP2 John P. Splichal, USN

SPECIAL ACT AWARDS

Navy Information Technology Acquisition Center

Steve Brenneman for service as lead engineer and team leader on the Source Selection Evaluation Board for the Navy Tactical Advanced Computer acquisition project

Navy Public Works Center, San Diego

Gordon Chase for substantial fund savings in repair of a portal crane providing direct support to aircraft carriers at NAS North Island

Navy Superior Civilian Service Award

Don Eddington for service as Navy Science Assistance Program (NSAP) Science and Technical Advisor to Commander in Chief, U.S. Pacific Command

Howard R. Talkington for leadership and significant personal contribution to ocean technology and exploration of the ocean environment

Earl Towson for strategic business and reorganization planning, and new business outlook analysis and forecasting

Dr. Sachio Yamamoto for service as Director of the Office of Naval Research Asian Office, during which he initiated new contacts with high-level Japanese R&D leaders

Navy Meritorious Civilian Service Award

Dr. Donald J. Albares for internationally recognized efforts in development of optical fiber and guided wave optical technologies

Jerome R. Beauchane for service as lead on-site systems engineer for the Navy Tactical Command System-Afloat, providing afloat and ashore command centers with state-of-the-art command and control capabilities

Dr. Roger D. Boss and Everett W. Jacobs for in-depth investigation into fractal image compression techniques

Ronald L. Broersma for key efforts on the NCCOSC Corporate Internet and Administrative System and his service as principal Navy representative on the Defense Research and Engineering Network Technical Advisory Panel

John Y. Chang for program management on the Marine Air Ground Task Force Tactical Warfare Simulation

Patrick J. Donahoe for test direction and systems engineering for the Surveillance Towed Array

Sensor System and the Low-Frequency Active project

Donald L. Endicott for efforts as the Navy representative on the Department of Defense High-Performance Computing Working Group, playing a major role in the DoD HPC implementation plan

Robert L. Frye for fiscal management direction as comptroller, using his expertise to guide the organization in an era of reduced resources, increased controls, and consolidations

Dean A. Hanna for technical leadership of the Undersea Surveillance Block Program, establishing new standards of quality for program management and for the block's technical products

Dr. Peder M. Hansen for technical leadership in submarine communications including testing of VLF antennas transitioning from the U.S. Navy to the Royal Australian Navy

Ronald M. Hidinger for technical development and leadership that enhanced Navy capabilities in antisubmarine warfare, computer technology, and undersea acoustic surveillance

James Kadane for leadership in fielding the Fleet Mobile Operational Command Center, enhancing Navy C^4I capability and providing the Naval Component Commander C^4I ashore and connectivity to the Joint Commander

Dr. William H. Marsh for achievements as chief scientist for Surveillance Towed Array Sensor System and Low-Frequency Active project, coordinating at-sea testing and data analysis

John A. Mayr for design, development, operation, and management of the hybrid simulator, providing hardware-in-the-loop simulation essential to test and evaluation of torpedo guidance systems

Jack R. Olson for underwater sensor design, fabrication, and deployment, particularly of experimental ocean environmental sensing and measurement devices for undersea surveillance

John A. Salzmann for management of one of the largest NRaD divisions, leading development of ashore and afloat command and control capabilities, moving toward a single integrated software development environment for C_2 systems

Richard T. Shearer for leadership as Technical/Executive Director during a difficult transition period including major reorganization, transfer of product lines into and out of the command, facilities closure, and personnel reductions

Cornell S. Stradling for management of the Navy Space Task, leading development of C^3I prototypes serving the Navy intelligence community in signal, electronic, and acoustic data collection and analysis

Thomas R. Tiernan for initiation of projects covering core technologies for an Advanced Technology Demonstration, based on the transition of simulator networks to an open system of distributed interactive simulation

Gary Toth for service as Navy Science Assistance Program Automatic Data Processing Technical Advisor to Commander, Sixth Fleet

Dr. Clifford J. Warner for communications networking expertise, including service as block manager for Communications Support System program and efforts on Communication Systems Network Interoperability program

Reynaldo F. Yturralde for leading development of environmental and electronic warfare databases to support Fleet C^4I systems, including contributions to a system employed by USS *Ranger* (CV 61) in Operation Desert Storm

Navy Award of Merit for Group Achievement

Automated Information System Accreditation Process Action Team

Lee Churchyard, Chairperson
Rick Avila
Tom Clark
Larry Core
Michelle Ferro-Czech
Marion Griffin
Lynn Roenicke
Nancy Vorce
Shirley Walbert

Fleet Mobile Operational Command Center Team

James Kadane, Project Manager
Todd Almond
Jerome Beauchane
Brian Britt
Refugio Delgado
Janet Fader
CDR Michael Ferguson, USN
Robert Fish
Patrick Garcia
Laura Hickman
DS3 Richard Jack, USN
Jesus Lopez
Ward Page
Charles Schwartz

Robert Stephenson
Kristine Ward

Landscaping Team

Drew Aitken
Sam Corrao
Don Defrain
Gabe Haduch
Bob Monroe
Gene Olaes
Randy Peacock
Scott Pogue
Leonard Scott

