DEPARTMENT OF DEFENSE IN-HOUSE RDT&E ACTIVITIES

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FY1999
Management Analysis Report

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DoD Agency (USUHS - AFRRI)

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1. REPORT DATE *(DD-MM-YYYY)*
4 May 2000

2. REPORT TYPE
Final FY1999

3. DATES COVERED *(From - To)*
1 Oct 1998 - 30 Sep 1999

4. TITLE AND SUBTITLE
Department of Defense In-House RDT&E Activities
FY1999 Management Analysis Report

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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Andrew Darby (DTIC)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Office of the Director of Defense Research and Engineering
Director Science and Technology Plans and Programs
3040 Defense Pentagon
Washington, DC 20301-3040

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Director, Defense Research and Engineering
3040 Defense Pentagon
Washington, DC 20301-3040

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The DoD In-House RDT&E Activities Report and database project is the DDR&E's central source of information on laboratory status, and serves four essential purposes:

(1) since inception, it has been the only compilation of statistics organized by location on DoD RDT&E Activities;
(2) it provides the basis for prompt responses to many general queries about DoD RDT&E Activities, without recourse to special surveys, etc.;
(3) it provides a historical database which can be utilized for tracing consolidations and organizational changes, and for special analyses and trend studies; and
(4) it provides insight into the technical and organizational environment of the DoD Laboratories and the financial, manpower, and facility investments made in them.

15. SUBJECT TERMS
Department of Defense Research, Development, Test & Evaluation
Department of Defense Laboratories

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Andrew Darby
Unclassified	Unclassified	Unclassified		450	**19b. TELEPHONE NUMBER** *(include area code)* 703-767-9128

DEPARTMENT OF DEFENSE IN-HOUSE RDT&E ACTIVITIES REPORT

for
Fiscal Year 1999

Prepared for:

The Office of the Secretary of Defense
Director, Defense Research and Engineering
The Pentagon
Washington, DC 20301

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FOREWORD

Introduction

The DoD In-House Research, Development, Test & Evaluation (RDT&E) Activities Report was started in the mid-1960s by the Office of Laboratory Management within the Office of the Secretary of Defense, at the request of the then Director of Defense Research and Engineering (DDR&E), Dr. John Foster. The annual report has been produced in official form since 1966.

The DoD In-House RDT&E Activities Report and database project is the DDR&E's central source of information on laboratory status, and serves four essential purposes:

(1) since inception, it has been the only compilation of statistics organized by location on DoD RDT&E Activities;
(2) it provides the basis for prompt responses to many general queries about DoD RDT&E Activities, without recourse to special surveys, etc.;
(3) it provides a historical database which can be utilized for tracing consolidations and organizational changes, and for special analyses and trend studies; and
(4) it provides insight into the technical and organizational environment of the DoD Laboratories and the financial, manpower, and facility investments made in them.

The Director, Science and Technology Plans and Programs leads a Steering Group which is responsible for the preparation and oversight of the report and its underlying database. The Steering Group is composed of representatives from the offices of the Director of Defense Research and Engineering, Director, Operational Test & Evaluation, Deputy Assistant Secretary of the Army for Research and Technology, Chief of Naval Research, Deputy Assistant Secretary of the Air Force (Science, Technology and Engineering), and Director of the Armed Forces Radiobiology Research Institute of the Uniformed Services University of the Health Sciences (USUHS).

A DoD organizational entity is considered to be a "DoD RDT&E Activity" when it is owned and operated by the Government, and a minimum of 25% of its total effort is devoted to research, advanced technology development, engineering and manufacturing development, demonstration/validation, systems or operational support, or some combination thereof. Examples are a research laboratory; a research, development and engineering center (RDEC), a test center or proving ground, and a multi-functional entity such as a "warfare center." An "In-House" RDT&E Activity is an organization where a minimum of 25% of the in-house manpower and/or 25% of the obligational authority used is devoted to research, exploratory or advanced development, engineering development, etc., conducted in-house.

Structure of Report

Selected data for the In-House RDT&E Activities of the Army, Navy, Air Force and the USUHS are summarized in tables in the first section of the report. Following the tables are individual sections which cover the In-House RDT&E Activities of the three Military Services and USUHS. Each Activity is described in a standard multi-page format.

Activities are listed alphabetically within their respective military departments. A partial organization chart, entitled "Abbreviated Functional Chart - Technical Organizations", appears for each Activity to provide an overview of its technical operations.

Funding data are broken down into the standard RDT&E sub-categories:

6.1 - Basic Research
6.2 - Applied Research
6.3 - Advanced Technology Development
6.4 - Demonstration & Validation
6.5 - Engineering and Manufacturing Development
6.6 - RDT&E Management Support
6.7 - Operational Systems Development
Non-DoD

All zero-filled report data fields reflect a zero amount reported.

Personnel data for the FY1999 report has been extracted, where possible, from 30 September 1999 data provided to the Defense Manpower Data Center (DMDC), by the Services.

Organizational changes for FY1999 appear in Appendix A. Appendix B contains definitions of the data elements displayed in this report. Appendix C defines selected abbreviations and acronyms.

Every effort has been made to provide accurate information. Each submission was reviewed and approved by the head of the reporting Activity. All numbers and statements submitted by each Activity were then thoroughly examined by the members and staff of the Steering Group. Please note, though, that this report does not represent the total DoD RDT&E program. It is also not an accounting or financial management document, but rather a "snapshot" of the operation of the individual Activities contained in the report. All funding data reflect total obligational authority received in FY1999. The data in this report should not be summarized or used for detailed comparative analyses, because the Service labs/centers use a number of different business accounting systems to satisfy their special needs. See Appendix B for further explanations.

The report is used by numerous DoD organizations, as well as various committees of Congress, the Library of Congress and the General Accounting Office. The report provides easily accessible comprehensive and accurate information without frequent querying of field Activities.

In-House Report Web Site

This report can be found in the **DOCUMENTS** section on the DDR&E Laboratory Management Web Site at *www.dtic.mil/labman,* for on-line browsing or downloading as a Word document or an Adobe Acrobat PDF document.

Distribution

This publication should be given widespread distribution in the DoD Laboratories, both as an internal resources reference document at the Director and Commanding Officer level, and as a catalog of general activity at the bench level. It provides laboratory staff an opportunity to familiarize themselves with the functional capabilities of other DoD Laboratories, thereby encouraging scientists and engineers to communicate with their counterparts at other labs on problems of common interest.

In addition, this publication has proven helpful to those in the private sector interested in exploring the potential for technology cooperation/transfer with DoD Laboratories (for example, Cooperative Research and Development Agreements - CRADAs).

Hans Mark
Director, Defense Research and Engineering

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TABLE 1. ARMY RDT&E ACTIVITIES, PROGRAM AND PERSONNEL DATA, FY 1999

INSTALLATION	FUNDING DATA (MILLIONS $)				PERSONNEL DATA					
	TOTAL	TOTALS IN-HOUSE	TOTALS RDT&E	IN-HOUSE RDT&E	TOTAL MIL	TOTAL CIV	DOC MIL	DOC CIV	S&E MIL	S&E CIV
Aberdeen Test Center	118.467	59.436	63.421	28.346	9	813	0	5	1	231
Aeromedical Research Laboratory	8.284	7.463	5.703	4.982	45	43	8	7	15	8
Armament RDEC	485.681	269.578	309.512	131.561	30	2984	0	59	23	1582
Army Materiel Systems Analysis Activity	41.243	30.635	12.433	11.561	5	346	0	7	0	206
Army Research Institute	22.185	11.568	19.157	9.331	4	122	0	50	4	29
Army Research Institute of Environ. Medicine	18.324	15.11	13.301	10.434	73	93	21	22	22	39
Army Research Laboratory	621.547	221.086	516.603	174.921	47	2179	7	349	18	922
Aviation RDEC	148.581	43.054	114.484	27.511	10	455	0	23	0	282
Aviation Technical Test Center	11.845	11.845	10.02	10.02	21	86	0	2	0	28
CECOM RDEC	463.31	101.56	296.221	65.172	26	1595	1	63	12	1001
Dugway Proving Ground	72.541	35.023	35.025	13.233	8	438	0	18	2	61
Engineer Research and Development Center	583.37	315.675	521.663	305.971	22	2012	0	266	20	810
Institute of Surgical Research	17.949	17.949	10.193	10.193	152	51	13	4	24	19
Medical Research Institute of Chemical Defense	35.333	25.987	28.323	18.977	54	141	15	26	7	30
Medical Research Institute of Infectious Diseases	37.216	37.066	32.603	32.453	214	218	48	45	48	54
Missile RDEC	511.503	131.987	324.39	51.789	6	1515	0	36	0	1046
Operational Test and Evaluation Command	192.742	186.694	147.639	142.027	504	857	0	18	26	247
Redstone Technical Test Center	55.072	55.072	26.08	26.08	0	139	0	0	0	96
Soldier and Biological Chemical Command	277.025	119.7	142.321	52.976	65	2088	0	105	3	854
Tank Automotive RDEC	226.653	76.173	150.702	24.873	10	1050	0	28	4	616
Walter Reed Army Institute of Research	65.504	65.504	55.146	55.146	359	393	63	93	93	165
White Sands Missile Range	339.713	183.445	309.556	159.836	284	1810	3	12	0	514
Yuma Proving Ground	122.514	22.334	111.245	15.913	32	626	0	0	0	107

TABLE 2. ARMY RDT&E ACTIVITIES, FACILITY DATA, FY 1999

INSTALLATION	HEADQUARTERS LOCATION	SPACE AND PROPERTY						
			SPACE (THOUSANDS OF SQ FT)				COST (MILLIONS $)	
		ACRES	LAB	ADMIN	OTHER	TOTAL	REAL PROPERTY	EQUIPMENT
Aberdeen Test Center	Aberdeen Proving Grd, MD	56707	119.200	138.700	981.100	1239.000	580.700	224.256
Aeromedical Research Laboratory	Fort Rucker, AL	4	69.000	22.000	37.000	128.000	12.041	45.205
Armament RDEC	Picatinny Arsenal, NJ	6493	325.270	864.896	2675.910	3866.070	193.470	177.073
Army Materiel Systems Analysis Activity	Aberdeen Proving Grd, MD	4	0.000	104.700	17.100	121.800	3.600	4.111
Army Research Institute	Alexandria, VA	0	12.325	53.600	3.425	69.350	13.200	10.124
Army Research Institute of Environ. Medicine	Natick, MA	1	42.581	21.483	43.732	107.796	9.168	31.443
Army Research Laboratory	Adelphi, MD	5645	1402.000	880.000	760.000	3042.000	697.000	581.906
Aviation RDEC	Redstone Arsenal, AL	5	91.644	90.154	47.626	229.424	6.652	28.795
Aviation Technical Test Center	Fort Rucker, AL	11005	0.000	89.633	125.004	214.637	3.600	106.373
CECOM RDEC	Ft. Monmouth, NJ	1077	532.324	233.016	99.000	864.340	80.000	296.000
Dugway Proving Ground	Dugway, UT	799	214.049	134.073	1906.580	2254.700	183.083	87.000
Engineer Research and Development Center	Vicksburg, MS	661	2646.230	438.120	332.730	3417.080	542.800	605.247
Institute of Surgical Research	Fort Sam Houston, TX	1	73.850	11.000	50.300	135.150	17.191	17.357
Medical Research Institute of Chemical Defense	Aberdeen Proving Grd, MD	30	37.419	38.433	125.024	200.876	23.400	29.500
Medical Research Institute of Infectious Diseases	Ft. Detrick, MD	150	121.000	78.925	148.000	347.925	24.892	43.797
Missile RDEC	Redstone Arsenal, AL	4000	961.572	230.472	143.587	1335.630	231.205	352.415
Operational Test and Evaluation Command	Alexandria, VA	23	0.000	498.000	214.000	712.000	38.100	1.500
Redstone Technical Test Center	Redstone Arsenal, AL	14000	580.000	62.000	168.000	810.000	320.000	0.000
Soldier and Biological Chemical Command	Aberdeen Proving Grd, MD	58	1221.750	375.836	485.246	2082.830	189.041	137.766
Tank Automotive RDEC	Warren, MI	95	513.949	174.870	22.202	711.021	137.050	259.738
Walter Reed Army Institute of Research	Washington, DC	0	894.262	55.400	0.895	950.557	12.882	41.800
White Sands Missile Range	White Sands, NM	2281659	1603.010	951.957	2813.130	5368.100	479.201	498.383
Yuma Proving Ground	Yuma, AZ	1008904	22.030	126.671	2068.710	2217.410	176.439	192.981

TABLE 3. NAVY RDT&E ACTIVITIES, PROGRAM AND PERSONNEL DATA, FY 1999										
	FUNDING DATA (MILLIONS $)				PERSONNEL DATA					
INSTALLATION	TOTAL	TOTALS IN-HOUSE	TOTALS RDT&E	IN-HOUSE RDT&E	TOTAL MIL	TOTAL CIV	DOC MIL	DOC CIV	S&E MIL	S&E CIV
Naval Air Warfare Center*	2913.732	1736.316	1069.510	680.852	1905	9163	4	207	163	3845
Naval Facilities Engineering Services Center	156.542	69.275	39.566	16.147	9	528	0	19	0	310
Naval Health Research Center	36.558	18.061	26.777	12.655	73	112	31	21	5	34
Naval Medical Research Center	45.925	32.353	25.647	20.795	200	380	59	36	21	86
Naval Research Laboratory	758.392	379.527	655.245	337.139	175	2785	0	810	0	814
Naval Surface Warfare Center*	2382.706	1309.778	918.809	535.511	279	10077	2	365	30	5206
Naval Undersea Warfare Center*	651.131	388.713	245.531	177.799	53	2840	0	122	0	1763
Navy Clothing and Textile Research Facility	4.954	3.809	2.144	1.637	0	31	0	1	0	21
Navy Personnel Research and Development Ctr	17.013	9.321	7.087	4.037	8	69	0	12	0	25
Space & Naval Warfare Systems Ctr, San Diego*	1233.407	437.100	572.156	167.046	78	3462	0	185	0	1645

**Note: The four Naval warfare centers provide full spectrum research, development, test and evaluation, engineering, and fleet support services and perform a substantial amount of non-RDT&E work. Prior to FY1998, the Navy reported each warfare center in its entirety, even though a considerable amount of the reported end strengths, funding, and other resources were devoted to other than RDT&E programs. For purposes of more accurately reflecting RDT&E In-House resources in this report, the Navy has applied the established RDT&E In-House criteria (i.e., a minimum of 25% of total funds is RDT&E and a minimum of 25% of in-house effort is devoted to RDT&E) at the division or major site level rather than reporting all warfare center sites, regardless of their level of RDT&E work. As a result, some warfare center entities have been eliminated from this report because they are below the 25% RDT&E threshold for inclusion in this report.*

TABLE 4. NAVY RDT&E ACTIVITIES, FACILITY DATA, FY 1999								
		SPACE AND PROPERTY						
			SPACE (THOUSANDS OF SQUARE FEET)				COST (MILLIONS $)	
INSTALLATION	HEADQUARTERS LOCATION	ACRES	LAB	ADMIN	OTHER	TOTAL	REAL PROPERTY	EQUIPMENT
Naval Air Warfare Center*	Patuxent River, MD	1140073	7097.398	1079.069	6890.514	15066.981	1401.238	663.104
Naval Facilities Engineering Services Center	Port Hueneme, CA	10	68.000	84.000	35.000	187.000	30.000	8.700
Naval Health Research Center	San Diego, CA	0	208.869	47.840	11.420	268.129	20.735	10.935
Naval Medical Research Center	Silver Spring, MD	8	306.209	106.005	85.639	497.853	25.897	12.645
Naval Research Laboratory	Washington, DC	532	3261.262	219.056	319.260	3799.578	195.338	491.178
Naval Surface Warfare Center*	Arlington, VA	8795	5819.758	1493.493	5903.892	13217.143	864.250	550.190
Naval Undersea Warfare Center*	Newport, RI	891	1642.000	297.000	565.000	2504.000	205.500	493.300
Navy Clothing and Textile Research Facility	Natick, MA	0	12.667	16.000	0.000	28.667	4.300	2.805
Navy Personnel Research and Development Ctr	San Diego, CA	3	34.500	16.400	4.500	55.400	1.000	4.676
Space & Naval Warfare Systems Ctr, San Diego*	San Diego, CA	553	1045.000	848.000	1210.000	3103.000	130.703	179.076

**Note: The four Naval warfare centers provide full spectrum research, development, test and evaluation, engineering, and fleet support services and perform a substantial amount of non-RDT&E work. Prior to FY1998, the Navy reported each warfare center in its entirety, even though a considerable amount of the reported end strengths, funding, and other resources were devoted to other than RDT&E programs. For purposes of more accurately reflecting RDT&E In-House resources in this report, the Navy has applied the established RDT&E In-House criteria (i.e., a minimum of 25% of total funds is RDT&E and a minimum of 25% of in-house effort is devoted to RDT&E) at the division or major site level rather than reporting all warfare center sites, regardless of their level of RDT&E work. As a result, some warfare center entities have been eliminated from this report because they are below the 25% RDT&E threshold for inclusion in this report.*

TABLE 5. AIR FORCE RDT&E ACTIVITIES, PROGRAM AND PERSONNEL DATA, FY 1999

INSTALLATION	FUNDING DATA (MILLIONS $)				PERSONNEL DATA					
	TOTAL	TOTALS IN-HOUSE	TOTALS RDT&E	IN-HOUSE RDT&E	TOTAL MIL	TOTAL CIV	DOC MIL	DOC CIV	S&E MIL	S&E CIV
Air Armament Center	678.246	349.146	466.541	238.221	4166	2856	0	14	90	644
Arnold Engineering Development Center	310.006	279.946	263.219	242.695	107	202	0	3	12	71
Flight Test Center	721.871	581.618	438.983	332.506	3650	2962	5	5	119	559
HQ Air Force Research Laboratory	28.231	0.000	28.231	0.000	73	155	2	6	19	46
AF Office of Scientific Research	333.495	0.000	213.395	0.000	27	99	12	35	7	7
Air Vehicles Directorate	118.956	62.367	93.877	37.288	37	347	3	48	29	206
Directed Energy Directorate	186.991	19.649	98.977	9.901	203	419	28	92	64	103
Human Effectiveness Directorate	161.223	35.130	132.016	35.080	232	343	19	83	69	100
Information Directorate	553.440	53.864	444.927	42.991	92	711	5	31	41	321
Materials & Manufacturing Directorate	248.027	47.583	187.292	33.294	54	458	5	92	34	243
Munitions Directorate	74.566	18.570	74.566	18.570	61	260	6	34	35	146
Propulsion Directorate	274.250	55.608	273.508	55.608	80	486	10	81	30	230
Sensors Directorate	326.364	15.142	326.364	15.142	69	567	17	74	41	356
Space Vehicles Directorate	260.489	19.312	189.015	19.312	139	460	9	92	80	134

TABLE 6. AIR FORCE RDT&E ACTIVITIES, FACILITY DATA, FY 1999

INSTALLATION	HEADQUARTERS LOCATION	SPACE AND PROPERTY						
		SPACE (THOUSANDS OF SQUARE FEET)					COST (MILLIONS $)	
		ACRES	LAB	ADMIN	OTHER	TOTAL	REAL PROPERTY	EQUIPMENT
Air Armament Center	Eglin AFB, FL	463546	2267.770	1048.589	9191.576	12507.935	947.390	839.343
Arnold Engineering Development Center	Arnold AFB, TN	39081	230.549	505.851	2097.570	2833.970	1403.502	243.244
Flight Test Center	Edwards AFB, CA	297732	332.522	261.645	8953.882	9548.049	910.727	273.673
HQ Air Force Research Laboratory	WPAFB, OH	1	0.000	49.000	0.000	49.000	1.914	1.402
AF Office of Scientific Research	Arlington, VA	0	0.000	25.250	0.000	25.250	0.000	0.000
Air Vehicles Directorate	WPAFB, OH	44	438.050	139.716	115.961	693.727	210.000	1001.000
Directed Energy Directorate	Kirtland AFB, NM	4325	373.000	86.000	154.000	613.000	84.828	39.600
Human Effectiveness Directorate	WPAFB, OH	125	307.241	195.587	136.268	639.096	499.922	45.403
Information Directorate	Rome, NY	84	1065.400	89.200	220.300	1374.900	54.500	83.500
Materials & Manufacturing Directorate	WPAFB, OH	135	294.500	189.300	83.400	567.200	103.800	43.800
Munitions Directorate	Eglin AFB, FL	1159	207.484	19.628	42.888	270.000	23.700	34.780
Propulsion Directorate	WPAFB, OH	41642	1413.000	16.000	130.000	1559.000	151.000	2.500
Sensors Directorate	WPAFB, OH	100	292.790	127.276	64.650	484.716	182.164	43.500
Space Vehicles Directorate	Kirtland AFB, NM	5787	237.000	67.000	450.000	754.000	153.000	364.000

TABLE 7. USUHS RDT&E ACTIVITIES, PROGRAM AND PERSONNEL DATA, FY 1999										
	FUNDING DATA (MILLIONS $)				PERSONNEL DATA					
INSTALLATION	TOTAL	TOTALS IN-HOUSE	TOTALS RDT&E	IN-HOUSE RDT&E	TOTAL MIL	TOTAL CIV	DOC MIL	DOC CIV	S&E MIL	S&E CIV
Armed Forces Radiobiology Research Institute	12.452	12.452	11.228	11.228	48	81	0	17	0	35

TABLE 8. USUHS RDT&E ACTIVITIES, FACILITY DATA, FY 1999								
		SPACE AND PROPERTY						
			SPACE (THOUSANDS OF SQUARE FEET)				COST (MILLIONS $)	
INSTALLATION	HEADQUARTERS LOCATION	ACRES	LAB	ADMIN	OTHER	TOTAL	REAL PROPERTY	EQUIPMENT
Armed Forces Radiobiology Rsrch Inst.	Bethesda, MD	10	61.750	34.257	23.908	119.915	18.610	11.921

DEPARTMENT OF THE ARMY

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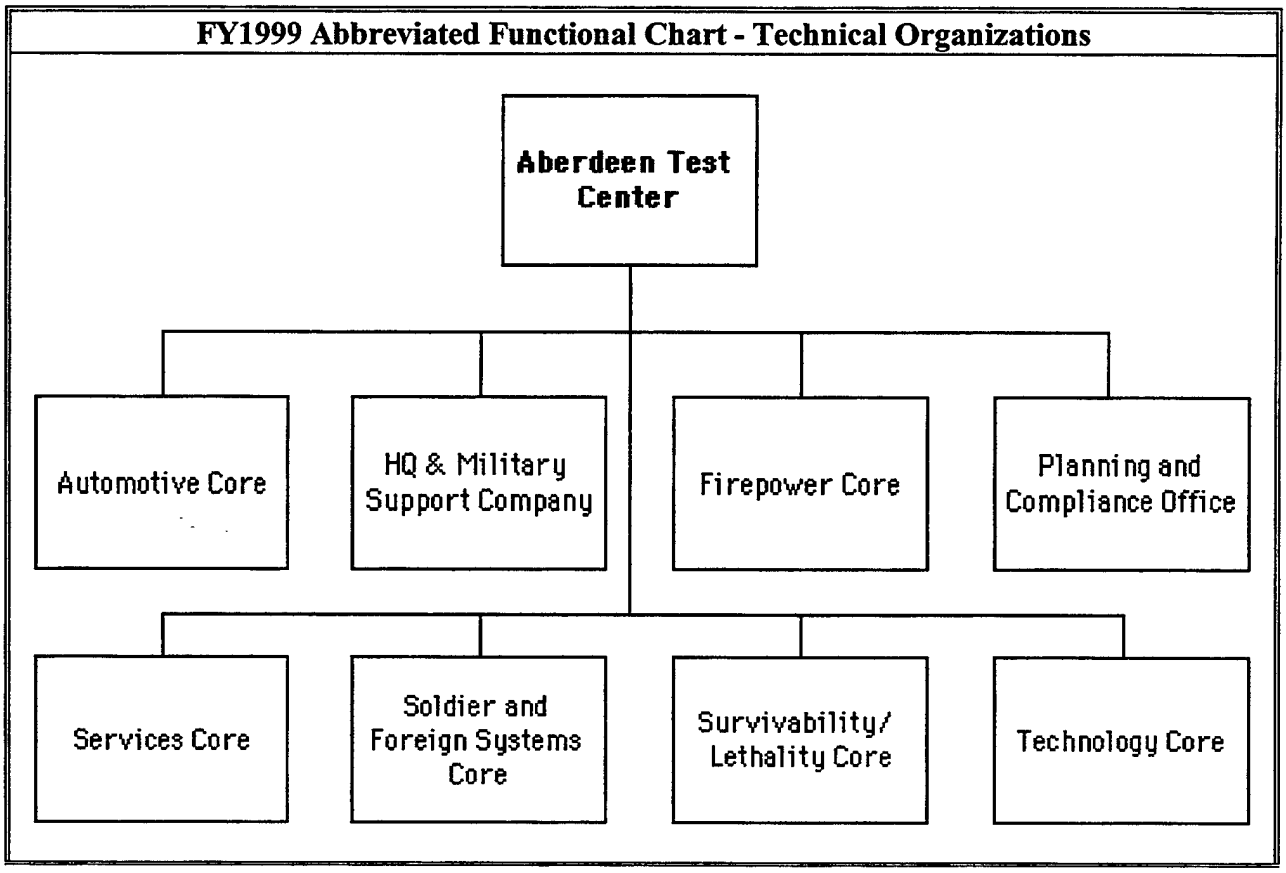
DEPARTMENT OF THE ARMY

The Army's twenty-three (23) In-House RDT&E Activities are:

Aberdeen Test Center 2-2
Aeromedical Research Laboratory 2-10
Armament Research, Development and Engineering Center 2-14
Army Materiel Systems Analysis Activity 2-24
Army Research Institute for the Behavioral & Social Sciences 2-30
Army Research Institute of Environmental Medicine 2-34
Army Research Laboratory 2-40
Aviation Research, Development and Engineering Center 2-52
Aviation Technical Test Center 2-58
CECOM Research, Development and Engineering Center 2-62
Dugway Proving Ground 2-72
Engineer Research and Development Center 2-80
Institute of Surgical Research 2-90
Medical Research Institute of Chemical Defense 2-94
Medical Research Institute of Infectious Diseases 2-100
Missile Research, Development and Engineering Center 2-104
Operational Test and Evaluation Command 2-120
Redstone Technical Test Center 2-124
Soldier and Biological Chemical Command 2-128
Tank Automotive Research, Development and Engineering Center 2-142
Walter Reed Army Institute of Research 2-156
White Sands Missile Range 2-160
Yuma Proving Ground 2-164

Aberdeen Test Center



Aberdeen Test Center
Aberdeen Proving Ground, MD 21005-5059
(410)278-3574

Commander: Andrew G. Ellis, COL, FA
Technical Director: James W. Fasig

MISSION

Aberdeen Test Center (ATC) is the most diverse test facility within DoD, testing a broad spectrum of military weapons systems and equipment including armored vehicles, guns, ammunition, trucks, bridges, generators, night vision devices, individual equipment (boots, uniforms, helmets, etc.), and surface and underwater marine systems. As a multi-purpose proving ground, with a temperate climate, our primary mission is to plan, conduct, analyze and report on projects supporting research, development, test and evaluation (RDTE), design, engineering, production, surveillance and operational tests for DoD and other government agencies, contractors, foreign government, and private industry. In this single location, ATC can subject an item to a full range of tests from automotive endurance and full weapons performance with environmental extremes, to full-scale live fire vulnerability/survivability/lethality testing utilizing an extensive array of test ranges/facilities, simulators and models. In addition to testing domestic systems, we exploit foreign systems to assess the enemy threat. We also develop state-of-the-art test procedures (DoD, International), methodologies and instrumentation in order to meet the test requirements of advancing military technologies. ATC is partnered with CINCLANTFLT forming the Chesapeake Regional Range Complex which provides air, land and sea test and training support to the joint warfighter.

CURRENT IMPORTANT PROGRAMS

Bradley Fighting Vehicle System (BFVS) M2A3/M3A3L
M1A2 System Enhancement Program (SEP)Temperate
Family of Medium Tactical Vehicles A1 (FMTVA1)
Heavy Dry Support Bridge (HDSB)Production Prove-O
Tactical Quiet Generator Set (TQG), 30 & 60 KW,RE
Bradley Fighting Vehicle System (BFVS),M2A3 & M3A
FY98 A/B-1 Shock Qualification Test Series
Tactical Quiet Generator Set (TQG), 3KW, Re-Buy
FY96/FY97 Machine Shop Support(Fog Oil Tank)

Technology Transfer Efforts:

AV Technologies/ATC - Under a cooperative agreement ATC and AV successfully completed the first phase supporting the test and training initiative for the PANDUR commercialization program. This is the first combined test and training initiative between the private sector and this DoD facility.

Drexel University/Patuxent River Naval Air Warfare Center/ATC - A project proposal was developed to create a large scale model of the U.S. Electric Power Grid. This project will link a computer – hardware - based and digital control system with an interchangeable set of standard power system components to produce a very flexible model at a fraction of the cost of current models. Furthermore, the proposed model will provide analytical data 12 times faster than current models. Federal agencies concerned with power and vulnerabilities will be able to get good information without relying on vested interests of the power industry. A training tool of unparalleled importance will be available to the nation.

CURRENT IMPORTANT PROGRAMS

The Mid-Atlantic Technology Application Center, Army Research Laboratory and ATC have been working with the civilian firefighting community in several critical areas. Technology transfer has already begun in helmet mounted, hands free microphones to provide clear communications on the fire ground. Technology transfer also began on providing firefighters the means to see through smoke. Work is being pursued to provide precise location of fire fighters in a building. A project proposal was developed concerning design and testing of a new concept in fire trucks for the next century. It appears that a smaller, lighter, but still well equipped fire engine is required to meet changing priorities of first responders. Fire trucks cannot now traverse failing bridges or fit into tight urban streets. New demands exist to respond to acts of terrorism while protecting the crew from a variety of hazards. The concept of designing a new, multipurpose engine has been accepted by the National Fire fighting Task Force at a symposium hosted by ATC in FY99. Work in FY00 will include discussion with the Fire Apparatus Manufacturer's Association and similar bodies to gain input. Congressional funding of a design and test effort will be solicited. It is envisioned that several universities will undertake the design effort with initial testing to be done at ATC's Virtual Proving Ground. Should these tests work well, prototype vehicles could be built and tested on ATC Ranges.

EQUIPMENT/FACILITIES

WORLD-RENOWNED FACILITY

Munson Test Area: Automotive field test area consisting of 9 miles of roadways/test courses encompassing 150 acres; paved - 2200'; sand course - 500'; Belgian Block course-3900';wave course - 440';vertical walls 18" to 42" H; slide slope, 20% to 40%, 100' to 700'; simulated loading ramp-40', 20 degrees; improved gravel road 10,700'; abrasive mud course - 950'L X 240'W; 2 and 6 inch washboards - 800'; 2 to 4-inch radial washboard - 240'; 3-inch spaced bump course - 760'; longitudinal slopes, 5% to 60%, 80' to 480'; shallow and deep fording basings - 270'L x 6'D, 315' L x 20'D; amphibious vehicle swim area (Spesutie Narrows/Chesapeake Bay).

Perryman Test Area: Level cross-country, secondary, and paved road vehicle endurance and reliability test area; six primary test courses cover about 2,000 acres; 3-mile straight and level paved road with turnarounds; two secondary roads, 2.4 miles and 3.2 miles; four cross-country courses of varying severity, 1.8 miles to 5.2 miles; off-road courses vary from moderate gravel surfaces to extremely rough terrain including marshy areas; supports other vehicle tests, i.e., braking, stability, road vibration, steering, etc.

Churchville Test Area: Hilly cross-country tracked and wheeled vehicle endurance and reliability test area; 250 acres with 11 miles of interconnecting roads and test courses; 7% to 29% grades; 3-mile and 4-mile winding closed loop courses; mud, dust, and gravel surfaces; temperate climate; 4-bay maintenance shop; complete coverage with telemetry/on-board instrumentation; slopes are prepared by tilling and water supply is available for wetting.

Dynamometer Course: Bituminous concrete straight roadway, 1 mile long, 17 feet wide, with oval turnarounds at both ends used for field dynamometer test course; level within 0.1%; supports vehicle performance tests such as drawbar pull, tractive resistance, acceleration and braking and fuel consumption; mobile dynamometers provide load absorption capability up to 100,000 pounds.

EQUIPMENT/FACILITIES

Mile Loop: Continuous concrete surface test course consisting of level, parallel 1/4-mile segments connected by 1/4 mile banked semicircular sections at each end; 1-mile long oval paved course; a butting exterior oval gravel course; special-purpose vehicle test courses located within the loop-pothole course, 1-inch bump course, 6-inch cross-tie course; winch test area with 1,000,000-pond capacity anchor (deadman).

Lift and Tie Down Facility: Proof-load testing capability which satisfies the required provisions of MIL-STD-209H and MIL-STD-913; capable of applying lift loads up to 500,000 pounds and tie-down loads up to 200,000 pounds; includes real-time video and acquisition instrumentation; accommodates test items up to 20'wide.

Automotive Tilt Table: Facility for tilting vehicles to determine static roll and/or pitch stability; solid flat platform measuring 100' long by 14' wide; width expands to 25' at midsection; lift capacity- 700 tons (uniform loading); maximum tilt angle of 40 degrees (84%)(greater angles possible with alternative configuration).

Automotive Test Facility Instrumentation: Supports technical and engineering tests addressing performance and reliability, availability, maintainability, (RAM) issues for: automotive, fire control, road shock and vibration, transportability and environmental; resources to plan and conduct testing, and collect, analyze, and report test data - approximately 100 personnel, approximately $50M of instrumentation and over 30,000 square feet of laboratory and shop space; initial staging point for test preparations, instrumentation installation, and verification and centralized data collection/reduction.

Land Vehicle Maintenance Facility: 45,000 square feet of interior bay space includes 13 maintenance bays; electric battery shop; engine test cell; closed loop steam cleaning facility; maintenance/diagnostic analysis to direct support/general support level for prototype, standard/production, and foreign systems; rebuild capability for electrical components/systems, hull/chassis assemblies, and power train components; 90,000-pound lift system.

Foreign Systems Test Facilities: Provides a critical mission capability for the technical exploitation of Threat Combat Systems; test and maintenance facility encompasses several buildings utilized for a wide variety of test sponsor requirements; key features are approximately 10 acres of inside and outside storage for vehicles and major assemblies; 14 combat vehicle indoor maintenance and storage bays with secure capability for classified hardware; proximity to tank access roads leading to the Perryman Test Area, Tank Gunnery Ranges, the National Ground Intelligence Center/203rd Military Intelligence Complex, and the Phillips Army Airfield Cargo Loading Ramp.

Moving Target Simulator (MTS): Air-supported 100' radius hemisphere provides a 'laboratory' environment for assessing weapon control systems and determining hit probability; controlled, repeatable stationary vehicle/moving target test scenarios; computer-generated stationary, moving, and evasive ground and aerial targets using a laser beam steering system; thermal target capability; instrumentation acquires data such as video scoring, weapon and thru-sight video, data bus activity, weapon system/component performance, target position, etc.

Evasive Target Firing Range (Tank Warfare I): Direct fire range for assessing tank fire control systems under stationary and moving test item/target scenarios; computer-controlled evasive laser beam ground target projected on a replaceable, reflective surface; thermal target capability; target ranges to 3000 meters; limited capability for gunnery and crew training exercises; gravel, bump, zigzag and natural earth terrain test courses; instrumentation acquires data such as target scoring, projectile velocity,

EQUIPMENT/FACILITIES

meteorological, thru-sight and weapon video, data bus activity, and test system performance; training devices are available for system capability testing; on-site maintenance facility.

Multiple Target Firing Range (Tank Warfare II): Highly instrumented stationary vehicle/stationary target direct firing range designed to determine interactions of fire control system, weapon, ammunition, and weapon mount; two lines-of-fire to accommodate depleted uranium and 'live' high-explosive projectiles; multiple targets to 3000 meters; velocity profile via Doppler radar; real-time measurement of jump, projectile miss distance, boresight retention, trajectory mismatch, aim error, weapon system implementation error, and hit probability; instrumentation system includes weapon and thru-sight video, target scoring, projectile velocity, data bus acquisition, weapon system/component measurements, and meteorological data.

Turret Maintenance Facility (Tank Warfare): On-site tank/turret maintenance areas include 80'x60',60'x60', and 50'x 50' shops and 40'x 100' office space; outdoor roof secure storage area, 120' x 80'; classroom and hands on training facilities; direct support maintenance and electronic troubleshooting; extensive technical manual library; conference facilities for planning and coordination; command/control and training support equipment for system tests; software test and analysis; armament accuracy check sight synchronization/boresighting range.

Tank Armament Test Range (H-Field): Direct fire multirange test area for evaluation of tank armaments systems under moving and stationary tank and target scenarios; gunnery and crew training exercises; moving target and pop-up targets; four target ranges to 3000 meters; 5000-meter range for long-range firing; various terrain courses-gravel, bump, zigzag, and natural earth; water range for amphibious activities; instrumentation acquires various data-video based target scoring and location, projectile velocity, meteorological, weapon and thru-sight video, test system performance, data bus; 4-bay maintenance facility with secure area.

Multiple Small Arms Firing Ranges and Facilities: Multiple ranges designed and equipped to handle all phases of small arms and light automatic cannon testing. Instrumented ranges also available to conduct precision accuracy firings and general small arms tests. Facilities also available to permit total containment of small arms firing.

Accelerated Corrosion Complex: Provides aggressive controlled exposure of corrosive conditions to land systems to hasten their weathering process and determine susceptibility to the environments; incorporated into durability test cycle comprised of selected test courses; includes a series of individual corrosive environments-- Mist booth -60'L x 15'W x 15'H up to 3-minute mist applied to top and vertical surfaces; Splash trough-75'L x 20'W, solution depth up to 2 inches subjected to undercarriage; Grit trough 75'L x 14'W, slurry depth up to 8 inches subjected to undercarriage; Humidity booth-40'L x 15'W x15'H, up to 160 degrees F, 1 to 2 ml/hr condensate; facilities and equipment provide identification, analysis, and documentation of corrosion.

Fire Safety Test Enclosure (FIREBOX): Designed for full scale fire suppression testing and environmental technology studies; environmentally sound enclosure-internal dome design will completely contain and recover all test fluids and gaseous effluents produced during testing; 84' in diameter and 62' high pressure vessel covers a 4 inch thick x 54' deep x 57' high fragmentation shield; accommodates full-up vehicles; static or dynamic detonations; able to contain a 75'-pound TNT equivalent detonation; full scale-Automatic Fire Extinguishing System (AFES), vulnerability and insensitive munitions testing; asset protection system embedded into fragmentation shield and stand pipes on floor.

EQUIPMENT/FACILITIES

Underwater Explosions (UNDEX) Test Facility: Capability of testing UNDEX shock to MIP-SPEC-901, torpedoes, warheads, missiles, amphibious vehicles, ROVS, underwater gun firings, and acoustics; available for joint test and training exercises, submarine systems and subsystems air blasts, air-to-water/air-to-ground/ground-to-ground gun firings; elliptical shape of 1070' long by 920' wide, with a depth of 150'; flat-surfaced bottom diameter of 300'; slide slopes of 2.0:1 to 2.5:1; pond perimeter lined with stone to prevent erosion from wave action; maximum charge weight 4100 pounds TNT equivalent; marine rail launch and recovery system (700' long, up to 220-ton load) capstan/bollard system around pond perimeter; concrete working platform with electrical service and welding pits; barge wet slip for delivery of test items directly from Chesapeake Bay; hydraulic bogie and gripper jack system for transporting large test models from the barge to the launch cradle; 250-ton cranes, barges, 200-ton heavy transport trailer, support boats, man lift; extensive dive services.

