

FINAL TECHNICAL REPORT
DARPA COOPERATIVE AGREEMENT #MDA972-97-2-000-1

INTRODUCTION

As the *Ocean State*, Hawaii has been a leader in ocean-directed research for many years. In the late 1960's, for instance, the study, *Hawaii and the Sea*, highlighted research areas to be pursued by government, academic, or commercial organizations. Hawaii's mid-Pacific location is unique and allows extraordinary access to a variety of ocean environments—particularly the deep ocean—in a climate generally mild enough for year-round, at-sea activity.

Department of Defense (DoD) ocean-related activities, facilities, and assets in Hawaii are also numerous, exceptional, and long standing. Recent DoD emphasis has focused on providing advanced technology to both war-fighting and support units, while emerging DoD programs seek to increase use of commercially developed advanced within DoD systems and system-development cycles. Hawaii provides an ideal location for a federally supported state program to develop ocean technologies for DoD applications.

CONGRESSIONAL ACTION

The National Defense Center of Excellence for Research in Ocean Sciences (CEROS) was created by congressional action. House Bill 8761, published in the September 18, 1992, *Congressional Record*, contained a section entitled *Research, Development, Test, and Evaluation, Defense Agencies* and provided for

“ . . . an additional amount for RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE AGENCIES, \$74,800,000, to remain available for obligation until September 30, 1993. Provided that \$5,000,000 of the funds appropriated in this paragraph shall be made available only for a National Defense Center of Excellence for Research in Ocean Sciences to be established through cooperation between the Defense Advanced Research Projects Agency (DARPA) and the Hawaii High Technology Development Corporation (a government entity) for the purpose of conducting research and development (R&D) activities of interest to the Department of Defense on such topics as ocean environment preservation technology, new ship hull design concepts, shallow water and surveillance technologies, ocean measurement instrumentation, and the unique properties of the deep ocean environment.”

NATIONAL DEFENSE CENTER OF EXCELLENCE FOR RESEARCH IN OCEAN SCIENCES (CEROS)

Background

In February 1993, DoD technical needs, combined with ocean technology capability in Hawaii, yielded the National Defense Center of Excellence for Research in Ocean Sciences (CEROS). CEROS was established through a grant from the Defense Advanced Research Projects Agency (DARPA) to the High Technology Development Corporation (HTDC), an agency of the State of Hawaii attached to the Department of Business, Economic Development and Tourism (DEBDT). CEROS was funded

“ . . . for the purpose of conducting research and development activities of interest to the Department of Defense . . . and . . . to support and stimulate a broad spectrum of research in ocean science in the State of Hawaii.”

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DARPA Grant No. MDA 972-93-1-0008

DARPA awarded Grant No. MDA 972-93-1-0008 for \$5,000,000 to HTDC for CEROS in February 1993. This grant supported a core program of eleven projects involving twelve prime contractors during CEROS FY93. Technical work was complete for this grant by December 1997, and the final grant report was delivered to DARPA in September 1998.

DARPA Grant No. MDA 972-94-1-0010

DARPA awarded Grant No. MDA 972-94-1-0010 to HTDC for CEROS in May 1994. This grant, with total funding of \$18,737,796, supported a core program of thirty-nine projects involving nineteen prime contractors during CEROS FY94, FY95, and FY96. Technical work was complete for this grant by June 1999, and the final report was delivered to DARPA in September 1999.

DARPA Cooperative Agreement No. MDA972-97-2-0001

DARPA awarded Cooperative Agreement No. MDA972-97-2-0001 to the Natural Energy Laboratory of Hawaii Authority (NELHA) in September 1997. This agreement, with total funding of \$31,707,564, supported a core program of eighty projects involving thirty-five prime contractors during CEROS FY97, FY98, FY99, FY00 and FY01. Contract details are listed in Table 1. This report describes the work done under the 1997 agreement.

The purpose of the grant is

“. . . to support a broad spectrum of research in Ocean Sciences in the State of Hawaii and to provide support for CEROS. This effort shall be carried out as set forth in this article to this Cooperative Agreement, and the Awardee’s proposal entitled ‘CEROS Procurement Plan: February 1997’ . . .”

State Oversight and Interaction

The State of Hawaii and DBEDT recognize that building and reinforcing a competitive ocean research and development (R&D) community with guided networking, marketing, and new business interchanges are important functions of CEROS. When CEROS was created, it was administered by the State of Hawaii through HTDC. In December 1995, CEROS was transferred to the Natural Energy Laboratory of Hawaii Authority (NELHA), another State of Hawaii agency.