Surveillance Towed Array Sensor System/Low-Frequency Active (SURTASS/LFA) Team

Dr. Robert S. Smith, Program Manager
Alfred Aburto
Scott Adams
Don Barach
Dr. Homer Bucker
Cecilia Burrus
Melquiades Calderon
LCDR Richard Chase, USN
Margaret Cobleigh
Margaret Cooper
Dana Cottrell
Joseph Culver
Jerone DeJaco
Andrew de Torres
Patrick Donahoe
Vickie Flood
Mary Ann Garbarini
David Gillette
Marilyn Green
James Gregg
David Keir
James Lockwood
Charles March
William Marsh
Steven McCarthy
Larry McKinley
Clifford Meland
Daniel Michon
Ulysses Miller
William Miller
Michael Morey
Donald Murdock
Charles Nichols
Barbara Peugh
Gunnar Ramstrum
Willard Rask
James Reese
Daniel Rountry
Frank Ryan
Phillip Schey
STS1 Robert Schlayer, USN
Rhett Shaw
CDR William Sleichter, USN
STG1 James Taylor, USN
Ray Tejidor
James Thomson
Gary Turton

NRaD AWARDS

Lauritsen-Bennett Award

Kenneth D. Anderson for Excellence in Science

Dr. Robert R. Smith for Excellence in Engineering

Helen Brown for Excellence in Staff Support

Exemplary Achievement Awards

Henry M. Adams
Todd A. Almond
Jorge L. Alvarez
Amalia E. Barrios
John J. Berlin
Kevin E. Boner
Henrietta T. Borunda
Wayne S. Bratt
Nancy L. Campbell
Yvonne Carlson
Margaret R. Cooper
Salvatore A. Corrao
Sandra W. Courtney
Ronald W. Dahlseid
Gary L. Davis
Timothy K. Dowd
Jayson T. Durham
Doris I. Eiswald
Donald T. Erskine
James R. Feeley
Dr. Kathleen Fernandes
Michelle J. Ferro-Czech
Stuart G. Gathman
Angela A. Gegelys
Anthony Geneva
William T. Gex
Janine L. Greenhill
Larry O. Harris
Eric W. Hendricks
Charles A. Hewett, Jr.
James J. Hlava
George P. Imthurn
Norman F. Johnson
Roy W. Kampen, Jr.
Brenda-Lee Karasik
Eugene P. Kelley
Douglas S. Lange
David B. Law
David F. Little
Edward A. Mack

Kathleen M. Mancuso
Brian J. Marsh
Bullet McBride
Thomas S. McIntyre
Sharon G. Miller
Margaret A. Minor
Patricia N. Miranda
Warren R. Montgomery
Robert H. Mumm
Arnold O. Musolf
Stephen M. Norris
Shelia E. Padgett
Melody K. Petersen
Cheryl D. Putnam
John M. Quintana
Jose A. Ramos
Kenneth M. Register
Teresa L. Roe
James J. Rohr
Dr. Richard Scheps
Donald H. Schirr
Betty J. Smith
Janice E. Southall
Beth M. Sundheim
John F. Toale
William C. Torrez
Celia M. Vaught
Mark E. Vaughn
Patrick J. Walls
Steven K. Whiteside
Alfred P. Woerner
Amelia Wolff
Jesus Zuniga

Publication Awards

Terence R. Albert
Gregory W. Anderson
Dr. Whitlow W. L. Au
Don Barach
Dr. Richard P. Bocker
Dr. Pamela A. Boss
Dr. Randall L. Brill
Michael R. Brininstool
Wallace D. Bryan
Dr. Adi R. Bulsara
Mark A. Carroll
Margaret E. Cathcart
Dr. Paul R. de la Houssaye
Douglass C. Evans
Dr. Graham A. Garcia
David L. Gillette
Dr. Eric W. Hendricks
Dr. Charles A. Hewett, Jr.
Dr. Stephen L. Hobbs
John E. Howard
George P. Imthurn
Everett W. Jacobs
Leopold J. Johnson
Scott A. Jones
Dr. Thomas E. Jones
John Z. Lou
Dr. Edward P. McDaid
John R. McDonnell
Dr. Wayne C. McGinnis
Dr. Patrick W. Moore
James N. Morrow
Dr. Donald P. Mullin
Richard Nguyen
Dr. Richard C. North
Bruce W. Offord
Laurel W. Reidy
Dr. James J. Rohr
Frank J. Ryan
Charles E. Suggs
Dr. Stanislaw J. Szpak
Dr. Isao R. Yumori
Mark W. Zabriskie
Dr. James R. Zeidler
Dr. Carl R. Zeisse

Secretarial Awards

Sandi Courtney
Jan McCready
Karen Prath
Ruth Villaneuva

Sailor of the Quarter

First Quarter—AT1 (AW) Timothy J. Hodge, USN

Second Quarter—OTA1 (SW) Scott C. Czarcinski, USN

Third Quarter—AT1 (AW) Jerome Streeter, USN

Fourth Quarter—OS1 (AW) Charles K. Briggs, USN

Sailor of the Year

OT1 Timothy L. Hirtle, USN

NCCOSC Sailor of the Year

OS1 (SW) Jeffrey S. Lock, USN

Space and Naval Warfare Systems Command Sailor of the Year

OS1 (SW) Jeffrey S. Lock, USN

PROFESSIONAL ORGANIZATION AWARDS

Royal Institute of Navigation Gold Medal

Eric R. Swanson, NRaD retiree, for his contributions to the theory and practice of navigation, particularly as related to the Omega Navigation System, on which he worked for a number of years while employed here

Acoustical Society of America Pioneers of Underwater Acoustics Medal

Dr. Homer Bucker for outstanding contribution to the science of underwater acoustics, specifically for his work in modeling sound propagation through matched-field processing, and for his efforts in signal processing, computational acoustics, and experimental methods