Other Facilities/Capabilities:

Automatic Weapons Elevation-Depression
Recoiless Rifle Ranges
Direct-Fire Ranges B-1/B-2/B-3
High Velocity and Barricade C Ranges
Ammunition Assembly Plant
High Explosives Plant
Rough Handling Testing
Vibration
Inspection and Evaluation
Experimental and Acceptance Weapons
Industrial X-Ray
Metrology
All-Caliber Soft Recovery and Vertical Firing Positions
Ballistics Range
Multi-Purpose Indirect-Fire Range
Indirect-Fire Proof and Recovery Ranges
Romney Creek 8000-Meter Mortar Range
Tracking Radar
Developmental Firing Range at Wallops Island
Multi-Caliber Fragmentation Facility (Poverty Island)
Land Mine Test Facility
Firing Impulse Simulator (FIS)
Climatic Simulation Facilities/Capabilities
Electromagnetic Interference Test Facility (EMITF)
Environmental Chambers
Bridge Test Sites
C41.1/Shelter Maintenance and Operation Facility
Clothing and Individual Equipment Test Areas
Footwear Durability Course
Tentage Facility (Mile Loop)
Material-Handling Equipment Test Site
Generator Test Facility
Mobile Generator Test System
Human Factors and Air Flow Test Facility

EQUIPMENT/FACILITIES
Human Factors Engineering (HFE) Mobile Data Acq. System
Joint Warfighter Range Complex
Analytical Chemistry Laboratory
Health Physics Team and Radiochemistry Laboratory
Materials and Evaluation Testing (Chemistry)
Toxic Fumes and Field Testing (Chemistry)
Materials Laboratory
Materials Testing School
Multimedia Production
Rail Transport Facility
Phillips Army Airfield
External Air Transport
Internal Air Transport
Army Pulse Radiation Facility
Aircraft Vulnerability Airbase Ranges 3 and 4
Armor/Antiarmor R&D Range (C-Field)
Internal Blast Test Site (Briar Point Range-Position 3)
Ballistic Test Site Terminal
Intermediate Fire Laboratory (IFL)
Depleted Uranium (DU) Containment Facility (SUPERBOX)
Depleted Uranium Disassembly Facility
Live Fire Toxic Fumes Test Facility
Vehicle Vulnerability/Survivability Test Range (AA-5)
Spesutie Island Vulnerability Ranges
Indoor Armor Test Ranges
Outdoor Armor Test Ranges (Six Ranges)
Supersonic Ballistic Test Rail (L-Field)
Signature Measurement Test Facility
Experimental Fabrication Facility
Surface Ship Systems Survivability (S4) Test Site
UNDEX Pond at Briar Point Test Range

Aberdeen Test Center
Aberdeen Proving Ground, MD 21005-5059
(410)278-3574

Commander: Andrew G. Ellis, COL, FA
Technical Director: James W. Fasig

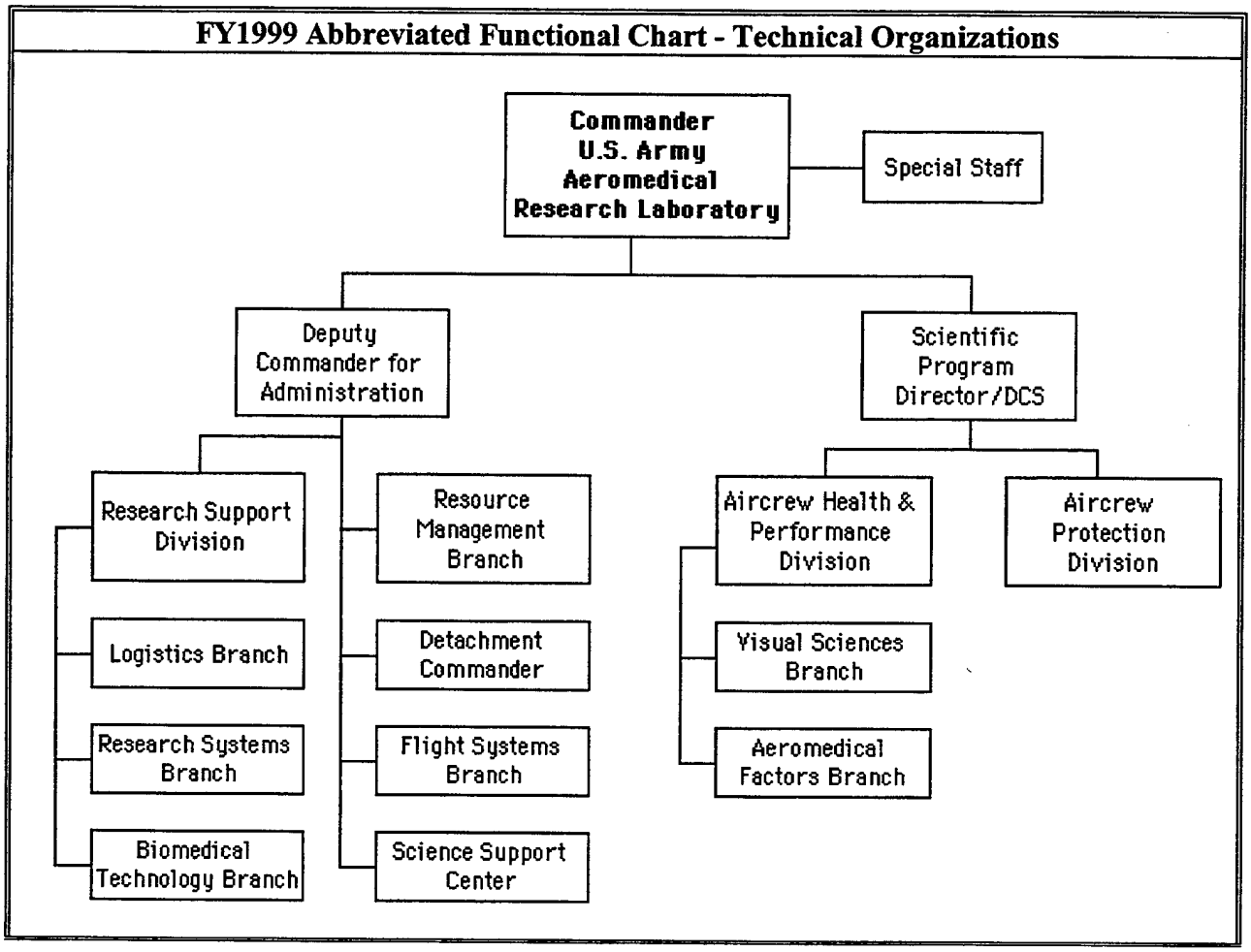
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.152	0.002	0.116	0.270
6.2	1.824	0.019	2.442	4.285
6.3	0.323	0.003	0.433	0.759
Subtotal (S&T)	**2.299**	**0.024**	**2.991**	**5.314**
6.4	0.498	0.011	1.96	2.469
6.5	3.990	0.039	5.348	9.377
6.6	19.573	0.211	22.243	42.027
6.7	0.155	0.001	0.000	0.156
Non-DOD	1.831	0.039	2.208	4.078
TOTAL RDT&E	**28.346**	**0.325**	**34.75**	**63.421**
Procurement	12.110	N/A	10.327	22.437
Operations & Maintenance	6.632	N/A	4.164	10.796
Other	12.348	N/A	9.465	21.813
TOTAL FUNDING	**59.436**	**0.325**	**58.706**	**118.467**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	1	8	**9**
CIVILIAN	5	231	577	**813**
TOTAL	**5**	**232**	**585**	**822**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	119.200	**REAL PROPERTY**	580.700
ADMIN	138.700	* NEW CAPITAL EQUIPMENT	3.523
OTHER	981.100	**EQUIPMENT**	224.256
TOTAL	**1239.000**	* NEW SCIENTIFIC & ENG. EQUIP.	2.443
ACRES	**56707**	* Subset of previous category.	

Aeromedical Research Laboratory



Aeromedical Research Laboratory
Fort Rucker, AL 36362-0577
(334) 255-6917

Commander: COL John A. Powell
Sci Pro Director/DCS: Dr. Kent A. Kimball

MISSION

Conducts research and development on health hazards of Army aviation, tactical combat vehicles, selected weapons' systems, and airborne operations. Assesses the health hazards from noise, acceleration, impact, and visual demands of these systems and defines measures to offset hazards. Assesses stress and fatigue in personnel operating aviation systems and develops countermeasures. Assists in the development of criteria upon which to base standards for entry and retention in Army aviation specialties. Assists other U.S. Army Medical Research and Materiel Command laboratories and institutes in research on the bioeffects of laser systems, medical defense against chemical agents, impact of continuous operations on individual and crew performance, development of improved means of patient evacuation and in the test and evaluation of medical equipment used in aeromedical evacuation. Assesses current life support equipment to identify causes of failure, and devises improved design criteria. Assists the combat developers and materiel developers of new Army aviation and tactical combat vehicles systems to recognize and eliminate health hazards as early as possible in the developmental cycle. Conducts collaborative research with Department of Defense and other federal agencies on medical research and development issues of common concern.

CURRENT IMPORTANT PROGRAMS

Helmet Protective Capability/Tolerance to Head Supported Mass

Spatial Disorientation in the Rotary-Wing Environment and Countermeasures

Injury Prevention and Restraint Technologies for Ground and Air Vehicles

Optimization of Visual Performance with Optical and Electro-optical Systems

Aviator Performance Effects of Sustained Operations, Sleep Cycle Disruption and Coping Mechanisms

Airworthiness Certification Evaluations of Medical Devices for Use Aboard Army Rotary-Wing Aircraft during Medical Evacuations

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRDA's)

BCI International for collaborative research, development, test and evaluation on MEDEVAC Equipment

Bethel College for collaborative research, development, test, and evaluation on aeromedical equipment

H. Koch & Sons for collaborative research on advanced aircrew restraint systems

Honeywell for collaboration in visual testing of image intensifier components and systems

ITT Defense for collaborative research in visual testing of image intensifier components and systems

CURRENT IMPORTANT PROGRAMS

University of South Carolina Medical Department of Ophthalmology for research and development on visual performance issues in aviation

PhysioControl Corporation for research, development, test, and evaluation of the LifePak 10

Purdue University for collaborative research in hierarchically ordered information in intelligent multifunction displays

Rush Support Medical for development of advanced helmet technologies

Simula Technologies, Inc. for research in advanced aircrew protection systems

SpaceLabs Medical Corporation for collaborative research, development, test, and evaluation on aeromedical equipment

EQUIPMENT/FACILITIES

Multi-Axis Ride Simulation System. Helmet Drop Test Tower and Impact Facility. Variable Center of Gravity Helmet Device. Head and Neck Inertial Loading Sled. Mass Properties (Center of Mass Location & Mass Moments of Inertia) Measurement System. Biochemistry Lab. UH-60 Visual Flight Simulator for Aeromedical Research. Helicopter Inflight Monitoring System. Modified Aircraft for Inflight Medical Research (JUH-1 Huey; JUH-60 Blackhawk). Data Acquisition and Telemetry Systems for use in either JUH-1 or JUH-60. Sleep Study Center. Spatial Disorientation Laboratory. Crew Coordination Analysis Center. High Intensity Impulse Noise Generator (Shock Tube). Mobile Acoustics Lab. Anechoic and Reverberation Chambers. Scanning Laser Ophthalmoscope. Ophthalmic Telemedicine System. Corneal Physiology and Topography Center. Optical Testing Lab. Optical Fabrication Facility. Electro-Optical Testing Lab. Visual Displays Analysis Center. Scientific and Medical Research Information Center. MEDEVAC Equipment Testing Facility.

Aeromedical Research Laboratory
Fort Rucker, AL 36362-0577
(334) 255-6917

Commander: COL John A. Powell
Sci Pro Director/DCS: Dr. Kent A. Kimball

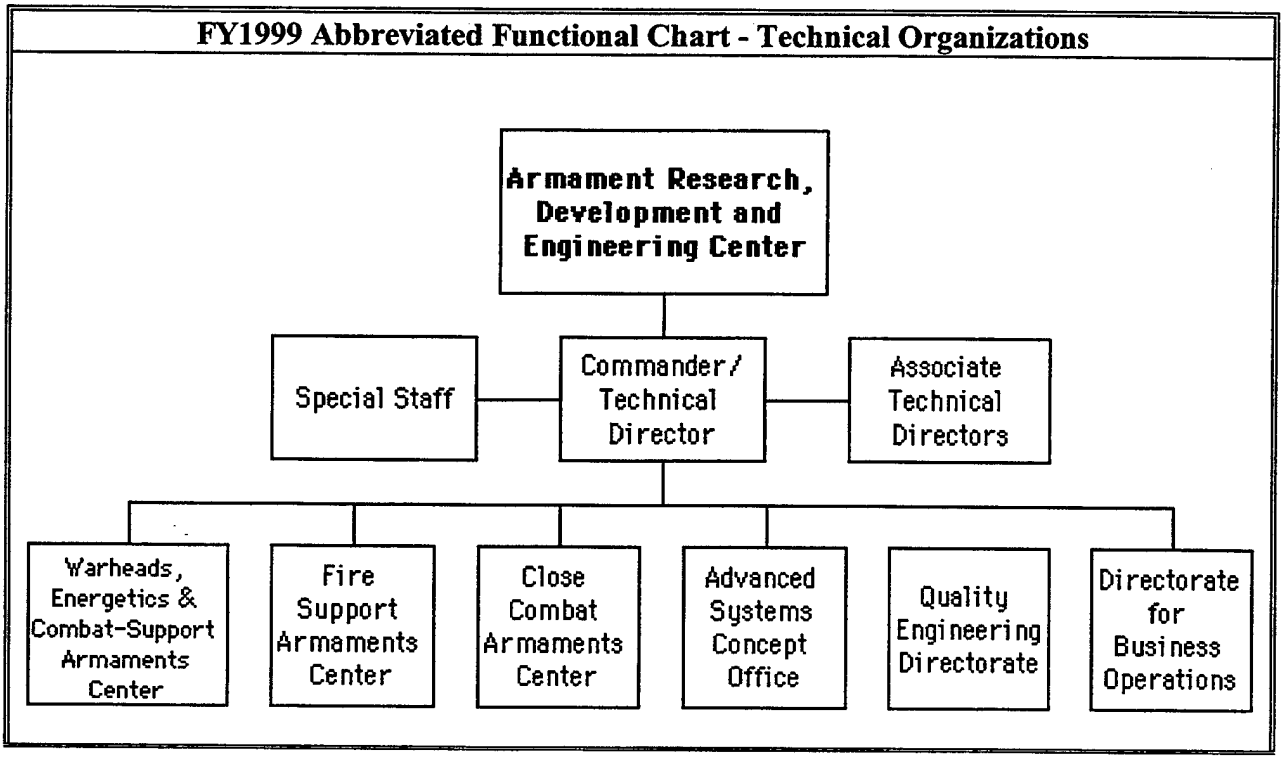
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.040	N/A	N/A	0.040
6.1 Other	0.300	0.000	0.000	0.300
6.2	3.967	0.040	0.306	4.313
6.3	0.634	0.000	0.000	0.634
Subtotal (S&T)	**4.941**	**0.040**	**0.306**	**5.287**
6.4	0.011	0.000	0.000	0.011
6.5	0.030	0.000	0.000	0.030
6.6	0.000	0.000	0.375	0.375
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**4.982**	**0.040**	**0.681**	**5.703**
Procurement	0.001	N/A	0.000	0.001
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	2.480	N/A	0.100	2.580
TOTAL FUNDING	**7.463**	**0.040**	**0.781**	**8.284**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	8	15	22	**45**
CIVILIAN	7	8	28	**43**
TOTAL	**15**	**23**	**50**	**88**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	69.000	**REAL PROPERTY**	12.041
ADMIN	22.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	37.000	**EQUIPMENT**	45.205
TOTAL	**128.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.109
ACRES	**4**	* Subset of previous category.	

Armament RDEC



Armament RDEC
Picatinny Arsenal, NJ 07806-5000
(973)724-6000

Commander: COL (P) Wm M. Lenaers
Technical Director: Mr. Michael F. Fisette

MISSION

TACOM-ARDEC is a business center of the Tank-Automotive and Armaments Command (TACOM), a major subordinate command of the US Army Materiel Command (AMC). TACOM-ARDEC provides the United States military with the firepower to achieve decisive battlefield victory. Our mission is to conduct or manage research, development and life cycle engineering, including quality engineering for ammunition, weapons, fire control and associated items. This includes engineering support for production and integrated logistics support. We provide procurement and management of initial production quantities and technical support to soldiers and equipment in the field throughout their entire life cycle. TACOM-ARDEC is also the Army executive agent for research and development for pollution prevention.

The primary function of TACOM-ARDEC is to be the smart buyer for armaments and the integrator of complex technologies into armament systems. TACOM-ARDEC currently retains the technical knowledge and expertise for current, historical and future experimental and developmental ammunition and weapon systems, many of which have no counterpart in industry. In order to develop and maintain this knowledge base, TACOM-ARDEC is active in all phases of the life cycle process. We maintain a technology base to assure that technologies transition to weapon systems developments which currently account for over 90% of the Army's lethality. TACOM-ARDEC performs system analyses that consider a diverse number of systems and technologies, both in-house and contractor developed, resulting in the best technical approach and best buy decisions. TACOM-ARDEC also performs technical assessments of the current state-of-the-art in ammunition and weapon systems that points the way to future developmental programs and technology transfer to industry.

CURRENT IMPORTANT PROGRAMS

Our core business areas and corresponding technical initiatives are:

SMART MUNITIONS: To develop self-contained munitions for all mission areas with the ability to autonomously sense, engage, and kill their intended targets.

INDIRECT FIRE: To maximize defeat of enemy personnel and vehicular targets by developing advanced artillery and mortars with extended range and accuracy. We will achieve autonomous operations, increase range, increase rate of fire, and reduce manpower requirements over current fielded systems.

DIRECT FIRE: To develop weapons and munitions which will defeat the most advanced enemy armor through increased frontal penetration, higher hit probabilities, and enhanced top attack capabilities, while reducing crew size and stress.

SOLDIER WEAPONS: To upgrade armaments for light infantry and special operation forces (SOF), and to develop advanced small caliber weapons that will significantly increase kill capability, enhance survivability and improve the capability to destroy hard targets, and to develop non-lethal weapons for

CURRENT IMPORTANT PROGRAMS

low intensity/peacekeeping missions.

MINES & DEMOLITIONS: To defeat or deter advanced helicopters, vehicles & personnel with highly intelligent minefields, with features such as area denial, complete user control, and Identification Friend or Foe (IFF) capability, as well as alternatives to Personnel landmines.

FUZING & LETHAL MECHANISMS: To greatly increase the lethality of armament materiel by focusing on advanced chemical energy warheads (shaped charge and explosively formed penetrators), kinetic energy (KE) penetrators, associated warhead materials, and low collateral damage munitions. Also, to create fuzes with integrated sensors, signal processing, and guidance and control; capable of performing target/clutter discrimination and having multi-option capability for compatibility with autoloaders, and containing electronic safe and arm (S&A) functions.

FIRE CONTROL: To provide life cycle engineering and management of fire control subsystems, software, command, control, and communications; test, measurement and diagnostic equipment and training devices utilizing an integration of sensors, computers, advanced controls and artificial intelligence aids for a rapid response to command orders of engagement.

MUNITIONS SURVIVABILITY: Insure the survivability of the critical warfighting assets through Munitions Logistics, Munitions Survivability. The program provides "built in" survivability improvements that will help preclude destructive reactions within logistics nodes, transportation assets and combat vehicles using proven/available technologies.

POLLUTION PREVENTION R&D: TACOM-ARDEC is the Army agent for pollution prevention R&D, providing the Army with technical management for pollution prevention R&D, integration of pollution prevention concerns into the weapons system R&D process, and technical assistance and integration expertise to the Army, other government agencies, and industry.

Some of our key strategic system initiatives are:

Precision Guided Mortar Munition (PGMM). PGMM is a 120mm Global Positioning System (GPS) / laser guided mortar munition with an extended range guide capability. PGMM is envisioned as the maneuver task force commander's "hip pocket" precision indirect fire weapon capable of providing responsive standoff defeat of threats behind protective cover. The target set includes crew served weapons, command posts, observers, etc. employed in fortified positions such as bunkers and buildings.

Advanced Kinetic Energy (KE) Cartridge for Tanks. Advanced KE cartridge designs integrating the following technologies: novel penetrators effective against explosive reactive armor protected targets, lightweight sabot technology for 120mm, advanced propellant formulations, and axial or radial thruster technology enhancing system to increase accuracy up to 70% at extended ranges.

Tank Extended Range Munition (TERM). Advanced munitions technologies which provide tanks with a long range, line-of-sight, and non-line-of-sight anti-armor capability against high value threats, targets to include battle command vehicles, recon vehicles, and armored vehicles equipped with explosive reactive armor and/or active protection systems.

Light Weight 155mm Howitzer. The Light Weight 155mm Howitzer will be a lighter (40-50%) towed howitzer with digital fire control and advanced navigation systems. It will replace our current light division general support artillery system - the M198. The system provides improvements in lethality,

CURRENT IMPORTANT PROGRAMS

survivability and responsiveness.

Battlefield Acoustic Sensors. Acoustic sensor technology will be enhanced to provide passive, non-line-of-sight target detection, classification and tracking of military targets including artillery, ground combat vehicles and aircraft.

Objective Individual Combat Weapon (OICW). OICW will be a lightweight weapon capable of firing kinetic energy projectiles and an air-bursting fragmentation munition. It will allow soldiers to effectively attack targets at greater ranges, and to attack targets in defilade. It combines leading edge technologies in miniaturized fuzing; integrated fire control; lightweight, high strength materials; and munitions effects. OICW will increase the lethality and survivability of the individual soldier. It is the sole lethality component of the Dismounted Battle Lab's 21st Century Land Warrior (21 CLW) Top Level Demonstration.

Objective Crew Served Weapon (OCSW). The OCSW will be a Lightweight, 2-man portable, crew-served weapon system providing the dismounted soldier with overwhelming lethality resulting in increased survivability through long range defeat of defilade protected personnel targets. It will be a more effective replacement for selected medium and heavy machine guns.

Nonlethal Defeat Mechanisms. TACOM-ARDEC has taken a leading role in the development of Nonlethal Technologies. With increasing emphasis on peacekeeping, low-intensity conflict and humanitarian missions, it becomes important to devise weapons which restrain or immobilize. To this end, TACOM-ARDEC is developing weapons such as: sponge grenades (co-developed with ARL), which are designed to incapacitate without imparting serious injury; acoustic weapons, which project sound waves, causing nausea and disorientation; sting nets, which envelop a foe and deliver a nonlethal electrical shock to discourage struggle; laser and other directed energy munitions, which are designed to degrade vehicle sensors; and radio frequency and electromagnetic pulse weapons, which could be utilized against enemy equipment in order to disrupt their electronics. Many of these technologies serve as dual-use applications for use in riot-control and civil disturbance situations.

TACOM-ARDEC has over 49 active CRADAs. Some of these are:

1. **Picatinny Innovation Center (PIC)** - County College Morris.
2. **Air rifle terminal ballistics** - Forensic Pathology Associates.
3. **Material compatibility analyses with liquid propellant** - General Dynamics.
4. **Proximity fuze sensors for munitions** - KDI Precision Products.
5. **Epileptic sensor** - New York State Center for the Disabled.
6. **Recuperator designs and virtual reality modeling** - NIKE.
7. **Advanced materials for imaging applications** - Rennsselear Polytechnic Institute.
8. **Environmentally friendly technologies for lead-based paint removal** - Rutgers University.
9. **Improved shaped charge** - Western Atlas, International.
10. **Pharmaceutical applications of cubane derivatives** - Yeshiva University.
11. **Ammonium Dinitramide Propellants** - Atlantic Research.
12. **High Performance Computing** - HTPI.
13. **Improved Accuracy of Stabilized Systems** - Kollmorgen Electro Optical.
14. **Viability of Sonic Denial Systems** - Performance Sounds.
15. **Fuel Cells** - Materials Technology - Plug Power.

EQUIPMENT/FACILITIES

TACOM-ARDEC's **Stereolithography Lab** provides rapid prototyping for form, fit and function trials and produces masters for soft modeling and investment castings. The lab's capabilities range from the design and fabrication of a sheet "brass catcher" for the Squad Automatic Weapon to the modeling of complete scaled versions of the Crusader and Paladin recoil system prototypes. This service, available to TACOM-ARDEC engineers, academia and industry, reduces the developmental time and associated manufacturing and procurement costs by up to 75%.

The Automated Inspection Device for Explosive Charge in Shell (AIDECS) replaces visual x-ray film inspection of loaded artillery projectiles. The AIDECS pilot system at TACOM-ARDEC is the only operational unit of its kind, providing the capability to automatically examine 155mm rounds and smaller shells. Base separations, cracks, cavities and other critical defects in the explosive filler are detected by scanning the shell with x-rays. Radiation scattered from within the shell is electrically detected, and a computer analysis identifies and classifies each defect in the explosive. The computer makes an accept/reject decision for each shell and prints an inspection report. Benefits of the AIDECS system include improved reliability for detecting base separations and other critical defects accomplished in a totally automated manner, and cost savings due to elimination of x-ray film.

TACOM-ARDEC's Distributed Interactive Simulation (DIS) Facility supports a full spectrum of battlefield simulation activities to determine how technology, weapons and weapon mixes can be used to maximize the effectiveness of the soldier. DIS analyses of weapons in combined arms scenarios can influence designs long before any metal has been "bent", thereby minimizing cost and development time. Linkage to other sites and real systems allow real-time interaction on a hybrid battlefield.

The **Department of Defense's Center for X-Ray Diffraction** at TACOM-ARDEC is well recognized for its complete line of sophisticated X-Ray equipment, including two of the latest diffractometers and spectrometers, as well as for the comprehensive knowledge and experience of its personnel. The facility is used to enhance ballistic performance by determining the optimal crystal orientation of warhead and penetrator materials.

Benet Labs represents the Army's capability for large caliber cannon research, design and development, prototype production and engineering support. Benet works closely with the Watervliet Arsenal's cannon production facility to provide rapid prototyping services in support of new and improved weapon systems. Some of Benet's facilities are:

FATIGUE EXPERIMENTATION FACILITY: Capability of duplicating firing pressures in its breech mechanism facility and tube facility. This allows the rapid evaluation of new concepts of materials, and the establishment of safe firing parameters for these components in the laboratory rather than the much more expensive experimental firing previously necessary. These combined facilities provide Benet with a capability not available elsewhere.

GAS DYNAMICS LABORATORY: The Gas Dynamics Laboratory is a new research multi-task facility which includes two firing bays, a high bay area and a laboratory. The high bay area is used for experiments for heavy weapons and weapon components. Instrumentation includes 12 channels of digital data capture and display in 3 synchronized nicolet oscilloscopes with 4K points per channel. There is also a data acquisition system with 10 channels at 256K points per channel.

SMALL ARMS SIMULATOR: The Small Arms Simulator is a single lane computerized firing system with standard gun, M4 Carbine, converted for simulator use. Other weapons included in the simulator

EQUIPMENT/FACILITIES

are the M203 Grenade Launcher and the M16A1/A2. All the guns retain their normal feel, operating characteristics and features. Recoil and noise are realistically simulated and shooting accuracy matches that of the original weapons. The Ft. Pickett range and MOUT village has been digitized and implemented into the facility. All targets are graphically generated E-silhouettes and DI Guy soldiers with the capability to design the target scenario by the user. Graphical targets include pop-up, moving, stationary or multiple targets at various ranges as defined by the user. It is presently being used to support programs through JSSAP and PM SA such as Objective Individual Combat Weapon (OICW) and M4 Carbine Alternate Butt Stock. The system is also being used to support Land Warrior, Force XXI Land Warrior, and Combat ID programs which are managed by Soldier System Command (SSCOM) and CECOM.

TURRET LABORATORY: Benet Labs provides engineering support for Turret hardware (less fire control systems) for Tracked Combat Vehicles, including the M551 Light Weight Air Transportable Assault Vehicle, and M60A3 and M1A1 Main Battle Tanks. The Turret Laboratory currently houses all of these vehicles and the tools and equipment necessary for investigation of problems relating to field, depot and spare parts procurement activities.

TERRAIN SUSPENSION/TURRET ENVIRONMENT SIMULATOR: This motion system consists of a large platform (18 ft x 10 ft) mounted on six large hydraulic cylinders, a hydraulic power supply unit and an electronic control cabinet. The simulator is a six-degree-of freedom system capable of providing all six motions simultaneously. The maximum payload that can be carried by the simulator is 18,000 lbs. This, it is capable of evaluating a full size tank turret.

FULL SCALE INVESTMENT CASTING FOUNDRY: Benet's investment casting foundry provides the necessary base from which technical support is provided to the Laboratory in the form of the development of new castings and providing prototype castings, to Watervliet Arsenal in the form of production castings to meet initial deliveries until a contractor can start full deliveries, and to Outside Contractors in the form of technical assistance to overcome problems encountered in meeting the requirements of castings for production.

VESSEL ELECTROPLATING FACILITY: A full-scale pilot production facility, built and operated by Benet Laboratories in a joint venture with the Watervliet Arsenal, provides a new process technology and the capability for plating an improved form of chromium (LC chrome) on any size cannon tube up to and including the 30-foot long 155-mm "Extended Range Cannon".

The **Armament Technology Facility (ATF)** is a 52,000 square foot, secure and environmentally safe integrated small and cannon-caliber design and test facility. The ATF co-locates simulation modeling, design, validation, and diagnostic engineering with the capability to immediately conduct confirmation experimental firings of interior and exterior ballistics. This concurrent engineering facility will support multi-service infantry, air defense, aircraft and combat vehicle armament systems and is available to government as well as private industry. It has four weapon validation bays with an environmental chamber capable of weather conditions between -65F to +165F; two indoor ranges - the first 100 meters in length and the second 300 meters. The latter can accept a Bradley Fighting Vehicle System firing its primary armament; or an Abrams-series tank firing secondary armament. The 300-meter range also has a -65F to +165F environmental chamber.

The **Keith L. Ware Simulation Center** is a research facility specializing in the analysis of helicopter armaments and small arms. The Ware Center is composed of two 100 meter indoor firing ranges and two 1000 inch indoor firing ranges. Small arms can be fired from any number of ground and vehicle mounts

EQUIPMENT/FACILITIES

as well as several weapon mount simulators located at the center. Helicopter armaments are fired from the 6-Degree-of-Freedom simulator which is capable of mounting a helicopter fuselage and inputting vibration and other motions into it. This allows armaments to be investigated in realistic conditions at a great cost savings over field trials. A large environmental room is available connected to one of the 1000 inch firing ranges. This room can subject items to extreme temperatures from -65 degrees F to +160 degrees F as well as other environmental conditions such as humidity, salt fog, salt immersion, sand and dust. The Ware Simulation Center has extensive instrumentation capabilities to measure characteristic data and performance of weapon systems such as: accuracy, dispersion, rate of fire, round velocity, blast pressure, recoil force, temperature, strain, acceleration, linear and angular displacement, voltage and current. High speed video and regular speed video are also available.

The **Instrumentation and Measurements Lab** includes cutting-edge capabilities in the art of data reduction, signal processing, shock resistant telemetry design and radar analysis. One of its facilities consists of a radio frequency anechoic chamber equipped with a radar cross-section (RCS) measurement system utilizing a supercomputer. RCS measurements of various systems, including projectiles, identify radar reflectivity patterns. This technology is used for artillery experiments to evaluate and improve projectile performance parameters such as range, yawing motion, spin and position. Some services and capabilities include: Development of telemetry concepts and systems Telemetry component technology; In-bore and in-flight telemetry techniques Secure telemetry systems; Qualification, compatibility and RFI Coordination of telemetry operations with test ranges; Collection and reduction of telemetered firing test data; Printed Circuit Board design, fabrication and assembly; Measurement System Design and Implementation Acoustic and Magnetic Signature Analysis Image Analysis/ Processing; Industrial Control, Design and Implementation RF Anechoic Studies.

The Advanced Warhead Facility provides a 40 foot diameter reinforced concrete dome, lined with armor plate, that will be attached to a 35 foot long tunnel. This allows for extended target standoff experiments for explosively formed penetrators, shaped charges and other experimental warheads. Traditional and heavy metal liners such as tantalum and tungsten will be accommodated. Instrumentation includes flash radiography, streak cameras and electronic streak array.

Our **subsonic, transonic and supersonic wind tunnels** provide excellent opportunities to apply research to time and cost savings. The facility is used to design, develop and conduct experiments on tactical and training rounds for the Army. The facility has been awarded twelve U.S. patents in the last five years. One of the patents was for a stabilizer for the M831A1 TP-T tank training ammunition, developed using wind tunnel data. Optimization resulting from the experiments saved an estimated $40 million in annual production costs.

Electromagnetic Environmental Effects (E3) facilities perform assessments on weapon systems to determine their compliance against numerous electromagnetic environments such as Personnel Electrostatic Discharge (PESD), Helicopter Electrostatic Discharge (HESD), Hazards of Electromagnetic Radiation to Ordnance (HERO), Electromagnetic Vulnerability (EMV), and Electromagnetic Interference (EMI). High explosives are also assessed at our facilities.

ARDEC's Life Cycle Software Engineering (LCSE) Center is a state-of-the-art facility consisting of the latest computer hardware, software and environments used for designing, developing, testing, managing, controlling, storing, fielding, and maintaining Mission Critical Computer Resources (MCRR). Included in this MCCR are embedded software for Army Battlefield Automated Systems, Automated Trainers for Gunnery and Maintenance Institutional and Field simulators and trainers, in support of Army TRADOC Schools. The Center supports such systems as the Paladin M109A6 Howitzer; Crusader;

EQUIPMENT/FACILITIES
Abrams Family of Vehicles (M1, M1A1, and M1A2); and Bradley Fighting Vehicles System (BFVS); The TACOM LCSE Center is one of the three (3) charted Army Materiel Command LCSE Centers in support of all Army MCCR software. **PROPELLANT SURVEILLANCE FACILITY:** This unique facility is equipped with chambers heated to elevated temperatures in which large quantities of propellants undergo aging tests to determine safe lifetimes. This multi-service facility identifies propellant lots close to their maximum lifetime for destruction before a catastrophic accident occurs. Samples of propellants from field storage are also testing to ensure different environmental conditions don't degrade the propellant at a faster rate.

Armament RDEC
Picatinny Arsenal, NJ 07806-5000
(973)724-6000

Commander: COL (P) Wm M. Lenaers
Technical Director: Mr. Michael F. Fisette

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.788	N/A	N/A	1.788
6.1 Other	0.646	0.220	2.226	3.092
6.2	18.699	4.919	49.687	73.305
6.3	0.746	3.269	33.023	37.038
Subtotal (S&T)	**21.879**	**8.408**	**84.936**	**115.223**
6.4	43.823	0.779	7.871	52.473
6.5	17.245	0.307	3.097	20.649
6.6	42.060	4.469	45.145	91.674
6.7	3.193	2.007	20.268	25.468
Non-DOD	3.361	0.060	0.604	4.025
TOTAL RDT&E	**131.561**	**16.030**	**161.921**	**309.512**
Procurement	74.038	N/A	22.842	96.880
Operations & Maintenance	58.904	N/A	13.596	72.500
Other	5.075	N/A	1.714	6.789
TOTAL FUNDING	**269.578**	**16.03**	**200.073**	**485.681**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	11.800

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	23	7	**30**
CIVILIAN	59	1582	1343	**2984**
TOTAL	**59**	**1605**	**1350**	**3014**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	325.270	**REAL PROPERTY**	193.470
ADMIN	864.896	* NEW CAPITAL EQUIPMENT	0.000
OTHER	2675.906	**EQUIPMENT**	177.073
TOTAL	**3866.072**	* NEW SCIENTIFIC & ENG. EQUIP.	3.076
ACRES	**6493**	* Subset of previous category.	

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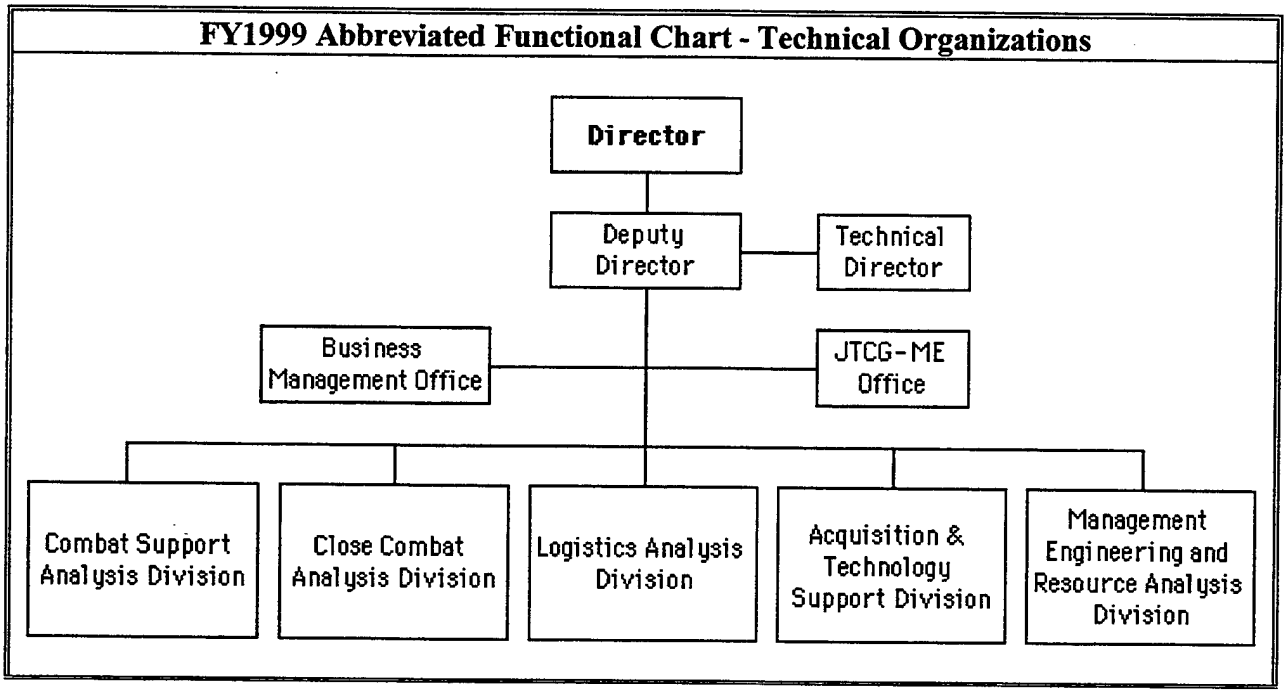
Army Materiel Systems Analysis Activity



Army Materiel Systems Analysis Activity
Aberdeen Proving Ground, MD 21005-5071
(410)278-6614

Director: Mr. David J. Shaffer
Military Deputy: COL Pete Bucha

MISSION

Provide analysis of Army materiel and logistics systems to support decision making for equipping and sustaining the Army.

CURRENT IMPORTANT PROGRAMS

The U.S. Army Materiel Systems Analysis Activity (AMSAA) has focused its analytical capabilities into five core business areas: item/system level performance and investment strategies; modeling and simulation (M&S); acquisition and technology support; logistics analysis; and business and resource analysis. These interdependent core competencies combine to provide the Army with analytical capabilities that are unique in both breadth and depth across the life cycle of Army materiel. Below are several paragraphs that summarize the capabilities and responsibilities in the Research, Development, Test, and Evaluation (RDT&E) and Operations and Maintenance, Army (OMA) areas.

Primarily funded by RDT&E: AMSAA is the Army's center for item and system level performance analysis and certified data. AMSAA utilizes methodologies and models to characterize the functionality of Army materiel systems. Unique models and methodologies have been developed to accurately predict critical performance variables, such as, weapon accuracy, target acquisition, rate of fire, the probability of inflicting catastrophic damage, and system reliability. AMSAA is responsible for the generation of these effectiveness measures and for ensuring their standard use across Army and Joint studies. Item and system performance analyses are initiated in the technology base and evolve with the system through the entire acquisition cycle. AMSAA is actively involved in the Army Science and Technology Objective and Advanced Technology Demonstration processes by examining how emerging technologies can potentially satisfy future Army requirements. AMSAA performs verification, validation, and certification of performance data, provides an analytical basis for the formulation of exit criteria, conducts performance analyses, and verifies, validates, and accredits (VV&A) required models and simulations. These capabilities support the timely transition of warfighting technologies from the tech base to materiel and system specific applications. AMSAA's linkage with the Integrated Concept Team (ICT) process creates an opportunity for the Army to take advantage of systems analysis even earlier. AMSAA is positioned to support ICTs through early requirements trade-off analyses before specific solutions are identified. The integration of cost as an independent variable, as part of this process will help ensure the development of cost-effective systems that will provide critical war fighting capabilities to the future Army. As the Executive Agent for the Department of Defense (DoD) for the tri-service Joint Technical Coordinating Group/Munitions Effectiveness program, AMSAA applies its item and system level performance expertise to manage the program and to ensure standardized weapons effectiveness assessments are used across the services. The publication of Joint Munitions Effectiveness Manuals provides single source documents for modelers, materiel developers, and strategic and operational planners. AMSAA's M&S capabilities support the development, linkage, and accreditation of live, virtual, and constructive simulations, and provide unique tools that support systems analysis of both individual systems and combined arms environments. This M&S expertise is utilized both to strengthen the organization's internal capabilities and to provide critical capabilities to external customers. Internally, AMSAA has resident and maintains a significant number of models and simulations, most of

CURRENT IMPORTANT PROGRAMS

which were developed in-house to address specific analytical voids. This M&S infrastructure provides a hierarchical modeling process that is unique to AMSAA and allows for a comprehensive performance prediction capability that can be utilized to make trade-off and investment decisions prior to extensive and expensive hardware testing. Externally, AMSAA applies its M&S capabilities to a wide variety of Army programs and activities. In Army Regulation (AR) 70-1, AMSAA is identified as the Army's Executive Agent for VV&A of item level performance models. In this role, AMSAA assists model developers with the development and execution of V&V plans to ensure new models and simulations faithfully represent actual systems. Additionally, AMSAA is extensively involved in M&S accreditation across the Army. Above the item level, AMSAA has gained extensive experience in the planning, execution and analysis of distributed interactive simulation exercises, and in the V&V of computer generated forces and system simulators. Shrinking modernization budgets have forced the Army to increasingly focus its research and development efforts toward fewer critical systems and capabilities that will equip the force with the most "bang for the buck." Investment decisions across weapon systems and technologies are being forced earlier in the process, with cost effectiveness playing an increasingly dominant role in these decisions. AMSAA has developed and implemented new methodologies capable of examining decision alternatives in terms of value-added, cost benefit, and total risk. Potential exists to conduct analyses within battlefield capabilities, such as, anti-armor, sensors, and command and control as well as to examine relative contributions across capabilities.