Program Summary

CEROS advances the state’s goals of expanding technology-based industries by encouraging the participation of Hawaii companies that have special expertise of interest to DoD. The NELHA Board of Directors set broad goals, developed policy, and provided guidance for the general management and direction of CEROS under Cooperative Agreement No. MDA972-97-0001. As CEROS grantor, DARPA reviewed and evaluated CEROS programs and management to assure grant conformance and consistency with congressional intent.

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The CEROS Technical Director is the agreement's Principal Investigator and is responsible for technical program development and execution. The Technical Director impanels a research advisory board to provide functional oversight, guidance, and advice throughout the CEROS source-selection process and to plan and implement strategic development. As a condition of funding, CEROS programmatic goals and managerial approaches are presented to DARPA annually as an operational plan.

Program Objectives

The purpose of CEROS is to solicit and support innovative technology development for national maritime military applications and sustained technology-based economic development in Hawaii. This is to include demonstrating capabilities and building residual benefits.

The CEROS technical program seeks to identify leading-edge, value-added technologies that support DoD requirements, use facilities, and infrastructure in Hawaii, and foster potential commercial development. The technical topic areas addressed by the CEROS program were identified in the congressional legislation as

- Ocean environmental preservation technology
- New ocean platform and ship concepts
- Shallow water surveillance technologies
- Ocean measurement instrumentation
- Unique properties of the deep ocean environment.

Program Scope

CEROS supports R&D projects that are intended to produce measurable results or products within 12 months. Procurement is based on priorities that are issued in published solicitations, emphasizing near-term results. Proposals can include options for an extended period of performance. However, incremental or follow-on funding of any such option is not guaranteed.

If a project is proposed that probably cannot be procured within time or budget limitations, the CEROS Technical Director and the CEROS Research Advisory Board will try to reduce the risks and consequences of postponing, scaling, or not funding. Trade-offs among cost, performance, and schedule are evaluated relative to programmatic goals and planned procurement schedule and appropriate risk-reduction strategies are identified and implemented.

Procurement

CEROS solicits proposals for concept development and demonstration of ocean technologies and applied ocean sciences for military maritime purposes through annual Broad Agency Announcements (BAAs). An offeror must be a commercial enterprise to be eligible for consideration. CEROS selects and supports technical projects that conform to its mission. CEROS procures R&D based on programmatic priorities and goals; the resultant procurement contracts include terms and schedules for delivery. The selection process emphasizes technology development in Hawaii and the Pacific without eliminating applicable projects of merit with a focus elsewhere. CEROS determines best value through technical and

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programmatic evaluations that match proposed efforts with DoD technology needs and CEROS programmatic objectives within funding constraints. As a condition of funding, DARPA approves CEROS contract policy and procedures and assures that they are consistent with applicable federal acquisitions regulations and guidelines.

The BAA for each year covered under this agreement was published in the Commerce Business Daily as follows:

<u>YEAR</u>	<u>SOLICITATION</u>	<u>RELEASE DATE</u>
FY97	BAA-CEROS-97-01	December 11, 1996
FY98	BAA-CEROS-98-01	October 10, 1997
FY99	BAA-CEROS-99-01	October 2, 1998
FY00	BAA-CEROS-2K-01	October 1, 1999
FY01	BAA-CEROS-01-01	October 2, 2000

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TABLE 1
CEROS PROJECTS – FY97 THROUGH FY01

Contractor	Year	Project	Amount	Contract No.
Aquaculture Technology Incorporated	97	Continuous Production of Marine Algae <i>Chaetoceros</i> Spp. In an Open System	\$440,000	42803
Band, Lavis & Associates, Inc.	97	Application Techniques & Comparative Effectiveness of Non-Toxic Anti-Fouling Surfaces to Immersed Nettings Used in Naval and Aquaculture Industries	\$225,483	42982
BBNT Solutions LLC (formerly BBN Corporation)	99	Hydrofist: A Non-Explosive Means for Generating Intense and Focused Underwater Shock Waves (Phase 1)	\$999,819	45694
	00	Hydrofist: A Non-Explosive Means for Generating Intense and Focused Underwater Shock Waves (Phase 2)	\$800,000	47343
	01	A Proposal to Implement and Demonstrate Antisubmarine Warfare (ASW) Targeting and Weapon Control Using Non-Organic Sensors: Netted Combat Control System (Netted CCS) Phase 1	\$1,112,450	48213
Black Pearls, Inc.	97	Probiotic Bacteria: The Key to Expanded Use of Deep Seawater In Tropical Aquaculture and the Solution to a Growing Industry Problem	\$121,392	42839
	00	Deep Seawater Use in a Photobioreactor; More Efficient Microalgal Production and Broader Deep Seawater Applications	\$173,201	46762
	01	Development of a Sensitive, Sessile Monitor for Non-Point Source Heavy Metal Pollution for Tropical and Sub-Tropical Indo-Pacific Waters	\$138,097	48210
Cox Environmental Systems	00	Water Properties Sensor Project	\$215,004	46763
Detection Limit Technology, Inc.	97	Solution+ In-Situ Ocean Sediment Chemical Analyzer	\$360,000	42887
	98	Polychlorinated Biphenyl (PCB) Analyzer for Shallow Ocean Water	\$380,000	44524
	00	Surface-Enhanced Raman Spectroscopy (SERS) Immunoassay Detection System: "Dog Nose" Sensor for TNT Detection and Detection of an Aquaculture Virus	\$439,937	47339
Dynamics Technology, Inc.	00	Analysis of Synthetic Aperture Sonar (SAS) Data for Geological Surveys	\$98,239	47258
Edward K. Noda & Associates, Inc.	98	Modeling of Hurricane-Induced Coastal Flooding for the Hawaiian Islands	\$182,345	44370
Gateway Technologies International, Inc.	98	Personal Emergency Lifesaving System (PELS)	\$240,920	44023