Armed Forces Communications and Electronics Association

AFCEA Hawaii Executive of the Month

Dr. Bernie Schneiderman

Distinguished Young AFCEAn

John Robusto for professional efforts in direct support of the Fleet in application of space systems in the tactical environment and for leading advanced intelligence systems research

APPENDIX B

PATENT AWARDS

FY 93

Inventor(s)	Title	Patent No.	Date
Everett, Hobart R., Jr.	Pneumatic Actuator With Hydraulic Control	5,161,449	10 Nov 92
Moberg, Victor L.	Method of Frequency Shifting Using a Chromium Doped Laser Transmitter	5,163,061	10 Nov 92
Moberg, Victor L.	Method of Frequency Shifting Using a Chromium Doped Laser Transmitter	5,163,062	10 Nov 92
Russell, Stephen D. Sexton, Douglas A. Kelley, Eugene P.	Laser Texturing	5, 164,324	17 Nov 92
Lockwood, James C.	Dual-Frequency Receiving Array Using Randomized Element Positions	5,168,472	1 Dec 92
Moberg, Victor L.	Method of Emitting on a Specific Wavelength Fraunhofer Line Using a Neodymium Doped Laser Transmitter	5,181,212	19 Jan 93
Holzschuh, Jack E. Hightower, John D.	Hybrid Data Link	5,186,414	16 Feb 93
Alsup, James M. Jelks, Edward C.	Fix-Tracking System	5,191,342	2 Mar 93
Hanson, Frank Dick, David	Blue Generation at the H-Beta Fraunhofer Wavelength Using Noncritically Phase-Matched Optical Parametric Generation in Lithium Borate (LiB_3O_5)	5,191,587	2 Mar 93
Flesner, Larry D. Miller, Stephen A. Dubbelday, Wadad B.	Optically Powered Photomultiplier Tube	5,196,690	23 Mar 93
Burgener, Mark L. Garcia, Graham A. Reedy, Ronald E.	Method and Apparatus for Characterizing the Quality of Electrically Thin Semiconductor Films	5,196,802	23 Mar 93
Scheps, Richard	ND Laser With Co-Doped Ion(s) Pumped by Visible Laser Diodes	5,200,972	6 Apr 93
Everett, Hobart R., Jr. Gilbreath, Gary A.	Method and System for Fusing Data From Fixed and Mobile Security Sensors	5,202,661	13 Apr 93
Holzschuh, Jack E.	Magnetic Stabilization of Spooled Fiber Optic Data Links	5,213,212	25 May 93
Adams, Gregory L.	Fraunhofer Line Laser Transmitting System	5,222,181	22 Jun 93

Inventor(s)	Title	Patent No.	Date
McGinnis, Wayne C. Jones, Thomas E.	Method for Measuring the Resistive Transition and Critical Current in Superconductors Using Pulsed Current	5,223,798	29 Jun 93
Cronyn, Willard M.	Low Cost Radar Target Simulator for Remote Radar Testing	5,223,840	29 Jun 93
Sexton, Douglas A. Russell, Stephen D.	Laser Formation of Graded Junction Devices	5,225,371	6 Jul 93
Tietsworth, Steven C.	Very Low Frequency and Low Frequency Transmitting Antenna Parameter Monitoring System	5,233,537	3 Aug 93
Berry, Mark H. Gookin, Debra M.	Wide Bandwidth Differential Amplifier	5,235,455	10 Aug 93
Reich, Ronald S.	Submersible Dock and Dump Mechanism	5,235,932	17 Aug 93
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Sun, Chen-Kuo Wu, Chao C. Chang, Ching T. Yu, Paul K. Lai McKnight, William H.	Bridge Type Optoelectronic Sample and Hold Circuit	5,239,181	24 Aug 93
Nguyen, Richard Hewett, Charles A.	Method for Fabricating Self-Aligned Gate Diffused Junction Field Effect Transistor	5,248,626	28 Sep 93
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Scheps, Richard	Tunable Lasers Pumped by Visible Laser Diodes	5,249,189	28 Sep 93
Scheps, Richard	Internally Folded Scalable Laser	5,249,196	28 Sep 93

APPENDIX C

DISTINGUISHED VISITORS

JANUARY 1993

- 5 Jan: Mr. Lewis Lundberg, Technical Director, Naval Air Warfare Center
- 12 Jan: RADM Robert Sutton, USN, Commander, Training Command, U.S. Atlantic Fleet
- 26 Jan: RADM George W. Emery, USN, Commander, Submarine Group Five

FEBRUARY 1993

- 2–3 Feb: RADM Leonard Oden, USN, Director, Customer Service Division (N6), Office of the Chief of Naval Operations
- 8 Feb: Representative Glen Browder (Alabama), House Armed Services Committee, U.S. House of Representatives

  Ms. Alma Moore, Professional Staff Member, Military Installations and Facilities Subcommittee

  Mr. Bob Schafer, Professional Staff Member, Seapower Subcommittee, House Armed Services Committee, U.S. House of Representatives
- 16 Feb: RADM Geoffrey Chesbrough, USN, Oceanographer of the Navy (OP 096), Office of the Chief of Naval Operations
- 18–19 Feb: Dr. Ira Blatstein, Technical Director, Naval Air Warfare Center
- 19 Feb: RADM George R. Meinig, USN, Commander, Naval Air Warfare Center
- 23 Feb: RADM Robert M. Moore, USN, Commander, Naval Information Systems Management Center