Primarily funded by OMA: AMSAA's logistics analysis expertise covers the full range of Army logistics needs, from the development and refinement of new logistics models to the analysis of innovative or modified logistics concepts. AMSAA's studies have led to recommendations for major changes to the Army logistics system resulting in significant improvements in the supply, maintenance, and transportation processes, such as, increased flexibility, responsiveness to the customer, reduction in the generation of excess, and providing the best mix of supplies in a timely manner. AMSAA supports the logistics part of the acquisition process with level of repair and initial provisioning analyses for materiel development programs. AMSAA works with the program manager to ensure initial provisioning stocks and maintenance concepts provide adequate logistics support and best value to the Army once systems are fielded. AMSAA is heavily engaged in analysis to support the Army planning process for sustaining our forces during operations other than war, contingency operations, and in war. AMSAA develops Supply Class IX spare part contingency support packages for the Area Support Group, Core Support Group, Direct Support, and/or Organizational levels during wartime contingency planning. These support packages have been instrumental in planning logistics support and have served to assist in Bosnia, Somalia, Rwanda, and numerous other Army operations. AMSAA is the Army's executive agent for Sample Data Collection (SDC) and as part of this executes the Field Exercise Data Collection (FEDC) program providing quantitative and qualitative operational maintenance, manpower, reliability, and logistical support data for fielded materiel systems. Critical information is provided to warfighting units and this same information is used in analyses being conducted for senior Army leadership. AMSAA has been instrumental in the development, application, refinement, and investigation of models to support both wholesale and retail Army logistics operations and analysis. A library of models is maintained and new ones are regularly developed, as needed, either to support concept analysis or to improve a current methodology. AMSAA serves as the Army executive agent for reliability and maintainability standardization improvement by developing and implementing reliability and maintainability acquisition reform initiatives. AMSAA develops and applies reliability engineering approaches that assess the reliability of Army materiel, and recommend ways to reduce life cycle costs and create more robust designs. The Physics of Failure (PoF) program pioneered development of design and analysis tools to predict reliability and minimize potential redesign at the component level. PoF is based on the fundamental principle that it is not only important to understand how things work, but equally important to understand how things can fail under the intended operational environments. AMSAA supports a

CURRENT IMPORTANT PROGRAMS

broad range of efforts to improve the acquisition process and to apply new technology to the development and production of Army materiel. For example, continuous evaluations of military specifications and standards to include support in converting to commercial item descriptions and the preparation of performance specifications are conducted. To ensure new materiel can be produced and existing materiel can have significant modifications, production engineering and readiness reviews are conducted. AMSAA exercises overall program direction for the execution of the AMC Management Engineering Program. This includes the Workload Based Staffing Analysis Program and the Army Workload and Performance System. With all of the reductions occurring throughout AMC, AMSAA will be responsible for conducting and overseeing many outsourcing/privatization analyses and commercial activity studies. AMSAA ensures that the Army's approved 12-step process is appropriately applied AMC-wide. In this capacity, AMSAA validates AMC's personnel levels against actual workload requirements and defends these positions during the Army's POM and TAA processes.

AMSAA's overall RDT&E and OMA program provides the Army with the critical information and analysis needed to facilitate the complex decisions required to move the Army into the next century. As resources become increasingly constrained, it is critical the Army leadership continue to have access to timely, reliable, and high quality analysis on which they can base the decisions required to shape the future Army. AMSAA has developed an integrated set of skills and tools focused on its core competencies to be responsive to the breadth and depth of systems analysis requirements for the Army now and into the next century.

EQUIPMENT/FACILITIES

AMSAA has a unique Simulation Facility used for processing highly classified material and also the development, verification, validation, and accreditation of models and simulations. AMSAA also has additional facilities and equipment for use in the conduct of systems analysis.

Army Materiel Systems Analysis Activity
Aberdeen Proving Ground, MD 21005-5071
(410)278-6614

Director: Mr. David J. Shaffer
Military Deputy: COL Pete Bucha

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.195	0.000	0.000	0.195
6.3	0.655	0.000	0.000	0.655
Subtotal (S&T)	**0.850**	**0.000**	**0.000**	**0.850**
6.4	0.257	0.000	0.000	0.257
6.5	0.958	0.000	0.000	0.958
6.6	9.174	0.000	0.709	9.883
6.7	0.322	0.000	0.163	0.485
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**11.561**	**0.000**	**0.872**	**12.433**
Procurement	0.507	N/A	0.000	0.507
Operations & Maintenance	13.802	N/A	2.550	16.352
Other	4.765	N/A	7.186	11.951
TOTAL FUNDING	**30.635**	**0.000**	**10.608**	**41.243**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	5	**5**
CIVILIAN	7	206	133	**346**
TOTAL	**7**	**206**	**138**	**351**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	0.000	**REAL PROPERTY**	3.600
ADMIN	104.700	* NEW CAPITAL EQUIPMENT	0.000
OTHER	17.100	**EQUIPMENT**	4.111
TOTAL	**121.800**	* NEW SCIENTIFIC & ENG. EQUIP.	0.600
ACRES	**4**	* Subset of previous category.	

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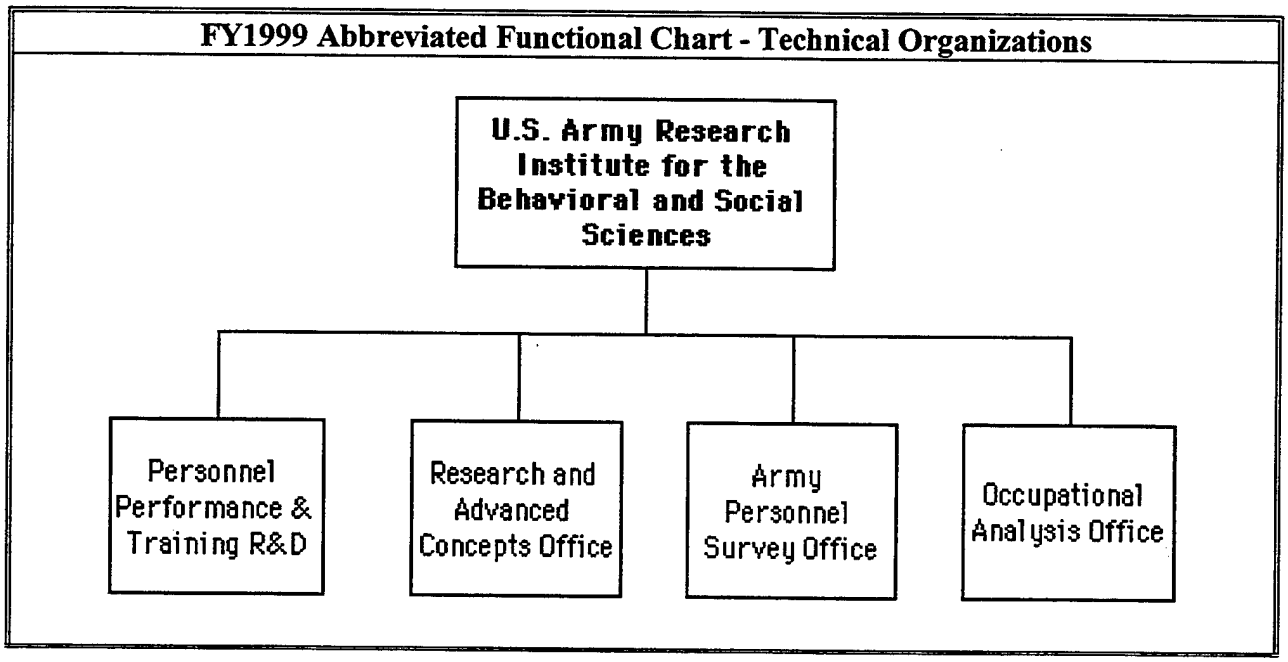
Army Research Institute for the Behavioral & Social Sciences



Army Research Institute for the Behavioral & Social Sciences

Alexandria, VA 22333
(703) 617-8636

Director: Dr. Edgar M. Johnson
Technical Director: Dr. Zita M. Simutis

MISSION

Maximize individual and unit performance and readiness to meet the full range of worldwide Army missions through advances in the behavioral and social sciences. ARI achieves its mission through research units located at headquarters in Alexandria, VA.; and tenant locations as follows: Simulator Systems Research Unit (Orlando, FL); Armored Forces Research Unit (Ft. Knox, KY); Infantry Forces Research Unit (Ft. Benning, GA); Reserve Component Training Research Unit (Boise, ID); Rotary-Wing Aviation Research Unit (Ft. Rucker, AL); Ft. Leavenworth Research Unit (Ft. Leavenworth, KS). Scientific Coordination Offices: Ft. Bragg (Ft. Bragg, NC); Ft. Hood (Ft. Hood, TX); USAREUR SCO (Heidelberg, GE); and TRADOC SCO (Ft. Monroe, VA).

CURRENT IMPORTANT PROGRAMS

1. Complete development of operational Enlisted Personnel Allocation System for IOT&E.
2. Implement and evaluate model Initial Entry Rotary Wing simulator-based training program.
3. Develop model of PERSTEMPO impacts on human resource outcomes.
4. Prepare a comprehensive research plan addressing digital skill training and retention issues.
5. Develop and evaluate prototype training and performance assessment methods for Force XXI.

Current Cooperative Research & Development Agreements:

1. Florida State Univ. -- Job Skills Education Program
2. MicroAnalysis & Design -- Development of a Family of Computerized Tutors Based on Military Language Tutor Project
3. University of Maryland -- Cooperative Research on Psychophysiological Correlates of Elite Performance
4. SAIC -- Developing Situational Awareness, Adaptive Command and Control Entities, and Intelligent Interfaces for Computer Generated and Semi-Automated Forces (CGF & SAF) Behaviors and Control in Distributed Interactive Simulation (SIM) Systems
5. University of Houston -- Training & Performance of Dismounted Teams in Virtual Environments
6. NovaLogic, Inc -- Develop and Evaluate PC-Based Software Image Generator (IG) for Defining Simulation Requirements for Flight Trainers and Evaluating Flight Simulation Parameters for Training Army Aviators

EQUIPMENT/FACILITIES

In-house experimental facilities include laboratory and computer facilities for real-time, man-in-the-loop experimentation. Unique assets include: combat arms simulators; Virtual Reality test bed; a modular, reconfigurable flight simulator for helicopter pilot research; simulators for UH-1Fs, AH-74A and UH-60A helicopters; research access to SIMNET; and Battle Command Experimentation Center.

Army Research Institute for the Behavioral & Social Sciences

Alexandria, VA 22333
(703) 617-8636
Director: Dr. Edgar M. Johnson
Technical Director: Dr. Zita M. Simutis

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.173	0.239	1.694	2.106
6.2	6.435	0.266	2.845	9.546
6.3	2.582	0.059	0.739	3.380
Subtotal (S&T)	**9.190**	**0.564**	**5.278**	**15.032**
6.4	0.000	0.000	0.000	0.000
6.5	0.036	0.000	0.000	0.036
6.6	0.105	0.322	3.662	4.089
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**9.331**	**0.886**	**8.940**	**19.157**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	1.666	N/A	0.791	2.457
Other	0.571	N/A	0.000	0.571
TOTAL FUNDING	**11.568**	**0.886**	**9.731**	**22.185**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	4	0	**4**
CIVILIAN	50	29	43	**122**
TOTAL	**50**	**33**	**43**	**126**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	12.325	**REAL PROPERTY**	13.200
ADMIN	53.600	* NEW CAPITAL EQUIPMENT	0.000
OTHER	3.425	**EQUIPMENT**	10.124
TOTAL	**69.350**	* NEW SCIENTIFIC & ENG. EQUIP.	43.600
ACRES	**0**	* Subset of previous category.	

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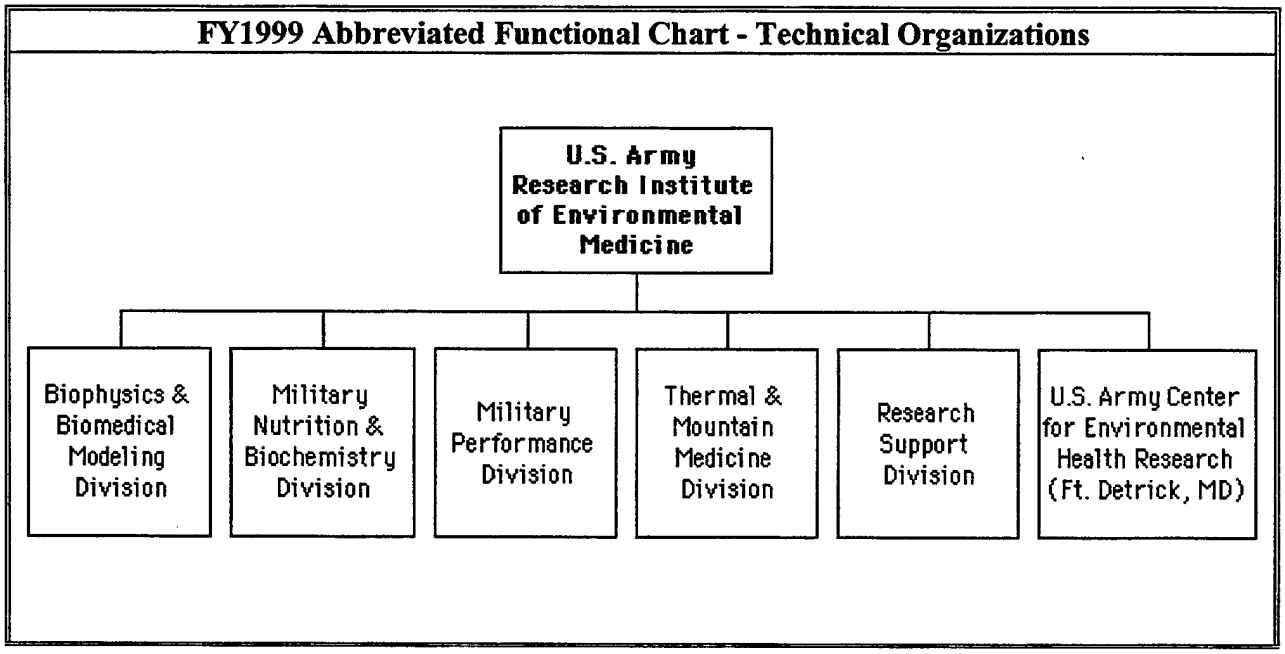
Army Research Institute of Environmental Medicine



Army Research Institute of Environmental Medicine
Natick, MA 01760-5007
(508)233-4811
Commander: COL David M. Penetar
Deputy Commander: COL John P. Obusek

MISSION

Conduct basic and applied research to determine how exposure to extreme heat, severe cold, and high terrestrial altitude, occupational tasks, physical training, deployment operations, and nutritional factors affect the health and performance of military personnel. Develop products, processes, and information to minimize or eliminate health risks and performance decrements of US Forces from toxic industrial/agricultural chemicals and other environmental contaminants (non-CBW).

CURRENT IMPORTANT PROGRAMS

Environmental Injury - Demonstrate the efficacy of strategies to predict, prevent, and treat environmental illnesses, injuries, and performance decrements. Heat injuries due to both hyperthermia and dehydration continue to be problems in the training environment. Additionally, overhydration has occurred is several instances. A series of laboratory and field studies have produced revised water replacement tables that take into account sweating rates by heat category and work load, and the physiological limits of water absorption. A genome bank for cataloging phenotype and genotype characteristics of cold, heat, and altitude-related injuries has been established and is being expanded.

Performance Limits - Develop and validate models to predict the effects of heat, cold, high altitude, hydration, nutritional status, and clothing and equipment on performance. Heat and cold strain prediction models have been integrated into real time environmental sensor systems to deliver an on-line risk assessment system for training environment use (MERCURY system now in operation at the Ranger Training Brigade). Basic research is gathering data and refining models of energy expenditure on various terrains, in differing climatic conditions, and for each military occupational specialty. Multidisciplinary approaches are being conducted to understanding and combating the consequences of stress to military readiness and operational performance.

Nutritional Strategies - Identify and demonstrate nutritional strategies to maintain health and enhance soldier performance to include maintaining immune system competency. A major effort, in collaboration with the Natick Soldier Center, is the development and evaluation of performance enhancing rations. Two carbohydrate supplements - the ERGO (energy rich, glucose optimized) drink, and the HOOAH bar - are now fielded. These carbohydrate supplements have been proven to have high acceptability and are easy to use during operations. Field tests have shown that physical performance and mood are significantly improved by the ERGO drink. The effects of acute and long term creatine use as a performance enhancer is under investigation. Specific nutritional vitamin and antioxidant mixtures are being evaluated for their ability to reduce cholesterol, reduce muscle soreness, and improve immune function during stressful and extensive field operations. Long term goals include shelf stable compact rations to increase metabolic efficiency, spare muscle protein, provide micronutrients, improve wound healing, and increase antibody delivery.

Musculoskeletal Injuries, Physical Performance, Biomechanics - Demonstrate the efficacy of methods to reduce the incidence of musculoskeletal injuries and optimize performance during military training and operations. Research is conducted to assess biochemical markers and catalog risk factors for stress fractures in the training environment. A large health database has been established to allow for the

CURRENT IMPORTANT PROGRAMS

evaluation of specific behavioral attributes and injury epidemiology. Special emphasis is on the biomechanical evaluation of how the body handles loads and forces generated by new equipment designs for load carriage. Recent accomplishments have been in the evaluation and modification of prototype future soldier systems (Land Warrior), the MOLLE backpack system, and combat footwear. Basic research has demonstrated significant physiological cost reductions in carrying heavy loads by simple alterations in center of mass placement.

Warfighter Physiological Status Monitoring - Develop, validate, and field test ambulatory monitoring instruments and sensors that assess an individual warfighter's physiological and psychological status in an operational environment. Develop and test data management and modeling strategies for high precision, short term predictions of physiological status. Prototype sensors and wireless body local area network configurations are being developed and tested in soldier training environments. An Integrated Research Team has been organized to coordinate, prioritize, and direct multilaboratory, multicontractor, and academic efforts in this fast advancing effort.

Medical Chemical Defense - Investigate and define mechanisms of vesicant injury. Basic research efforts use a mustard simulant and electron microscopy to explore DNA fragmentation in human epidermis cell model. Recent results have determined the role of pro-inflammatory cell mediators in epidermal damage and the effectiveness of putative vesicant antagonists in preventing cellular damage.

Deployment Toxicology - Develop new assays, methods and products for measuring chemical contaminants and their impact on the health and performance of US Forces in garrison and during deployment. This includes:

- Innovative strategies to assess health risks from environmental exposures to toxic chemicals: Invent screening and detection methods and animal models to assess health risks (such as resistance to disease and effects on fertility) from exposure to individual chemicals and complex mixtures.
- Rapid analysis of food and water for chemical and microbial contaminants: invent, develop, and test rapid, field-portable assays for contamination of food and water by toxic industrial/agricultural chemicals and human pathogens that can cause illness or death.
- Environmental sentinels and risk assessment: create and develop instrumented animal models that can be released into an environment for rapid or continuous, real-time monitoring of known or unknown hazards that may affect the health of indigenous species, including humans.

Technology Transfer Program - The Institute currently has 24 Cooperative Research and Development Agreements active. In FY 99, the following new CRDAs were negotiated and put in place:

- **University of Vermont College of Medicine** - To determine if leukotrienes are involved in the development of high altitude-induced illnesses (acute mountain sickness, high altitude pulmonary edema and high altitude cerebral edema).
- **Johns Hopkins University** - Collaborative research effort using the Total Army Injury and Health Outcomes Database (TAIHOD).
- **Yale University School of Medicine** - To develop a cohesive, sequential model of the functional alterations that occur in personnel engaged in fire suppression.
- **University of Lowell** - Collaborative research effort using the Total Army Injury and Health Outcomes Database (TAIHOD).
- **Duke University Medical Center** - To determine what physiologic and environmental characteristics are predictive of development of Acute Mountain Sickness.
- **Harvard School of Public Health** - Collaborative research effort using the Total Army Injury and Health Outcomes Database (TAIHOD).

EQUIPMENT/FACILITIES

Unique facilities include: high altitude/hypobaric, climatically controlled chambers able to simulate terrestrial altitudes up to 30,000 ft, high altitude performance physiology laboratory on Pikes Peak, Colorado, environmentally controlled (temperature, humidity, wind speed) physiological/performance chambers suitable for human or animal testing, fully AAALAC-I (Association for the Advancement and Accreditation of Laboratory Animal Care, International) accredited animal care and research facilities, animal biochemical and physiological laboratory, biophysical evaluation chambers for clothing and equipment, biomechanics laboratory complete with high speed motion detection and pressure sensitive equipment and force plate, Dual-Energy X-ray Absorptiometery machines for analysis of body composition, electron microscopy laboratory, psychology laboratory for assessment of variables associated with cognitive performance changes, water immersion laboratory for precise control of human core temperature, access to and primary user of the Doriot Climatic Chambers (warehouse-sized environmental chambers, owned and operated by the Natick Soldier Center). Facilities located at the US Army Center for Environmental Health Research, Ft. Detrick, MD include: AAALAC-I accredited aquaculture and aquatic toxicology laboratories, research suites to conduct in vivo and in vitro studies, analytical chemistry suites, mobile toxicology laboratories, and research facilities at Colorado State University.

Army Research Institute of Environmental Medicine
Natick, MA 01760-5007
(508)233-4811

Commander: COL David M. Penetar
Deputy Commander: COL John P. Obusek

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.080	N/A	N/A	0.080
6.1 Other	3.305	0.056	1.192	4.553
6.2	6.092	0.093	1.525	7.710
6.3	0.957	0.001	0.000	0.958
Subtotal (S&T)	**10.434**	**0.150**	**2.717**	**13.301**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**10.434**	**0.150**	**2.717**	**13.301**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.450	N/A	0.252	0.702
Other	4.226	N/A	0.095	4.321
TOTAL FUNDING	**15.110**	**0.150**	**3.064**	**18.324**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	21	22	30	**73**
CIVILIAN	22	39	32	**93**
TOTAL	**43**	**61**	**62**	**166**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	42.581	**REAL PROPERTY**	9.168
ADMIN	21.483	* NEW CAPITAL EQUIPMENT	0.000
OTHER	43.732	**EQUIPMENT**	31.443
TOTAL	**107.796**	* NEW SCIENTIFIC & ENG. EQUIP.	1.331
ACRES	**1**	* Subset of previous category.	

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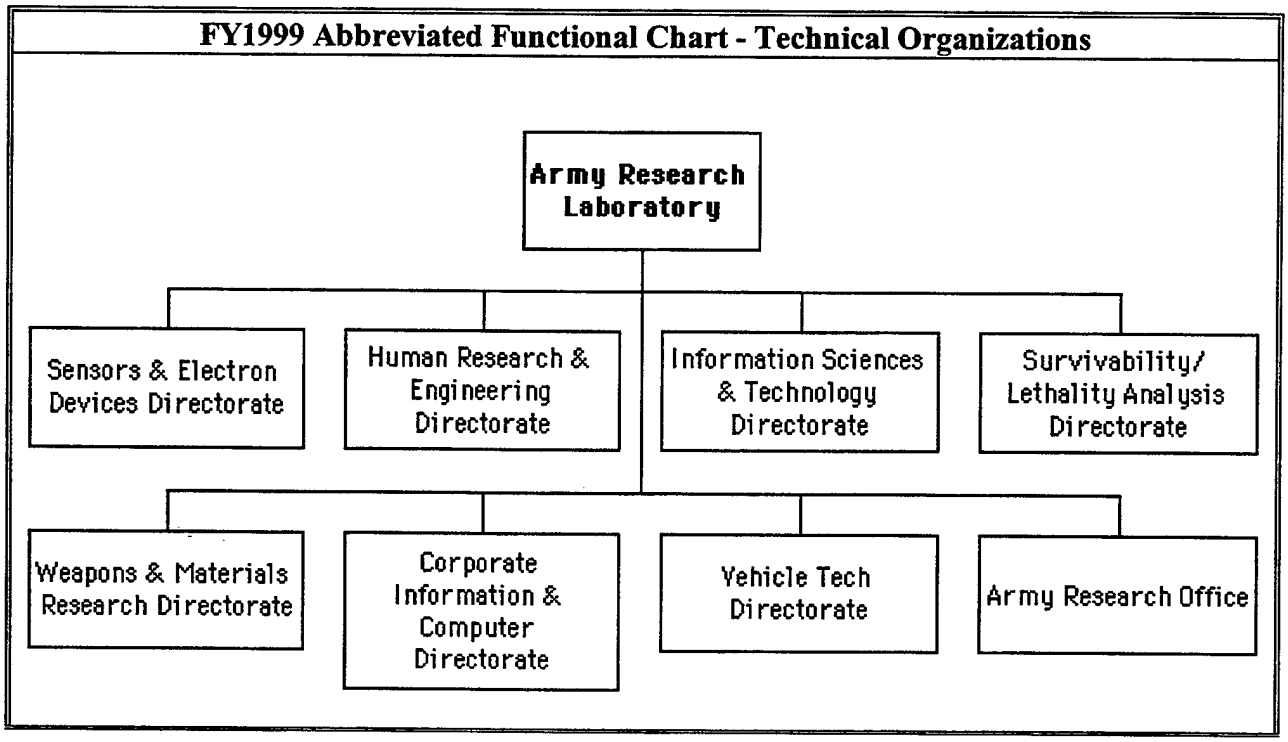
Army Research Laboratory



Army Research Laboratory
Adelphi, MD 20783-1197
(301)394-1067

Director: Dr. Robert W. Whalin
Assistant Director PPB: Mr. John Miller

MISSION

THE ARMY RESEARCH LABORATORY MISSION:
Execute fundamental and applied research to provide the Army the key technologies and analytical support necessary to assure supremacy in future land warfare.

THE ARMY RESEARCH LABORATORY VISION:
America's laboratory for The Army... Providing materiel readiness through innovative technology.

CURRENT IMPORTANT PROGRAMS

Technology Transfer

- New Cooperative R&D Agreements (CRDAs) = 18
- New Patent License Agreements (PLAs) = 2
- New Education Partnership Agreements (EPAs) = 1
- New International Agreements = 2
- Small Business Innovation Research (SBIR) awards of $20.5M (consisting of 44 Phase I and 48 Phase II awards)

Current Important Programs

- A CRDA with AeroMet successfully transferred a new laser forming rapid prototyping technology called the LASFORM SM system, the largest rapid prototyping system in the world.

- A CRDA with the US Advanced Battery Consortium seeks to utilize ARL-developed additives for electrolytes used in lithium-ion batteries for future electric cars.

- Two small companies receiving SBIR Phase II awards from ARL were honored as recipients of R&D Magazine "R&D 100 Awards for developing two of the 100 most technologically significant new products of the year.

- A CRDA with MSE Technology Applications will seek to develop new metal matrix composite materials which will have significantly improved strength and durability while weighing much less than existing materials.

ARL Personnel Exchanges

- Guest researchers sent out =114
- Guest researchers in = 221
- Minimum stay is two weeks

EQUIPMENT/FACILITIES

Flame Research Facility - (WMRD)
This facility enables us to conduct sophisticated studies in flame chemistry in support of propellant combustion simulation, so that advances can be made in gun propulsion. A wide variety of state-of-the-art spectroscopic and mass spectrometric diagnostic tools are used for experimental flame measurements. These measurements can be coupled with sophisticated flame computer models to support not only gun propulsion research but other flame research of military interest, such as fire suppression/extinction, hazardous waste incineration, and soot abatement.

Aerodynamics Experimental Facility - (WMRD)
This facility is used to measure the actual flight motion of projectiles up to 37-mm caliber under realistic pressures, densities, and velocities. It is the only experimental facility in the U.S. capable of obtaining the accurate data on small and medium-caliber projectiles needed for the preparation of precise aiming data and firing tables.

Transonic Experimental Facility - (WMRD)
This facility measures the actual flight motion of large-caliber projectiles (up to 8-in. diameter) under realistic pressures, densities, and velocities. It is the only range in the free world capable of obtaining accurate data on large caliber projectiles needed for input to artillery fire-control computers and firing tables. This facility also conducts full interior ballistic testing and evaluation, from the ignition and combustion of propelling charges, through projectile in-bore travel, to muzzle exit. The facility tests and evaluates advanced conventional gun propulsion technologies, electrical propulsion concepts, and innovative propulsion schemes, such as in-bore ram acceleration.

Tungsten Alloy Experimental Facility - (WMRD)
This Experimental Facility routinely conducts full-scale terminal-ballistic experiments with both kinetic-energy penetrators and shaped-charge warheads. It is able to fully instrument the terminal-ballistic tests of all advanced armors, including reactive armor.

Cannon-Caliber Electromagnetic Launcher Experimental Facility - (WMRD)
This installation measures the launch and flight performance of electromagnetic cannons up to 30-mm caliber. Equipped with a nearly 2.0-MJ power supply and a range of 250m, it performs diagnostics on electrical, mechanical, and aerodynamic qualities of electromagnetic gun systems.

Explosive Mechanics Facility - (WMRD)
At this facility, two enclosed blast chambers can test up to 23-kg of explosive material. The chambers feature high-speed photography (2 million frames per second), flash x-ray devices, four-channel x-ray cineradiography, and high-speed recording equipment. Projectiles are fired into the chambers from an adjacent gun room. The chambers are currently being used to study thresholds in special explosives for reactive armor and fundamental initiation processes in solid explosives.

Equipment Facility 6 (EF6) - (SLAD)
This test facility gives ARL a modern, centralized complex to evaluate the effects of explosive blast and fragmentation warheads, armor-piercing incendiary and high-explosive incendiary projectile impacts, and experimental penetrators and weapons, as well as unconventional threats, on aircraft components, subsystems, and complete operating fixed and rotary-wing aircraft. This testing capability benefits our participation in the DoD Joint Live-Fire Army-Air Force Program, as well as future developmental, specification, and live-fire test and evaluation associated with major Army aviation and anti-aircraft systems. In addition to Army test requirements, EF6 supports Air Force and Navy-sponsored anti-

EQUIPMENT/FACILITIES

aircraft warhead lethality evaluations and Aircraft Battle Damage Repair techniques. Specialized test resources and facilities at EF6 include a blast pad for the evaluation of the effects of large blast/fragment warheads (of up to 100-lb of high explosives) on operating helicopters or fixed-wing aircraft, a covered full-scale dynamic turbine engine and helicopter drive train test pad, indoor and outdoor small-to-medium-caliber ballistic ranges for component and subsystem testing, EPA-approved fuel systems test capability, helicopter rotor-blade static loading fixture, remotely operated helicopter ground test tie-down, mobile airflow generator capable of 500 knots of airflow directed at targets, and a centralized test preparation and control/instrumentation building. A dedicated full-scale dynamic structural test building with ballistic capability was also constructed within EF6.

Electromagnetic Coupling Facility (EFC) - (SLAD)
The EFC supports survivability analyses of developmental weapon systems and assists materiel developers in hardening systems to withstand the effects of electromagnetic pulse (EMP) and other electromagnetic environments. The facility obtains electromagnetic coupling and response measurements through two experimental techniques, radiated continuous-wave and current injection. The Continuous-Wave Instrumentation System (CWIS) radiates sinusoidal electromagnetic fields at selected frequencies between 10-kHz and 1-GHz using two antenna systems, a 1000-ft horizontal dipole and a log-periodic antenna with a large clear 2500-m2 test volume. The ECF also features current injection devices capable of producing a broad range of double-exponential and dampened sinusoidal waveforms, including sources that meet MIL-STD-188-125 requirements. Data measured by both techniques are transmitted, via fiber-optic link and network analyzers, to the facility's instrumentation trailer. These, computational resources determine the time-domain response to transient electromagnetic radiation, including the EMP threat, and duplicate threat-level system response to EMP or other transient electromagnetic coupling.

Mobility/Portability Obstacle Course - (HRED)
This calibrated obstacle course has become an Army standard for measuring the effects of various physical load configurations on soldier mobility and physiological functions. The course consists of hard surfaces and wooded march areas and obstacles that require the soldier to run, jump, crawl, climb. Objective course data are augmented with real-time physiological data. Features of the course include: Interactive system software for information identification, storage and retrieval: integrated computerized status display for real time trail status: and data collection software to compile time, intra-obstacle time, and total elapsed time.

Small Arms Experimental Facility - (HRED)
The Small Arms Experimental Facility is a 600 meter, computerized state-of-the-art facility for examining soldier weapon performance. It consists of multiple stationary and moving targets, controlled from a computer-equipped command and control center. This experimental facility permits the engagement of targets at a wide variety of distances, target exposure times, and angles. It features four firing lanes with target exposures from 10 to 550-meters; these firing lanes can be operated simultaneously with different target scenarios. Each lane has five targets, each at 10 and 25-meters for firing personal defense weapons and three targets each at 50, 75, 100, 150, 200, 250, 300, 400, 500, and 550-meters for rifle firing. Special in-house-designed targets and pneumatically operated target mechanisms are also featured. The computerized command and control center can present programmed arrays of targets at any distance, time interval, and sequence. The computer system has a software package that records and reduces range events such as targets presented, target time, target hits, shots fired, and time of shot.

EQUIPMENT/FACILITIES

High-Performance Computing Resources - (CISD)
ARL hosts one of four DoD Major Shared Resource Centers (MSRC) for High Performance Computing (HPC) in the DoD High Performance Computing Modernization Program (HPCMP). The ARL MSRC facility, located at Aberdeen MD, features state-of-the-art scalable parallel architectures and large vector-parallel systems supporting both classified and unclassified missions throughout the DoD Research Development and Test and Evaluation (RDT&E) community. The ARL MSRC provides DoD leadership in computational science research as well as the design, development and implementation of innovative high speed networking technologies through the Defense Research and Engineering Network (DREN) initiative. In addition to the MSRC, the ARL HPC Center provides management oversight of the Army High Performance Computing Research Center (AHPCRC), located at the University of Minnesota. The AHPCRC focuses efforts toward innovative HPC research and the development and application of advanced HPC technologies for critical Army technology needs.

Composites Processing Research Facilities - (WMRD)
Advanced low-cost, reliable processing techniques are essential to the future application of structural polymer matrix composites to Army ground vehicles, aircraft, and other materiel. ARL's state-of-the-art composites processing research facilities, such as the fully automated high-temperature (800° F) and pressure (450-psi) autoclaves, provide the necessary research tools to address scientific and engineering problems in process optimization and automated process control.

Materials Characterization Facility - (WMRD)
This unique facility enables ARL's scientists and engineers to conduct highly detailed measurements of the properties of ceramics, polymers, glasses, and composites. It includes extensive state-of-the-art instrumentation for analyzing the chemical properties of materials at a wide range of temperatures, as well as a full complement of optical and electron microscopy and other electron probe instruments for microstructural analysis, x-ray residual stress analysis, and electrical, magnetic, and thermal property characterization. It also features a unique combination of surface analysis equipment.

Ion Implantation Facility - (WMRD)
At this facility, employees develop and demonstrate novel ion surface treatments and coating techniques for Army materiel, such as machine tools and parts subject to corrosive or high-wear environments. This technology is demonstrating significant improvements in the quality of protective coating techniques, such as cadmium and chromium plating. In addition, the ion-implantation process has proven to be environmentally acceptable as an alternative to cadmium, chromium, and other heavy-metal plating processes which, collectively, account for 90 percent of the hazardous wastes generated by all electroplating processes within DoD. A cooperative effort with the Corpus Christi Army Depot is demonstrating the effectiveness and cost benefits of ion-implanted machine tools such as taps, drills, and end-mills.

Special Meteorological Equipment - (IS&T)
We have developed a variety of special meteorological equipment to meet unique Army and other customer requirements that cannot be satisfied with standard laboratory instrumentation. Some examples include specialized visible and infrared transmissometers used to evaluate Army electro-optical weapon systems operating in degraded and battlefield-obscured atmospheres, and an aerosol spectrum analyzer which can efficiently excite and measure fluorescence spectra of selected individual bioaerosol particles which will lead to rapid detection and identification.

EQUIPMENT/FACILITIES

Mobile Acoustic Source (MOAS) - (IS&T)
The MOAS is a pneumatic loudspeaker system that allows scientists to verify acoustic models with atmospheric effects. The system is a true exponential horn, 56-ft long, with full fidelity from 10 to 500-Hz. Ii will generate sound sufficient for testing acoustic propagation of sources up to 15-km away. Other features include the following: (1) it is transportable, mounted on an expandable flatbed trailer, (2) it can develop 20,000 acoustic watts of power, or over 150-db, and (3) it may be remotely controlled with fail-safe software to ensure safe operation. The MOAS can reproduce realistic signals simulating any sound at various ranges and under controlled conditions, and it can broadcast single tones, multiple tones, or tape playbacks. No other system with comparable features exists in the world today.

Intelligent Optics Laboratory Research Facilities - (IS&T)
This facility at Adelphi Lab Complex is used to conduct sophisticated studies in adaptive and nonlinear optics, advanced imaging and image processing, and laser communication for ground-to-ground applications. A variety of state-of-the-art adaptive optics, wavefront diagnostics and image processing tools are used for experiments. The facility also includes complex techniques for simulation of atmospheric turbulence effects on imaging and laser communication system performance. This facility also permits the development of innovative high-speed and high resolution, optically and electronically addressed liquid crystal spatial light modulators for dynamical holography, adaptive optics and signal processing. In 2000 this facility will include a direct optical atmospheric link between the intelligent optics laboratory and a tower located 1.6 miles away. Using this direct optical link, advanced laser communication and imaging systems could be field-tested in an actual atmospheric environment.

Profiler Proof of Concept System - (IS&T)
The only mobile system in the world today that combines a real time remote sounding capability with a near real time mesoscale model for analysis and forecasts over domains of up to 500 x 500 km, all contained in a HMMWV shelter with trailer for the wind radar. Remote sensors include the wind radar, a passive microwave radiometer for temperature profiles (and total water vapor and total liquid water above the radiometer), and a meteorological satellite receiver capable of receiving the full real time data stream from both NOAA and DMSP satellites. Data from the several remote sensors and a small portable ground station are used to produce a local combined sounding from the surface to as high as 30 km. The system also contains a communications satellite receiver for obtaining data from weather centers (e.g., AFWA) and from IMETS. The system can generate a local sounding as frequently as every 5 minutes. The included mesoscale model (Battlescale Forecast Model, BFM) can generate analyses and forecasts for up to 12 hours. The model can generate an analysis and a 3-hour forecast in less than 30 minutes. The system can serve as a test bed for new algorithms and experimental hardware. Examples include (1) neural network retrievals of profiles of atmospheric variables using met satellite and ground based data as input, and (2) small single board computers for "autonomous" data processing on sensor platforms. Other areas include use of image compression algorithms for transmission of very large met data sets and new algorithms for use in the mesoscale model. The system also may be used to support test and evaluation where rapid refresh rates are required for local soundings or mesoscale areas. The Profiler is a new technology area by itself, and can be used to evaluate other new technologies.

Electromagnetics Analysis Facility (EMAF) - (SLAD)
This facility conducts full-scale investigations of the vulnerability of weapon systems to electronic warfare, including radio frequency countermeasures (RFCM), millimeter-wave countermeasures, and high-power microwaves (HPM). Electromagnetic susceptibility experiments use three anechoic chambers: the primary investigation anechoic chamber, a 94-ft long, 32-ft wide, and 25-ft high chamber; and two smaller chambers, one used for RFCM and one for millimeter-wave CM. Featuring externally modulated high-power amplifiers, the EMAF offers the capability to continuously sweep from 100-MHz

EQUIPMENT/FACILITIES

to 18-GHz and to generate pulsed RF of up to 1-MHz and pulsed waves from 50-ns to continuous-wave. The facility can also generate AM, FM, and noise-modulated RF environments to expose the system under investigation to a comprehensive set of conditions that may be encountered in a battlefield. Resident state-of-the-art computational resources are available to provide equipment automation and real-time data analysis and storage. Also featured is a computer-controlled RF-threat emulator that provides complex high-fidelity single RF-threat radar waveforms for the RFCM investigations.

Electro-Optical Countermeasures Missile Flight Simulation Facility - (SLAD)
This hardware-in-the-loop missile flight simulator evaluates the effectiveness of EO air defense missile systems in CM environments. The simulator includes major portions of actual missile-guidance and control hardware with software embedded in the simulation loop. Real-time representations are solved, using both digital and analog computers, for missile dynamics in six degrees of freedom and target motion in three degrees of freedom. A multiprocessor digital computer solves the missile aerodynamics and propulsion and the relative target-missile geometry. The analog computer models subsystems with bandwidths too high to allow real-time digital solution, such as the wing servo or gyro transfer function. A second digital computer functions as the simulation controller and supervises the real-time trajectory and field-of-view displays hosted on two PCs. The primary output from the simulation is miss distance at the point of closest approach to the target, a criterion from which the overall effectiveness of a CM technique may be assessed. Further processing of the miss distance into a digital end-game model can yield probability of hit (i.e., missile lethality) against specific threat aircraft.