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Contractor	Year	Project	Amount	Contract No.
GuideNet, Inc.	98	Using Software Agents to Acquire and Visualize Environmental Information for Antisubmarine Warfare (ASW) Surveillance (Phase 1)	\$305,000	44404
	99	Using Software Agents to Acquire and Visualize Environmental Information for Antisubmarine Warfare (ASW) Surveillance (Phase 2)	\$360,000	45513
	00	Workflow Paradigm for Antisubmarine Warfare (ASW) by Reliable Meteorology and Oceanography (METOC) Data and Tasks	\$397,050	46676
Innovative Technical Solutions, Inc. dba NovaSol	01	Temporally Enhanced Adaptive Multi-Spectral (TEAMS) System for Detection of Underwater Objects	\$34,953	48580
Knapp Engineering, Inc. dba Structural Solutions	97	3-D Finite Element Design of Cables	\$190,000	43109
	98	A Probe for In Situ Characterization of Marine Carbonate Sands and Other Sediments	\$220,000	44748
	98	SMART SCUBA (Phase 1)	\$319,000	44751
	99	SMART SCUBA (Phase 2)	\$312,000	46008
	00	Modeling of Cable Fatigue	\$190,000	47073
	01	Experimental Investigation of Cable Fatigue	\$192,000	48488
Makai Ocean Engineering, Inc.	98	An Internet-Enabled Engineering Tool for Dynamically Analyzing and Planning World-Wide Subsea Cable and Array Installations (Phase 1)	\$379,985	44303
	00	Remote Monitoring and Expert Control of Submarine Cable and Array Installations	\$345,737	46765
	00	Improving Flow From Deep Water Pipelines	\$388,950	47072
Neptune Technologies, Inc.	97	Diver Homing Device Product Improvement (Phase 2)	\$39,300	42967
Nextwave Engineering	01	Snap-To Amphibious Footwear System	\$75,700	48002
Ocean Engineering Consultants, Inc.	00	Small Water Plane Area Twin Hull (SWATH) Ship Software and Verification	\$164,954	46684
Oceanic Imaging Consultants, Inc.	98	The ROVER's Eye Terrain Database Visualization as an Aid to ROV Navigation (Phase 1)	\$239,652	44366
	99	The ROVER's Eye Terrain Database Visualization as an Aid to ROV Navigation (Phase 2)	\$275,482	46005
The Oceanic Institute	99	Cultured Fish as Biological Indicators of Pollution	\$216,766	45852
Oceanit Laboratories, Inc.	97	Computational and Physical Modeling of the Hurricane Tower Desalination	\$150,000	43162
	01	Three-Dimensional Cloud Height Indicator for Marine Application (3D-CHIMA)	\$400,000	48216
Oceantek, Inc.	99	An Ocean Bottom Span Analyzer for Survey Planning and Installations of Submarine Cables	\$188,000	45770