MARCH 1993

- 2–3 Mar: RADM (Select) Charles J. Beers, USN, Deputy, Attack Submarine Branch (N872B), Office of the Chief of Naval Operations
- 11 Mar: RADM Edward Sheafer, USN, Director, Naval Intelligence (OP 092), Office of the Chief of Naval Operations
- 18 Mar: General Carl E. Mundy, Jr., USMC, Commandant, United States Marine Corps
- 22 Mar: Mr. Jean Reed, Professional Staff Member, R&D Subcommittee, House Armed Services Committee, U.S. House of Representatives

APRIL 1993

- 5 Apr: RADM Virgil L. Hill, Jr., USN, Commander, Operational Test and Evaluation Force
- 7 Apr: Lieutenant General C. C. Krulak, USMC, Commanding General, Marine Corps Combat Development Command

  Brigadier General Paul A. Fratarangelo, USMC, Commanding General, I MEF (Rear), Marine Corps Base Camp Pendleton
- 14–15 Apr: RADM George H. Strohsahl, USN, Commander, Naval Air Warfare Center

  Mr. Lewis Lundberg, Technical Director, Naval Air Warfare Center

  RADM Scott L. Sears, USN, Commander, Naval Undersea Warfare Center

  Mr. Earl Messere, Technical Director, Naval Undersea Warfare Center

  RADM George R. Meinig, Jr., Commander, Naval Surface Warfare Center

  Dr. Ira Blatstein, Technical Director, Naval Surface Warfare Center

  Captain P. G. Gaffney, USN, Commanding Officer, Naval Research Laboratory

  Dr. Tim Coffey, Director of Research, Naval Research Laboratory
- 23 Apr: RADM Wesley Jordan, USN, Deputy Director, Space and Electronic Warfare, Office of the Chief of Naval Operations

MAY 1993

- 4 May: RADM Ruurd Lutje-Schipholt (Navy of the Netherlands), Deputy Chief of Staff, Supreme Allied Command Atlantic
- 26-27 May: Dr. James Carlson, General Manager, Strategic Defense Initiative Organization

- 27 May: Commodore Terence Roach, RAN, Naval Attache, Australian Embassy

JUNE 1993

- 16-17 Jun: VADM Jerry O. Tuttle, USN, Director, Space and Electronic Warfare, Office of the Chief of Naval Operations
- 18 Jun: Major General Nak Yong Kim, Assistant Chief of Staff for C^3, Republic of Korea Army
- 28 Jun: Brigadier General Russell H. Sutton, USMC, Commanding General, Marine Corps Air/Ground Combat Center

  Brigadier General Carlton W. Fulford, USMC, Director, Training and Education Division, Marine Corps Combat Development Comand

JULY 1993

- 12 Jul: Dr. Tim Coffey, Director of Research, Naval Research Laboratory
- 12-13 Jul: RADM Walter Davis, USN, Director, Warfare Systems Architecture and Engineering, Space and Naval Warfare Systems Command
- 12-23 Jul: Dr. James Colvard, Chairman, Naval Research Advisory Committee

  RADM Marc Pelaez, USN, Executive Director
- 15-16 Jul: RADM Richard D. Williams, III, Program Executive Officer, Mine Warfare Program, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)
- 19 Jul: Mr. Thomas G. Drummond, Senior Defence Scientist, Canadian Defence Liaison Staff, Canadian Embassy, Washington, DC

  RADM George Huchting, USN, Director Reporting Program Manager for Aegis, Office of the Secretary of the Navy
- 27 Jul: Dr. Ed Whitman, Acting Assistant Secretary of the Navy (Research, Development and Acquisition)
- 27-30 Jul: RADM James R. Stark, USN, Commander, Training Command, U.S. Pacific Fleet

AUGUST 1993

- 3 Aug: Mr. B. Alan Weaver and Mr. Robert W. Lautrup, Professional Staff Members, Surveys and Investigations Staff, House Appropriations Committee, U.S. House of Representatives
- 11 Aug: Major General Paul K. Van Riper, USMC, Assistant Chief of Staff for Command, Control, Communications, Computers and Intelligence Headquarters, United States Marine Corps

  RADM George Wagner, USN, Program Executive Officer, Cruise Missile Project and Unmanned Aerial Vehicle Joint Program
- 23 Aug: Ms. Carol DeBastite, Principal Deputy General Counsel of the Navy
- 25 Aug: Ms. Melinda Kassen, Environmental Counsel, U.S. House of Representatives

SEPTEMBER 1993

- 1-2 Sep: RADM (Select) Lewis A. Felton, USN, Program Director, Communication Systems Program Directorate, Space and Naval Warfare Systems Command
- 7 Sep: RADM Charles Saffell, USN, Deputy Director, Unified and Specified Command for C^4, The Joint Staff
- 8 Sep: RADM Thomas Stevens, USN, Commander, Naval Security Group Command
- 13 Sep: Lieutenant General Albert Edmonds, USAF, Director, Command, Control, Communications and Computer Systems Directorate, The Joint Staff

  Lieutenant General Peter Kind, USA, Director, Information Systems for Command, Control, Communications and Computers, Office of the Secretary of the Army

  RADM Leonard Oden, USN, Director, Customer Service Division, Office of the Chief of Naval Operations

  Major General Paul Van Riper, USMC, Assistant Chief of Staff for Command, Control, Communications, Computers and Intelligence Headquarters, United States Marine Corps