Electro-Optical Data Acquisition and Tracking System (EDATS) - (SLAD)
The EDATS provides a unique capability of dynamically tracking and measuring target signatures during EW missile firing experiments. It consists of a 35-ft instrumentation van integrated with an automated tracking pedestal capable of controlling the operation of six electro-optical missile seekers in a captive track arrangement. Data collected from the captive seekers can be recorded for post-mission analysis. Video documentation of seeker responses to the EOCM environments aids quick-look analysis. The EDATS is equipped with infrared through ultraviolet spectrometers, radiometers, and imagers to obtain signatures of targets, countermeasures, and backgrounds. Automatic target tracking is achieved with a highly modified Chaparral AN/DAW-1B missile seeker or digital/analog outputs from the control computer. Manual target tracking is also available via a joy stick that operates the track mount (either remotely or directly by telescope optics). The motion of the track mount during a data run can be recorded to a computer file, which can be played back through the track mount to collect background signature data across the same path. The signature measurements of the background can then be subtracted from the target-plus-background data file to achieve target-only measurements.

Acoustic/Seismic Countermeasure Vehicle - (SLAD)
ARL operates a modified 5-ton stake-bed truck that can evaluate acoustic and seismic countermeasures by functioning as an acoustic/seismic decoy and an acoustic jammer. The vehicle houses an acoustic loudspeaker system, consisting of a 12-kW power generator, subwoofer cabinets, and power amplifiers, that can reproduce any signal within a frequency range of 40 to 200-Hz. The vehicle also tows a 750-lb tank sprocket used to generate seismic energy that produces spectral lines similar to those of ground combat vehicles but at a smaller magnitude. To simulate a moving ground vehicle target, the vehicle radiates a pre-recorded target signature as it travels along the ground. To simulate an acoustic jammer, it radiates broad-band noise designed to protect accompanying target vehicles by masking their acoustic signatures. The vehicle is currently being used to examine the effects of decoying and jamming on the Wide-Area Mine System - a system that relies on the acoustic and seismic energies emanating from a ground combat vehicle to engage it as a target.

EQUIPMENT/FACILITIES

Air Defense Electronic Warfare Facility - (SLAD)
This laboratory provides ARL with a quick-reaction capability for the implementation of EW techniques to ensure that all elements of the EW threat required for the vulnerability assessment process are addressed. Specialized hardware is developed and fabricated at this facility for the field experiments associated with surveillance, tracking, and guidance functions of Army systems. The facility supports a wide variety of special-purpose equipment, including airborne and ground-based RF jammers, EOCM equipment, passive RFCM equipment, and state-of-the-art field measurement systems. Although primarily developed to support EW vulnerability analyses, these resources have wide application and are routinely used by the other services as well as the international community.

Ultra Wideband (UWB) Synthetic-Aperture Radar (SAR) Test bed - (SLAD)
A mobile UWB SAR test bed, featuring a 150-ft measurement system, is used to support vehicle-mounted ground-penetrating radar developments, including mine detection systems. The UWB radar on a 150-ft boom lift allows for collection of two-dimensional apertures to support three-dimensional image formation for improved target detection and identification.

Zahl Physical Sciences Laboratory - (SEDD)
The Physical Sciences Laboratory is a 372,000 GSF state-of-the-art research facility. The cornerstone of this building is the 6,400 NSF class 1000 cleanroom. The facility also houses the Advanced Material Growth and Processing Facility, Display Materials Research Facility and, the Advanced Microanalysis Facility in a portion of its 78,000 NSF of general laboratory space. Other specialty space includes a 336 NSF less then 1% humidity level dryroom, a 168 NSF warm room, and a 168 NSF cold room. This lab space is fully configurable due to access points for building systems in each laboratory bay. The facility maintains a 6,000 gallon liquid nitrogen tank system and a 11,000 gallon ultrahigh purity gaseous nitrogen tank system. As well as, a closed-loop high purity processed cooling water system that also feeds the demineralized and deionized water systems. The building also uses its own acid and heavy metal waste treatment plant for waste disposal and two 1,500 kW diesel generators for 4 hours of emergency power. This site has a multiple containment stainless steel vacuum jacketed 48 line toxic gas system with central storage to increase the safety for the 400 building occupants and surrounding environment. The building also maintains separate personnel and chemical distribution corridors and a chemical elevator system from a central chemical pharmacy. These two main system and many others allow the PSL to meet all 1998 OSHA safety codes.

Electromagnetics Research Laboratory (EMRL) - (SEDD)
This facility conducts full-scale investigations of the vulnerability of weapon systems to electronic warfare, including radio frequency countermeasures (RFCM), millimeter-wave countermeasures, and high-power microwaves (HPM). Electromagnetic susceptibility experiments use three anechoic chambers: the primary investigation anechoic chamber, a 94-ft long, 32-ft wide, and 25-ft high chamber; and two smaller chambers, one used for RFCM and one for millimeter-wave CM. Featuring externally modulated high-power amplifiers, the EMAF offers the capability to continuously sweep from 100-MHz to 18-GHz and to generate pulsed RF of up to 1-MHz and pulsed waves from 50-ns to continuous-wave. The facility can also generate AM, FM, and noise-modulated RF environments to expose the system under investigation to a comprehensive set of conditions that may be encountered in a battlefield. Resident state-of-the-art computational resources are available to provide equipment automation and real-time data analysis and storage. Also featured is a computer-controlled RF-threat emulator that provides complex high-fidelity single RF-threat radar waveforms for the RFCM investigations.

EQUIPMENT/FACILITIES

Ultra Wideband (UWB) Synthetic-Aperture Radar (SAR) Test bed (SEDD)
A mobile UWB SAR test bed, featuring a 150-ft measurement system, is used to support vehicle-mounted ground-penetrating radar developments, including mine detection systems. The UWB radar on a 150-ft boom lift allows for collection of two-dimensional apertures to support three-dimensional image formation for improved target detection and identification.

Advanced Microanalysis Facility - (SEDD)
This center provides the Army and DOD with a fully integrated capability for chemical and structural analysis of electronic materials and devices. Characterization measurements reach resolution on the atomic scale and elemental detection sensitivities to parts per billion levels. The center contains surface and bulk characterization instrumentation including, secondary ion mass spectrometry (SIMS), Auger electron spectrometry (AES), X-ray photoelectron spectrometry (XPS), scanning electron microscopy (SEM) with associated techniques (EDX), powder and crystal X-ray diffractometers, Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), inductively coupled plasma mass spectrometer (ICP-MS), glow discharge mass spectrometer (GDMS), thermal desorption mass spectrometer (TDMS), surface profilometers and a host of state -of-the-art optical device characterization instruments. An added benefit of this center to the Army and DOD is the use of these capabilities on failure analysis on failed critical military devices or systems.

Power Conditioning Research Center - (SEDD)
This facility is the laboratory setting for development and component testing for high average power and high peak power defense systems requiring advanced power conditioning components to provide an efficient, compact, and protected interface between the prime power and the power electronics load. Within the facility are a unique collection of power supplies in the megawatt average power class, offering variable voltages up to 250 kV and direct current outputs up to 1200 amperes. A variety of modulators, capacitor banks, and power supplies are available that use high capability solid state (GTO and thyristor), thyratron, ignitron and spark gap switching. The test beds are configured for testing high average power components, power conditioning, loads such as directed energy devices, high average power devices, and also diagnostics and sensors. The extensive inventory of high voltage components permits other configurations to be arranged to satisfy the specialized requirements of facility users.

Millimeter-Wave Instrumentation Test Facility - (SEDD)
Here, specialists conduct basic research in propagation phenomena, remote sensing, and target signatures over the frequency range from 8 to 300-GHz. The facility is unparalleled in the breadth and depth of its instrumentation and analysis capability. Components and test equipment are available that can be readily configured for conducting feasibility studies of sensor concepts. Supporting tools include high-speed data acquisition and analysis systems, visualization tools, and model generation for performance evaluation. Through a synergistic relationship with the U.S. Army Combat Systems Test Activity (CSTA), ARL can conduct range testing using this facility with a minimum of in-house resources.

Acousto-Fluidic Test Facility - (SEDD)
At this location, a full acoustic anechoic chamber allows the study of fluidic sensors, fluidic signal processors, and other microphone systems. Fluidic microphones, with a flat bandwidth down to a true zero hertz (DC), can be configured to be more sensitive than any commercially available microphone. In addition to the research being conducted on these fluidic microphones, they can also be used as a research tool for other programs requiring increased sensitivity and nonelectronic acoustic sensing.

EQUIPMENT/FACILITIES

Display Materials Research Facility - (SEDD)
This facility is for the research and development of the materials, structures, and devices which will be the basis for the displays and display systems which the Army will need for our soldiers to effectively display and assimilate data on the digital battlefield. Some capabilities for luminescent research include: facilities for low and high voltage electron beam cathode luminescence (CL), electroluminescence, photoluminescence [Vacuum Ultraviolet-Near Infra-red (VUV-NIR), Raman, Raman imaging, Near Field imaging, reflectance/transmittance], Fourier transform spectrometer, and photometry. For device structures fabrication, there is an Atomic Layer Epitaxy Chemical Vapor Deposition (ALE CVD) reactor, a Radio Frequency sputtering system for electrodes, Rapid Thermal Annealing, sol-gel processing, and a multi-source system with laser ablation, sputtering, and thermal cells.

Advanced Material Growth and Processing Facility - (SEDD)
Is an advanced, centralized set of labs capable of producing cutting-edge semiconductor materials. The facility is equipped with six state-of-the-art molecular beam epitaxy (MBE) and one metal-organic chemical vapor deposition (MOCVD) systems. These systems enable the growth of advanced III-V and II-VI semiconductors such as GaAs, AlGaAs, InGaAs, InP, GaSb, GaN, and HgCdTe that are used in a myriad of optical (lasers, detectors, etc.) and electronic (FETs, thyristors, etc.) components. The growth facility provides state-of-the-art capability in fine-line lithography (0.01 um), plasma etching, metals deposition, etc. that allows large scale device level processing. This facility represents a unique situation where quite extensive capabilities are located in a central set of labs

Army Research Laboratory
Adelphi, MD 20783-1197
(301)394-1067

Director: Dr. Robert W. Whalin
Assistant Director PPB: Mr. John Miller

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	34.186	1.714	146.085	181.985
6.2	81.339	0.907	77.304	159.550
6.3	2.698	0.522	44.462	47.682
Subtotal (S&T)	**118.223**	**3.143**	**267.851**	**389.217**
6.4	3.840	0.033	2.852	6.725
6.5	0.000	0.000	0.000	0.000
6.6	51.602	0.780	66.442	118.824
6.7	1.256	0.007	0.574	1.837
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**174.921**	**3.963**	**337.719**	**516.603**
Procurement	4.235	N/A	20.172	24.407
Operations & Maintenance	13.546	N/A	15.684	29.230
Other	28.384	N/A	22.923	51.307
TOTAL FUNDING	**221.086**	**3.963**	**396.498**	**621.547**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	1.300

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	7	18	22	**47**
CIVILIAN	349	922	908	**2179**
TOTAL	**356**	**940**	**930**	**2226**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1402.000	**REAL PROPERTY**	697.000
ADMIN	880.000	* NEW CAPITAL EQUIPMENT	0.300
OTHER	760.000	**EQUIPMENT**	581.906
TOTAL	**3042.000**	* NEW SCIENTIFIC & ENG. EQUIP.	12.240
ACRES	**5645**	* Subset of previous category.	

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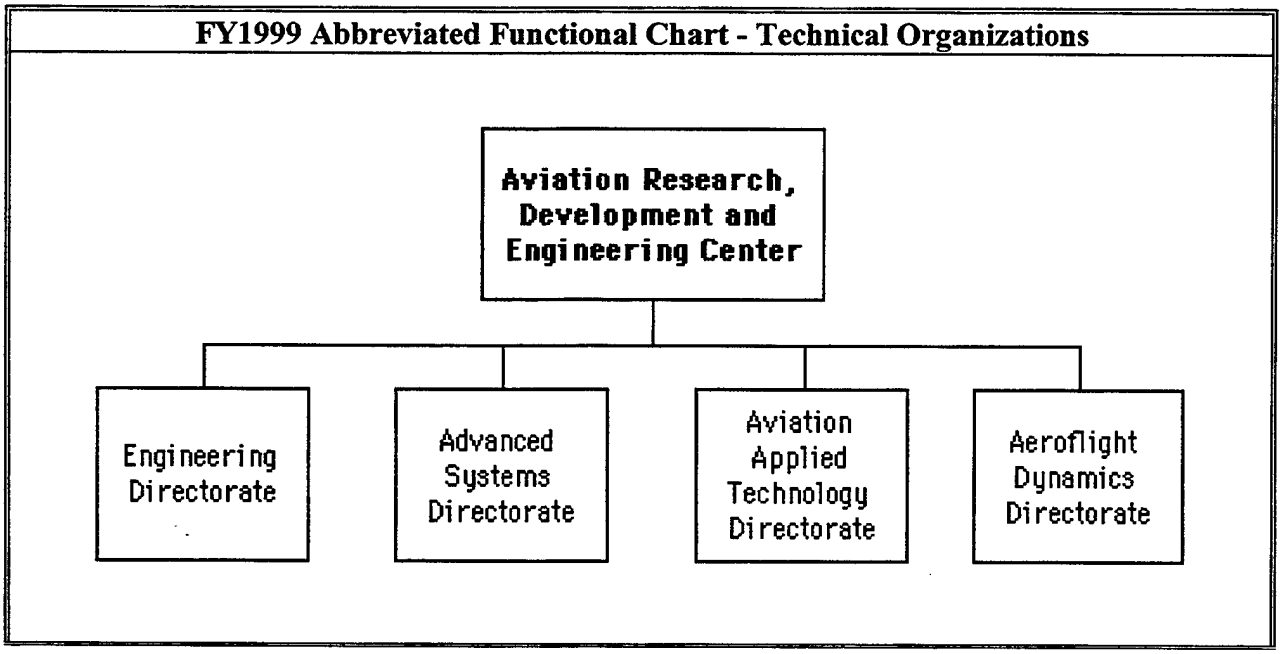
Aviation Research, Development and Engineering Center



Aviation Research, Development and Engineering Center
Redstone Arsenal, AL 35898-5241
(256)842-2201

Director: Robert V. Kennedy
Associate Director: John B. Johns

MISSION

Execute the DoD Rotorcraft Science and Technology program and provide "one-stop" engineering support to all life cycle phases as required to achieve technologically superior, safe, and supportable Army aviation systems and equipment. The Aviation RDEC has the responsibility to plan and, in most cases, execute the fundamental basic research, exploratory development, and advanced development programs supporting DoD rotorcraft needs in the areas of aeromechanics, propulsion, structures, reliability and maintainability, survivability, weaponization, avionics mission equipment, and systems integration/simulation.

CURRENT IMPORTANT PROGRAMS

Joint Turbine Advanced Gas Generator III; Advanced Rotorcraft Transmission; Rotary Wing Structures Technology; Cockpit Airbags; Rotorcraft Pilots Associate; Airborne Manned/Unmanned Systems Technology; Rotorcraft Open System Architecture; Low Cost Precision Kill 2.75 Rocket; Helicopter Active Control Technologies; Structural Crash Dynamics Modeling and Simulation; Variable Geometry Advanced Rotor Technologies; Advanced Rotorcraft Aeromechanics Technology; Low Cost Active Rotor; Rotorcraft Enhanced Survivability Technology; Unit Maintenance Aerial Recovery Kit; Advanced Composite Field Repair NDI/NDT; Advanced Cargo Handling

Cooperative Research and Development Agreements (CRDAs):

Company: Boeing
Subject: Simulation Use of RPA Cockpit in Manned/Unmanned Aerial Platform Operations on the Digitized Battlefield

Company: Carson Services
Subject: Helicopter Composite Main Rotor Blade Specimen Testing

Company: Sikorsky Aircraft
Subject: T-700 Engine Advanced HIRSS Technology Program

Company: Robertson Aviation
Subject: Design and Fabrication of Tactical, Crashworthy Self Sealing External Fuel Tanks

Company: Sikorsky Aircraft
Subject: Aviation Manned/Unmanned Systems Technology Requirements Definition

Company: Allied Signal Corp.
Subject: Laser Air Data & Wire Detection System

Company: Boeing
Subject: Rotorcraft Operational Capabilities Study

CURRENT IMPORTANT PROGRAMS

Company: Sikorsky Aircraft
Subject: S-92 flow studies using CFD methods for predicting the change in drag.

Company: Microbotics
Subject: Development and application of artificial intelligence technology and sensors to Army vehicles.

Company: Boundary Layer Research Inc.
Subject: Research collaboration on the strake invention, as it is being applied to the UH-1.

Company: Carson Helicopters
Subject: Design and test collaboration for an advanced main and tail rotor system for the S-61.

Company: Boeing-Philadelphia.
Subject: Development and testing of MIDAS (Beta Testing) use for evaluations of civil tilt rotor.

Company: Boeing-Seattle
Subject: Use of CONDUIT in support of Joint Strike Fighter

Company: Boeing Helicopters Philadelphia
Subject: Use of CONDUIT in Support of Boeing Digital SCAS Development

Company: Lockheed-Martin
Subject: Use of CONDUIT Control to optimize Tilt Rotor Handling

Company: Bell Helicopter
Subject: Use of CONDUIT Control to optimize Tilt Rotor Handling

Company: Boeing-Long Beach
Subject: Use of CONDUIT in Support of Flying Qualities Research

Company: Kaman Helicopter
Subject: Application and use of CONDUIT Control Systems Design to optimize design of the SH2G and unmanned KMAX (BURRO) AFCS.

Company: Northrop-Grumman
Subject: Use of CONDUIT to support VTUAV project development.

EQUIPMENT/FACILITIES

Crew Station Research and Development Facility: Three blue/red team stations; fiberoptic helmets; one or two seat standard cockpit; Mission Equipment Simulation Evaluation Facility (MESEF) Cockpit; technical center can simulate 11 other aircraft, 99 threats, 20 moving targets, and C3.

Flying Laboratory for Integrated T&E (FLITE): modified AH-1S aircraft; Apache PNVS; reconfigurable voice I/O system; flight symbology; fully integrated instrumentation.

NASA-Ames Vertical Motion Simulator: Four interchangeable cabins with virtual TV display; six DOF motion, acceleration, and velocities; sound generation system; pilot and co-pilot positions.

NASA-Ames Helicopter Human Factors Research Facility: Four part-task simulators to investigate; geographic orientation, visual cues simulator, voice actuated controls, and pilot decision-making.

NASA-Langley 14x22 Wind Tunnel: VSTOL/200 knots/variable test section; flow visualization and diagnostics; acoustics capability.

Countermeasures Test Facility: IR suppression fabrication shop; engine and test stand with indoor and outdoor test ranges; Sun workstation and software for test data recording and analysis, and design and simulation of IR suppressors.

Vehicle Antenna Measurement Facility: Automated antenna gain pattern measurement and adjustable vehicle rotation system capable of 360 degree azimuthal radiation pattern measurements of antennas and RF sensors on vehicles up to 40K lbs. GW an 36' WB.

Ballistic Test Range: Two outdoor and one indoor test range, fully instrumented for data collection and analysis; fuel recovery system; API and HEI up to 30mm in caliber. Experimental fabrication facility. Full-scale aircraft and component structural test facility.

Structural Test Facility: Full-Scale rotor blade test fixture, full-scale rotor blade root end test fixture, torsional fatigue test facility, full-scale aircraft test facility, MTS and Instrom load frames, environmental test chamber.

Research Support Area: Model Shop, Machine shop with NC control machines.

NASA-Ames 40x80x120 Wind Tunnel: NASA-Ames 7x10 Wind Tunnel; NASA-Ames Automation Sciences Research Facility; NASA-Ames Numerical Aerodynamics Simulator; NASA-Ames Fluid Mechanics Laboratory; NASA-Ames Hover Anechoic Chamber.

Aviation Research, Development and Engineering Center
Redstone Arsenal, AL 35898-5241
(256)842-2201

Director: Robert V. Kennedy
Associate Director: John B. Johns

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.222	N/A	N/A	1.222
6.1 Other	1.072	0.022	2.536	3.630
6.2	10.053	0.527	12.119	22.699
6.3	5.145	0.241	38.723	44.109
Subtotal (S&T)	**17.492**	**0.790**	**53.378**	**71.660**
6.4	1.975	0.104	6.109	8.188
6.5	2.652	0.117	6.627	9.396
6.6	2.766	0.132	8.314	11.212
6.7	2.626	0.135	11.267	14.028
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**27.511**	**1.278**	**85.695**	**114.484**
Procurement	5.516	N/A	10.091	15.607
Operations & Maintenance	7.093	N/A	3.774	10.867
Other	2.934	N/A	4.689	7.623
TOTAL FUNDING	**43.054**	**1.278**	**104.249**	**148.581**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	10	**10**
CIVILIAN	23	282	150	**455**
TOTAL	**23**	**282**	**160**	**465**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	91.644	**REAL PROPERTY**	6.652
ADMIN	90.154	* NEW CAPITAL EQUIPMENT	0.000
OTHER	47.626	**EQUIPMENT**	28.795
TOTAL	**229.424**	* NEW SCIENTIFIC & ENG. EQUIP.	0.148
ACRES	**5**	* Subset of previous category.	

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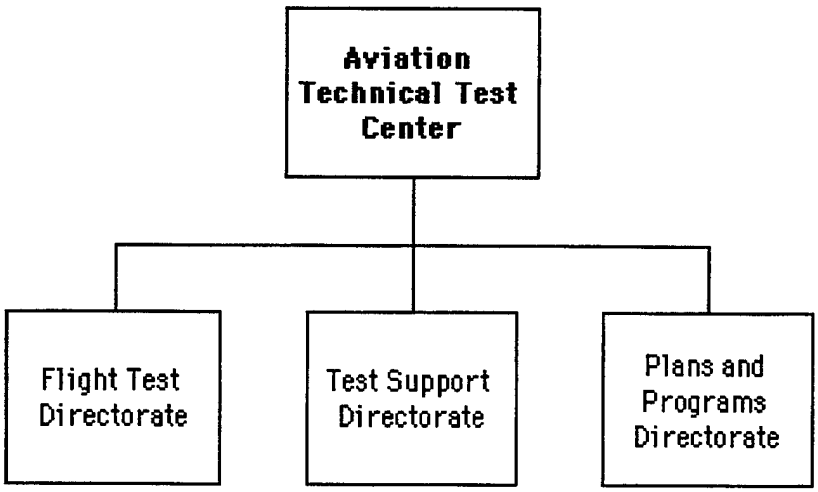
Aviation Technical Test Center

FY1999 Abbreviated Functional Chart - Technical Organizations



Aviation Technical Test Center
Fort Rucker, AL 36362-5276
(334)255-8000

Commander: COL Austin R. Omlie
Tech Director: Larry E. Eagerton

MISSION

Plan, conduct, analyze, and report on airworthiness qualification and developmental testing of aircraft, aviation systems, and associated equipment during development and throughout the materiel life cycle to optimize Army Aviation warfighting capabilities as well as meeting the requirements of the joint services, Federal agencies and the commercial aviation sector.

CURRENT IMPORTANT PROGRAMS

CH-47F (IMPROVED CARGO HELICOPTER) PROGRAM. ATTC has participated with Boeing Helicopters in a Combined Test Team to qualify technologies to be inserted into the CH-47F. The T55-GA-714A engine/Full Authority Digital Engine Control (FADEC) qualification effort enables the CH-47D and CH-47F to meet critical performance measures to include a combat radius of 100 nautical miles with an M198 Howitzer. During the Enhanced Air Transportability Kit development and demonstration, the airframe was modified to allow removal of the aft pylon and transmission as a unit in 45% of the previously required time. Removal of the aft pylon is required for air transport in C-5A aircraft.

UH-60 MODERNIZATION PROGRAM. ATTC has joined efforts with Sikorsky Aircraft Corporation as a Combined Test Team (CTT) to qualify the Wide Cord Blades (WCBs) and the Advanced Flight Control Computer (AFCC). The WCB is designed to provide additional lift capabilities at higher gross weights, and the AFCC is designed as a drop-in replacement for the stability augmentation system/flight path stability (SAS/FPS) computer currently installed in the UH-60 which is becoming obsolete. Both of these programs/efforts are Dual Use Application Programs (DUAPs) initiated by Sikorsky and intended to be a part of the UH-60L+ and UH-60X modernization effort. Flight testing on both programs has been completed.

FLIGHT DEMONSTRATION OF THE PROTOTYPE COMANCHE RISK REDUCTION PILOT NIGHT VISION SENSOR (CRR PNVS) SECOND-GENERATION FORWARD-LOOKING INFRARED (FLIR) ON THE AH-64A APACHE. The CRR PNVS program incorporated and demonstrated the Comanche Second-Generation FLIR technology in a modified AH-64A Apache PNVS test-bed. The Apache Project Manager's Office, Lockheed-Martin Corporation, and ATTC teamed to conduct this risk reduction demonstration. FLIR testing was conducted in four phases: integration fit and function, engineering ground testing, engineering flight testing, and a mission-task evaluation. Flight testing was completed in November 1999. ATTC is supporting integration of the Kaiser helmet-mounted display system and the Second-Generation FLIR for a systems demonstration test in January and February 2000.

RAH-66 COMANCHE TEST PROGRAM AND FLIGHT TEST. ATTC, as an integral part of the Comanche Combined Test Team, continued Comanche flight test activities in 1999 at the Sikorsky Development Flight Center in West Palm Beach, FL. The focus of testing included the support of preliminary design efforts related to the follow-on Preproduction Program (PPP) configuration (which will include Aircraft 3-15), and Milestone II Exit Criteria. PPP design-related testing included investigations into issues that may have significant impact on the final design, to include tail buffet, Fantail performance, thermal investigations, and main rotor behavior. Milestone II-related testing included infrared signature, vertical climb performance, and fault diagnostics/ supportability issues. The second DEM/VAL aircraft (AC02) made its first flight in April 1999, joining AC01 as part of the developmental test program.

CURRENT IMPORTANT PROGRAMS

RAH-66 COMANCHE TEST PROGRAM – FLIGHT TEST SIMULATION STATION (FTSS). Development of the FTSS continued throughout CY99 at the Sikorsky Flight Test Center in West Palm Beach, Florida, Advanced Rotorcraft Technology (ART), and at the Anacapa Science/ThoughtWave contractor sites. Achievements include development of major components of the Comanche flight dynamics model, LHTEC T-800 engine and flight control system models using FlightLab software. Custody was taken of the Piloted/Remote Intelligent Symbology Management Simulator (PRISMS) hardware. PRISMS software enhancements were made to the host rotorcraft model. Analysis capabilities were enhanced with the purchase of I-deas structural dynamics software. FTSS hardware and software were shown at the STEP Expo and ITEA Workshop. Two FTSS technical papers were published. Efforts were made toward the High Level Architecture compliance of FTSS.

OH-58D(R) CONTROL DISPLAY SYSTEM VERSION 4. ATTC was teamed with Yuma Proving Ground, Arizona; Bell Helicopter Textron, Incorporated; Honeywell Systems, and the Scout Attack Project Manager's Office to evaluate the next-generation improved master control processor unit (IMCPU) and software. The IMCPU will incorporate an improved processor chip designed for future growth and new software to handle new joint variable message format digital communications. Testing is scheduled for the 4th quarter FY00 at YPG.

AIR WARRIOR SYSTEM. The Air Warrior (AW) System is designed to provide the Army aviation community with a mission-tailorable system that standardizes and integrates mission and individual equipment for aircrew personnel during flight and ground operations. Initially, AW will integrate existing aviation life support equipment (ALSE) with technical insertions of new equipment in the future. ATTC has been tasked to develop, fabricate, and qualify an electrical wiring harness to connect all personnel-mounted electronic components to a single-point disconnect. The design of AW will concentrate on ensuring the mission equipment and ALSE will interface with aircraft-mounted equipment through a common interface and designed-in compatibility. ATTC will support AW development through the Engineering, Manufacturing, Development-phase (Milestone III decision).

UH-1H/CTS800-54 ENGINE INTEGRATION PROGRAM. This is a joint U.S. Army and Army National Guard effort to design and test the integration of the CTS800-54 engine (a civil variant of the Comanche T800-LHT-801) as a replacement for the current T53-L-13 engine. For this program, the ATTC is acting as the contract administrator, system integrator and combined test team lead. During 1999, the ATTC completed the integration of two aircraft and approximately 20 hours of ground testing. Flight test is currently scheduled for 2nd Qtr 2000.

EQUIPMENT/FACILITIES

Nineteen rotary and fixed-wing aircraft are currently assigned (3 AH-64A, 2 CH-47D, 1 C-23A, 2 OH-58D, 3 UH-1H, 4 UH-60A, 1 UH-60L, 1 U-21H, 1 EH-60A, 1 RC-12G) as test beds. Helicopter Icing Spray System (HISS): a CH-47D with an integrated 1,800-gallon water tank and spray apparatus combined with a highly instrumented U-21H/RC-12G to provide cloud physics documentation, conducts in-flight icing evaluations under both artificial and natural conditions. Full flight test instrumentation capability exists. Analog and digital aircraft data can be recorded and/or telemetered to the ground. On-site data processing and display exist--real time and postmission. Capability to collect and process video, still, and high-speed pictures exists. C-23A aircraft serves as a multi-sensor, configurable test bed for comparative side-by-side testing.

Aviation Technical Test Center
Fort Rucker, AL 36362-5276
(334)255-8000

Commander: COL Austin R. Omlie
Tech Director: Larry E. Eagerton

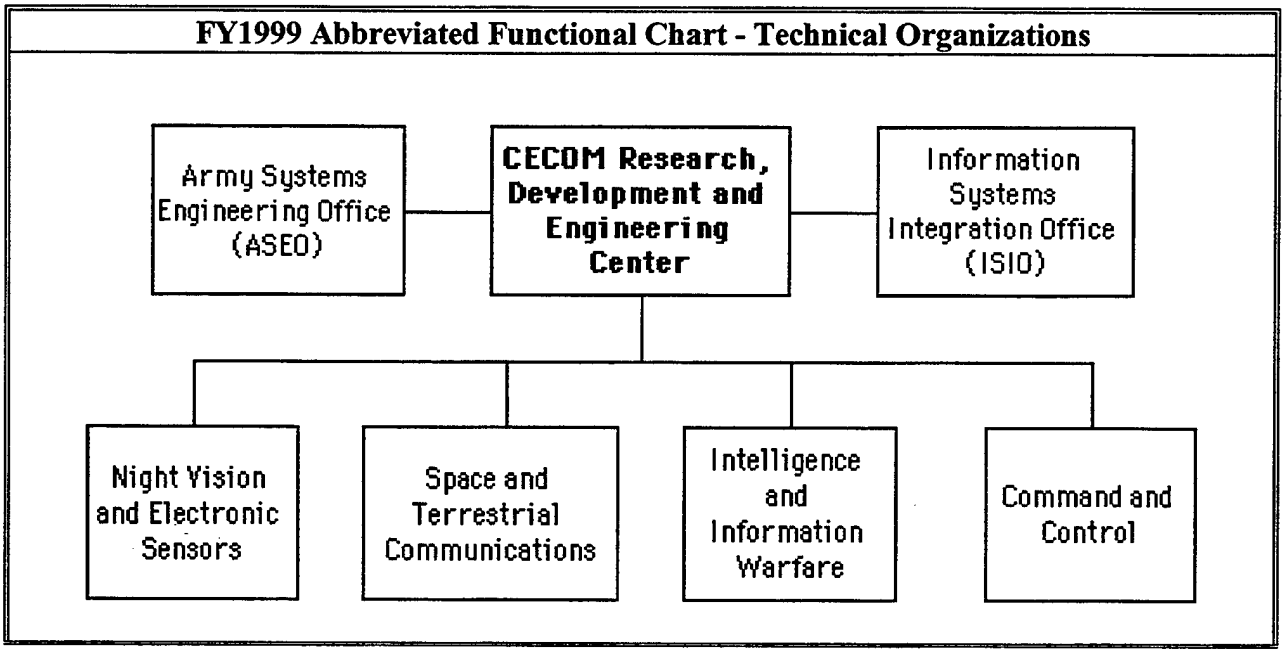
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000
6.3	0.000	0.000	0.000	0.000
Subtotal (S&T)	**0.000**	**0.000**	**0.000**	**0.000**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	0.000	0.000
6.6	10.020	0.000	0.000	10.020
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**10.020**	**0.000**	**0.000**	**10.020**
Procurement	0.645	N/A	0.000	0.645
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	1.180	N/A	0.000	1.180
TOTAL FUNDING	**11.845**	**0.000**	**0.000**	**11.845**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	0	0	21	**21**
CIVILIAN	2	28	56	**86**
TOTAL	**2**	**28**	**77**	**107**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	0.000	**REAL PROPERTY**	3.600
ADMIN	89.633	* NEW CAPITAL EQUIPMENT	0.000
OTHER	125.004	**EQUIPMENT**	106.373
TOTAL	**214.637**	* NEW SCIENTIFIC & ENG. EQUIP.	0.433
ACRES	**11005**	* Subset of previous category.	

CECOM Research, Development and Engineering Center



CECOM Research, Development and Engineering Center
Ft. Monmouth, NJ 07703-5209
(732)427-2686
Director: Dr. Louis C. Marquet
Associate for System: George R. Oliva, Jr.

MISSION

To provide America's Warfighter with superior information technologies and integrated systems enabling battlespace dominance by identifying, developing, evaluating and tailoring emerging information technologies; by facilitating the transition of selected technologies into operational systems; and by performing and promoting System of Systems integration.

Vision: To be the universally recognized leader in providing information dominance capabilities to America's warfighters, "...so overwhelming that decisive victory is achieved."

CURRENT IMPORTANT PROGRAMS

Night Vision and Electronic Sensors:

The Multi-Function Staring Sensor Suite (MFS3) Program will develop the next generation sensor suite primarily for use on ground vehicles for wide area search and long range target identification. The MFS3 will demonstrate a modular, reconfigurable Multi-Function Staring Sensor Suite utilizing sensor fusion and multiple advanced sensor components including staring infrared arrays, multifunction laser, and acoustic arrays. The MFS3 will provide ground vehicles, amphibious assault vehicles, and surface ships with a compact, affordable sensor suite for long range non-cooperative target identification, low signature target acquisition, mortar/sniper fire location, and air defense targeting against low signature UAVs and long range helicopters.

The Ultra Low Power, Ultra Low Volume and Ultra Low Weight (UL3) Infrared Camera represents a revolution in thermal imaging technology and supports the Medium Strike Brigade by providing a foundation for the Warrior Extended Battlespace Sensor program. This camera is a long wave infrared sensor that is unique in size and weight and in its temperature stabilization method which does not use a thermal electric cooler as is typically done. The camera will be used in applications such as APLA, soldier systems, border surveillance, robotics, unmanned aerial vehicles payloads, and physical security. The completed camera is expected to consume less than 600 milliwatts of power, weigh 2.5 oz, and have a volume of less than 4 cu in. The camera is designed to have a single element lens with a 40 degree by 30 degree field of view.

The Humanitarian Demining Research and Development Program focuses on the testing, demonstration and validation of equipments suitable for immediate use in various international humanitarian demining environments. The program concentrates on R&D technologies that reduce the time and cost associated with demining while improving the overall safety of the operator. This is accomplished through the adaptation of commercial off-the-shelf equipment, integration of mature technologies, and the leveraging from past and current R&D project activity in the tactical countermine and unexploded ornnance clearance mission areas.

Command and Control:

The Battlespace Command and Control (BC2) ATD is a four year advanced development program

CURRENT IMPORTANT PROGRAMS

with the objective of exploiting information technologies that can enhance the science of Battlefield Visualization (BV) which is a key element in two phases of battle command: Mission planning, and Rehearsal and Execution Monitoring. BV is the cognitive process whereby the Commander develops a clear understanding of his current state (enemy and environment), envisions a desired end state, and visualizes the sequence of activity that will move his force from its current state to the desired end state. The approach we use is to: Identify critical requirements that can be addressed by applying information technologies; Leverage and extend commercial and DOD Techbase technologies to develop initial solutions; Use a spiral development process, with warfighters at AWEs, to evolve and refine capabilities; and Incremental transition of selected solutions to production systems. The Technologies we are developing include Course of Action development and analysis tools, 2D / 3D terrain visualization tools, High resolution displays, and Human-computer interface Technology.

The High Energy, Cost-Effective Electrochemical Power Sources STO is a joint effort between CECOM RDEC and ARL to develop high energy, cost-effective electrochemical power sources. The objectives to be obtained by this STO are to develop hybrid power systems optimizing rate and energy; develop lighter weight, lower cost primary and rechargeable batteries; and develop universal charging capability for forward field battery charging.

The Logistics Command and Control ATD Program will enable the logistics commander to shorten the operation decision cycle and optimize resources. The objective includes transitioning the following products to PM CSSCS: Course of Action (COA) software for CSS, Data exchange, and Automated CSS data input. The program will produce a wide variety of battle planning, agent services and platform data collection tools. The tools are prototyped, refined in user experimentation then either transitioned not only to PM CSSCS, but also to the entire ABCS community. Objectives for FY 2000 are to: Demonstrate technologies, transition first software capability to PM, develop COA Tool Development, and test platform data collection.

Intelligence and Information Warfare:

Warfighting Electronic Collection and Mapping STO. This system will use evolving multi-function radios as local threat collection system and emitter mapping to provide real time tactical level alerts, warnings and emitter location plus add capability against obscured or terrain masked emitters.

Joint Intelligence Surveillance & Reconnaissance ACTD. JISR provides a new capability for the Brigade Commander, distributed, nonlinear battlefield operations, and an independent mode of Brigade Intelligence operations. For the first time the Brigade Commander will be able to draw-down real time, intelligence data from a combination of National and Tactical assets and get in integrated Blue and Red forces picture.

Integrated Situation Awareness and Targeting ATD. ISAT will address near, mid and far term Army priorities in Information Dominance through the ability to identify, locate, and target hostile forces using tactical platform survivability systems as non-traditional information sources.

Space and Terrestrial Communications:

Tactical Command & Control (C2) Project is an Advanced Technology Demonstration designed to develop, integrate and validate hardware and software tools that will secure the systems and networks of the First Digitized Division (FDD) and beyond. This SARD-funded program will be applicable to tactical Army networks, and will work in conjunction with the C2 Protect (DISC4 funded) which is

CURRENT IMPORTANT PROGRAMS

applicable to any tactical Army network, as well as posts, camps and stations. The goal of this program is to protect the information process and dissemination through systems and networks, ensuring confidentiality, integrity and assured delivery to the correct recipients. Receiving trustworthy and reliable information enables the warfighter to make more accurate decisions.

Multifunctional On-the-Move Secure Adaptive Integrated Communications (MOSIAC). Our technical objective is to develop communications systems and adaptive mobile network protocols required for enhanced Battle Command mobility, a reduced battlefield signature and increased survivability. Areas of focus within this program are bandwidth management, adaptive network protocols to support infrastructure mobility, and integration of commercial and DoD wireless technologies. The success of this program will enable the warfighter to develop and execute battlefield concepts and plans without impediments by providing seamless, wireless connectivity, providing the tactical commander the flexibility required to carry out the mission.

Wideband Radio Networking (WRN) Program: There is currently a need for new wideband network waveforms and radios with higher data rates than those provided by the current legacy radios, such as SINCGARS, EPLRS, NTDR, etc. The Wideband Radio Networking (WRN) STO and program was initiated in 1998 to facilitate the development of these new waveforms, as required by the Joint Tactical Radio System (JTRS) and the Army's future digitized battlefield. The items being developed under the program shall provide an enhanced wideband network development environment within the CECOM Digital Integrated Laboratory (DIL) and includes a modular software programmable Wideband Network Radio (WNR); a Wideband Radio Network Test bed (WRNT); a Software Development Environment (SDE) for the WNR; and a candidate wideband network waveform.

EQUIPMENT/FACILITIES

The CERDEC boasts many world-unique and U.S. Government-unique facilities supporting a broad range of technical areas. A sampling of our state-of-the-art equipment and facilities follows.

The Digital Integrated Laboratory (DIL) is a dynamic world-class distributed integration facility that electronically links distributed CERDEC labs, industry facilities, Battle Labs, field sites, as well as joint and allied activities. The DIL can be rapidly reconfigured to replicate diverse existing and evolving tactical C4I2W battlefield environments for systems engineering, development, integration, and evaluation of the digital battlefield. The DIL played a major role in the testing of systems for TFXXI and the Division AWE. It is expected to play a similar role in the evaluation of interoperability of systems prior to fielding as part of the First Digitized Army Division, the first digitized corps and the continued digitization of the Army, to include the new Medium Brigade.