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Contractor	Year	Project	Amount	Contract No.
Oceantronics, Inc.	99	Electronic Charting Display and Information System (ECDIS-N) with Special Emphasis on Submarine Navigation - Hi Plot	\$393,000	45300
ORINCON Corporation	97	Antisubmarine Warfare Commander's Workstation Upgrades & ARTS	\$500,000	42705
	97	An Improved Acoustic Intercept Receiver for Submarine Applications (Phase 1)	\$450,000	42703
	97	An Integrated System for Detection, Classification, Localization, Multisensor Tracking and Reporting of Submarine Contact Data	\$700,000	43055
	98	Situation Awareness System (SAS) Processor for Submarine Applications, Phase 2	\$171,777	44367
	98	Upgraded Advanced Real-Time Sensor (ARTS) Processor for Maritime Patrol Aircraft Applications	\$373,000	44368
	98	An Improved Acoustic Intercept Receiver for Submarine Applications (Phase 2)	\$560,000	44369
	99	Automation and Integration of Environmental Factors Into ASW Tracking	\$497,415	45290
	99	At-Sea Evaluation of the Situation Assessment System Processor	\$775,864	45812
	00	Mission Reconfigurable Signal Processing System	\$749,504	46675
	01	Theater-Wide Situational Awareness For Decision Wall	\$150,000	48163
	01	Passive Assured Access (PAA) System	\$749,203	48390
Pacific Environmental Technologies	99	Mass Spectrometer Using Rotating Fields for Exploratory Research (Mass SURFER) Phase 1	\$141,743	45291
	00	Mass Spectrometer Using Rotating Fields for Exploratory Research (Mass SURFER) Phase 2	\$171,864	46821
Pacific Marine & Supply Company, Ltd.	97	Computational Fluid Dynamics (CFD) Code Validation and Improvement Using Large Scale Tests	\$663,300	42787
	98	Development of a Patentable Combination Propeller-Pump Jet Integrated Propulsion Pod with Boundary Layer Suction	\$300,000	43959
	99	Fabrication and Demonstration of a Patentable Combination Propeller Pump Jet Integrated Propulsion Pod with Boundary Layer Suction Designed Under a CEROS 98 Grant	\$1,019,000	45496
	00	Large-Scale Producibility Demonstration of 3-D Lifting Bodies	\$980,000	47257
	01	Flapping Foil Technology for Motion Stabilization of Novel High-Speed Vehicles	\$250,000	48211

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Contractor	Year	Project	Amount	Contract No.
Raytheon Company	97	Integrated Sensor System for Search and Classification of Subbottom	\$753,008	43320
	98	Multispectral, Interferometric, Synthetic Aperture Sonar System (SAS)	\$550,034	44414
	99	Frequency Agile Sequential Transmission Synthetic Aperture Sonar (FastSAS) Risk Reduction Technology Demonstration for NetTORP -- TERMINATED	\$119,976	45773
Science & Technology International, Inc.	98	Undersea Fanbeam Spectral Imaging (FSI) Risk Reduction Technology Demonstration	\$398,895	44304
	98	Patuxent River Dual Camera HSI System	\$565,498	45125
Science Applications International Corporation	99	Web-Based Processing for State-of-the-Art Large Aperture Multidimensional (SLAM) Array	\$500,000	45772
	00	Web-Based, Propagation and Noise Effects on Signal Processing (Phase 2)	\$670,000	47316
	01	Web-Based Simulation, Modeling and Signal Processing	\$399,868	48575
Scientific Solutions, Inc.	01	Implementation of an Ocean Acoustic Laboratory at Pacific Missile Range Facility (PMRF)	\$150,392	48389
Sea Engineering, Inc.	97	On Site, Preliminary Analysis of Sediment Core Samples (Phase 2)	\$102,650	42849
	97	Development of a 3-D, Forward/Aft Sweeping, High Resolution Buried Object Imaging System (Phase 1)	\$388,660	42913
	98	Development of an Ultra-High Resolution Stress Detection System for Marine Application	\$319,154	44632
	98	Dev of a 3-D, Forward/Aft Sweeping, High Resolution Buried Object Imaging System, Phase 2	\$421,200	44801
	99	Development of an Enhanced Resolution Filter for Improving Sonar Imagery	\$148,287	45514
SEE/Rescue Corporation	98	LIFE/FLOAT The One-Person Survival Craft	\$70,000	44373
	00	Compact-Inflatable-Mobile Survival Platform for Military/Special Forces and Commercial Applications (Phase 2)	\$120,000	47505
STI Services, Inc. (TerraSystems, Inc.)	01	vSAR: Video Search And Rescue	\$337,123	48214
	01	Reconnaissance of Mines and Obstacles in the Surf Zone (SZ)	\$34,999	48574
Synthetic Technology Corporation	97	Bioactive Marine Isonitrile Compounds from Hawaiian Sponges as Models	\$300,033	43313
TerraSystems, Inc.	98	Development of an Underwater Compositional Mapping (UCM) System	\$351,177	44002
	99	Enhanced Sea & Land Rescure Visibility Systems	\$253,839	45292

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Contractor	Year	Project	Amount	Contract No.
Trex Enterprises	00	Development of a Sensor for Pesticide Monitoring Based on a Porous Silicon Optical Biosensor	\$537,000	46764
	01	Porous Silicon Biosensor	\$499,826	48215
Varian Associates, Inc.	97	Laser Heterodyne Imaging for Littoral Water Surveillance (Phase 2)	\$395,435	43314