  Brigadier General Richard Bohn, USAF, Director, Joint Interoperability and Engineering Organization, Defense Information Systems Agency
- 13-15 Sep: Ms. Deborah Castleman, Deputy Assistant Secretary of Defense for Command, Control and Communications, Office of the Secretary of Defense
- 15 Sep: VADM David B. Robinson, USN, Commander, Naval Surface Force, U.S. Pacific Fleet
- 20-24 Sep: Dr. John M. MacCallum, Executive Director, Office of the Director of Defense Research and Engineering/Advanced Technology
- 27 Sep - 6 Oct: Mr. Andrew Tape, Representative for Director, Naval Communications Establishment, Australia

OCTOBER 1993

- 13–14 Oct: RADM Walter H. Cantrell, USN, Commander, Space and Naval Warfare Systems Command

  Ms. Genie McBurnett, Deputy Commander, Space and Naval Warfare Systems Command

- 20 Oct: RADM Edward S. McGinley, II, USN, Commander, Naval Surface Warfare Center

  Lieutenant General George R. Christmas, USMC, Commanding General, First Marine Corps Expeditionary Force

- 21 Oct: RADM Dennis Blair, USN, Commander, Cruiser Destroyer Group Five

NOVEMBER 1993

- 4–5 Nov: Brigadier General Mokhtar El Nomrsy, R&D Department, Headquarters, Egyptian Air Force

  Brigadier General Safwet El Nahas, E-2C Laboratory Commander

- 15 Nov: Dr. Fred Saalfeld, Deputy Chief of Naval Research

DECEMBER 1993

- 9 Dec: RADM Richard D. Williams, III. USN, Program Executive Officer, Mine Warfare Program, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)

- 16 Dec: RADM Robert E. Traister, USN, Deputy Commander for Surface Ships, Naval Sea Systems Command

- 20 Dec: RADM George Huchting, USN, Direct Reporting Program Manager for Aegis, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)

APPENDIX D

MAJOR CONFERENCES

JANUARY 1993

- 11–12 Jan: Defense Research and Engineering Network Technical Advisory Panel Meeting
- 13–14 Jan: ICEX Planning Meeting
- 21–29 Jan: Tactical Information Management Simulation Meeting
- 25–29 Jan: NATO Low-Cost ASW Weapon Steering Committee Technical Advisory Group Meeting
- 27–28 Jan: Battalion/Brigade Battle Simulation and Distributed Interactive Simulation Interoperation In-Progress Review
- 29 Jan: Inshore Undersea Warfare Group 1 Commanders Briefing

FEBRUARY 1993

- 2–4 Feb: NATO AC/243 Panel 10 Research Study Group Meeting on Anti-Radiation Missile Countermeasures for Air Defense Systems
- 3–4 Feb: Naval Financial Accounting System Meeting
- 17–18 Feb: Command, Control and Communications Senior National Representatives Meeting

  NCCOSC CO/ED Meeting
- 22–26 Feb: NATO Identification Meeting
- 23–25 Feb: Navy Space Test Program Conference

MARCH 1993

- 1–4 Mar: TADIXS-B Users Group Meeting
- 2–4 Mar: Submarine Communications Executive Committee Conference
- 8–12 Mar: The Technical Cooperation Program (TTCP) Networking Sub Group 5 Workshop
- 11–12 Mar: Armed Forces Communications and Electronics Association of C^4I Symposium
- 16–17 Mar: Naval Environmental Protection Support Services Specialty Office Annual Meeting
- 17–18 Mar: Office of the Chief of Naval Research Active Control Review Meeting

  Operations Support System Fleet Project Team Meeting
- 20–21 Mar: Office of Naval Research Science and Technology 719 Naval Reserve Meeting
- 22–26 Mar: Fleet Requirements Working Group (Navy Tactical Command System-Afloat) Technical Meeting
- 31 Mar: NRaD/California Department of Transportation Intelligent Vehicle Highway System Technical Meeting

APRIL 1993

- 5–9 Apr: ONR Computer Technology Spring Review
- 8–9 Apr: Battalion/Brigade Battle Simulation Meeting
- 13–14 Apr: Information Exchange Program (IEP) ABC 37 Networking Sub Group Meeting
- 13–15 Apr: Fourth Navy R&D Information Exchange Conference
- 14–15 Apr: Navy Laboratories/Centers Coordinating Group Meeting
- 20–23 Apr: Tri-Service Group on Communications and Electronics, Sub-Group on Data Distribution (Sub-Group 9), Working Group on Data Links (Working Group 4)
- 20–21 Apr: Defense Research and Engineering Network Working Group Meeting
- 23–24 Apr: Annual ONR NSAP Naval Reserve National Training
- 27–28 Apr: Federal Aviation Administration Technical Center Working Group
- 27–29 Apr: National Security Industrial Association 33rd ASW Conference

  Data Fusion Working Group

MAY 1993

- 3–7 May: The Technical Cooperation Program (TTCP) Subgroup J Technical Panel 14 Meeting
- 4 May: Over-The-Horizon-Targeting Configuration Control Meeting
- 13 May: First Greater San Diego Paraprofessional Development Workshop
- 24–25 May: Office of Naval Research/Center for Naval Analyses Science and Technology Study Panel
- 25–27 May: U.S./French Meetings on Target Physics/Acoustics

  Low-Frequency Active (LFA-11) Sea Test Planning Meeting

JUNE 1993

- 7 Jun: Intelligent Vehicle Highway System Technical Community Meeting
- 8 Jun: Naval Advisory Group for High Performance Computing
- 8–10 Jun: COMTRAPAC ESC Meeting
- 9 Jun: Navy Lab/Center Computer Committee
- 9–10 Jun: Secure Tactical Data Network-4 (STDN-4) Conference
- 15 Jun: ICEX '94 Planning Meeting
- 18 Jun: Center for the Control of Fluids One-Day Workshop on Dynamics and Control of Nonequilibrium Turbulence