Intelligence and Information (I2) Warfare Facility. Completed in 1997, this 89,000 square foot facility houses the I2 Simulation Lab, an Anechoic Chamber and the High Bay System Integration Lab. The facility has limited access and Sensitive Compartmented Information Facility (SCIF) areas. It has enabled CERDEC to expand our world-class R&D capabilities in the areas of signal intelligence, intelligence collection, intelligence data fusion and electronic countermeasures. In 1999, I2 acquired the NVES Directorate North programs and another state-of-the-art simulation laboratory and EOIR laboratory were assembled within the existing facility.

The Semiconductor Microfactory has introduced a revolutionary approach to the rapid prototyping of semiconductor materials for future infrared sensors. This processing line depends on vapor phase

EQUIPMENT/FACILITIES

processes and the use of high vacuum cluster equipment that prevent contamination of the microchips as often occurs on conventional manufacturing lines. The Microfactory occupies 3200 sq. ft and features the ability to carry out all fabrication steps, i.e. epitaxial growth, metallization, etching, and passivation while maintaining a wafer in the protective environment of a high vacuum system.

The Virtual Prototyping and Simulation Facility is a state-of-the-art facility that can be used for various activities to include simulation and assessment demonstrations, Advanced Warfighting Experiments, providing virtual reality capability, training support, red team/blue team exercises, video teleconferencing. It's main viewing area seats 36 and presentations are projected onto a 24 x 64-ft. screen. Its computer capabilities include high-end Silicon Graphics computers, SGI and Sun workstations as well as PCs. Computer-aided Design (CAD) and analysis software is used to create and test virtual prototypes. Various night vision sensors can be simulated through the Paint the Night software program that includes atmospheric and sensor effects with realistic virtual vehicles and terrain databases.

NVESD's outstanding facilities for Fabrication and Integration of prototypes, surrogates and components provides comprehensive in-house manufacturing capability for a range of small high precision components up to heavy steel and vehicle-based systems. A 56,750 square foot fabrication facility is staffed by mechanical engineers, machinists, sheetmetal mechanics, welders and engineering technicians. The integration facility and staff specializes in small quantity, custom, and surveillance/optical systems and is fully equipped to construct and install prototype and surrogate items for R&D test beds.

Three test facilities are operated at nearby Fort A.P. Hill, Va. **The Observation Range** is used for ground-to-ground, air-to-air and ground-to-air sensor operations and evaluation. It contains a heliport with two pads and a hanger, a 12-bay observation building overlooking an 800 x 3500 meter long line of sight observation range with 20 surveyed and monument points to provide exact target locations. **The Laser Range** is a unique and highly instrumented facility allowing users safe testing of non-eyesafe lasers. It contains four bays, an isolation platform and an elevated platform. Targets of interest can be deployed for ground an air testing at six discrete target ranges all with high voltage, high current commercial power. **Range 71A** is uniquely suited to test mine detection equipment and is specially located to allow high impact explosive demonstrations.

NVESD's newest clean room will be utilized to fabricate both cooled and uncooled infrared detectors. This facility will house both a class 100 clean room and a "white" room. It will have photolithographic and metalization capabilities to allow detector array patterning, reticulation, and contact metalization of microfactory grown samples. The "white" room will provide packaging and discrete device testing facilities.

The NVESD Mine Lanes Facility at Ft. Belvoir was built in 1959 to support Countermine testing. Six mine lanes, each 8-feet wide by 6-feet deep by 108-feet long contain five different soil types (sand, gravel, clay, loam, and magnetite). Two lanes have the same type soil. The lanes are separated by nonmetallic barriers to prevent the mixing of soils between adjacent lanes and prevention of false alarms that metallic barriers would produce. Various buried mine targets can be emplaced in this clutter-controlled environment. The entire shelter is nonmetallic to reduce any possible adverse effects on highly sensitive mine detectors. Three ceiling mounted trolleys are in place on which to mount detection systems and sensors. A control room overlooking the lanes is complete with recording and monitoring devices and contains controls to operate the trolleys. The facility has traditionally been used for hand-held mine detector evaluation, primarily electromagnetic induction sensors and more recently to test ground penetrating radar sensors. It is often used for briefings and to give technical demonstrations.

EQUIPMENT/FACILITIES

Power Sources Battery Test Facility. This facility performs safety, performance, quality and reliability tests on state-of-the-art power sources for the Army. Everything from developmental prototypes to high volume production samples can be tested to include all types of primary and rechargeable batteries, hybrid power sources, fuel cells and thermophotovoltaic devices.

Navigation Laboratory. This lab provides the capability to evaluate a wide number of navigation sensors and system integrations. It includes a GPS Satellite Signal Simulator, Doppler Navigation System Fault and Aircraft Simulator, as well as the Precision Navigation System. The GPS simulator provides the full Precise Positioning Service signal to a GPS receiver, injects jamming signals, and models dynamic platform trajectories and aiding sensor inputs (Doppler, Inertial and Altimeter). The Navigation Mobile Van is a 36-foot vehicle configured to provide a mobile laboratory environment for field testing of navigation technology.

Communications System Design Center (CSDC). This laboratory is for evaluating and experimenting with fielded voice and data communications systems. This center includes the following: MSE Support Facility (circuit and packet network systems); Development Engineering Facility (in-house design/development/product improvements/unique devices); System of Systems Central Patching; Army Integration Network (AIN) Terminal (communications with sites worldwide); Advanced Network Technology Facility (ATM Switching); Networks Management Facility (ATM switching systems) and Classified Data Processing Center.

Satellite Communications (SATCOM) Engineering Laboratories (SEL). The SEL supports research development, performance evaluation, system certification testing and anomaly resolution of space dependent and space based communications systems and equipment in the UHF, SHF, and EHF frequency bands. The SEL has four functional areas: Strategic Sys Lab, Control Systems Lab, Tactical Sys Lab, and Broadcast Management Center. All of the labs are interconnected with each other as well as to the CECOM Software Engineering Center and other CERDEC Digital Integrated Labs. This allows full connectivity to DISA for AIN, SIPRNET, NIPRNET, JWICS, etc. access and permits joint testing with the other services, battle labs, academia and industry. There are several unique assets in the labs, such as AN/GSC-39 SATCOM Terminals, DSCS III Satellite Simulator, Digital Communication Satellite Subsystem, Standardized Tactical Entry Point, UHF SATCOM Manpack Terminals, 5KHZ and 25KHZ DAMA UHF Satellite Test Emulators, and prototype SATCOM on-the-move antennas.

Wideband Communications Mobile Network Environment (WCMNE) This S&TCD laboratory supports the research and development of advanced communications protocols and technologies for tactical mobile users, specifically dismounted, handheld and vehicular. The facility provides the capability to test selected protocols in a laboratory environment, in a simulated mobile environment, as well as in local field environments. It supports the rapid prototype development of a representative operational capability to facilitate a system developers' understanding of quickly evolving networking communications protocols and technologies. Both performance characterizations and requirements validations can be performed within the facility. WCNME is a sophisticated state of the art facility that includes a reconfigurable eight-node bench top analysis capability to evaluate emerging communications development in mobile wireless networking protocols, architectures and technologies. The bench top capability includes network evaluation tools for example Net-X-Ray, NetTest, TARDIS NTP Time client / server software, the SEAM-LSS related User Behavior Model (UBM) Traffic Generator and an array of COTS hardware (radios and computers) and software. The environment incorporates the use of the CECOM Wide band Radio Network Test bed (WRNT) to provide for dynamic experiments. A key component of the facility is the ability to coordinate real experiments with virtual experiments. The Simulation and Evaluation of Adaptive Mobile Large Scale Network Systems (SEAM-LSS) modeling

EQUIPMENT/FACILITIES

and simulation environment provides the capability to emulate large networks and assess scalability and topology. The capability of the environment provides for the evaluation and integration of emerging middleware and applications. The facility also includes a Software Development Environment and an Integrated Signal Processing Environment for system-level design. The environment is flexible and provides for deployment capability to the field for experimentation and demonstration. WCMNE provides for the capability to transition / leverage emerging technologies into current and next generation's military systems. The facility currently supports the DARPA SUO SAS and GloMo programs, JTRS and Wireless LAN.

The WRNT is one of four products of the **Wideband Radio Networking (WRN) Program**. The test bed is a computer automated wideband radio network emulator, which allows scripted repeatable tactical mobile network scenarios to be exercised in a laboratory environment, eliminating the expense and complexity of actual field testing. The present WRNT can perform test and evaluation of up to 8 legacy of future network radios, waveforms, or protocols, with expandability to a network size of up to 100 radios. The system is presently being used in the CECOM WCMNE facility to aid in the test and evaluation of DARPA GloMo Program network and protocols and technology as well as several commercial network radios and communications products. The test bed will be used in the development of advanced wideband (high data rate) network waveforms for future porting to the Joint Tactical Radio System (JTRS) family of radios. The WCMNE facility has also been offered to the JTRS Joint Program Office as a joint test bed for JTRS prototype radio testing and architecture validation. The WRNT is a valuable RDEC asset, and expansion and enhancement of its capabilities is planned in the near future.

SEAMLSS provides an integrated modeling and simulation environment that supports the evaluation of mobile communications networks. It includes the capability to model realistic military communications environments to include threaded traffic, scenarios, terrain, propagation, metrics and analysis. It provides capability to simulate voice, video, data and multi-media traffic in a heterogeneous network comprised of over 500.000 discrete nodes in a unicast, multi-cast or broadcast mode. It includes features to model Quality of Service and encryption. It can be "parrellized" to improve performance and has the capability to be used remotely over a web based graphical user interface. The SEAM-LSS environment, once populated with system models can showcase those technologies enabling evaluation of military efficacy.

The Tactical Internet Laboratory: The Tactical Internet Laboratory in the CECOM Digital Integrated Lab provides test results and recommendations for contractors and Program Managers to develop network architecture and the communications software for TI. The goal of the CECOM TI Lab is to validate the Tactical Internet capability through laboratory network testing, and to sponsor experimentation and technology demonstrations to enhance Tactical Internet technology. The TI Lab can be configured to replicate different portions of the TI architecture for testing and experimentation. Data generators are used to apply prescribed levels of traffic loading and to measure the response of the network. Special network test tools are used to monitor traffic on the net and to measure delay and message completion rate under various conditions.

A. Network Radio Laboratory:
The Network Radio Laboratory facilities are devoted to the RDT&E of radios, modems, and ancillary devices. The laboratory is divided into several functional areas to provide for testing, evaluation and analysis of various aspects of communications systems. Developmental and non-developmental hardware are evaluated. The Lab is used to provide support to external customers on a full range of HF/VHF/UHF communications test and evaluation services to include production and field problems with mobile radios (both ground and airborne) which are investigated and resolved.

EQUIPMENT/FACILITIES

B. Radio Access Point Facility:
The RAP facility includes computer workstations and routers, communications access to ATM switches in other labs, a T1 connection to AT&T and access to the Network Radio Laboratory. This is to enable work with protocols and related communications software so as to enhance existing (largely commercial) products in order to add or enhance features required for military use, specifically to make products robust for survivable communications on the move.

C. S250C HF/VHF Channel Simulator:
The S250C HF/VHF Channel Simulator is a modular constructed piece of test equipment that allows for a wide variety of configurations. It is available with a range of options that makes it easy to obtain just the right channel simulator configuration for any application. Fully equipped, the channel simulator can provide a comprehensive hardware communications testing over a vast range of possible HF/VHF channels, and facilitate unattended operation of long and tedious radio/modem tests.

CECOM Research, Development and Engineering Center

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(732)427-2686
Director: Dr. Louis C. Marquet
Associate for System: George R. Oliva, Jr.

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.304	N/A	N/A	1.304
6.1 Other	0.015	0.004	0.015	0.034
6.2	20.694	5.186	58.085	83.965
6.3	27.170	6.795	98.324	132.289
Subtotal (S&T)	**49.183**	**11.985**	**156.424**	**217.592**
6.4	5.600	5.098	7.399	18.097
6.5	3.754	3.304	12.570	19.628
6.6	3.519	0.392	14.961	18.872
6.7	3.116	3.120	15.796	22.032
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**65.172**	**23.899**	**207.150**	**296.221**
Procurement	19.078	N/A	54.677	73.755
Operations & Maintenance	14.409	N/A	29.514	43.923
Other	2.901	N/A	46.510	49.411
TOTAL FUNDING	**101.560**	**23.899**	**337.851**	**463.310**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	1	12	13	**26**
CIVILIAN	63	1001	531	**1595**
TOTAL	**64**	**1013**	**544**	**1621**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	532.324	**REAL PROPERTY**	80.000
ADMIN	233.016	* NEW CAPITAL EQUIPMENT	0.400
OTHER	99.000	**EQUIPMENT**	296.000
TOTAL	**864.340**	* NEW SCIENTIFIC & ENG. EQUIP.	6.000
ACRES	**1077**	* Subset of previous category.	

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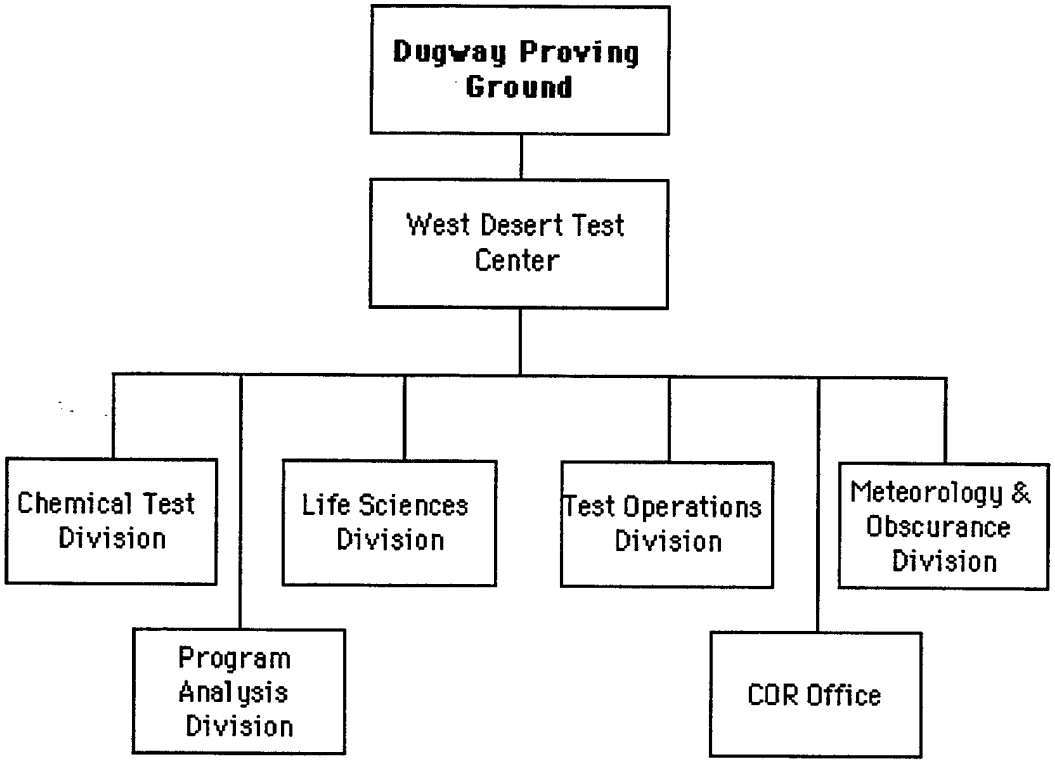
Dugway Proving Ground

FY1999 Abbreviated Functional Chart - Technical Organizations



Dugway Proving Ground
Dugway, UT 84022
(435)831-3701

Commander: Colonel Edward A. Fisher
Chief Scientist: Dr. William A. Dement

MISSION

To test U.S. and Allied chemical and biological defense systems. Perform NBC survivability testing of defense material. Test environmental characterization and remediation technology. Act as the DoD joing chem/bio defense contact point in support of warfighting CINCs. Provide support to chemical and biological weapons conventions. Safeguard the environment. Operate and maintain an installation to support the test mission.

CURRENT IMPORTANT PROGRAMS

The FY99 research, development and laboratory investigations. Joint-operations chemical and biological defense test and studies for CINCS and Service. Munitions development/acceptance and production testing. Environmental studies to support DPG and Army programs.

FY 99 important programs include:

- Advanced Integrated Collection Protection System (AICPS)
- Advanced Tactical Power Unit (ATPU), 1.1 MW, Theater High Altitude Area Defense (THAAD) NBC Study
- Aerial Dissemination Improvements
- Agent Concentration for Onset of Symptoms in Unwarned Unprotected Civilian Personnel (PA-14), D049
- Air-Platform Interface Issues during Recovery & Turn-ARD CB Agent Contaminated Naval Aircraft, D049
- Aluminum M6 NBC Study
- Anti-Material Chemical/Biological Agents (Assessment) D049
- Assembled Chemical Weapons Assessment (ACWA) Program
- A898/M762 Sadarm Projectile, 155MM, Carc vs. Enamel Test
- BFVSA3 NBC Contamination Survivability (NBCCS) Verification Test
- Biological Aerosol Warning System (BAWS), Advanced Technology Demonstration (ATD)
- Biological Integrated Detection System (BIDS)-P3I, JPO-BIO
- Biological Integrated Detection System (BIDS) Reagents
- Biological Point Detection System (BIDS) Joint Out-door Field Trials V (JFT-V)
- Biological Point Detection System (BIDS) Joint Out-Door Field Trials (JFT-VI)
- Biological Weapons (BW) Trilateral/Biological Weapons Convention (BWC) Tech SPT to DSWA
- Biotechnology Characterization by Unconventional Signatures (BACHUS Prog), Support to DSWA
- C-130 Aircraft Characterization of System Function and Dispersion of Released Chaff, Air Force
- Canteen Insert Water Purifier (CIWP)
- Cargo Aircraft Contamination Control, Field Test, - D049
- Cargo Helicopter Interior Contamination Control- (Assessment)
- Cartridge, 60MM, Practice SR, M766, First Article and 21 Lots, Pocal Industries, BTR 25-97C
- Characterize New BG

CURRENT IMPORTANT PROGRAMS
• Chem Warfare Convention/Treaty Verification - Tech Rep/Consultation (Quick Reaction)
• Chemical Biological Mass Spectrometer (CBMS), Bio - Profiling, Block II
• Chemical Treaty Compliance Program
• Chemical Warfare Treaty testing of Flow Injection - Trace Analyzer (Lab Test)
• Clothing Decontamination (Chemical Lab Test), D049
• Component Testing, Biological Integrated Detector System (BIDS) P3I
• Counter Proliferation Long Range Biological Standoff Detection System, XM94 E1
• Counter-Proliferation, Bio-Detection: Support to Defense Nuclear Agency (DNA) Field Tests at WSMR
• Critical Area Decontamination of Biological Agents (BD-4), Lab Test, D049
• Critical Reagent Program Development, Target Agent Repository, Support to JPO Biological Defense
• Cryofracture Demilitarization (M16A2, AP Land Mines, M483 Proj, Rockeye II MK118 Anti-Tank Bomblets)
• CW Treaty, CBDCOM Screening Kit Evaluation
• CW Treaty, Swept Frequency Acoustic Interferometry (SFAI)
• Data Logger: Pond Tests for Battelle
• Defense Threat/Vulnerability Analysis of Potential - Biological Threat Agents
• Demolition Characterization of the 122MM Chemical-Filled Rocket to Support OSD Gulf War Illness Team
• Effect of Chem Warfare on Airbase OPS (PA-13)/Impact of MOPP on Aircraft Sortie Generation, D049
• Emission Products Characterization of Munitions, Support to U.S. Army Environmental Center
• Establishment of Evaporation Rates, VX Studies, Defense Special Weapons Agency, (Live Chem Warfare)
• Exterior Decontamination of Aircraft (Assessment)
• FY99/FY00 Demilitarization and Range Clearance
• FY99/FY00 Environmental Support
• FY99/FY00 Non Test Support to Tooele Army Depot
• FY99/FY00 Non-Test Support to Army Customers
• FY99/FY00 Support to USAF for Test and Training Programs on UTTR
• FY99/FY00 Support to National Guard Units
• F22-Tactical Aircraft Interior Decontamination Study (TACAIDS)
• G-Agent Hydrolysis Study, Phase I
• Grenade, 66MM, Non-Lethal Distraction, XM98 Production Verification
• Grenade, 66MM, Non-Lethal Blunt Trauma, XM99 Production Qualification
• High Temperature Incendiary Devices (HTI), Support to Defense Special Weapons Agency (DSWA)
• Hot Spots Meteorology: Middle East (Assessment) D049
• HRT Multi-Phased Exercise
• Identification of Deactivated Pathogens and Toxins
• Installation Restoration Project (IRP) - Chem Lab Analytical Spt to US Army Environmental Center
• Integrated System Control (ISYSCON) NBC Study
• Javelin Joint Venture: Testing for Raytheon/Lockheed Martin (Spts Govt Contract)
• Javelin Missile Command Launch Unit (CLU) NBC Testing
• Joint Biological Point Detection System (JBPDS)
• Joint Biological Point Detection System (JBPDS), Methodology Project
• Joint Biological Point Detection System Mini Field Trials

CURRENT IMPORTANT PROGRAMS

- Joint Biological Point Detection System, IOT&E, OTP-1858
- Joint Biological Remote Early Warning System (JBREWS) Live Agent Test
- Joint Biological Remote Early Warning System (JBREWS) ASEC Chamber Test
- Joint Biological Remote Early Warning System (JBREWS), Field Trials
- Joint Chemical Agent Detector (JCAD) - POT
- Joint Chemical Agent Detector (JCAD), Engineering Test
- Joint Chemical Agent Detector (JCAD), Test Method Study
- Joint Service Lightweight Integrated Suit Technology (JSLIST) P3I: Limited Fit Test F/CMSL Analysis
- Joint Serivce Lightweight Integrated Suit Technology (JSLIST) P3I: Quick Fix Man-in-Simulant Test
- Joint Services Lightweight Integrated Suit Technology (JSLIST) P3I: Chemical Lab Testing
- Joint Services Lightweight Standoff Chemical Agent Detector (JSLSCAD), Test Method Study
- Joint Vaccine Acquisition Program (JVAP)
- JPACE Joint Program (Navy Lead), Baseline Comparison Test
- Land Warrior: NBCCS Review, Man-in-Simulant (Mist) Review
- Large Diameter Container NBC Survivability Assessment
- Laser Airborne Remote Sensor (LARS)/Nonproliferation Airborne Laser Experiment (N-ABLE): SPT to USAF
- Lightweight Water Purifier (LWP) NBC Survivability
- Liquid/Vapor Swatch Test Validation - Joint Service Lightweight Integrated Suit Tech (JSLIST), P3I
- LVOSS PVT
- MET Operations Support
- Methodology Effort - Surface Sampler Probe XM279 for XM22 Automatic Chem Agent Det Alarm (ACADA)
- Miscellaneous Suits, Man-in-Simulant (MIST): NATICK Closure Test
- Miscellaneous Suits, Man-in-Simulant (MIST): TTCP Comparison Test
- Mitigation of CW/BW Effect on Unprotected Civilian during Non Combatant Evacuation OPS (PA-11), D049
- Mobile Munition Assessment System (MMAS)
- Multipurpose Integraded Chemical Agent Alarm (MICAD), NBCCS Contractor Support
- Munitions Management Device (MMD)
- M745 Fuze, PD, 3 Lots, Alliant Techsystems/Accudyne Operations, BTR 45-97
- M767 Cartridge, First Article and 3 Lot Acceptance Tests
- M819 Cartridge, 81MM RP, Six Lots, Pine Bluff Arsenal, BTR 5-95
- M880, 81MM Short Range Practice CTG (SRPC), M987 Ignition Cartridge Test
- NUNN-LUGAR-DOMENENCI (N-L-D) Exercise and Testing Program
- Outdoor Diffusion Experiments for the Navy
- Patriot Limited Life Missile and Component Storage Facility Test
- PEQ-2A Target Pointer/Illuminator/Aiming Laser (TPIAL) NBC Contamination Survivability Test
- Planning and Initiatives for FY98/FY99, D049
- Project Cooler: Range Support to US Air Force 46TH Test Wing (AFMC) Eglin AFB
- Project III, IV, V
- Project VI
- Projectile, 155MM, SMK, WP M825A1, 49 Lots, Pine Bluff Aresenal, BTR QAS-2-97
- Proposed Restoration of Operations (RESTOPS) Advanced Concept Technology Demonstration (ACTD)

CURRENT IMPORTANT PROGRAMS

- P3I: Liquid/Vapor Swatch Test Screening - Joint Service-Lightweight Integrated Suit Tech (JSLIST)
- QA Program for Testing and Air Safety
- RF Navy Countermeasure Devices - Naval Weapons Support Center
- Sea Port of Debarkation (SPOD), D049
- Self-Contained Toxicological Environmental Protective Outfit 35 Mil Glove, Chemical Agent Test
- Self-Contained Toxicological Environmental Protective Outfit (STEPO) Neoprene/Butyl Gloves
- Short Range - Biological Standoff Detection System (SR-BSDS), Methodology Study
- Short Range - Biological Standoff Detection System (SR-BSDS), Development Field Test
- Short Range - Biological Standoff Detection System Signature Data Collection - Quantify Simulant Clouds
- Single Shelter Switch (SSS) NBC Analysis
- Smart-T Biological/Chemical Contamination and Decontamination Requirements Verification
- Smokes & Obscurants Data Archiving and Retrieval
- Sorbent Decontamination System - Production Qualification Test
- Standard Integrated Command Post System (SICPS) NBC Contamination Survivability Test
- Study of Alternate Delivery Method
- Supercritical Water Oxidation (SCWO) System, Assembled Chemical Weapons Assessment (ACWS) Program
- SWMU - Installation Restoration Activities
- Tactical Message System (TMS) NBCCS Analysis
- Tactical Quiet Generator Set (TQG), 3KW, Re-Buy
- Tactical Water Purification System (TWPS) NBC Survivability
- Technical Committee Support
- Thermal Weapon Sight (TWS), AN/PAS-13, (Bridge) Biological and Chemical Decontamination Testing
- Trilateral Field Testing of Advanced Mitigation Techniques for the Navy
- U.S. Air Force Operational Test and Evaluation Center (AFOTEC) General Support
- Ultraviolet Laser Induced Flourescence System for Use on Unmanned Aerial Vehicle
- Urban Modeling Program, Defense Threat Reduction Agency
- Virtual Proving Ground Effort (40WX)
- VPG - DPG Support
- VPG Synthetic Environmental Integration - DPG
- VPG: M&S for Chamber Testing
- VPG: M&S Infrastructure Test Bed
- VPG: Probabilistic CL Model
- VPG: VPG Support
- VPG: 4DWX
- VX & VX Simulant Laboratory & Field Testing, Project D049
- VX Hydrolysis Study, Phase II
- Waste Characterization Study (ODOBI) Support to Miscellaneous DOD Customers
- Water Support in a Toxic Environment D049
- X-33 Program, Support to NASA
- XM279 Surface Sampler for XM22 Automatic Chem Agent Det Alarm (ACADA): PQT for Battelle
- XM767 Cartridge, First Article and Lot Acceptance Test
- XM767 Cartridge, 60MM, Illum, Infrared
- XM767 Engineering Lot Acceptance Tests (3 Lots)

CURRENT IMPORTANT PROGRAMS

- XM94E1 Counterproliferation Long Range - Biological Standoff Detection System (CPLR-BSDS)
- 120MM Illum Mortar Cartridges, XM930/XM983
- 120MM Mortar Lightweight Monopack Container Final Hazard Classification, NBC Study
- 60MM Mortar, M721 Illuminating Cartridge

EQUIPMENT/FACILITIES

Instrumented grids for chemical, biological and smoke/obscurant systems. Artillery and mortar ranges for conventional, smoke, an illumination munitions. Ballistics and dissemination tests with field sample, sample mass analysis, meteorological (auto data acquisition and MESOMET network) system. Physical and environmental test facility chambers for agent containment and MILSTD 810 work. Operations supported by meteorological research on behavior of clouds. Capability for planning analysis, evaluation of tests and operations research. Labs equipped for wide range of chemical, microbiological, toxicological, immunological and pollution studies. Environmental characterization and remediation technology testing. External communication and range safety system. Outstanding features are: large land area, restricted air space, long and flat artillery ranges, projectile recovery, sonic and electromagnetic sterility and diverse technical and scientific skills.

Dugway Proving Ground
Dugway, UT 84022
(435)831-3701

Commander: Colonel Edward A. Fisher
Chief Scientist: Dr. William A. Dement

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.095	0.000	0.101	0.196
6.3	0.099	0.000	0.106	0.205
Subtotal (S&T)	**0.194**	**0.000**	**0.207**	**0.401**
6.4	0.130	0.000	0.139	0.269
6.5	0.859	0.000	0.921	1.780
6.6	11.805	0.000	20.483	32.288
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.245	0.000	0.042	0.287
TOTAL RDT&E	**13.233**	**0.000**	**21.792**	**35.025**
Procurement	0.405	N/A	1.209	1.614
Operations & Maintenance	2.253	N/A	1.200	3.453
Other	19.132	N/A	13.317	32.449
TOTAL FUNDING	**35.023**	**0.000**	**37.518**	**72.541**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	2	6	**8**
CIVILIAN	18	61	359	**438**
TOTAL	**18**	**63**	**365**	**446**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	214.049	**REAL PROPERTY**	183.083
ADMIN	134.073	* NEW CAPITAL EQUIPMENT	0.000
OTHER	1906.580	**EQUIPMENT**	87.000
TOTAL	**2254.702**	* NEW SCIENTIFIC & ENG. EQUIP.	3.000
ACRES	**799**	* Subset of previous category.	

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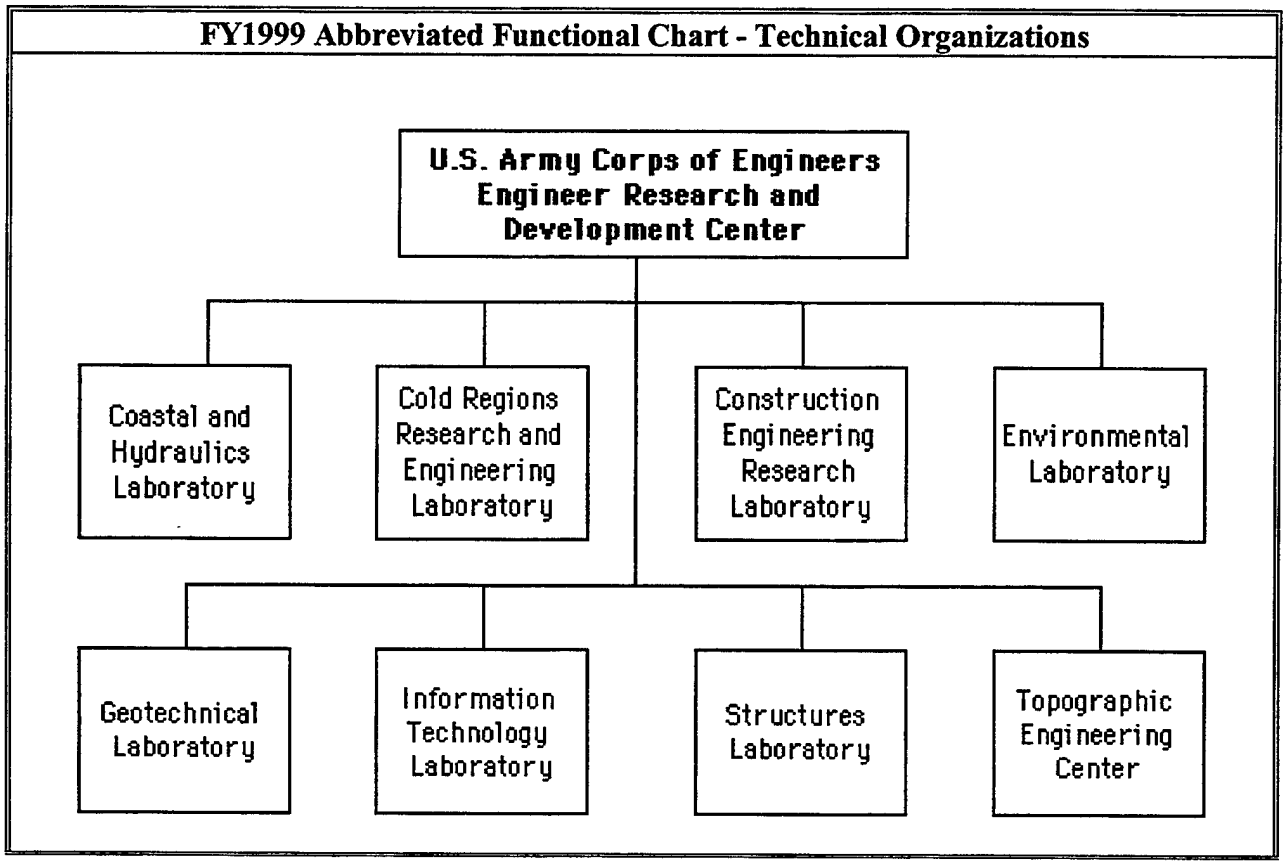
Engineer Research and Development Center



Engineer Research and Development Center
Vicksburg, MS 39180-6199
(601)634-2504

Acting Director: Dr. Lewis E. Link, Jr.
Commander: COL Robin R. Cababa

MISSION

The Engineer Research and Development Center (ERDC) is the research and development organization for the U.S. Army Corps of Engineers (USACE). The ERDC supports the total Army engineer effort through its Military Engineering and Civil Works research and development (R&D) programs.

The Military Engineering R&D supports both the combat engineer in the theater of operations and facilities engineer at Army installations located around the world. The ERDC research effort supporting the combat engineer focuses on mobility, countermobility, survivability, sustainment engineering, and topography. The ERDC also provides critical operational support to the Army in theater by providing terrain and terrain-related information on the battlefield environment. The installation support research program focuses on providing technologies to improve the affordability of Army facilities and lands while ensuring the Army meets its environmental compliance and stewardship responsibilities.

The ERDC Civil Works R&D program focuses on reducing the cost of constructing, operating and maintaining the Nation's infrastructure of navigable waterways, harbors, and related recreation areas. The Civil Works research program also addresses a variety of flood control, environmental quality, and emergency response issues. This research supports the operating Corps of Engineer Districts responsible for execution of the Army's Civil Works program.

The ERDC conducted over $450 million research program in FY99 at its eight laboratories. ERDC has over 1200 engineers and scientists and $1.2 billion investment in research equipment and facilities. The ERDC has eight laboratories at four sites:

Alexandria, Virginia -- Topographic Engineering Center (TEC)
Champaign, Illinois -- Construction Engineering Research Laboratory (CERL)
Hanover, New Hampshire -- Cold Regions Research and
Engineering Laboratory (CRREL)
Vicksburg, Mississippi -- Coastal and Hydraulics Laboratory (CHL), Environmental Laboratory (EL), Geotechnical Laboratory (GL), Information Technology Laboratory (ITL), and Structures Laboratory (SL).

CURRENT IMPORTANT PROGRAMS

In FY99 the Corps of Engineers consolidated its eight research laboratories under a single organization called the Engineer Research and Development Center (ERDC). The resulting integration of the research program will increase the synergy among research personnel at the eight laboratories while providing cost efficiencies. The Corps research community will continue to work closely with academia, industry and other Federal agencies in developing and applying innovative technologies.

CURRENT IMPORTANT PROGRAMS

Under its Military Engineering program the ERDC performs research and development for enhancing engineer capability to deploy rapidly and to sustain a full range of military operations. The major initiatives include those listed below:

- Airfields and Pavements for Force Projection
- Logistics Over the Shore
- Survivability and Protective Structures
- Lines of Communication Assessment and Repair
- Advanced Mobility Modeling
- Maneuver Support Modeling and Simulation
- Rapid Terrain Mapping and Visualization
- Tele-Engineering

Under its Installation Support program the ERDC conducts infrastructure and environmental sustainment research, development, studies and technical assistance to maintain a quality trained and ready Army and to preserve and protect its land, water and natural and cultural resources. Major research initiatives include the following areas:

- Munitions Production Compliance Technologies
- Sustainable Military Land Use and Stewardship of Army Lands
- Training Land Carrying Capacity
- Protocols for Military Training to Reduce Impact on Threatened and Endangered Species
- Facility Seismic Risk Mitigation
- Facility Delivery Process Improvement
- Integrated Installation Management
- Utilities Modernization and Optimization for Military Installations

The ERDC Civil Works research program focuses on developing and applying technologies for reducing the cost of constructing, operating and maintaining the Nation's Civil Works structures and facilities such as navigable waterways, harbors, and related recreation areas. Major research initiatives include the following areas:

- Ecosystem Management and Restoration
- Innovative Design and Construction
- Earthquake Engineering
- Risk Analysis for Civil Works Projects
- Geospatial Technology

The ERDC is expanding its use of the internet as a major delivery mechanism for transferring technology to military and civilian engineers. For example, the Tele-Engineering effort will provide combat engineers with real-time access to experts via satellite and the internet to help solve complex maneuver and force support engineering challenges in the theater of operations. The Land Management Systems (LMS) will integrate existing land management and environmental analysis systems and provide a common delivery framework for access to these integrated tools by users via the internet. The ERDC has also initiated a major effort to provide computer-based tools via the internet to facilitate real-time building design and constructability reviews by government and industry teams.

EQUIPMENT/FACILITIES

Spectral Research Facility - TEC
The Spectral Research Facility contains a Digital Multi-Spectral Video camera, and multiple spectral radiometers and fluorometers used in studying both passive and active phenomena in the visible, near infrared, and thermal electromagnetic regions.

Survey and Global Positioning System (GPS) Laboratory - TEC
The TEC Survey and GPS research laboratory has eight (8) geodetic-quality GPS receivers, permanent differential GPS reference stations with broadcast capabilities, and conventional survey equipment. This facility is used to develop and test survey techniques and equipment for use in positioning and navigation, and, in conjunction with other systems, for obtaining high-accuracy terrain and navigation channel elevation data.

Terrain Information Extraction System (TIES) - TEC
The TIES provides a capability for extracting up-to-date terrain data from remotely sensed images. The Collection Management Office (CMO) provides TEC the capability to rapidly query status and order National Imagery in hardcopy or softcopy formats.

Integration and Evaluation Center (IEC) - TEC
The IEC complex is an accredited facility providing real-time visualization of complex integrated joint service operations. The facility is capable of mixing both actual and simulated activities in a single visual/aural demonstration of an operational or training exercise, accessing data and imagery worldwide. It uses commercial wideband and tactical communications links to provide connectivity with live exercise activity and distributed simulation networks and acts as the central hub of the demonstration network.

Imagery and Geospatial Data Exploitation Test bed (IGDED) - TEC
The IGDED was developed to provide the warfighter with the technologies needed to achieve superior knowledge of the battlefield through more timely collection, exploitation, and dissemination of imagery and geospatial data and products. The IGDED provides the laboratory within which new imagery evaluation and examination tools can be installed and integrated, and imagery and national tasking capabilities evaluated.

Eagle Vision II (EVII) - TEC
The Eagle Vision II prototype is a mobile, integrated, commercial satellite imagery receiving and processing system. It allows access to multiple commercial satellite imaging systems from a forward-located position during natural disasters and other crises. The EVII prototype houses systems that directly download imagery from SPOT, Landsat, Radarsat, and EarlyBird commercial satellites while they are in direct line-of-site of the system. Additional satellites are under consideration for addition to the original EVII-accessible constellation.

Access to Intelink - TEC
TEC has presence on the Intelink, a classified information service modeled after the World Wide Web and sponsored by the intelligence and military communities. Services offered by TEC on the Intelink include military geographic intelligence, terrain analysis and water resources products, special crisis management products, national and commercial imagery collection services, and the Multispectral Imagery Desert Guide.

EQUIPMENT/FACILITIES

Mobile Ballistic Research System - SL
This facility provides the DOD with the capability to conduct projectile penetration field experiments at geologic sites of interest. The truck-mounted, breach-loaded ballistic gun can launch large-scale (up to 155-mm) projectiles at velocities as high as 3280 ft/sec. Associated diagnostic instrumentation and analysis hardware are contained within a support trailer.

Geodynamics Research Facility - SL
This unique facility within DOD houses a wide variety of high-pressure dynamic devices that simulate explosive loadings under controlled stress states on geologic and man-made construction materials. The characterization of their material behavior is required for weapons effects assessment against military fixed assets.

Projectile Penetration Facility - SL
Unique to DOD, this facility enables investigation of anti-penetration shielding technology techniques employing geologic and manmade structural materials against a wide variety of threats. An 83-mm diameter gas gun has the capability of launching projectiles with masses up to 6.2 lbs. at velocities in excess of 6562 ft/sec and launching projectiles with masses of 26.5 lbs. at velocities of 3280 ft/sec.

Mass Construction Materials Laboratory - SL
A 20,000 square foot concrete research and development laboratory for determining physical, chemical, and mineralogical properties of concrete and other construction materials as well as the structural response of subscale models.

DOD High Performance Computing Major Shared Resource Center - ITL
This 55,000 square foot facility includes multiple, state-of-the-art High Performance Computing systems which provide the most powerful scientific and engineering capability in DOD with 47000+ Megabytes of memory, 6,700 Gigabytes of high-speed disk, and 500 Terabytes of high-speed robotic archival storage. Includes a $4.1M Scientific Visualization Center to identify and develop innovative methods of interpreting large data sets from modeling/simulation, field data collection, and Computer Aided Design and Drafting (CADD) applications.

Airfields & Pavements Research Center - GL
This 25,000 square foot, state-of-the-art facility contains the DOD unique Joint Sealant Laboratory and an Automated Data Acquisition System for acquiring rheological data on creep, strength, resilient moduli, and fatigue of a variety of paving materials.

Soils Research Center - GL
The 10,000 square foot soil mechanics research facility in the largest in DOD, it has a loading capability of 250,000-lb on triaxial specimens up to 15 inches in diameter. Also included are direct shear devices for 3 to 24 inch specimens, automated consolidometers and rock-testing capabilities including anchor pullout tests.

Full-Scale Aircraft Loading Facility - GL
Simulates aircraft loading with different wheel loads and gear geometry applied to full scale constructed test pavements; response and performance data for development of new design and behavior theories; current fighter and transport aircraft simulators.

EQUIPMENT/FACILITIES

Heavy Vehicle Simulator-Aircraft - GL
The largest portable automated trafficking device in the world capable of replicating multiple or single aircraft or vehicle traffic. This device can apply over 1 million passes on a pavement section in 5 months to provide valuable data for predicting long-term pavement life.

Mobility Instrumentation Facility - GL
A 30,000 square foot complex is used for conducting research and development investigations of cross-country mobility, trafficability, and terrain data acquisition. This research requires complex design and fabrication of real-time data collection and analysis hardware unique to quantifying the performance of all types of wheeled, tracked, and amphibious military vehicles. A 14,000 square foot annex is optimally structured to support modeling and simulation in distributive interactive simulations and virtual prototyping in support of battlefield automation.

Geosciences Research, Applications, and Test Facility - GL
This facility provides the most extensive near-surface geophysics equipment and applications capability in DOD. Specializing in engineering, environmental, archeological, and groundwater geophysics, and geology, the facilities support the DOD requirements for foundation investigations, installation restoration, cultural resource assessments, military groundwater supply, tunnel detection, and environmental site characterization. In addition, a 15,000 square foot Engineering Geophysics Training Facility consisting of metallic and non-metallic targets buried at various depths and orientations, is used for evaluating geophysical instruments and providing hands-on training with the equipment.

US Army Centrifuge Research Center - GL
Uniquely large and powerful, the research centrifuge weighs 85 tons and has a 21-ft radius; it can apply a maximum g-force of 1256 g-tons operating at 350g's for a 2.2 ton payload and at 143g's for an 8.8 ton payload (1g = normal gravity). A 27.5-year event can be replicated in one day operating at 350g's. Research applications include all areas of civil and environmental engineering with particular focus on earthquake engineering, coastal engineering, structural engineering, blast phenomena, and groundwater behavior.

TeleEngineering Operations Center - GL
Unique to DoD, this facility provides the warfighter with solutions to complex, real-world engineering problems using the entire Corps of Engineers knowledge base capabilities through classified and unclassified computer networks and high performance computing assets. Rapid response problems beyond in-theater expertise will be provided using existing C2 architecture.

Hazardous and Toxic Waste Research Center - EL
The 17,000 square foot HTWRC is the only DOD-permitted (RCRA) facility to conduct large volume HTW research, development, test, and evaluation. EPA recognizes the HTWRC as the Nation's premier facility. An 8,000 square foot addition to this facility was completed in FY99.

Environmental Chemistry Laboratory - EL
A 22,000 square foot analytical chemistry research and testing facility houses state-of-the-art equipment to address DOD research, analytical, and quality assurance requirements for environmental quality, contaminated sediments, and environmental restoration facilities. This laboratory meets the demands for high hazard research (i.e. dioxins and dibensofurans) and at detection levels that meet requirements of health and regulatory risk-based hazardous risk assessments. The Corp's Chemistry Quality Assurance facility, with 20,000 square feet of chemistry laboratories, located in Omaha, NE, was realigned with WES in 1998. Together, these chemistry laboratories provide one-stop-services for all environmental

EQUIPMENT/FACILITIES

design and construction quality assurance during the engineering design and construction or environmental projects within the DOD.

Fate and Effects R&D Center - EL
This 30,000 square foot facility has complete experimental radioisotope, microbiology, toxicity, and instrumentation laboratories for investigations of contaminant fate and effects on ecosystems.

Lewisville Aquatic Ecosystem Research Facility (LAERF) - EL
This nationally recognized unique 110-acre aquatic research facility is located in Lewisville, TX. This facility is the largest complex of aquatic research micro-, meso-, and macrocosms in the world conducting research on ecology of aquatic and wetland vegetation, biocontrol techniques for aquatic vegetation, chemical control of nuisance vegetation, and hydraulic flow-through vegetation.

Eau Galle Aquatic Ecosystem Research Facility (EGAERF) - EL
This 2,000 square foot laboratory facility is located on Eau Galle reservoir near Spring Valley, WI. Research is conducted on phosphorus dynamics, sediment-nutrient interactions and restoration and environmental management of aquatic ecosystems.

Trotter's Shoals Limnological Research Facility (TSLRF) - EL
This facility is located on the Richard B. Russell Reservoir near Calhoun Falls, SC. This facility consists of a 1,400 square foot analytical building; a 2,040-square foot office complex, and numerous large research vessels. This facility provides field and laboratory support for research on limnological processes associated with operation of large flood control and hydropower projects.

Columbia River Basin Research Facility - EL
This facility is located at North Bonneville, WA. This facility consists of approximately 4,400 square feet of offices and several large research vessels. Research conducted at this facility supports large-scale experimental monitoring of fish passage in the region.

Aquatic and Wetlands Ecosystem Research Center - EL
This 10,000 square foot research center provides the capability to evaluate the impact of DOD activities on aquatic and wetland ecosystems, including impacts on threatened and endangered species, and wetland identification, delineation, and evaluation.

Cold Effects Laboratories -- CRREL
CRREL has a complex of low temperature laboratories and experimental research facilities not found anywhere else in the world. The main laboratory consists of 24 low temperature research laboratories with a temperature range down to -50 degrees F.

Ice Engineering Facility -- CRREL
The 73,000 square foot Ice Engineering Facility houses three special-purpose research areas; a large low-temperature towing tank, a 100-foot long refrigerated flume for modeling rivers, and a large hydraulic-model room for studying ice impacts on civil works facilities, primarily locks and dams.

Frost Effects Research Facility (FERF) -- CRREL
The 29,000 square foot FERF supports full-scale research on the impact of freeze-thaw cycles on pavements, foundations, and utility systems. The nationally unique FERF facility provides the capability to simulate natural 3-D freeze-thaw cycles to support research on the impact of these cycles on pavements, foundations, and utility systems.

EQUIPMENT/FACILITIES

Low Temperature Material Test Facility -- CRREL
The unique 9000 square foot Low Temperature Materiel Test Facility provides additional capability to investigate composite materials performance subject to low-temperature and thermal cycling for potential use for future Army armor vehicles. USACRREL also has access to two permafrost research sites in Alaska.

Heavy Vehicle Simulator (HVS) - CRREL
The HVS is a vehicle and aircraft accelerate trafficking machine capable of applying 20 years of equivalent traffic in four to five months. Truck dual tires or a super single tire can apply up to 11,000 passes a day at 8 miles per hour in one or both directions with up to a 25,000 lb. load. A C141 aircraft tire can apply up to 45,000 lbs. load at 4 mph in both directions for 11,000 passes a day.

Remote Sensing/Geographic Information System Center -- CRREL
USACRREL houses the 16,400 square foot Corps of Engineers' Civil Works Remote Sensing/Geographic Information System Center.

Department of Defense Cold Regions Technical Information Analysis Center (CRSTIAC) -- CRREL
The 24,000 square foot CRSTIAC facility is home to the most comprehensive collection of cold regions science and engineering data in the world.

Coastal Facilities - CHL
Approximately 400,000 square feet of space for three dimensional, high-precision coastal models and experiments. Contains over 850-ft of spectral wave generators (including a 90-ft long Directional Spectral Wave Generator) designed to reproduce waves of 2-ft in height.

Field Research Facility, Duck, NC - CHL
This facility is recognized worldwide for cooperative multi-national and multi-agency high precision field experiments in coastal and nearshore processes. The facility consists of 175 acres with a 1970-ft concrete and steel pier, 1 mile of beachfront, full suite of installed coastal processes instrumentation, special purpose beach and amphibious vehicles, etc.

RipRap Experimental Facility - CHL
The RipRap Experimental Facility is largest curved channel experimental facility in the world, used for study of effects of channel bendways on flow fields, specifically aimed at developing design criteria for riprap protection of bendways.

Hydraulic Engineering Experimental Facilities - CHL
This facility consists of approximately 2,500,000 square feet of space under roofs for models used in high-precision experiments relating to rivers, estuaries, hydraulic structures, and navigation.

Triaxial Earthquake and Shock Simulator (TESS) - CERL
The United States' first large triaxial shaking table is a unique dual-mode shock and vibration test facility. The TESS, in its biaxial mode, simulates a wide range of transient shock vibrations typical of military applications requiring large accelerations over a wide frequency range with moderately heavy test specimens. In the triaxial mode, it can simulate a variety of vibration environments including earthquakes and random vibrations, as well as log-sweep and resonant searches. The TESS is one of the premier seismic experimental test facilities in this country.

EQUIPMENT/FACILITIES

Ion-Plating Systems - CERL
The Ion-Plating System was custom-designed to meet highly specialized research specifications to do small scale prototype thin film coating experiments. It's the only facility of this kind (plasma-assisted physical vapor disposition) in the Army.

Heating, Ventilation and Air Conditioning (HVAC) Test Facility - CERL
A large 'mini-facility' with four rooms (zones) that can be thermally controlled separately to replicate a variety of HVAC systems and conditions. The facility can model dual or single duct and variable or constant air volume conditions; includes ventilation system, hot water supply loops, chilled water supply loops, HVAC systems configuration, facility controls, and data acquisition system. This facility was used to validate the energy thermodynamics analysis program and to analyze performance of proposed standard digital control panels unique within DOD.

Acoustics Laboratory - CERL
The Impulse Noise Technology Center is a state-of-the-art lab facility for the quantification and reduction of impulse noise from cannon, helicopters, blast and small caliber weapons firing. Contains a variety of sophisticated noise monitoring, recording, and analysis instrumentation for research on impact assessment and mitigation of impulse noise related to human annoyance and animal disturbance. Also includes a one-of-a-kind noise impedance tube for the test of noise energy absorption along surfaces.

Paint Laboratory - CERL
The Paint Laboratory contains specialized equipment necessary to perform Qualified Product List testing on paints used by the Army (an 'honest broker' function). The laboratory has the capability to manufacture lab size batches of experimental coatings, perform both real-time and accelerated performance testing of coatings, and perform forensic analysis of paint samples.

Controlled Archeological Test Site (CATS) - CERL
The CATS facility has been constructed with funding provided by the National Center for Preservation Technology and Training and will be utilized for research and training with geophysical applications in archaeology. The CATS facility replicates a range of archeological features commonly encountered in North American archaeological sites and offers a controlled environment for the application of non-destructive investigative techniques. The CATS facility will be available for research in a broad range of problems associated with archaeogeophysics such as, the effects of environmental conditions on geophysical expression, sensor type and configuration, spatial resolution, image processing and pattern recognition, operator variation, and feature variability.

Engineer Research and Development Center
Vicksburg, MS 39180-6199
(601)634-2504

Acting Director: Dr. Lewis E. Link, Jr.
Commander: COL Robin R. Cababa

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.664	N/A	N/A	0.664
6.1 Other	6.874	0.110	4.467	11.451
6.2	145.500	1.790	142.220	289.510
6.3	20.319	0.325	32.403	53.047
Subtotal (S&T)	**173.357**	**2.225**	**179.090**	**354.672**
6.4	0.681	0.011	0.692	1.384
6.5	0.900	0.031	2.314	3.245
6.6	31.110	0.000	2.414	33.524
6.7	0.000	0.000	0.000	0.000
Non-DOD	99.923	1.369	27.546	128.838
TOTAL RDT&E	**305.971**	**3.636**	**212.056**	**521.663**
Procurement	0.000	N/A	45.288	45.288
Operations & Maintenance	9.185	N/A	6.124	15.309
Other	0.519	N/A	0.591	1.110
TOTAL FUNDING	**315.675**	**3.636**	**264.059**	**583.370**

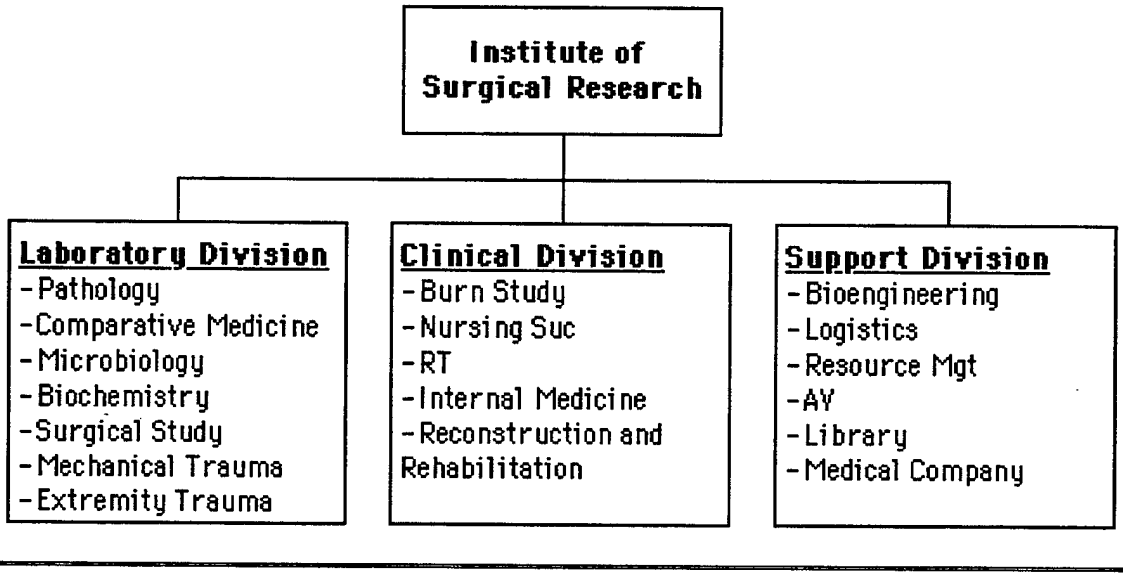
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	20	2	**22**
CIVILIAN	266	810	936	**2012**
TOTAL	**266**	**830**	**938**	**2034**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	2646.230	**REAL PROPERTY**	542.800
ADMIN	438.120	* NEW CAPITAL EQUIPMENT	4.998
OTHER	332.730	**EQUIPMENT**	605.247
TOTAL	**3417.080**	* NEW SCIENTIFIC & ENG. EQUIP.	2.151
ACRES	**661**	* Subset of previous category.	

Institute of Surgical Research

FY1999 Abbreviated Functional Chart - Technical Organizations



Institute of Surgical Research
Fort Sam Houston, TX 78234-6315
(210)916-2720

Commander & Director: COL Cleon Goodwin
Deputy Commander: COL David Zolock

MISSION

Provide Combat Casualty Care medical solutions and products for injured soldiers by integrating laboratory and clinical research.

CURRENT IMPORTANT PROGRAMS

The FY99 USAISR's research is focused on Combat Casualty Care and on providing the injured soldier a winning edge on the battlefield. The primary research thrust areas are: minimizing blood loss and optimizing fluid resuscitation; treatments to prevent secondary damage after hemorrhage or major injuries; and other battle and non-battle injuries. Current major research projects are:

- Develop a hemostatic dressing to stop/reduce uncontrolled compressible hemorrhage(extremity) from becoming life threatening. Uncontrolled hemorrhage is the major cause of death in injured soldiers. Develop a hemostatic foam to stop/reduce uncontrolled non-compressible hemorrhage (abdominal) from becoming life threatening.
- Develop improved resuscitative strategies prior to definitive treatment for injured soldiers before and during evacuation to minimize bleeding, promote tissue perfusion and optimize survival. Hemorrhagic shock remains the major cause of death on the battlefield.
- Develop an external fixator pin that stabilizes open fractures and resists infection and promotes healing. Extremity trauma is the most common (70%) trauma on the battlefield and pin tract infections affects definitive treatment and frequently leads to prolonged morbidity and amputation.
- Identify technologies to determine severity of inhalation injuries as early as possible and develop appropriate treatments.
- Identify technologies to monitor regional organ blood flow and function in the treatment of shock to ensure resuscitation strategies restore adequate blood flow to critical organs.
- Determine the protective capability of new antimine footwear by evaluating the forces and injury patterns and developing a mathematical model for analysis of redesigns of the footwear and other body armor.

EQUIPMENT/FACILITIES

The USAISR's equipment inventory of basic and clinical research equipment valued at over $17,357,000. The Institute consists of a 40 bed inpatient research unit of 50,300 square feet on the 4th floor of Brooke Army Medical Center and a clinical laboratory located in an adjacent 84,000 square foot research facility dedicated in FY96. Capabilities include: integrated clinical and laboratory research facilities and injured soldier test platforms; mass casualty burn care; aeromedical transport teams for multiple trauma victims with burns and other injuries; training in resuscitation and long term injury care; a long term computerized database to assess outcomes of severe injury; a nutrition and metabolic study program; comprehensive orthopedic surgery and extremity research staff and research program; ballistics research; state-of-the-art animal operating suites; an image analysis facility; biocontainment suite for studying the effects of hazardous materials; materials testing laboratory and tissue design and engineering capabilities; and the only research clinical evaluation/management facility for injured soldiers in the U.S. military.

Institute of Surgical Research
Fort Sam Houston, TX 78234-6315
(210)916-2720

Commander & Director: COL Cleon Goodwin
Deputy Commander: COL David Zolock

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.050	N/A	N/A	0.050
6.1 Other	0.978	0.000	0.000	0.978
6.2	6.382	0.000	0.000	6.382
6.3	2.433	0.000	0.000	2.433
Subtotal (S&T)	**9.843**	**0.000**	**0.000**	**9.843**
6.4	0.324	0.000	0.000	0.324
6.5	0.026	0.000	0.000	0.026
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**10.193**	**0.000**	**0.000**	**10.193**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	7.756	N/A	0.000	7.756
TOTAL FUNDING	**17.949**	**0.000**	**0.000**	**17.949**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	13	24	115	**152**
CIVILIAN	4	19	28	**51**
TOTAL	**17**	**43**	**143**	**203**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	73.850	**REAL PROPERTY**	17.191
ADMIN	11.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	50.300	**EQUIPMENT**	17.357
TOTAL	**135.150**	* NEW SCIENTIFIC & ENG. EQUIP.	1.224
ACRES	**1**	* Subset of previous category.	

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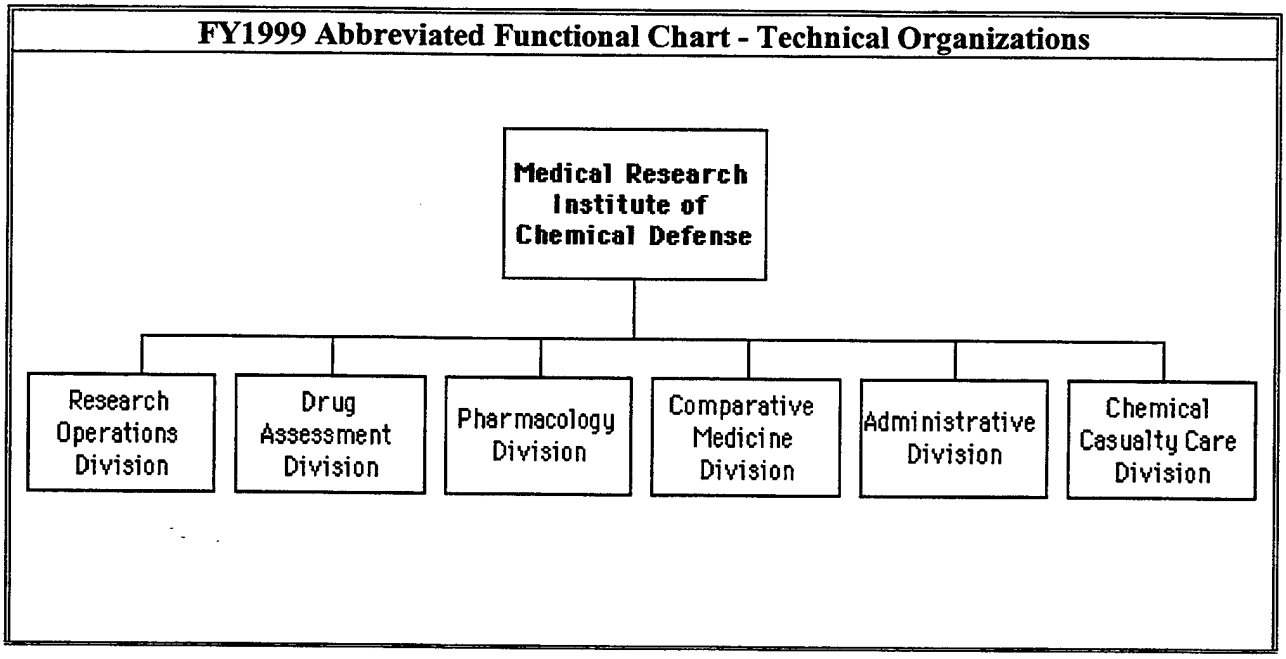
Medical Research Institute of Chemical Defense



Medical Research Institute of Chemical Defense

Aberdeen Proving Ground, MD 21010-5400
(410)436-3276

Commander: COL James S. Little
Deputy Commander: COL James A. Romano Jr.

MISSION

The U.S. Army Medical Research Institute of Chemical Defense is the Department of Defense's lead laboratory for development of medical countermeasures against chemical warfare (CW) agents and for training personnel in the medical management of chemical casualties. In order to establish a scientific and technical base from which to plan and formulate enhanced medical countermeasures to CW threats and develop improved prevention and treatment modalities for CW casualties, this missions includes: fundamental and applied research on mechanisms of action of CW threat agents, candidate pretreatment, treatment, and personal or skin decontamination compounds; test and evaluation of drugs, decontaminants, and medical equipment for the prevention, resuscitation, treatment, and management of chemical casualties. The Institute provides assistance in the integration of concepts and products from research development, test and evaluation mission activities into logistical, doctrine and organizational development and training systems as well as training of medical and non-medical personnel in the prevention and management of chemical casualties. The Institute also conducts research on medical defense against agents (neurotoxins) of biological origin.

CURRENT IMPORTANT PROGRAMS

Research programs at the Institute emphasize preservation of combat effectiveness by timely provision of medical countermeasures to chemical warfare (CW) agents in response to DA and DOD requirements. These programs maintain the technologic capability to meet present requirements and to counter future CW and neurotoxin threats, provide individual-level prevention and protection against these threats, and enhance the medical management of CW and neurotoxin casualties, enhancing survival and expediting and maximizing return to duty.

The Institute conducts basic research, exploratory development, non-system development, and advanced development of medical countermeasures for CW and neurotoxin agents, investigates the biomedical effects of CW agents, neurotoxins, and candidate medical countermeasures to these threats, conducts safety and efficacy studies of candidate pretreatment and prophylactic countermeasures, develops analytical technologies for medical countermeasures, and performs advanced research into CW and neurotoxin casualty care technology. We have met the objective of demonstrating efficacy of candidate countermeasures against vesicant injury in an animal model. We have made a milestone (MS) 1 transition of a methemoglobin former for pretreatment against cyanide and are conducting studies to demonstrate safety and efficacy of this product. The search for additional cyanide countermeasures is presently in a technology watch category. In addition to the development of mutant human butyrylcholinesterase as a biological scavenger, we are now developing mutant human carboxylesterase as another approach to meeting the MS 0 transition goals. We have also applied information gained in the bioscavenger program to the development of a reusable cholinesterase containing sponge that is capable of being used for nerve agent decontamination of patient wounds. Candidate advanced anticonvulsants are presently undergoing evaluation. We have demonstrated the efficacy and safety of a class of drugs as an advanced anticonvulsant to serve as an adjunct or component for the warfighter-buddy-use nerve agent antidote. This accomplished an objective to achieve a MS 1 on schedule for FY 00. The advanced anticonvulsant is more effective in rapidly terminating on-going seizures, preventing

CURRENT IMPORTANT PROGRAMS

their reoccurrence, protecting against nerve agent-induced, seizure-related brain damage, and also lacks abuse potential; all these features represent significant improvements over the current anticonvulsant product.

Efforts to demonstrate by FY02 safety and efficacy sufficient for a MS 0 transition of the technology for an active-topical skin protectant (TSP) that will provide protection against penetration and will detoxify both vesicant and nerve CW agents are on track. This product will represent a significant improvement in protection over the TSP that is presently in advanced development. The Institute maintains a significant effort in determining the effects of chronic exposure to low doses of CW agent and the effectiveness of current medical countermeasures against novel threat CW agents. A pathophysiology database has been developed on respiratory agents that are currently in a technology watch category.

The Chemical Casualty Management effort identifies and utilizes new technologies to improve decontamination and clinical diagnosis, prognosis, and management of chemical agent casualties. A noninvasive methemoglobin prototype monitor is undergoing evaluation and direct comparison with results from blood samples analyzed by a hemoximeter. This device will monitor therapy used to provide protection against or treatment for cyanide exposure. The Cholinesterase Test System received approval by the FDA and a MS 1/3 transition was coordinated by MRMC. The use of CO2 laser debridement for sulfur mustard wounds of the skin produced accelerated healing through improved viability and organization of the epidermis.

During FY99, 28 Medical Chemical & Biological Casualty (MCBC) courses on the Medical Management of Chemical Casualties were conducted for 2,528 students and 6 Field Chemical & Biological Casualty (FCBC) courses where 289 students were trained. In addition, the Institute provided a satellite broadcast course on Medical Response to Chemical Warfare and Terrorism. This broadcast was received in all 50 states at 748 sites. It was estimated that the broadcast was viewed by 2.5 million persons and 40,032 students registered for CME credits. The Institute maintained 1 Cooperative Research and Development Agreement (CRDA) and 31 Material Transfer Agreements (MTA) during FY 99.

EQUIPMENT/FACILITIES

The Institute's facilities support chemical casualty care training, physiology, drug assessment, pathophysiology, pharmacology, analytical chemistry, neurotoxicology, veterinary surgery, chemical safety/surety, medical maintenance, information and resource management, logistics support, and quality assurance. A technical library with 6,000 books, 1,000 journal titles, and access to many databases is an integral part of our Institute. Video facility, computer facility and a 14,500 SF animal facility also supports our researchers. Radioisotope chemical antidote and biochemical analysis, histochemistry, behavioral testing, drug screening, pharmacokinetics, molecular modeling, liquid, gas, column and affinity chromatography, quantitative image enhancement/analysis, electrophoresis, spectroscopy, fluorometry and spectropolarimetry, GC mass spectrometry, nuclear magnetic resonant (NMR), multi-photon lazer scanning microscope (MPLSM), electron spin resonance and peptide synthesis/sequencing, amino acid analysis, monoclonal hapten antibodies; electron, scanning and X-ray microscopy, cell cloning, and receptor analysis are also supported.

EQUIPMENT/FACILITIES

Major Facilities and Equipment:

Building E-3100: Main Medical Chemical Defense Research Laboratory and Administrative Building.

Building E-3081: Unique to DOD. Contains a Chemical Surety Materiel Laboratory for Medical Chemical Defense Research.

Building E-3156: Large Animal Holding/Chemical Research Facility.

Building E-3244: Biotoxin Research Facility.

Building E-3103/E-3106: Chemical Casualty Care Training Facility.

Building E-3103/Classroom: Chemical portion of the Management of Chemical and Biological Casualties Course (6H-F26) is conducted here.

Building E-3101: Administrative Facility: Surety, Safety, Environment, and Contract Management.

Hazardous Materiel Storage and 90-Day Hazardous Waste Sites: These sites meet stringent specifications which conform to the environmental requirements for the storage and disposition of chemicals and hazardous materials.

Building E-3105: Information Management Support Facility.

Building E-3107: Equipment Turn-in Facility.

Building E-3104: Environmentally Controlled Building for Electronic Equipment.

Building E-2180: Equipment Storage and Turn-in Facility.

Building E-3083: Equipment storage for Medical Chemical and Biological Casualties course.

Building E-5826: Animal Care Equipment Storage Facility.

Building E-3221: Toxic Waste Storage Facility.

Direct Digital Control HVAC System: System provides constant control and 24-hour remote monitoring of chemical fume hoods in the Surety Area of building E-3081, controls HVAC throughout remainder of laboratories and administrative areas, and controls and remotely monitors all animal rooms in buildings E-3081, E-3100, E-3156, and E-3244.

Walk-in Coolers in Building E-3081, E-3100: Storage of chemicals used for research.

Chillers, Building E-3081: Installed in 1994 to meet EPA requirements. Each unit produces 350 tons of cooling using 123 refrigerant.

Chillers, Building E-3100: Installed in 1994 to meet EPA requirements. Each unit produces 350 tons of cooling using 123 refrigerant.

EQUIPMENT/FACILITIES

Air Compressor: Required to supply laboratories with bench air for research.

Chemical/Biological/Radiological (CBR) Filter Trains: Provided for all 77 chemical/biological hoods located in buildings E-3100, E-3081, and E-3244. Each CBR filter train consists of a housing unit containing prefilter, as well as the appropriate number and size of High Efficiency Particulate (HEPA) and High-Efficiency Gas-Phase Absorber (HEGA) filters. All filter trains are in support of the Chemical/Biological Defense Program and are in compliance with Environmental Protection Agency, State, and Federal Standards.

Exterior Walk-in (adjacent Bldg E-3100): Storage of animal carcasses prior to incineration.

Auxiliary Chillers (E-3100): Provides renovated laboratories with additional cooling to support electronic equipment.

Decontamination Showers Required to conduct research in accordance with regulations.

Building E-3156/Associated Animal Pens and rooms: Quarantine area for newly arrived large animal species. Required for the care of animals used in research.

House Water Distillation System (Bldgs E-3100, E3081, E-3244): This central system feeds water to satellite polishing systems in the individual laboratories. Pure laboratory water is needed in virtually all segments of laboratory research. High-purity water is used for reagent buffers and sensitive instrumental analyses (such as High Pressure Liquid Chromatograph, Gas Chromatograph/Mass Spectrometer, as well as inwashing and/or preparing biological solutions such as media for tissue culture.

Hazardous Materiel and 90-Day Hazardous Waste Sites: These sites meet stringent specifications which conform to the environmental requirements for the storage and disposition of chemicals and hazardous materials.

Emergency Generator (Bldg E-3100): Provides emergency power for lighting, freezers, incubators, and other specialized equipment which must remain operational.

Administrative and Laboratory Emergency Generator (Bldg E-3081): Provides emergency power for lighting, freezers, incubators, and other equipment which must remain operational.

Surety Area Back-up Generator (Bldg E-3081): Supplies emergency power to the entire chemical surety wing to include all fume hoods, heating, ventilation and air conditioning systems, and electrical systems.

Surety Area Holding Tanks (Bldg E-3081): Consists of two 10,000 gallon tanks which hold all waste water generated in the surety wing. This ensures that chemical spills will not escape into the sanitary sewer.

Medical Research Institute of Chemical Defense
Aberdeen Proving Ground, MD 21010-5400
(410)436-3276

Commander: COL James S. Little
Deputy Commander: COL James A. Romano Jr.

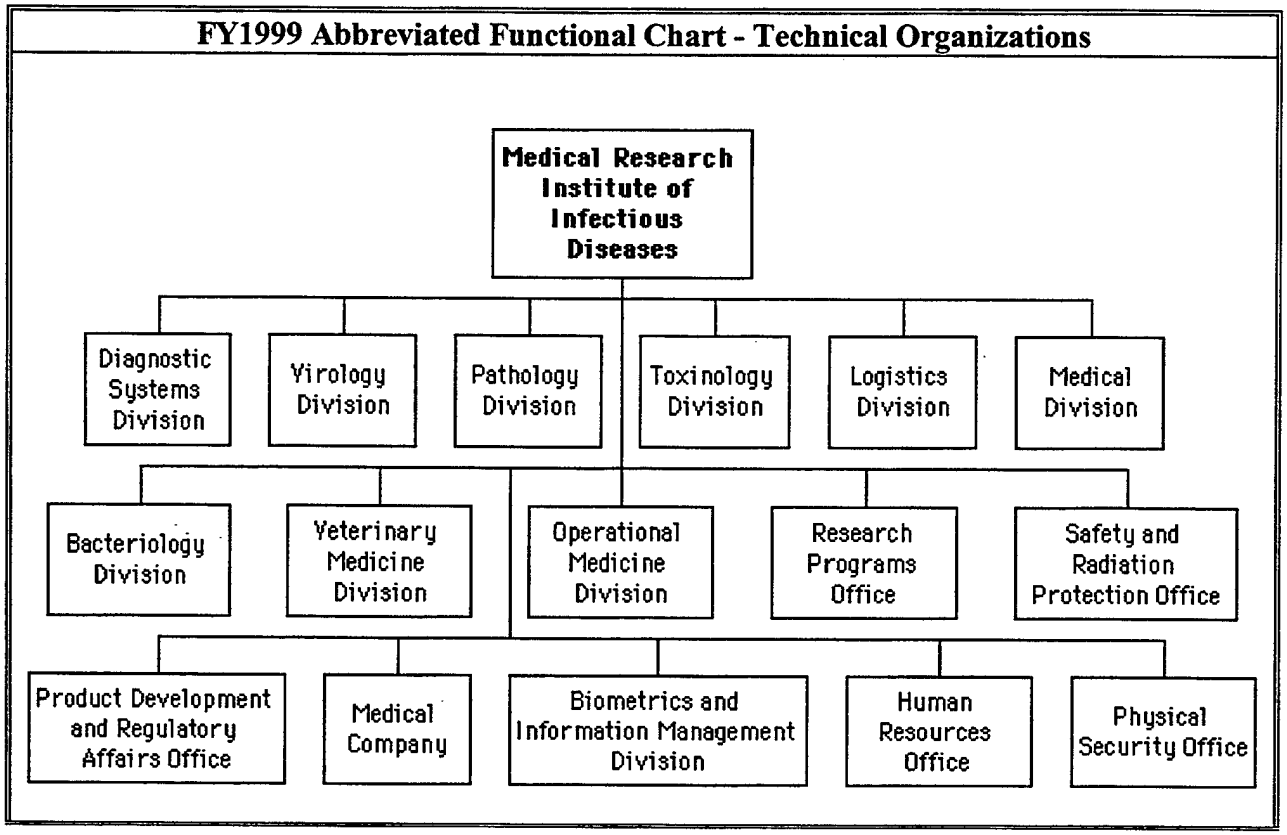
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.038	N/A	N/A	0.038
6.1 Other	4.274	0.000	3.697	7.971
6.2	10.687	0.000	0.943	11.630
6.3	3.617	0.000	4.706	8.323
Subtotal (S&T)	**18.616**	**0.000**	**9.346**	**27.962**
6.4	0.021	0.000	0.000	0.021
6.5	0.340	0.000	0.000	0.340
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**18.977**	**0.000**	**9.346**	**28.323**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	2.463	N/A	0.000	2.463
Other	4.547	N/A	0.000	4.547
TOTAL FUNDING	**25.987**	**0.000**	**9.346**	**35.333**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	15	7	32	**54**
CIVILIAN	26	30	85	**141**
TOTAL	**41**	**37**	**117**	**195**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	37.419	**REAL PROPERTY**	23.400
ADMIN	38.433	* NEW CAPITAL EQUIPMENT	0.000
OTHER	125.024	**EQUIPMENT**	29.500
TOTAL	**200.876**	* NEW SCIENTIFIC & ENG. EQUIP.	2.000
ACRES	**30**	* Subset of previous category.	

Medical Research Institute of Infectious Diseases



Medical Research Institute of Infectious Diseases
Ft. Detrick, MD 21702-5011
(301)619-2833
Commander: COL Gerald W. Parker
Deputy Commander: LTC George W. Korch, Jr.

MISSION

USAMRIID's mission is to conduct research to develop strategies, products, information and training for medical defense against biological warfare threats and against naturally occurring infectious agents of military importance that require special containment. Medical countermeasures developed to protect military personnel against biological attack include vaccines, therapeutic drugs, diagnostic capabilities, and various medical management procedures. These products are intended to eliminate or minimize the effects of disease and preserve fighting strength. The Institute is the lead research laboratory in the Medical Biological Defense Research Program and participates in crucial aspects of the Infectious Disease Research Program. The Institute serves a key role in national defense and in infectious disease research as the largest biological containment laboratory in the Department of Defense for the study of hazardous diseases. In addition, USAMRIID provides critical and timely training in medical management of biological casualties to both military and civilian health care providers. USAMRIID provides technical expertise and consultation to other DoD and civilian government agencies as a member of several interagency biological counterterrorism groups. As a world-renowned resource, USAMRIID serves as the reference laboratory for DoD and other government agencies for identification of biological agents and diagnosis of diseases caused by them, and is also a reference center for the U.S. Centers for Disease Control and Prevention and the World Health Organization.

CURRENT IMPORTANT PROGRAMS

The development of medical countermeasures, to include vaccine and therapeutic drug candidates and diagnostic tests for biological warfare threats continues to be the highest mission priority. New vaccine candidates based on naked DNA or constructed using a benign virus vector have been generated using genetic engineering approaches and are in various stages of advanced preclinical testing. Candidate vaccines for Venezuelan equine encephalitis and four serotypes of botulinum toxins were transitioned to advanced development. Other promising vaccine candidates that have been generated using genetic engineering techniques are being evaluated for transition to advanced development. These include a vaccine candidate for plague, which is based on two key bacterial proteins, and a candidate for anthrax, which is based on the protective antigen protein. Significant research advances in understanding the mechanism of action of botulinum toxins were achieved, to include the first complete x-ray crystal structure of one serotype of the toxin. USAMRIID researchers demonstrated the potential usefulness of multiagent vaccines based on naked DNA using animal models. Promising results in identification of antiviral drugs for treatment of orthopox viruses and filoviruses provided the basis for more advanced studies to eventually develop the most promising drugs for treating humans. Continued interactions with the pharmaceutical industry through Cooperative Research and Development Agreements allow researchers access to drugs that are in clinical development for commercial purposes so that they can be tested against the agents of military interest, to include viruses, bacteria and toxins, at USAMRIID. Diagnostic tests developed at USAMRIID are fielded with the 520th Theater Army Medical Laboratory to provide the capability for that laboratory to diagnose and identify the classical biological warfare agents as well as important endemic infectious diseases. Immunochromatographic assays for several biological threat agents were refined for use in the reference laboratory. Highly sensitive and specific gene-based technologies for identification of biological agents were implemented in several formats, to

CURRENT IMPORTANT PROGRAMS

include laboratory based and portable, integrated prototype systems. In collaboration with industry partners and other federal laboratories, to include those supported by DARPA biodefense programs, equipment prototypes for automated sample handling, processing and analysis of biological agents were developed and provided to USAMRIID for assessment. The reference laboratory capabilities for identification of biological threat agents was expanded to include additional technologies and diagnostic materials, and procedures implemented to bring the reference laboratory into compliance with established quality standards such as ISO Guide 25. Several molecular technologies are being explored for creation of effective multiagent vaccines, and interdisciplinary groups of researchers have been formed to identify creative approaches for vaccines, therapeutics and diagnostics for genetically engineered or novel biological threat agents. The interactive distance learning program designed to increase our capability to train military health-care providers in the Medical Management of Biological Casualties was continued in partnership with the Centers for Disease Control and Prevention, and broadcast in September 1999 to hundreds of sites, reaching approximately eighteen thousand enrolled students. USAMRIID also is recognized as an important national resource for support in countering biological terrorism. The formal response team established to assist other responsible agencies in this arena participated in numerous exercises, presentations, and training sessions, providing technical expertise and laboratory capabilities to address this problem. USAMRIID researchers actively support the DoD Cooperative Threat Reduction program, participating as collaborators with Russian biological scientists in several mission-related research projects.

EQUIPMENT/FACILITIES

Three buildings provide 347,000 square feet with approximately 15% of the laboratory space capable of operations at biosafety level 3 and approximately 3% capable of operations at biosafety level 4 (maximum containment). These containment laboratories are a unique national and international resource for the safe study of high hazard disease agents; the biosafety level 4 laboratories are the only such laboratories within the DOD. Other unique facilities include: a 16-bed clinical research ward; high containment patient care facility (the only such facility in the U.S.) and support functions; contained dynamic aerosol laboratory exposure systems; cell culture and hybridoma laboratory; and electron microscopy equipment. The laboratory facilities also include a farm for the care and housing of large animals used in research. The laboratory animal facilities are accredited by the Association for the Assessment and Accreditation of Laboratory Animal Care, International. The laboratories contain state of the art equipment to support studies in molecular biology, protein chemistry, gene sequencing and analysis, microbiology, virology, and biochemistry. In addition, USAMRIID has special mobile patient containment equipment designed to allow for the safe transport and medical care of a patient with a highly hazardous disease.