JULY 1993

- 8 Jul: Mayor's City of the Future Advisory Committee Meeting
- 12–23 Jul: Naval Research Advisory Committee (NRAC) Summer Study
- 14 Jul: ICEX '94 Planning Meeting
- 18–21 Jul: National Research Council Marine Board on Undersea Vehicles and National Needs
- 19–20 Jul: Marine Mammal Workshop on Dual Uses: Marine Mammal Research and the Navy's Integrated Undersea Surveillance System
- 27–30 Jul: COMTRAPAC Commanders ESC Strategic Planning Meeting

AUGUST 1993

- 9–15 Aug: Mobile Inshore Underwater Warfare (MIUW) System Upgrade Assessment
- 10–11 Aug: Submarine Communications Steering Committee Meeting
- 26–27 Aug: Naval Warfare Tactical Database Working Group

SEPTEMBER 1993

- 7–10 Sep: The Technical Cooperation Program (TTCP) Subgroup J 35th Annual Working Group
- 9 Sep: San Diego Communications Council Meeting
- 13–16 Sep: Secure Tactical Data Network-4 (STDN-4) Demonstration

  U.S./Republic of Korea C^3 Interoperability Board Meeting
- 16 Sep: Association of Configuration and Data Management Meeting
- 21–23 Sep: Advanced Tomahawk Weapon Control System (ATWCS) Human Computer Interface Working Group

OCTOBER 1993

- 4–5 Oct: National Research Council/Naval Studies Board Information Warfare Study
- 13–15 Oct: Theatre Ballistic Missile Defense BM/C^3I Integration Group (TBIG) Meeting
- 19–21 Oct: Pacific ASW Improvement Program (PACASWIP) Meeting

NOVEMBER 1993

- 1–3 Nov: Submarine Communications Executive Meeting
- 9 Nov: ICEX '94 Planning Meeting
- 16–17 Nov: Information Exchange Program (IEP) ABC 37 Networking Sub Group Meeting
- 16–18 Nov: Tactical Decision Making Under Stress (TADMUS) Technical Advisory Board Meeting

DECEMBER 1993

- 30 Nov – 3 Dec: NATO Research Study Group 24 Human Engineering Test and Evaluation Meeting

ACRONYMS

ACRONYMS

A

AAUS Active Adjunct Undersea Surveillance
ACDS Advanced Combat Direction System
ACS Afloat Correlation System
AdDA Advanced Deployable Array
ADS Advanced Deployable System
AESD Advanced Electronics School (Navy)
AGF Miscellaneous Command Ship
ALSP Aggregate Level Simulation Protocol
APL Applied Physics Laboratory (Johns Hopkins University)
APTS Automatic Position Tracking System
ARL Applied Research Laboratory (Pennsylvania State)
ARPA Advanced Research Projects Agency
ASN Assistant Secretary of the Navy
ASROC Antisubmarine Rocket
ASW Antisubmarine Warfare
ASWCS ASW Control System
ATD Advanced Technology Demonstration
ATDS Air Tactical Data System
AUSS Advanced Unmanned Search System
AUTODIN Automated Digital Information Network
AWDS Automated Weather Distribution System
AWSIM Air Warfare Simulator

B

BAI Battlefield Air Interdiction
BARSTUR Barking Sands Tactical Underwater Range
BBN Bolt, Beranek and Newman, Inc.
BCA Broadcast Control Authority
BG Battle Group
BGPHES Battle Group Passive Horizon Extension System
BiCMOS Bipolar Complementary Metal-Oxide Semiconductor

C

C^2 Command and Control
C^2P Command and Control Processor
C^3 Command, Control, and Communications
C^4I Command, Control, Communications, Computer, and Intelligence
CAFWSP Combat Air Forces Weather Software Package
CARIBROC Carribean Regional Operations Center
CBRN Caribbean Basin Radar Network
CCN Configuration Change Notice
CCS Combat Control System
CDS Combat Direction System
CEC Cooperative Engagement Concept
CECOM Communications Electronics Command (Army)
CEL Civil Engineering Laboratory
CGN Guided Missile Cruiser (Nuclear Propulsion)
CINC Commander in Chief
CINCLANT Commander in Chief, U.S. Forces, Atlantic
CINCPAC Commander in Chief, U.S. Naval Forces, Pacific
CINPACFLT Commander in Chief, U.S. Naval Forces, Pacific Fleet
CINCUSNAVEUR Commander in Chief, U.S. Naval Forces, Europe
CJTF Commander, Joint Task Force
CMOS Complementary Metal-Oxide Semiconductor
CNO Chief of Naval Operations
CNSG Commander, Naval Security Group
CO Commanding Officer
COEA Cost and Operational Effectiveness Analysis
COMCRUDESGRU Commander, Cruiser-Destroyer Group
COMNAVSEASYSCOM Commander, Naval Sea System Command
COMSEC Communication Security
COMSEVENTHFLT Commander, Seventh Fleet
COMTHIRDFLT Commander, Third Fleet
COTS Commercial Off-the-Shelf (Equipment)
CSNI Communications Systems Network Interoperability
CSSQT Combat Systems Ship Qualifications Test
CTAPS Contingency Theater Auto Planning System
CTD conductivity-temperature-depth
CUALT Composite Unit Accelerated Life Test
CVN Attack Aircraft Carrier (Nuclear Propulsion)
CWS Combat Weather System
CWTA Captain Weapons Trials Assessment
CY Calendar Year