Medical Research Institute of Infectious Diseases

Ft. Detrick, MD 21702-5011
(301)619-2833

Commander: COL Gerald W. Parker
Deputy Commander: LTC George W. Korch, Jr.

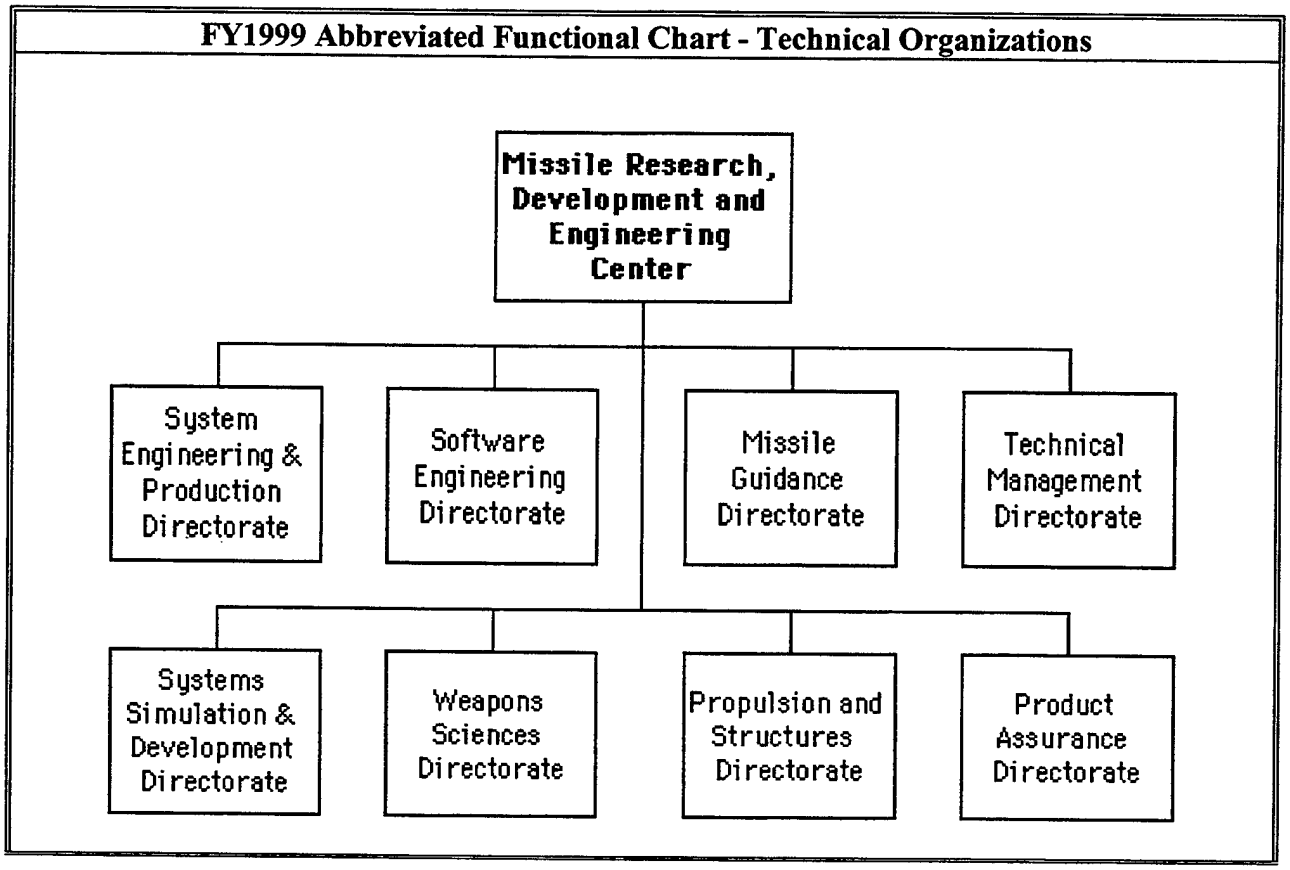
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.093	N/A	N/A	1.093
6.1 Other	10.512	0.050	0.000	10.562
6.2	9.739	0.050	0.000	9.789
6.3	10.974	0.050	0.000	11.024
Subtotal (S&T)	**32.318**	**0.150**	**0.000**	**32.468**
6.4	0.105	0.000	0.000	0.105
6.5	0.030	0.000	0.000	0.030
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**32.453**	**0.150**	**0.000**	**32.603**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	1.563	N/A	0.000	1.563
Other	3.050	N/A	0.000	3.050
TOTAL FUNDING	**37.066**	**0.150**	**0.000**	**37.216**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	48	48	118	**214**
CIVILIAN	45	54	119	**218**
TOTAL	**93**	**102**	**237**	**432**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	121.000	**REAL PROPERTY**	24.892
ADMIN	78.925	* NEW CAPITAL EQUIPMENT	0.260
OTHER	148.000	**EQUIPMENT**	43.797
TOTAL	**347.925**	* NEW SCIENTIFIC & ENG. EQUIP.	3.209
ACRES	**150**	* Subset of previous category.	

Missile Research, Development and Engineering Center



Missile Research, Development and Engineering Center

Redstone Arsenal, AL 35898-5241
(256)842-2201

Technical Director: Dr. William C. McCorkle
Associate Director: Michael C. Schexnayder

MISSION

To plan, manage and conduct research, exploratory and advanced development for guided missile and rocket weapon systems and related components; to provide scientific, engineering, and technical support for weapon system programs over the complete life cycle; and to manage computer resources embedded in battlefield automated systems. MRDEC provides the technical expertise to enable the services to be smart buyers and users of missiles, rockets, unmanned vehicles and their unique command and control systems, directed energy, non-lethal technology, computer resources embedded in battlefield automated systems, and related models and simulation and, as such, is an essential part of the acquisition process.

MRDEC's science and technology base mission includes planning, managing, and conducting research, advanced development, and exploratory investigation in response to Army system needs. MRDEC's national defense mission includes mutually beneficial relationships with the private sector for those areas where parallel paths should be and can be reduced by cooperation. MRDEC's life cycle systems engineering mission includes planning, establishing, and managing the Missile Command programs to develop new weapon systems, evaluate system and subsystem performance, and maintain high readiness status, assure effectiveness of fielded systems, and control both acquisition and O&S costs. Selective research and component development is conducted to generate new manufacturable technology, reduce development lead time and system cost, and improve reliability.

MRDEC is the Army's lead organization for technologies in missile propulsion, guidance and control/terminal homing, high energy lasers, missile systems simulation, and unmanned vehicles. MRDEC is the System Integrator for the Joint Program Office for Unmanned Aerial Vehicles. MRDEC has the DoD Lead in the Rapid Force Projection Initiative (RFPI), a major Advanced Concept and Technology Demonstration (ACTD) that includes AMC-wide simulation/demonstration/residual support. In addition, MRDEC manages both AVRDEC and MRDEC common process-driven areas as follows: management of operations and business; systems engineering and production; product assurance; battlefield automation; test and evaluation management.

VISION: Weapon System Technology for Swift Decisive Victory without Casualties.

STRATEGIC GOALS:

1. Demonstrate feasibility of new systems concepts that significantly enhance warfighting capabilities by integration of enabling technology into demonstration efforts.
2. Focus the science and technology base on the new realities.
3. Increase market share: broaden the marketplace.
4. Improve the responsiveness, affordability, and quality of MRDEC products and engineering services.

ENABLING STRATEGIES:

1. Keep workforce fully engaged in state-of-the-art technology work to preserve capability as smart buyer.
2. Develop a superior workforce and a quality environment.

CURRENT IMPORTANT PROGRAMS

Guided MLRS ATD - This program will demonstrate a low cost guidance and a control package for the MLRS rocket. At extended ranges, large quantities of baseline rockets are required to defeat the target. With the addition of a guidance system, an improved delivered accuracy will be achieved. The number of rockets required to defeat the target will be reduced to one-sixth the current quantity at maximum ranges. This program successfully demonstrated the guidance in flight tests.

Rapid Force Projection Demonstration - The integrated system of systems concept of the ACTD provides lightweight, responsive precision fires to destroy threat armor forces during day, night, and adverse weather. This ACTD will evaluate the value added by the insertion of these new technologies into the force structure of an existing light unit in a lift constrained environment. The inserted systems will consist of forward sensors (hunters), advanced C2, and a suite of standoff killers. This program has successfully demonstrated the concept in a major field experiment and is in the residual phase.

Compact Kinetic Energy Missile (CKEM) Technology - This project demonstrates the compact kinetic energy missile technology necessary for future kinetic energy weapons. CKEM will match the lethality of the LOSAT while reducing the LOSAT take off weight by 40-50%, missile diameter by 20%, minimum range to peak velocity by 40-50%, and provide the maneuver capability required to destroy attacking fixed and rotary wing aircraft. This concept is being designed to be compatible with the LOSAT target acquisition and tracking system and could be compatible with the fire control system for close combat and short range air defense missions.

Low Cost Precision Kill (LCPK) 2.75" Guided Rocket - This project provides for demonstration of a low cost, accurate (1-m CEP) guidance and control retrofit package for the 2.75" Hydra-70 rocket that provides a stand-off range for a high single shot probability of hit (Ph > or = 0.7) against the long range target, exceeding the current unguided 2.75" rocket baseline by 1 or 2 orders of magnitude and thereby providing a 4 to 1 increase in stowed kills at 1/3 the cost per kill compared to current guided missiles. The increased accuracy will minimize collateral damage, reduce risk of fratricide, and will reduce mission times and sorties resulting in increased system survivability. A retrofit guidance package approach based on a solid state (strapdown) mechanization of semi-active laser (SAL) guidance, will be developed and tested, with user participation, to assure the most cost effective transition to EMD.

Counter Active Protection Systems (CAPS) - This project develops and demonstrates technologies which can be applied to Anti Tank Guided Weapons (ATGW) for improving their effectiveness against threat armor equipped with Active Protection Systems (APS). Current technology development is concentrated in the following areas: Radio Frequency (RF) Counter-measure (RFCM) technology for jamming or deceiving APS sensors used for detection, acquisition, and tracking; warhead integration and ballistic hardening of ATGW to reduce vulnerability to fragment impact.

PKAT (Precision Kill and Autonomous Targeting) - This effort will demonstrate, through flight simulations and component developments, technologies for a long range (>30Km) weapon system for maneuver forces (with potential air defense and artillery applications). These technologies will provide enhanced sensor-shooter connectivity, continuous in-flight autonomous feedback of target coordinates to local field commanders, minimized timeline for placing weapons on target, and battlefield damage assessment with last images before impact as well as demonstrate automatic target recognition (ATR) and man-in-the-loop target acquisition and engagement concepts.

CURRENT IMPORTANT PROGRAMS

Compact Aerial Vehicle-Shooter Linker (CAV-SL) - This effort will provide a small, easy-to-operate, inexpensive UAV which will be organic to small units such as a tank platoon. CAV-SL will provide information for targeting, battle damage assessment (BDA), and fratricide avoidance.

Multimode Airframe Technology (MAT) (formerly known as Long Range Fiber Optic Guided Missile (LONGFOG)) - This program will provide a 40 km day/night, multiple and high value time sensitive point target strike capability while inflicting minimum collateral damage. The LONGFOG system will provide the capability to select priority targets after launch, conduct limited man-in-the-loop BDA, and provide target area reconnaissance in addition to target attack by means of variable cruise velocity over areas of interest.

Future Missile Technology Integration (FMTI) (formerly known as The Army Combined Arms Weapon Systems (TACAWS)) - This project provides for the demonstration of advanced tactical missile technologies including seekers, propulsion, airframes, warheads, and guidance and control. The project will demonstrate lightweight multi-role missile technology in support of ground-to-ground, ground-to-air, air-to-air, and air-to-ground missions. Combined, flexible capability allows one system or variants of one system to replace many, realizing potential extensive savings in development costs, logistics, training, etc. The FMTI demonstration program is transitioning technology to the Modernized Hellfire/Common Missile, and Joint Advanced Weapons System (JAWS), an Army/Marine Corps multi-purpose, multi-platform missile.

Cooperative Research and Development Agreements (CRDAs):

COMPANY: Sy Technologies, Inc.
DURATION: 5/94 through 1/99
SUBJECT: Development and analysis of designs, and fabrication and test of these designs of binary optic elements for use in unique state-of-the-art optical systems.
PAYOFF: Reduction in costs, increase in reliability and performance of optical elements used in Army missile and optics systems.

COMPANY: Rockwell International Corp
DURATION: 7/94 through 1/97
SUBJECT: Development and verification of advanced analytical design methodology and design tool that optimizes the structural performance of components made of composite materials by tying material properties directly to the manufacturing process.
PAYOFF: Acceleration of the use of lightweight, high strength structures in the development of advanced Army missile systems and aircraft.

COMPANY: Signature Products
DURATION: 7/94 through 1/97
SUBJECT: Increasing the production rate and improving the C(60) reactor process for Radar Absorbing Materials (RAM).
PAYOFF: Increasing efficiency (higher impulse) in missile propulsion systems.

COMPANY: Optical Processing Technology Systems
DURATION: 4/95 through 9/97
SUBJECT: Development of components and algorithms required for demonstration of a diverse pattern recognition system using optical processors.
PAYOFF: High throughput, smaller size, decreases power consumption, and lower costing processors.

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COMPANY: Hughes Missile Systems
DURATION: 5/95 through 12/96
SUBJECT: Development of a comprehensive Tolerance Optimization and Variability Reduction (TOVAR) process and methodology model which can be integrated into both product development and production processes.
PAYOFF: Increased production yields, lower production costs, and increased product reliability and robustness.

COMPANY: Optical Corp of America
DURATION: 5/96 through 9/97
SUBJECT: Optical Processing Architectures and Algorithms for Automatic Target Recognition - This research, development, and demonstration of revolutionary optical processing architectures and algorithms for automatic target recognition for military and commercial applications.
PAYOFF: Reduction in the production cost of military systems.

COMPANY: Rochester Photonics Inc.
DURATION: 9/96 through 5/99
SUBJECT: E-Beam Fabrication Technology - This research will evaluate the technique of direct E-Beam fabrication for diffractive optical components and performance of replication studies.
PAYOFF: Lower cost of optical components.

COMPANY: Georgia Tech Research Corporation
DURATION: 11/92 through 1/99
SUBJECT: Development of advanced manufacturing processes and equipment in the areas of microelectronics and photonics.
PAYOFF: Reduction in the production costs of military systems.

COMPANY: Hughes Missile Systems
DURATION: 7/97 through 6/99
SUBJECT: Computer Aided Modeling Design and Analysis (CAMDA) - This research will be used as a tool to investigate advanced missile concepts and have direct commercial applications in computer modeling and simulation.
PAYOFF: Enhanced computer-aided modeling with commercial and military applications.

COMPANY: Northrop Grumman Corp
DURATION: 6/97 through 1/99
SUBJECT: Adaptive Rocket Payload Configuration (ARPC) - This research will have direct commercial applications in the area of foreign military sales for multiple payload configurations and missile technology using large nose cone missiles launched from existing small launch tubes.
PAYOFF: Reduction in the production cost of military systems.

COMPANY: Honeywell, Lucent Technologies & Northrop Grumman
DURATION: 12/96 through 12/00
SUBJECT: Plastic Encapsulated Microcircuits in Severe Storage Environments -This effort involves cooperative research and development to determine the risk in using plastic encapsulated microcircuits in severe storage environments.
PAYOFF: Low cost hardened electrical circuits.

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COMPANY: Nichols Research Corp DURATION: 12/96 through 10/01
SUBJECT: Adaptive Radio Interface Device - The radio infrastructure developed under this effort will be designed with the intent of supporting multiple communications protocols, multiple physical radio implementations, and multiple form factors.
PAYOFF: Multiple protocols for military communications.

COMPANY: Northrop Grumman Corporation
DURATION: 12/09/97 through 3/31/98
SUBJECT: Elliptical Rocket Payload Section (ERPS). This research will have direct commercial applications to foreign military sales of multiple payload configurations and missile technology using large nose cone missiles launched from existing small launch tubes.
PAYOFF: Cost-effective, readily fieldable, delivery system for several types of precision strike submunitions.

COMPANY: Vision Partners, L.P.
DURATION: 12/18/97 through 12/31/99
SUBJECT: Ocular Refractive Error/Disease Detection System (OREDDS). This research will have direct commercial applications such as mass screening preschool/kindergarten age children for ocular defects such as myopia, hyperopia, amblyopia, astigmatism, strabismus, and cataracts.
PAYOFF: Mass screening of adolescent children and learning impaired adults for vision abnormalities. Utilized by Armed forces for initial screening of Recruits.

COMPANY: Hughes Missile System
DURATION: 2/28/98 through 12/31/00
SUBJECT: Automatic Target Recognition (ATR). This involves evaluation of automatic target recognition technology for tactical weapons systems.
PAYOFF: Accelerate the development of next-generation Automatic Target Recognition. It will also provide for automatic car tag character decoding, text/symbolic character recognition.

COMPANY: University of Rochester
DURATION: 3/31/98 through 4/30/99
SUBJECT: Semi-Conductor Laser Dynamic Research (SLDR). This joint research will explore novel approaches to the fundamental formulation and understanding of the interactions and couplings of semiconductor materials with laser fields.
PAYOFF: This research will enhance telephone communications, optical communications, fiber optics, optical integrated elements, data processing, communications, stabilization of lasers in integrated optical systems, CD applications, and semiconductor phased arrays (for advanced infrared (IR) applications).

COMPANY: Oklahoma State University
DURATION: 3/31/98 through 4/30/99
SUBJECT: Semi-Conductor Laser Dynamic Research (SLDR). This joint research will explore novel approaches to the fundamental formulation and understanding of the interactions and couplings of semiconductor materials with laser fields.
PAYOFF: This research will enhance telephone communications, optical communications, fiber optics, optical integrated elements, data processing, communications, stabilization of lasers in integrated optical systems, CD applications, and semiconductor phased arrays (for advanced infrared (IR) applications).

COMPANY: University of Alabama in Huntsville (UAH)
DURATION: 3/31/98 through 4/30/99

CURRENT IMPORTANT PROGRAMS

SUBJECT: Semi-Conductor Laser Dynamic Research (SLDR). This joint research will explore novel approaches to the fundamental formulation and understanding of the interactions and couplings of semiconductor materials with laser fields.
PAYOFF: This research will enhance telephone communications, optical communications, fiber optics, optical integrated elements, data processing, communications, stabilization of lasers in integrated optical systems, CD applications, and semiconductor phased arrays (for advanced infrared (IR) applications).

COMPANY: Raytheon Missile Systems
DURATION: 3/31/98 through 4/30/99
SUBJECT: Long Range Fire Support Missile (LRFSM). This research will have direct commercial applications such as remote unmanned surveillance, uncooled Imaging InfraRed (IIR), and multi-mission payloads.
PAYOFF: The development of a modular missile/launcher system.

COMPANY: Aegis
DURATION: 5/31/98 through 3/31/00
SUBJECT: Photonic Sensor Components. This research will have direct commercial applications such as telecommunications, commercial-grade guidance and control systems, chemical and biological sensors, high-speed interconnects, and parallel optical processors.
PAYOFF: Development of low cost electro-optic sensors.

COMPANY: Northrop Grumman Corporation
DURATION: 7/7/98 through 1/31/02
SUBJECT: Adaptive Rocket Payload Configuration (ARPC). This research will have direct commercial applications in the area of foreign military sales of multiple payload configurations and missile technology using large nose cone missiles launched from existing small launch tubes.
PAYOFF: Reduction in the production cost of military systems.

COMPANY: OPTS, Inc.
DURATION: 8/19/98 THROUGH 7/30/00
SUBJECT: Microelectromechanical Support Element (MEMS). This research will have direct commercial applications such as optical communications links, miniature actuators, optical switching, and sensors.
PAYOFF: Reduction in cost of microelectronic devices (sensors, temperature, humidity, load sensors).

COMPANY: The Boeing Company
DURATION: 10/98 through 8/00
SUBJECT: Low Cost Precision Kill (LCPK) - Advanced missile concepts that research will have direct commercial applications such as precision guidance of small free rockets.
PAYOFF: Securing concept that can be extended to missiles of various diameters, such as MLRS, STINGER, etc.

COMPANY: Cogitat Ergo Est
DURATION: 11/98 through 9/01
SUBJECT: Artificial Conscious System - This research will have direct commercial applications such as computer games, bots (software robots), robots, agricultural machines, vehicles, smart rooms (medical ICU's, warehouses) networks, internet software agents, financial software agents, and appliances.
PAYOFF: Provide security information warfare & intelligence and vehicles for autonomous surveillance.

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COMPANY: Raytheon Missile Systems
DURATION: 12/98 through 10/01
SUBJECT: Hypervelocity Anti-tank Missile Weapon System (HATM) - This is to utilize state-of-the-art design, analysis, and test tools to address technological problems associated with design and development of HATM weapon system.
PAYOFF: Enhances the performance of anti-tank weapon systems form & fit compatible with other TOW launch platforms.

COMPANY: Tracor (Macroni Aerospace Systems, Inc)
DURATION: 1/99 through 12/00
SUBJECT: Wind Tunnel Testing Low Cost Precision Kill - Technology that investigates advanced missile concepts and will have commercial applications as laser seeker configurations, missile technology utilizing small diameter missiles launched from existing small launch tubes.
PAYOFF: Long range weapons development, i.e., Advanced Fire Support System (AFSS) and modernized Hellfire missiles.

COMPANY: Beta Squared, Inc.
DURATION: 1/99 through 11/03
SUBJECT: Inductively Coupled Plasma Source Chamber - This research will have direct commercial applications such as plasma etching of silicon-based substrates.
PAYOFF: Provide bulk micro-machining capability that allows deep etching with vertical sidewalls.

COMPANY: Thiokol Corporation
DURATION: 2/99 through 12/99
SUBJECT: Propulsion for the Stinger Block II (SBII). The objective of this CRDA is to develop a preliminary propulsion design of the next-generation STINGER missile.
PAYOFF: Provide technical design evaluations and next-generation STINGER missiles.

COMPANY: University of Tennessee Space Institute
DURATION: 2/99 through 10/00
SUBJECT: Jettison Modeling and Flight Test Research (JETMOFT) - This research will have direct commercial applications such as improvements in accuracy of computer models, increase speed of flight test data reduction and improve low speed aircraft flight test procedures.
PAYOFF: Improve Helicopter GPS approaches; DOD test range document testing, Improve instrumental flight test.

COMPANY: Summa Technology
DURATION: 4/99 through 2/02
SUBJECT: Surveillance and Reconnaissance Ground Equipment (SARGE) system - The commercial application are security, search, and observation tasks utilizing wireless data and image transmission from a remote platform.
PAYOFF: Improve Helicopter GPS approaches; DOD test range document testing, Improve instrumental flight test.

COMPANY: Orbital Technologies, Inc.
DURATION: 9/99 through 8/01
SUBJECT: Multiple Impinging Stream Vortex Injector Rocket Engine (MISVIRE) - The commercial applications are sounding rockets, upper stage launch vehicles, and industrial combustion for retorts,

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central power station boilers, and waste stream incinerators.
PAYOFF: Advanced/upgraded Army tactical missiles, such as Hellfire, LONGFOG, and other air-to-air, air-to-ground, and ground-to-air systems that use gelled propellants or hybrid rocket engines.

COMPANY: Optelecom
DURATION: 9/99 through 9/01
SUBJECT: Navigation Grade Interferometric Fiber Optic Gyroscope (IFOG) coils. This project is to qualify new coil winding patterns and mounting designs to achieve navigation grade performance IFOGs of substantially reduced volume. This research will have direct commercial applications such as aircraft navigation; ships, mining, and surveyors.
PAYOFF: Low cost miniaturized gyroscopes for navigational operations.

TECHNOLOGY TRANSFER HIGHLIGHTS: Nine new Cooperative Research and Development Agreements (CRDAs) were approved during FY99, and two existing CRDA was amended and extended through FY02. CRDAs were signed with the following companies: Optelecom, Orbital Technologies, Sy Technology, Inc., Summa Technology; University of Tennessee Space Institute, Thiokol, Beta Squared, Inc., Tracor; Raytheon; Cogitat Ergo Est and Boeing; with technologies ranging from optics & lasers/optical detection, miniaturized gyroscopes, surveillance and reconnaissance systems; Modeling and Flight testing.

The MRDEC Director presented nineteen (19) Domestic Technology Transfer Awards. These awards were given to each outstanding contributor for their effort to bring MRDEC technologies to the commercial market place.

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Propellant Aging and Mechanical Properties Facility - This is the most modern facility in the world dedicated to solid rocket motor structural integrity and service life extension investigation. Completed in 1988, it meets DoD's latest safety requirements for handling hazardous propulsion materials.

Gel Propellant Rheology Facility - This facility is used to determine rheological properties of gelled propellants over the full range of the Army operational temperature limits and for shear rates equivalent to those imposed on the gels by engine injectors. This information is required to minimize the volume and weight of gel propulsion systems.

Ducted Rocket Test Facility - This is the most modern, economical, sub-scale direct connect air facility in the world and is used for testing ducted rockets and ramjets. Completed in 1995, it utilizes state of the art computer control to deliver a wide range of air flow rates and temperatures during a single test run, in effect 'flying' a mission while on the test stand.

Signature Characterization Facility (SCF) - This facility is used to characterize the exhaust plumes of rocket motors. The facility consists of a static test stand mounted inside an environmental chamber. Small test motors can be fired under any atmospheric condition of temperature and humidity, and evaluated as to their exhaust characteristics. These include visible and infrared flash, visible and infrared smoke attenuation, toxicity, particle analysis, and mm wave radar absorption.

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Target and Seeker Measurement Facility (TSMF) - Used by the Army and Air Force for sensor/seeker design measurements, this facility includes a 300 foot tower and elevator combination allowing an operator access to equipment at any elevation up to the maximum. It also includes a 70 ton capacity target turntable with multiple degrees of freedom.

Advanced Simulation Center - This center, unequalled in the free world, provides hardware-in-the-loop-simulation capability for missiles and submunitions throughout their lifecycles. Consisting of 12 hardware-in-the-loop simulation facilities, the Center provides unique capabilities for closed guidance loop system performance evaluation in a laboratory environment of missiles and submunitions guided and/or fuzed by: microwave and millimeterwave radar; scanning and staring infrared sensors; other electro-optical signals; and by inertially sensed motion. Its international reputation is demonstrated by previous and on-going international programs and consultations with the representatives of Australia, Belgium, France, Germany, Israel, Japan, Korea, and the United Kingdom.

The AMCOM Distributed Simulation (DS) Center - This facility provides the central node at AMCOM for distributed simulation. This facility contains ten interconnected application rooms for the development and operation of virtual prototype simulators, multiple local area networks, and supporting hardware and software essential to the conduct of DS exercises. It houses the node, or gateway, to the Defense Simulation Internet which facilitates simultaneous distributed experiments at multiple facilities throughout the U.S., and an extensive WAN which includes HWIL simulations, weapons system hardware, and virtual prototypes of systems and facilitates simultaneous distributed experiments at multiple facilities throughout the AMCOM.

The Advanced Protyping, Engineering and Experimentation (APEX) Laboratory - This facility is a research and development facility whose mission is to address the existing gap between warfighter simulation and engineering level simulation capabilities through the application of Distributed Interactive Simulation (DIS) and the emerging DOD High Level Architecture (HLA) technologies. It provides the infrastructure necessary to link live, virtual and constructive elements in common synthetic environments. This involves integrating the dynamics of doctrine, tactics, mobility, logistic support, Command, Control, and Communications (C3) decision making, and human reaction in a synthetic battlefield driven by both tactical and technical constraints. The APEX Lab provides a full spectrum systems engineering approach for evaluating emerging systems and concepts in a virtual prototyping environment.

Guidance and Control Analysis Facility - An all digital facility for check out of flight systems, this capability is unprecedented in its system bandwidth. It is currently used for real time check out of extremely high bandwidth ADKEM guidance and control components.

Anechoic RF Test Chamber - This facility is world renowned for it's wide anechoic bandwidth and physical size. A specially designed floor provides realistic simulation of surface wave propagation - a unique capability.

Fire Support System Integration Lab - Designed for end-to-end weapon system hardware check out, this facility contains distributed, netted communication nodes which can perform high and low level system tests. The facility is currently uniquely configured to check out the MLRS family of munitions.

UAV System Integration Laboratory - A world class facility unique in its ability to integrate multiple UAV systems and test common subsystem integration interfaces.

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Weapon System Interoperability Test Facility - Designed for weapon system software and communication testing, this is the only facility in the U.S. Government having, in residence, Army deployed tactical air defense systems, Unmanned Aerial Vehicle C3 assets, and other ground and fire support weapon and C3 systems. It is regularly used for joint interoperability certification testing, AWE and field demonstration preparation, and soldier training.

Composites Manufacturing Facility - Wholly Government owned and operated, the Composites Manufacturing Facility provides MRDEC engineers with a "hands on" capability in missile composites manufacturing from project concept, through fabrication, and testing. This facility is the Government's principal repository of technical expertise in this area.

Automated Manufacturing Cells - Contains a uniquely automated, fiberoptic winding capability and a cell for automated inspection of printed circuit boards down to 1-2 mils line width.

Laser Induced Chemistry Facility - Unique facility which includes lasers covering ultraviolet to infrared and analytical instrumentation to identify compounds resulting from laser induced reactions.

Laser Range - The Physical Sciences Building was designed for high energy laser operation. A laser range was built behind the building which allows the operation and use of the range from inside the building either by the hi-bay or directly from the lab. The range is approximately 1720 ft long with four islands each with a large mirror mount and electricity. A concrete bridge designed to support an M1 tank connects the islands with the hi-bay area. Chain link fence and interlocks on the interior doors restrict access to the range. Warning lights are positioned down the centerline of the range and on the access doors and gates.

Automated Laser Seeker Performance Evaluation System (ALSPES) - This $2M, one-of-a-kind facility provides complete open-loop test capability for semi-active laser (SAL) seekers/sensors operating at 1.064 microns. ALSPES provides characterizations on prototype/R&D hardware including specification compliance requirements, functional performance, and active electro-optical countermeasures (EOCM) susceptibility, and it has taken a commanding lead in EOCM susceptibility analysis. The facility has been used to test/characterize both foreign and domestic hardware, such as Copperhead, HELLFIRE, HELLFIRE II, Krasnopol, Vehicle defensive-aid suites, and 2.75" laser guided rockets. The modular equipment/software interface allows numerous systems to be tested with minimal changeover downtime.

The Laser Guidance Analysis Facility - This facility, which provides for real time, closed loop evaluation of semi-active laser guidance hardware, has and continues to be instrumental in the development and life cycle support of such systems as HELLFIRE and Copperhead. It is currently being utilized in the development and demonstration of new laser guidance concepts for the LCPK 2.75 Inch Guided Rocket program.

The Longbow/HELLFIRE and STINGER Systems Integration Facility - This facility is used to evaluate the interfaces and integration of the aircraft platforms, launchers, laser and Longbow HELLFIRE missiles, and Stinger missile. It provides the capability to assess hardware and software designs for entire weapon systems and supporting equipment such as test sets and training missiles.

Actuation Systems Test Facility - This facility provides the capability for testing pneumatic, hydraulic, electro-mechanical, and cold gas jet reaction control systems. It contains equipment for hydrostatic testing pressure vessels to 40 kpsi and pressurizing pressure vessels to 15 kpsi. The facility contains a

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six-component test stand with instrumentation for testing the forces and moments generated by a cold gas jet reaction system.

Guidance and Control Analysis Facility - An all digital facility for check out of flight systems, this capability is unprecedented in its system bandwidth. It is currently being used for real time check out of high bandwidth GMLRS guidance and control components and will be utilized in the near future in support of the CKEM and LCPK technology programs.

Inertial Guidance Management and Technology Center - The Center was established by the Army and funded in FY65 to provide central army monitorship of all R&D in inertial system/components navigation for missiles, aircraft and drones, land navigation; and other applications such as inertial land surveying and inertial fuzing. Full Inertial Test facilities and instrumentation to carry out that function is available.

Global Positioning System (GPS) Test Facility - The GPS Test Facility has the capability to provide inexpensive GPS hardware testing in a dynamic environment through the use of the two GPS Satellite Simulators (Tester)-GPST. The GPST is used to determine overall system performance including total system navigation accuracy, initial acquisition time-to-first-fix (TTF), geometrical effects (GDOP) satellite management, effects of vehicle dynamics, selective availability/anti-spoofing (SA/A-S) operation, inertial navigation system (INS) aided and unaided performance, antenna gain pattern modeling, jamming susceptibility, and space and control segment errors.

Control Actuation System (CAS) - MRDEC spun off in-house development of a Control Actuation System (CAS) to the prime contractor of the guided MLRS EMD program (Lockheed Martin Vought Systems). Successful development and demonstration of a CAS by MRDEC during the Guided MLRS ATD program has reduced the risk and cost of the GMLRS EMD program. Development and demonstration of a CAS significantly reduced risk areas such as thermal environment, aerodynamic loads, and canard flutter. Cost information gained from development of the ATD CAS was used to negotiate a realistic price with the prime contractor. MRDEC spun off in-house design of a three-axis Control Actuation System (CAS) for the Stinger Block II program. In support of the Low Cost Precision Kill ATD program MRDEC designed a three-axis CAS that meets the package and performance requirements of Stinger Block II.

Air Defense Radar Facility - This facility consists of laboratories, experimental test equipment, including a state-of-art test bed radar, and test ranges. This facility is now being used to support PATRIOT and SENTINEL product improvement programs, the MEADS development program, and air defense technology projects.

Compact Range Facilities - This facility provides the capability of precisely measuring amplitude and phase transmission characteristics of MMW antennas, radomes, and other devices. These compact ranges have been utilized to characterize threat radar antennas, BAT-P3I Seeker antennas, and multi-spectral materials. Most recently, one of these Compact Ranges has been extensively utilized in the support of PATRIOT's PAC-3 Seeker Development.

Army Air and Missile Defense Network Design Facility (AAMDNDF) - This facility provides JTIDS network designs and platform initialization load files for all Joint and Army-only tests, exercises, operations, and contingency events in which Army JTIDS-equipment units participate. The AAMDNDF is the Army's only JTIDS network design facility. Additionally, the NDF supports Army platform specific communications subsystem design, analysis, and testing for intra-Army, Joint, and Allied

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interoperability on this Joint mandated link. While routinely providing on-call technical support, the NDF is frequently called on to provide on-location support for tactical units deployed to field locations for exercises and contingency missions.

Computer/Software Development (Debug and Modeling) Environment - This one-of-a-kind environment provides full visibility into the operation of code on embedded systems operating with many microprocessors. This environment is microprocessor and microprocessor mount (processor in a socket or permanently attached) independent. This environment allows full visibility into the firmware's operation by stopping the code via breakpoints; display and/or alter the CPU's and code's resources (data structures, registers and the like); and trace the code flow in real time. Using the modeling capabilities within the environment, analysis based on the actual timing and data flow is used to construct a software architecture (repartitioned across the multiple processors). This integrated environment is based on a modular hardware/software architecture and can be easily reconfigured to interface with numerous systems with minimal downtime.

Applied Imagery Lab (AIL) - The AIL is a center of excellence for integrating COTS imagery into tactical applications, particularly trainers and system-in-the-loop stimulators for weapon systems. Lab focuses on providing low-cost, supportable, high-end PC-based technologies to solve real-time simulation problems. The AIL leverages these PC products with in-house expertise to provide prototyping, development, integration, demo, and test capabilities for tactical system-compatible products requiring real-time operator interactions with visible targets in a virtual environment. Actual tactical system sensors are stimulated with these virtual views to provide a realistic operational environment viewpoint to the weapon system operator. Facility is used by a number of program management offices and user organizations to reduce program risk, improve product quality of system trainers, and improve integration capabilities.

Life Cycle Software Engineering Center (Annex) - In September 1998 construction started on a 182,300 square foot facility that will expand the Software Engineering Directorate's (SED's) capability to support Aviation and Missile Systems. This facility will provide a unique platform to enhance the SED mission of performing Interoperability Weapon System Development, Verification/Validation and Testing. The facility will consist of laboratories, a highbay, and engineering work space to support 661 personnel.

Microfabrication Laboratory - Includes approximately 1,700 sq. ft. of specialized cleanroom space up to class 100, plus an additional 1500 sq. ft. of cleanroom space housing associated equipment. This area is divided into three separate laboratory areas. The first complex contains mask making and photolithographic equipment. Included is a pattern generator plus a step and repeat camera capable of 0.8 micron resolution. Mask aligners and spinners including one with capability for double sided patterns used in micromachining technologies (i.e., MEMS) is located here. Specialized equipment of layering EO polymer materials is included. Also, housed in this complex are precision surface analysis instruments such as surface profilers and an atomic force microscope.

Kiowa Warrior (OH-58D) Scout Helicopter Cockpit Procedures Trainer with Image Generator (CPT-IG) Software Support Environment (SSE) - The CPT-IG SSE will provide the AMRDEC Software Engineering Directorate (SED) with the capability to maintain, support and upgrade CPT-IG Trainer software. The trainers are used at the Army Flight School, Ft. Rucker, AL to assist in the training of Pilots, Co-pilots and Maintenance Test Personnel in operational/maintenance procedures of the actual aircraft.

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The lab is also expanding to include a Software Support Environment to perform Post Production Software Support (PPSS) for the Kiowa Warrior's Crew Station Mission Equipment Trainers (CSMET).

Robotics Lab – This facility is used for design, development, test and integration of robotic systems. The lab is used in the integration of technology from various sources including other Government facilities and commercial products. The lab is used to expose the user community to robotics and to test new concepts of use.

Software Engineering Directorate Configuration and Data Management Repository – The repository was established to maintain all the technical software documentation for systems that the SED has software maintenance responsibility. The repository also contains the computer systems and tools used for the daily automated configuration and data management activities that are involved with making software changes to controlled baselines.

Task Force Exerciser - The Task Force Exerciser (TFX) is an Army Air and Missile Defense (AAMD) realtime hardware-in-the-loop interoperability test bed. The TFX utilizes tactical hardware, software, communication devices, and realistic virtual threats to assess AAMD systems' ability to support a single integrated air picture, provide and use external sensor support, and to provide supporting information to other joint TAMD mission areas. The TFX provides an environment for AAMD systems to evaluate tactical software prior to field tests, live exercises, or formal tests.

Missile Research, Development and Engineering Center

Redstone Arsenal, AL 35898-5241
(256)842-2201
Technical Director: Dr. William C. McCorkle
Associate Director: Michael C. Schexnayder

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.278	N/A	N/A	1.278
6.1 Other	0.267	0.014	0.200	0.481
6.2	12.667	1.101	35.330	49.098
6.3	10.610	3.885	100.681	115.176
Subtotal (S&T)	**24.822**	**5.000**	**136.211**	**166.033**
6.4	9.662	5.228	26.143	41.033
6.5	6.096	5.855	24.013	35.964
6.6	4.951	1.656	38.703	45.310
6.7	5.780	2.765	24.761	33.306
Non-DOD	0.478	0.000	2.266	2.744
TOTAL RDT&E	**51.789**	**20.504**	**252.097**	**324.390**
Procurement	43.141	N/A	37.697	80.838
Operations & Maintenance	15.902	N/A	29.317	45.219
Other	21.155	N/A	39.901	61.056
TOTAL FUNDING	**131.987**	**20.504**	**359.012**	**511.503**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	6	**6**
CIVILIAN	36	1046	433	**1515**
TOTAL	**36**	**1046**	**439**	**1521**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	961.572	**REAL PROPERTY**	231.205
ADMIN	230.472	* NEW CAPITAL EQUIPMENT	3.408
OTHER	143.587	**EQUIPMENT**	352.415
TOTAL	**1335.631**	* NEW SCIENTIFIC & ENG. EQUIP.	3.934
ACRES	**4000**	* Subset of previous category.	