D

DAC Digital Autopilot and Control
DAMA Demand Assigned Multiple Access
DCS Defense Communication System
DGUW Director General Underwater Weapons
DIS Distributed Interactive Simulation
DoD Department of Defense
DOT Deep Ocean Technology
DSCS Defense Satellite Communication System
DSI Defense Simulation Internet
DSPAT Digital Signal Processor Acoustic Target
DSTP Distributed Surveillance Technology Project
DSVC Dam Neck Systems Validation Center
DT Development Test
DTC Desktop Tactical Computer
DTS Data Terminal Set

E

ECCM Electronic Counter-Countermeasures
EDM Engineering Development Model
ENWGS Enhanced Naval Wargame System
EPA Environmental Protection Agency
EPAC Eastern Pacific (Satellite Network)
ESM Electronic Support Measures
ESMTS Electronic Support Measures Test System
ETSM Extended TRAP Status Message
EUA Early User Assessment
EW Electronic Warfare
EWCM Electronic Warfare Coordination Module

F

FDDS Flag Data Display System
FFG Guided Missile Frigate
FLIP Floating Instrument Platform
FLTEX Fleet Exercise
FLTSAT Fleet Satellite
FMOCC Fleet Mobile Operational Command Center
FOMC Fiber–Optic Microcable
FORACS Fleet Operational Readiness Accuracy Check Site
FY Fiscal Year

G

G&A General and Administrative
GCCS Global Command and Control System
GDFS Graphical Data Fusion System
GEM Generalized Emulation Microcircuitry
GFCP Generic Front-End Communications Processor
GNATS General Noise and Tonal System
GPS Global Positioning System
GVS Gemini Visual Systems

H

HF High Frequency
HLF Horizontal Line Array
HMMWV High-Mobility Multipurpose Wheeled Vehicle ("Humvee")
HyDy Highly Dynamic Aircraft

I

IED Independent Exploratory Development
IMA Intermediate Maintenance Activity
INS Inertial Navigation System
IOP Initial Observation Period
IR Independent Research
ISABPS Integrated Submarine Automated Broadcast Processing System
ISEA In-Service Engineering Agent
IUSS Integrated Undersea Surveillance System
IUW Inshore Undersea Warfare
IV&V Independent Verification and Validation

J

JADO Joint Air Defense Operations
JEZ Joint Engagement Zone
JMCIS Joint Maritime Command Information System
JOTS Joint Operational Tactical System
JSOTF Joint Special Operations Task Force
JTF Joint Task Force
JTIDS Joint Tactical Information Distribution System

L

LAN Local-Area Network
LCAC Landing Craft Air Cushion
LEASAT Leased Satellite
LEDS Link-11 Display System
LFA Low-Frequency Active
LHD Amphibious Assault Ship (Multipurpose)
LPH Amphibious Assault Ship
LSD Dock Landing Ship

M

MADD Multiaccess Data Device
MAPTIP Marine Aerosol Properties and Thermal Imager Performance
MATT Multimission Advanced Tactical Terminal
MB&P Major Bid and Proposal
MCM Multichip Module
MCTSSA Marine Corps Tactical Systems Support Activity
MDARS Mobile Detection, Assessment, and Response System
MDS Minimum Discernible Signal
MIDS Multifunctional Information Distribution System
MIPRs Military Interdepartmental Purchase Requests
MIUW-SU Mobile Inshore Undersea Warfare System Upgrade
MLSE Multilink System Exerciser
MMRT Missile Motor Railcar Transporter
MMS Marine Mammal System
MOS Metal-Oxide Semiconductor
MOSC Mission Support Operations Center
MOTU Mobile Technical Unit
MPL Marine Physical Laboratory (at Scripps Institution of Oceanography)
MRHA Multiple Robot Host Architecture
MSO Minesweeper, Ocean (Nonmagnetic)
MSP Mobile Sensor Platform
MTS Moving Target Simulator
MULTOTS Multiple Unit Link Test and Operational Training System

N

NAS Naval Air Station
NATO North Atlantic Treaty Organization
NAVAIR Naval Air Systems Command
NAVCAMS Naval Communication Area Master Station
NAVFAC Naval Facility
NAVFACENGCOM Naval Facilities Engineering Command
NAVFOR Naval Force
NAVOCEANO Naval Oceanographic Office
NAVSEA Naval Sea Systems Command
NAVSSI Navigation Sensor System Interface
NAWC Naval Air Warfare Center
NAWCWPNS Naval Air Warfare Center, Weapons Division
NBC Nuclear, Biological, Chemical
NCCOSC Naval Command, Control and Ocean Surveillance Center
NCS Navy (or National) Communication System (or Station)
NCSS Naval Combat Surveillance Systems
NEESA Navy Energy and Environmental Support Activity
NFESC Naval Facilities Engineering Support Center
NIF Navy Industrial Fund
NIPS Naval Intelligence Processing System
NISE WEST NCCOSC In-Service Engineering Division West Coast
NISE EAST NCCOSC In-Service Engineering Division East Coast
NOAA National Ocean and Atmospheric Administration
NOSC Naval Ocean Systems Center (NRaD predecessor)
NPS Naval Postgraduate School
NRaD NCCOSC RDT&E Division
NRL Naval Research Laboratory
NRT Near Realtime
NSWC Naval Surface Warfare Center
NTCS-A Navy Tactical Command System-Afloat
NTDS Navy Tactical Data System
NUSTF Navy UHF Communications Test Facility
NVIS Near-Vertical Incidence Skywave

O

OCNR Office of the Chief of Naval Research
ONT Office of Naval Technology
OPEVAL Operational Evaluation
OPNAV Office of the Chief of Naval Operations
OPTASKLINK (30: Link-16/JTIDS)
ORD Operational Requirements Document
OSO Operation Support Office
OSP Ocean Survey Program
OSS Operations Support System
OSV Ocean Survey Vessel
OT Operational Test
OTC Officer in Tactical Command
OTCIXS Officer-in-Tactical Command Information Exchange System
OTECH Oceaneering Technology
OTH-T Over-the-Horizon Targeting
OTHAAC2 Over-the-Horizon Amphibious Assault Command and Control
OUTBOARD Organizational Unit Tactical Baseline Operational Area Range Detection

P

PAC CMS Pacific Crisis Management System
PACAF Pacific Air Forces
PAO Public Affairs Office
PDR Preliminary Design Review
PDTS Programmable Data Terminal Set
PDU Protocol Data Unit
PENEX Polar Equatorial Near-Vertical-Incidence Experiment
PFAT Pre-Fleet Acceptance Test

PLRS Position Locating Reporting System
PMS Planned Maintenance System
POL Petroleum, Oil, Lubricant
POST Prototype Ocean Surveillance Terminal
PRISM Portable, Reusable, Integrated Software Modules
PSP Portable Sensor Platform

R

R/V Research Vessel
R/P Research Platform
RADCON Radio Controller
RCPs Requests for Contractual Procurement
RCS Radar Cross Section
RDT&E Research, Development, Test, and Evaluation
REMCON Remote Controller
RESA Research, Evaluation, and Systems Analysis (Facility)
REWS Range Electronic Warfare Simulator
RF Radio Frequency
RIO Radar Intercept Officer
RIXT Remote Information Exchange Terminal
RLBTS Reconfigurable Land-Based Test Site
RLGN Ring Laser Gyro Navigator
ROTHR Relocatable Over-the-Horizon Radar
RSSC Radar Sonar Surveillance Center
RSP Remote Sensor Platforms
RSS Regional Strategic Strike
RSTA Reconnaissance, Surveillance, Target Acquisition

S

SAIC Science Applications International Corporation
SAR Synthetic Aperture Radar; Search and Rescue
SATCOM Satellite Communications
SCAPS Site Characterization and Analysis Penetrometer System
SCORE SIGINT Classification of Recognized Emitters
SDR Software Design Review; System Design Review
SDS Surveillance Direction System
SEPO Software Engineering Process Office
SEU Single-Event-Upset
SHF Super High Frequency
SHFTAMS SHF Test and Monitoring System
SIF Systems Integration Facility
SIGINT Signals Intelligence
SIL Systems Integration Laboratory
SIT System Integration Testing
SOCAL Southern California
SOL Swimout Launcher
SOSUS Sound Surveillance Underwater System
SPAWAR Space and Naval Warfare Systems Command
SRAM Static Random Access Memory
SSA Software Support Activity; (30: GPS)
SSE Site Specific Experiment
SSEE Ship's Signal Exploitation Equipment
SSIXS Submarine Satellite Information Exchange Subsystem
SSN Attack Submarine (Nuclear Propulsion)
SSTD Surface Ship Torpedo Defense
STDN-4 Secure Tactical Data Network-4
STIC Surveillance Test and Integration Center
STTS Shipboard Tracking and Telemetry System
SURF SIGINT Universal Recognition Facility
SURTASS Surveillance Towed Array Sensor System
SWELL Shallow-Water Evaluation Cell
SWELLEX Shallow-Water Environmental Cell Experiment

T

TACINTEL Tactical Intelligence
TACTS Tactical Air Combat Training Systems
TADIL Tactical Digital Information Link
TADIXS Tactical Data Information Exchange Subsystem
TDA Technical Development Agent
TDMA Time Division Multiple Access
TDP Tether Development Project; Tactical Data Processor
TDPCON Tactical Data Processor Control
TECHEVAL Technical Evaluation
TELECOM Telecommunications
TGF TADIXS Gateway Facility
TGP TADIXS Gateway Processor
ThAW Theatre Acoustic Warfare
TIMS Tactical Information Management System
TIS Thermal Imaging Sensor
TLCF TACINTEL Link Control Facility
TOV Teleoperated Vehicle
TQL Total Quality Leadership
TRANSDEC Transducer Evaluation Center
TRAP Tactical Related Applications
TRP Technology Reinvestment Program
TTGP Tactical Training Group Pacific
TVC Thrust Vector Control

U

UAV Unmanned Aerial Vehicle
UB Unified Build
UFCS Underwater Fire Control System
UFL Ulchi Focus Lens
UGV Unmanned Ground Vehicle
UHF Ultra High Frequency
UV Ultraviolet

V

VCS Voice Communications
VERDIN (Modulation System Used in Shore-to-Ship Communications)
VIS Visual Imaging Sensor
VLA Vertical Line Array
VLF Very Low Frequency
VLS Vertical Launching System
VOCAR Variability of Coastal Atmospheric Refractivity
VVFD Voice, Video, Fax, and Data

W

WDM Wavelength Division Multiplexing
WES Waterways Experiment Station
WSS Waterside Security System

X

XBT Expendable Bathythermograph

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INDEX OF TECHNICAL PROGRAMS AND MAJOR TOPICS

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