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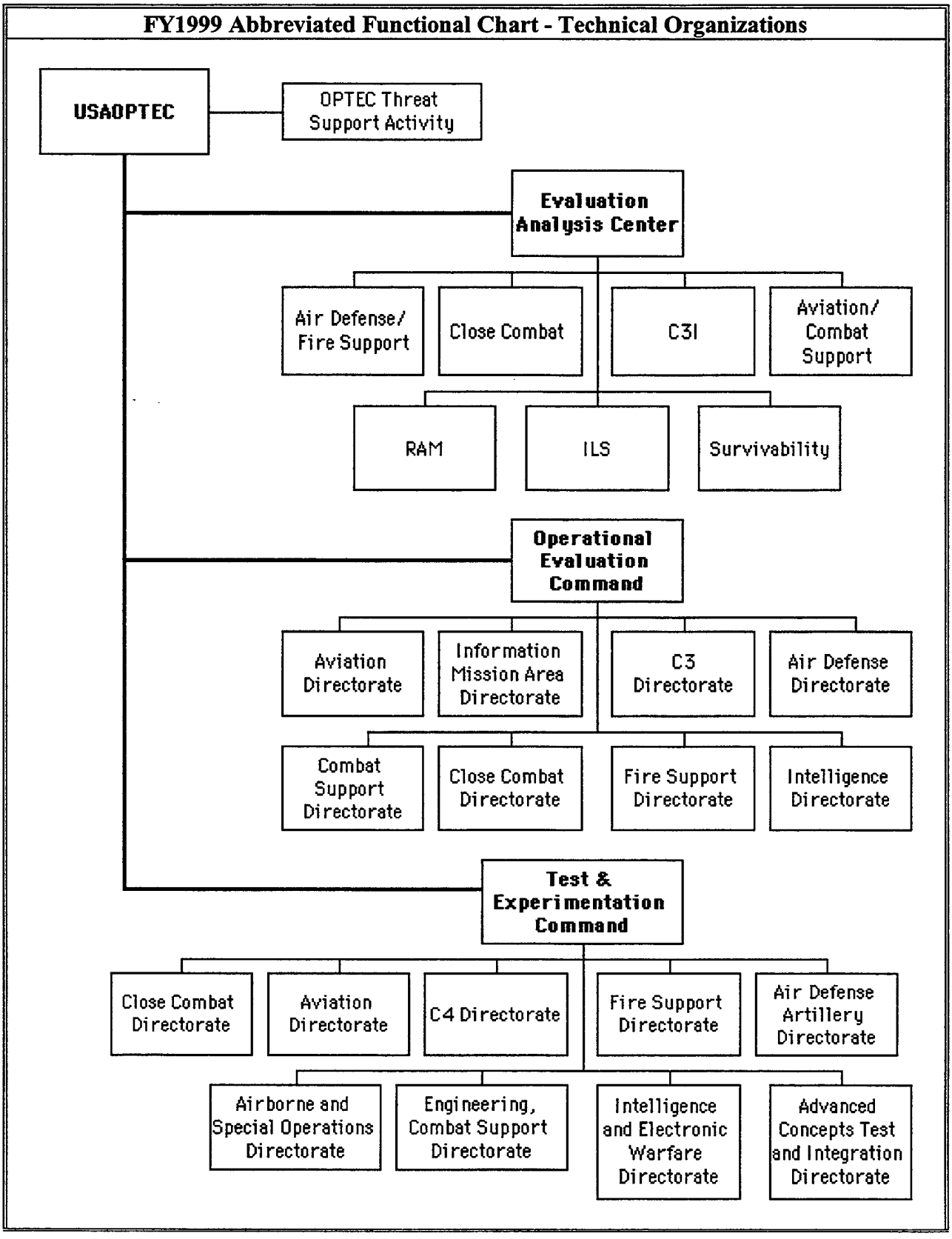
Operational Test and Evaluation Command



Operational Test and Evaluation Command
Alexandria, VA 22302-1458
(703)681-9365

Commander: MG A.J. MADORA
Technical Director: BRIAN BARR

MISSION

The mission of the United States Army Operational Test and Evaluation Command (OPTEC) is to support the soldier and the Army's fighting forces by planning and conducting Joint and Multiservice operational tests; Reporting on system operational effectiveness suitability and survivability; Planning and conducting force development tests and experiments, and managing the Army's Continuous Evaluation Program. The execution of this complex mission requires a dedicated workforce committed to continuous improvement and a cohesive team approach in all facets of test and evaluation.

CURRENT IMPORTANT PROGRAMS

AFTADS	Advanced Field Artillery Tactical Data System.
ASAS	All Source Analysis System.
ASV	Armored Security Vehicle.
ATACMS	Army Tactical Missile System.
BFVS A3	Bradley Fighting Vehicle System.
BIDS P3I	Biological Integrated Detection System.
CBPS	Chemically and Biologically Protected Shelter.
CCTT	Close Combat Tactical Trainer.
Comanche/RAH-66	Comanche Helicopter.
CRUSADER	Crusader.
CV2	Command and Control Vehicle.
C-17	Aircraft.
FBCB2	Force XXI Battle Command Brigade and Below.
FMTV	Family Medium Tactical Vehicles.
GRIZZLY	Full width mine clearing blade.
HAB	Heavy Assault Bridge.
ICH	Improved Cargo Helicopter.
ISYSCON	Integrated System Control.
ITAS	Improved Target Acquisition System.
JCF	Joint Contingency Force AWE.
JSLIST	Joint Service Lightweight Integrated Suit Technology.
JSTARS	Joint Stars.
JWF 99	JT&E Joint Warfighter.
LFT&E	Live Fire Test & Evaluation.
LRAS3	Long Range Advanced Scout Surveillance System.
LW	Land Warrior.
M1A2	Sep M1A2 Abrams Sep.
M270A1	Multiple launch Rocket System IOTE.
M2709 ESIT	Extended System Integration Test.
MCS	Maneuver Control System.
MIDS	Multifunctional Information Distribution System.
NBCRS	Nuclear, Biological and Chemical Reconnaissance system.

CURRENT IMPORTANT PROGRAMS	
PAC3	Patriot Advanced Capabilities, Configuration 3.
PK II-AFATDS -	Advanced field Artillery Tactical Data System.
SADARM	Sense and Destroy Armor.
SIRFC	Suite of Integrated Radio Frequency Countermeasures.
SMART-T	Secure, Mobile, Anti-Jam, Reliable, Tactical terminal.
THAAD	Theater High Altitude Area Defense.
TSV	Trough sight video.
UH-60Q	Utility Helicopter 60Q.

EQUIPMENT/FACILITIES

Position location, high angle modular integrated target, video, data acquisition and reduction, thermal imaging, fiber optics and video multiplexer/demultiplexer, range timing, microwave, environmental measurement and survey.

Point to Point Video Tele Conferencing (VTC) with direct link capability, desk top VTC's, CISCO Router direct linked, color copiers, Prioris dual processor server, and cabletron hubs.

Threat support hardware that includes EW, RADAR, AND C3 SYSTEMS.

Operational Test and Evaluation Command
Alexandria, VA 22302-1458
(703)681-9365

Commander: MG A.J. MADORA
Technical Director: BRIAN BARR

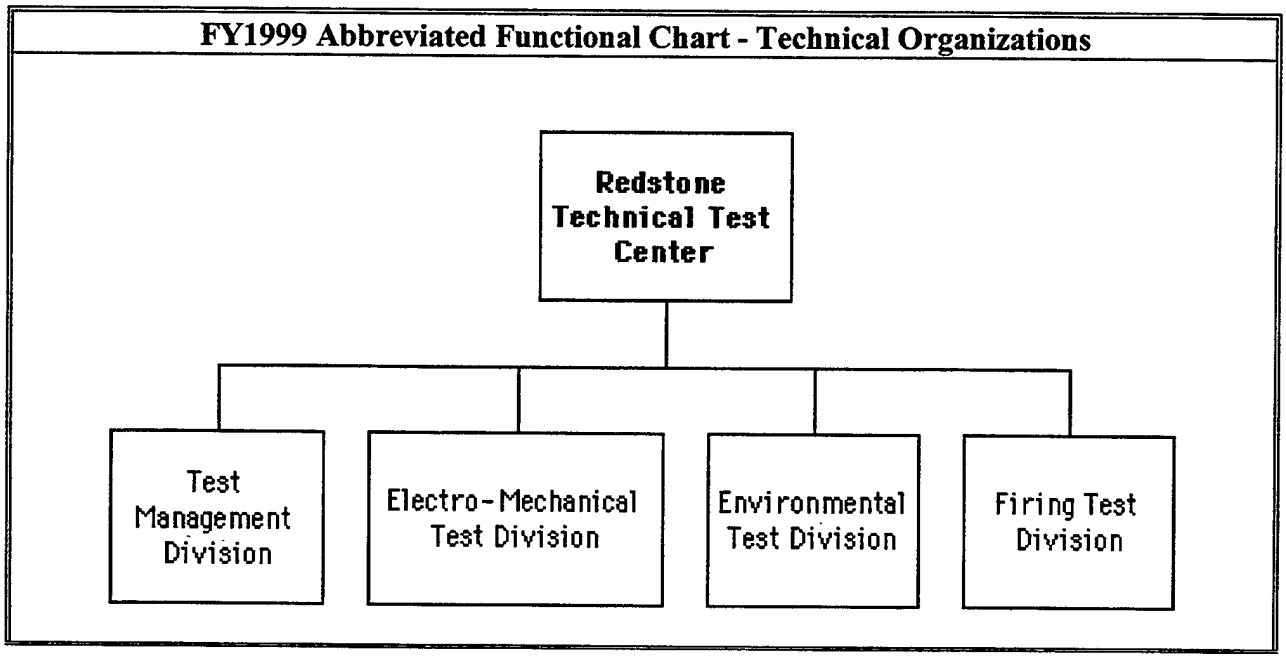
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.000	0.000	0.000	0.000
6.3	0.000	0.000	0.000	0.000
Subtotal (S&T)	**0.000**	**0.000**	**0.000**	**0.000**
6.4	0.000	0.000	0.000	0.000
6.5	0.469	0.000	0.469	0.938
6.6	141.558	0.000	5.143	146.701
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**142.027**	**0.000**	**5.612**	**147.639**
Procurement	1.600	N/A	0.000	1.600
Operations & Maintenance	43.067	N/A	0.436	43.503
Other	0.000	N/A	0.000	0.000
TOTAL FUNDING	**186.694**	**0.000**	**6.048**	**192.742**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	26	478	**504**
CIVILIAN	18	247	592	**857**
TOTAL	**18**	**273**	**1070**	**1361**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	0.000	**REAL PROPERTY**	38.100
ADMIN	498.000	* NEW CAPITAL EQUIPMENT	8.000
OTHER	214.000	**EQUIPMENT**	1.500
TOTAL	**712.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**23**	* Subset of previous category.	

Redstone Technical Test Center



Redstone Technical Test Center
Redstone Arsenal, AL 35898-8052
(256) 876-3552

Director: Carl E. Roberts
Technical Director: Terry B. Farris

MISSION

The mission of Redstone Technical Test Center (RTTC) is to plan, conduct, analyze and report the results of technical tests of missile and rocket components, subsystems, and systems while supporting development, production and sustainment of Army materiel (principally tactical missile systems and associated technologies) throughout the life cycle. Additionally, RTTC serves as the Department of Defense (DoD) Lightning Effects Tester for live ordnance and munitions. RTTC provides testing and test support for rockets and missile research, development, test and evaluation and other missions of authorized customers within and outside DoD, to include government and non-government organizations, domestic and foreign.

CURRENT IMPORTANT PROGRAMS

JAVELIN Missile System
Air to Ground Missile Systems – HELLFIRE and LONGBOW
Improved Target Acquisition System (ITAS)
Improved Bradley Acquisition Subsystem (IBAS)
Multiple Launch Rocket System (MLRS) - Rockets and Launcher
ATACMS/BAT
TOW Missile System
MPIM/SRAW
M72
Bunker Defeat Munition (BDM)
Hydra 70
AMCOM Missile Repair Parts Program
AMCOM Missile Shelf Life/Surveillance Program
AMCOM Missile Stockpile Reliability Program (SRP)
AMCOM Aviation Flight Safety Parts
AMCOM RDEC Technology Base

EQUIPMENT/FACILITIES

RTTC's facilities are categorized into the broad functional areas of Firing, Electro-Mechanical, and Environmental Test. The Center offers a single testing organization with 'cradle to grave' test capabilities. Testing begins at the concept design phase with models and prototypes and continues with component, subsystem, and system integration and refinement through the production qualification and first article test phase into sustainment testing of repair parts, conduct of shelf-life and stockpile reliability tests, limited retro-fit, etc. RTTC uses mobile data acquisition and test control capabilities to meet test requirements remote from Redstone Arsenal. The Test Management Division provides overall test program management. This group is responsible for test planning, analysis of test criteria, coordination and reporting of all RTTC test activities.

EQUIPMENT/FACILITIES

Firing test activities consist of open air range, or field testing of rocket/missile systems and subsystems, including target detection, acquisition and recognition technologies. Two test ranges are available for flight test. Test Area 1 (TA-1) is dedicated to R&D testing for advanced technology hardware and project managed systems. It includes a primary flight test range 8 kilometers long with a 45 degree safety fan located on 8000 acres of terrain similar to that found in Northern Europe. A small rockets range and two sled tracks (1000 ft. and 2000 ft.) are also located within TA-1. Full instrumentation, with radar, optical and electronic data gathering capability is available to support surface to surface and air to surface flight tests. TA-6 is a 3300 meter range adapted primarily to Production Acceptance Flight testing of anti-tank missiles. Extensive optical coverage is available at this range. Airborne Systems Laboratory, located adjacent to a 2225 meter runway, supports captive carry testing with aircraft, site preparation and instrumentation, as well as a complete, mobile IR signature measurement van. RTTC uses a stabilized sensor platform for captive carry testing or terrain mapping to remove unwanted vibrations. TA-3 is a non-firing range used for airborne and ground target acquisition/seeker/laser testing in benign or in "dirty battlefield" atmospheric conditions. RTTC maintains a fleet of US and foreign armored vehicles as targets. RTTC performs static motor firings on systems ranging from small, one shot impulse thrusters to large boosters used to launch satellites. Solid rocket and liquid engine propulsion sections and components are tested at controlled temperatures. RTTC also performs motor dissection, warhead evaluation, and insensitive munitions tests at TA-4 & 5.

RTTC provides the full spectrum of support to dimensionally inspect and functionally test a wide variety of weapon system subsystems and components. This includes all areas of electromagnetic environmental effects (E3) testing and laboratory testing of mechanical, electronic, optical and electro-optical, and microwave/millimeter wave test items. The E3 group provides detail test design and planning, E3 test conduct, data reduction, analysis, and determination of "fixes" if necessary. RTTC has the only known facilities to conduct ESD and lightning effects testing on "live" munitions. State-of-the-art laboratory facilities are available to characterize performance of lasers, semi-active laser seekers, and imaging infrared seekers and target acquisition systems. Hardware-In-The-Loop, flight or platform motion simulation test fixtures employing real-time scene projectors, temperature conditioning and high performance computer resources are available to provide realistic field test environments. Utilizing advanced modeling and simulation techniques, including high fidelity system models, subsystem test results can be extrapolated to system level performance. The radar system group can test a wide variety of millimeter wave and microwave components and employs both near and far field techniques for antenna metrology. The component test group provides capabilities to perform dimensional analysis and functionally test a wide variety of mechanical, electronic, optical and electro-optical devices.

Environmental testing capabilities include natural and man-made environmental stresses that cover the transportation, stockpile, deployment and flight portions of the life of weapon systems. Non-destructive methods are used to measure and observe environmental effects on the test items. Environments experienced in world wide deployments are accurately simulated. Environmental stressing is induced at controlled temperatures by dynamic test facilities that perform vibration, shock and acceleration testing. RTTC acquires transportation and deployment field data on a road course located at TA-7 or onboard aircraft and performs data reduction, analysis, and specification development for systems and subsystems. RTTC performs modal surveys and analyses for complex vehicles that range in size from a HMMWV to 19 ton solid rocket boosters sections. RTTC possesses a variety of both environmental and non-destructive test facilities for component, subsystem and system level test.

Redstone Technical Test Center
Redstone Arsenal, AL 35898-8052
(256) 876-3552

Director: Carl E. Roberts
Technical Director: Terry B. Farris

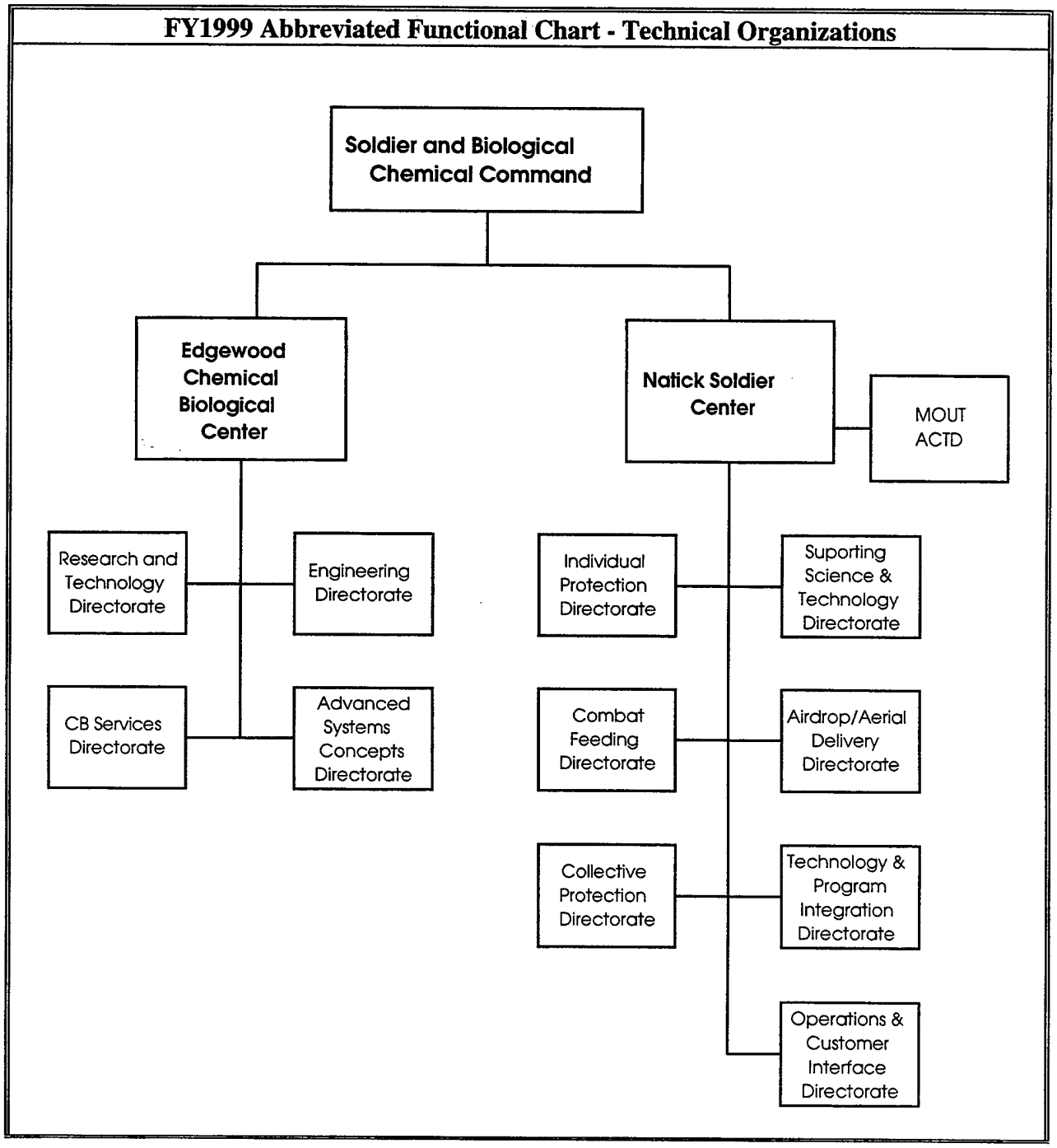
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	1.888	0.000	0.000	1.888
6.3	2.284	0.000	0.000	2.284
Subtotal (S&T)	**4.172**	**0.000**	**0.000**	**4.172**
6.4	0.260	0.000	0.000	0.260
6.5	6.138	0.000	0.000	6.138
6.6	13.209	0.000	0.000	13.209
6.7	2.301	0.000	0.000	2.301
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**26.080**	**0.000**	**0.000**	**26.080**
Procurement	13.624	N/A	0.000	13.624
Operations & Maintenance	1.921	N/A	0.000	1.921
Other	13.447	N/A	0.000	13.447
TOTAL FUNDING	**55.072**	**0.000**	**0.000**	**55.072**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	0	**0**
CIVILIAN	0	96	43	**139**
TOTAL	**0**	**96**	**43**	**139**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	580.000	**REAL PROPERTY**	320.000
ADMIN	62.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	168.000	**EQUIPMENT**	0.000
TOTAL	**810.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**14000**	* Subset of previous category.	

Soldier and Biological Chemical Command



Soldier and Biological Chemical Command
Aberdeen Proving Ground, MD 21010
(410)436-5501

Technical Director: Jim Zarzycki

MISSION

The Edgewood Chemical Biological Center's (ECBC) mission is to provide research, development and engineering to execute the chemical and biological defense programs for the Army and the Joint Services (JS). To provide research, development and acquisition as well as life cycle engineering support for chemical/biological defense and smoke/obscurant equipment under DODD 5160.5. To act as DoD lead lab for the JS chemical/biological/smoke technology base. In addition, ECBC is responsible for the Domestic Preparedness Program, preparing the United States for the possibility of a terrorist attack involving nuclear, biological or chemical weapons.

The Natick Soldier Center's (NSC) mission is to maximize the warrior survivability, sustainability, mobility, combat effectiveness and quality of life through the basic & applied research, technology development and demonstration, and engineering of rations, food service equipment, combat clothing and individual equipment, shelters, airdrop systems and organizational equipment. In addition, the NSC provides the Systems Integration RD&E of technologies for combat-essential elements of Command and Control, Survivability, Lethality, Sustainability and Mobility of the Soldier System Platform. Similar functions are also performed to integrate technologies for soldier support systems and for warrior systems and warrior support systems for other services and agencies.

CURRENT IMPORTANT PROGRAMS

Contamination Avoidance. Includes NBC reconnaissance, detection, identification, warning, and reporting. Earliest possible warning is fundamental in avoiding chemical and biological agent contamination. The program aggressively pursues technology advances in chemical and biological standoff detection, remote/early warning detection, sensor miniaturization, and improved detection sensitivity. Systems include; M22 Automatic Chemical Agent Detector Alarm (ACADA), M21 Automatic Chemical Agent Alarm, Biological Integrated Detection System (BIDS), Improved Chemical Agent Monitor (ICAM), M93 Fox NBC Reconnaissance System, Joint Services Lightweight Standoff Chemical Agent Detector (JSLSCAD), Joint Warning and Reporting Network (JWARN), Multipurpose Integrated Chemical Agent Alarm (MICAD).

Decontamination. In the event that contamination cannot be avoided, personnel and equipment must be decontaminated in order to reduce and/or eliminate hazards after chemical and biological agent employment. Decontamination systems provide the force a regeneration capability for units that become contaminated. Modular decontamination systems have been developed to provide decontamination units with the capability to tailor their equipment to support specific missions. The program is pursuing technology advances in sorbents, coatings, and physical removal, which will reduce logistics burden, manpower requirements, and lost operational capability to tailor their equipment to support specific missions. The program is pursuing technology advances in sorbents, coatings, and physical removal, which will reduce logistics burden, manpower requirements, and lost operational capability associated with decontamination operations. Systems include; Modular Decontamination System, Sorbent Decontamination System.

CURRENT IMPORTANT PROGRAMS

Individual and Collective Protection. In the event that early warning is not possible or units are forced to occupy or traverse CB contaminated environments, individual and collective protection systems provide the warfighter life sustaining and continued operational capabilities. Individual protection includes protective masks, suits, boots and gloves. Collective protection equipment includes standalone shelters and integrated systems that provide a contamination-free, environmentally-controlled surroundings for soldiers to perform their missions. Collective protection, i.e., overpressure, can be applied to mobile and fixed command posts, medical facilities, rest and relief shelters, buildings/fixed sites, vehicles, aircraft, and ships. The program is pursuing technology advances that provide an individual with improved vision and voice capabilities, increased protection levels and reduced heat stress over current individual protective equipment. Also the program pursues technology advances that improve generic CB protective filters and fans and advances that reduce weight, volume, cost, logistics and manpower requirements. Systems include; M40 Chemical/Biological Protective Field Mask, Joint Service General Purpose Mask (JSGPM), M45 Aircrew Chemical-Biological Mask, M43 Chemical-Biological, Aircraft Mask, M41 Protection Assessment Test System (PATS), Advanced Integrated Collective Protection System (ACIPS).

Smoke/Obscurants. In a matrixed partnership with the Product Manager, the program covers all technical disciplines in all phases (tech base, development, production, and sustainment) of the acquisition life cycle necessary to provide Army forces with a state of the art battlefield obscurant capability. These programs provide products/systems that focus on two key elements, specifically, large area smoke, and rapid obscuration smoke. Large area smoke provides both visual and infrared obscuration capability to our forces, to include both light and heavy maneuver units. Rapid obscuration also provides both visual and infrared obscuration capabilities, but is designed primarily for self-protection of individual maneuver vehicles. The program includes interface with the other services, actively seeks joint development possibilities and encompasses international cooperative development, to include foreign military sales. Systems include; M56 Smoke Generator System, M58 Smoke Generator System, M157A2 Smoke Generator Set & M1059/M1059A3 Smoke Generator Carrier. Lightweight Vehicle Obscuration Smoke System (LVOSS).

Domestic Preparedness. The initiative was formed under FY 1997 Defense Authorization Bill (Public Law 104-201, September 23, 1996), commonly called the Nunn-Lugar-Domenici legislation. The bill provides funding for the Department of Defense (DOD) to enhance the capability of federal, state and local emergency responders in incidents involving nuclear, biological and chemical terrorism. ECBC is the lead DOD agency charged with enhancing existing metropolitan response capabilities to include nuclear, chemical and biological incidents. Six separate training courses have been developed to accomplish this task: Awareness, Operations, Technician-HAZMAT, Technician-Emergency Medical Service, Hospital Provider and Incident Command. Program training is arranged by a federal interagency team comprised of representatives from the Federal Bureau of Investigation, Federal Emergency Management Agency, Department of Energy, Environmental Protection Agency, Public Health Service and Department of Defense. Initially, team representatives explain their role and capabilities to the city. The city then schedules training and determines which classes are best suited for the community's emergency responders. Cities are trained in a team approach, which combines subject matter experts with experienced emergency responders. This special training team dynamic combines DOD chemical and biological expertise with experienced, professional emergency responders. An interagency tabletop exercise provides opportunities for emergency responders and leaders to demonstrate practical decision-making applications of the classroom training. The courses are designed to "train-the-trainer," supplying emergency responders with the knowledge and experience needed to conduct their own training program with specialized nuclear, chemical and biological training materials.

CURRENT IMPORTANT PROGRAMS

Force Protection. Chemical and biological support to Joint Staff (J34) vulnerability assessments at select DOD installations. Standards/guidelines/tools developed to prepare installations against Weapons of Mass Destruction (WMD) threat. WMD training provided.

Installation Protection. The program is an integrated solution to prepare U.S. CONUS power projection sites to prepare and protect against a CB attack (particularly during a deployment), to assure continuity of operations by quickly restoring vital projection missions, and to safely mitigate the impact of such attacks. The program will include assistance in CB planning, training, exercising, identifying CB defense equipment and facility protection requirements, and providing other technical assistance as required. The program will also procure CB defense test equipment identified during the planning phase which is required to prepare, protect and restore operations following a CB attack.

Operations and Remediation/Restoration. Environmental monitoring, analysis, demolition and protection.

Chemical and Biological Arms Control and treaty assistance. Compliance and verification programs.

Chemical and Biological Counterterrorism. RDT&E for the Technical Support Working Group.

Forensic Services. The Forensic Analytical Center offers customers high quality analysis of materials relating to chemical and/or biological warfare, backed by its internationally recognized ISO 9001 registration and ISO Guide 25 accreditation. Current customers include all the other branches of the Armed Forces, the Defense Threat Reduction Agency, the Chemical Biological Rapid Response Team, the Federal Bureau of Investigation Laboratory Division, the Federal Aviation Administration Technical Center, the Program Manager for Chemical Demilitarization, and the Cooperative Threat Reduction program

Natick Solider Center - As part of the Force XXI Land Warrior S&T program, NSC is developing man-worn technologies for the future warfighter that provide enhancement of warfighter combat performance in the areas of lethality, survivability, command and control, mobility and sustainment. Particular emphasis is placed on minimizing overall soldier system weight, cost and power demand. Systems integration and demonstration of these technologies is conducted to improve soldier radio communications, target acquisition and identification, navigation, mobility and system control. Potential architectures for future warrior systems feeding the Army strategy for a leap-ahead, next generation soldier system within the next decade are being investigated.

The Military Operations in Urban Terrain (MOUT) Advanced Concept Technology Demonstration (ACTD) program encompasses a breadth of technologies including advanced individual precision weapons, combat identification, counter-sniper technologies, nonlethal weapons, advanced sensors, situational awareness and personal protection. The operational capability realized will be a series of advanced systems or components forming a MOUT ACTD "System of Systems" to ensure effective interoperability and functionality. Within the Individual Protection Directorate, the Warrior's survivability is maximized through the development of technologies and components that provide individual protection from ballistic, percutaneous chemical and biological, environmental, flame, surveillance, and directed energy threats. Ballistic protection systems have been identified which achieve a 20-30% weight reduction over the baseline while providing protection from a 7.62 ball round. A research team was established for behind armor effects. The team includes academia, other government agencies, domestic and foreign to define and answer questions regarding injury to the skull, torso and

CURRENT IMPORTANT PROGRAMS

extremities from non-penetrating projectiles. Advanced lightweight CB protection membrane and novel, multi-layer fabrics were fabricated into prototypes and tested extensively in a field exercise, and were transitioned to the JSLIST P3I program. Novel closure systems were also demonstrated with troops in the field. Counter-surveillance, near infrared technology was transitioned to the PM-Soldier/DSCP/USMC and was inserted into existing production contracts for new loadbearing equipment and cold weather parkas/trousers. The U.S. Marine Corps (USMC) provided funds to research, develop and procure clothing and individual protective equipment during FY99. The MOLLE and Interceptor were type classified by the USMC and a patent license agreement was negotiated with a commercial partner for two NSC owned patents used on the MOLLE system. An industry partner has begun commercial sales with 8% Royalty coming back to SBCCOM. Lightweight helmet technology developed and transitioned as a candidate for the USMC lightweight helmet program. The Bureau of Engraving and Printing (BEP) accepted a plan to expand their operation at the NSC with new equipment purchases procured during FY00.

One Cooperative Research and Development Agreement (CRDA) supports ballistic protective fibers produced through genetic engineering techniques for ballistic impact applications. Four other CRDAs are in place to support the RDT&E of new materials and configurations for protective clothing and individual equipment systems. Another CRDA supports research into the development of synthetic fibers from recycled polyester (PET) bottles. Five new CRDAs were signed in FY99 that leverage nanotechnology and biotechnology approaches for development of revolutionary fibers and materials for individual protective clothing and equipment.

The Airdrop/Aerial Delivery Directorate is developing technologies for airdrop equipment, personnel, supplies and equipment in support of mass assaults, re-supply, and humanitarian relief. Airdrop/Aerial Delivery S&T efforts focus on cargo/re-supply airdrop to deliver more precise weapons and munitions, reduce aircraft and payload vulnerability, improve load survive-ability, and improve drop zone dispersion and reassembly time. Two approaches are used, development of low altitude (500 ft) airdrop technologies for precision aerial delivery of heavy cargo and development of technologies for precision guided, high-altitude, standoff delivery capabilities. NSC has been investigating and developing novel airdrop platforms (e.g., parafoil, semi-rigid wing) with autonomously guided (GPS guidance/navigation), high altitude (25,000 feet), offset (25 miles) delivery capabilities. In the personnel airdrop area, efforts are focused on reducing parachutist injury due to high velocity landing, enhanced maneuverability and extended gliding capabilities, and parachute design optimization to achieve lower cost, lower volume parachute designs.

One CRDA supports airdrop R&D in the area of cushioning airdrop payloads by using gas-injected airbag technology. Another CRDA is using a phased approach to explore the flight control characteristics of high glide, semi-rigid wings, and to assess the feasibility of increasing range by use of a glide augmentation system.

The Collective Protection Directorate is developing advanced shelters and shelter systems that provide new capabilities or enhancements, such as high pressure, airbeam-supported maintenance shelters (lighter weight, less cube, quick erection); command posts; and collective protection medical treatment facilities and hospital complexes. A new CRDA was signed in FY 99 supporting innovative materials for tentage, airbeam shelters and parachutes.

The DoD Combat Feeding Directorate is developing a Joint Service family of performance-enhancing combat rations (special-purpose and standard individual/group) and modularized field feeding equipment, such as the Rapid Deployment Kitchen, to support the full spectrum of tactical scenarios.

CURRENT IMPORTANT PROGRAMS

15 CRDAs support combat rations and field feeding R&D with innovative methods to provide irradiation, radio frequency, and non-thermal processes for the preservation of foods; improved capability for preparing special microencapsulated performance-enhancing nutrients; shelf-stable, eat-out-of-hand ration components; candidate replacements for the hydrogen producing Flameless Ration Heater (FRH); research for the production of fresh-like fruit and vegetables with reduced weight and volume; interactive food packaging, and another CRDA in effect supports the development of biodegradable plastics from milk fat.

Of particular note in FY99 has been the receipt of the Federal Laboratory Consortium Excellence in Technology Transfer award for shelf stable pocket sandwiches, and successful petition for Dual Use Science and Technology funding for high pressure processing food technology.

Three new master CRDAs have been signed with major commercial R&D companies covering a wide range of commodity areas. One CRDA supports advanced protective clothing, food formulations/services, collective protective technologies, and organizational equipment. Another supports ballistics protection, CB protection and associated equipment, and environmentally protective clothing and equipment. The third involves a major software developer in the Army development of high resolution terrain visualization for assessment of Natick systems.

The Supporting Science and Technology Directorate is evolving and exploiting research in materials science, human sciences, operations research/systems analysis (e.g. SMART). Its broad multi-disciplinary research encompasses diversified scientific and engineering disciplines; e.g., food chemistry, polymer chemistry, physics, chemical engineering, applied mathematics, mechanical engineering, engineering and experimental psychology, food acceptance, nutrition, microbiology, biology, and biotechnology. Some unique programs in (a) bioengineering technology and nanotechnology that are breaking new ground to provide the technology for new advanced materials; (b) physical anthropology that is providing capabilities to address work station design, clothing sizing and tariffing, and other issues involving the effects of human sizes and shapes on the effective utilization of systems; and (c) biomechanics that, in addition to providing basic physical-mechanical design parameters for soldier equipment, in combination with physical anthropometry is also furnishing trade-off information between coverage or fit and mobility or maneuverability for soldier items such as advanced body armor.

National Protection Center (NPC) - The Natick Soldier Center has continued its efforts to establish what is to be known as the National Protection Center (NPC). The NPC will be a collaborative effort between Government (Local, State and Federal), Academia and Industry that will be a forum and catalyst for sharing information, technology and products in the Individual Protection Area. To date, several CRADA's have been signed with state and local agencies such as the Massachusetts Executive Office of Public Safety and the Boston Emergency Management Agency (BEMA), and with the University of Massachusetts, Dartmouth. An Interagency agreement has been signed with NASA and a Natick Site-Office for the Department of Justice Office of Law Enforcement Technology Commercialization (OLETC) has been established.

EQUIPMENT/FACILITIES

Edgewood Chemical Biological Center - Major equipment is contained in a complex of R&D engineering/laboratory areas and includes:

Berger Laboratory Complex. The executive building consists of 12,000 square feet of office space. In addition, the building contains a 98-seat auditorium with state-of-the-art audiovisual equipment. The auditorium is used for conferences, seminars, and in-house briefings sponsored by the directorates. The executive building is linked by a glass-covered walkway to the 93,000 square foot main building, which contains laboratories and engineering office space. About 300 scientific and engineering employees occupy the main laboratory building. Towards the rear of the facility is the 32,000 square foot Test Bay Area, which is composed of five test bays that are two stories high. The bays are specifically designed so that a typical combat vehicle can be driven into them for any functional testing. They are also equipped with movable, and detachable, engine exhaust hoses and rooftop ventilators.

McNamara Life Sciences Research Building. This new laboratory was constructed at a cost of over $30 million and has almost 120,000 square feet of laboratory and administrative space. It was designed to conduct state-of-the-art research and testing. This major Army construction project provides the Edgewood Chemical Biological Center with a secure facility to perform life science studies in a work environment that meets the safety, security, and surety requirements of the regulatory agencies.

Process Engineering Facility (PEF). The PEF is a 20,000 square foot research and development facility dedicated to bioprocess engineering studies for the scale-up and process optimization of cellular products. Current operations include antibody process laboratories with bioreactor capacities up to 30 liters and fermentation capacities up to 1500 liters with downstream processing.

Respirator Prototyping Laboratory. A 300 square foot research and development facility dedicated for the design and prototyping development of new respiratory protection products. It encompasses all the equipment necessary to take an idea for a respirator from concept to a concept model.

Simulant agent challenge test chamber.

Rubber/elastomer mold facility. A 300 square foot research and development facility dedicated for the product and process development of new respiratory protection products. The rubber laboratory possesses all the equipment necessary to take an idea for a respirator from crude concept to a minimum level production run (i.e., 1000 to 2000 items).

Specialized chemical agent labs.

Pyrotechnic mixing, loading, handling facility.

Subsonic, supersonic, transonic wind tunnels. A Continuous Flow Subsonic Wind Tunnel (up to Mach 0.2) A Blow Down Transonic Wind Tunnel (Mach 0.4 to 1.2). A Blow Down Supersonic Wind Tunnel (Mach 1.5 to 3.8). A Continuous Flow Subsonic Vertical Wind Tunnel (up to Mach 0.1). A Continuous Flow Subsonic Vertical Wind Tunnel (up to Mach 0.3). A 2-D Demonstration Smoke Tunnel .

Complete analytical chemistry (trace analysis/tandem mass spectrometry).

Obscurant test chambers for transmission measurements.

EQUIPMENT/FACILITIES

Laser spectroscopy lab.

Robotic toxic agent lab.

CAD/CAE/CAM Network. The Computer Aided Design/Engineering (CAD/CAE) facility, operated by a highly skilled team, provides customers with design, analysis and rapid prototyping services using state-of-the-art equipment and sound engineering principles. The facility maintains the latest technologies and qualified personnel to execute complex projects covering all aspects of mechanical and interdisciplinary design, including virtual prototyping, rapid prototyping, small-scale production, and much more.

Super toxic facility.

Design Evaluation Laboratory. A research and development test facility capable of performing chemical (surety, simulant, and other hazardous material) evaluations of protective materials, neutralization reactions, and agent detection and monitoring systems using state-of-the-art testing and analytical equipment in accordance with the latest test protocols. The lab has 7 laboratory rooms, which contain 26 certified fume hoods and 2 environmental test chambers. Eleven highly-trained personnel are currently certified to work with chemical surety material (CSM).

Decontamination/Detoxification Facility.

Explosive test facility. The Edgewood Chemical Biological Center has two Toxic/Explosive Test Facilities located in the Edgewood area of Aberdeen Proving Ground. They are ISO 25 Guide certified for the Alternate Technologies and Approaches Program. Both facilities have a chamber that is uniquely designed for total containment in the testing of chemical (Military and Industrial) related equipment and explosive/toxic munitions simultaneously if needed, under engineering controls. In addition, these facilities are capable of testing equipment and systems under various climatic conditions.

Toxic Dissemination Test Chamber.

Inhalation Toxicology Laboratories.

Molecular Modeling Facility.

Microland Laboratory with electron microscopy and surface spectropy. The Edgewood CB Center maintains and operates a laboratory for collaborative materials and biological research and forensics, specializing in morphological and compositional characterization, surface analysis, and fine particle technology.

Experimental Fabrication Facility.

Nephelometry laboratory/Single Particle Laboratory.

Smoke Breeze Tunnel. The facility consists of an environmentally contained tunnel, 14 ft x 14 ft, and 196 ft in length. The main functions of the facility are to determine obscuration properties and cloud characterization of obscuration materials, to evaluate full size smoke generators and their components, and to determine the impact on military hardware caused by obscuration materials present on the battlefield.

EQUIPMENT/FACILITIES

Controlled Environment.

Soil-Core Microism Unit Chambers.

Decontamination Test Facility.

Chemical Evaluation Laboratory. An internationally accredited (ISO 9002, ISO Guide 25) government-certified (contractor performance program) facility for testing and analysis with chemical surety agents.

Forensic Analytical Center. Formerly called the Army Materiel Command Treaty Laboratory, offers customers high quality analysis of materials relating to chemical and/or biological warfare, backed by its internationally recognized ISO 9001 registration and ISO Guide 25 accreditation.

Environmental and Field Testing Facilities

Natick Soldier Center - The Natick Soldier Center has the facilities and capabilities to perform all physical wet and dry performance testing, and visual and instrumental color analysis on textile materials. Other unique capabilities include the Climatic Chambers, Rain-room Facility, Camouflage Analysis and Demonstration Facility, the Shade Room and the Microscopy Laboratory.

The Doriot Climatic Chambers are used in support of both SBCCOM and the U.S. Army Research Institute of Environmental Medicine (USARIEM) programs. The support includes testing soldier endurance at environmental extremes, evaluating developmental items prior to procurement, and conducting extensive human physiological research.

There are two large wind tunnels and two smaller conditioning rooms for testing new clothing items, shelters, airdrop equipment, and other items developed by the U.S. Army and Navy. USARIEM conducts human physiological research. Scientists conducting research in the building strive to maximize the survival and improve sustaining and supporting for our armed forces on future battlefields that could be located in any climate on earth. Each Chamber is designed for human (They can support prolonged live-in studies) and equipment research with a test monitoring area outside each chamber. The chambers can: reproduce temperature ranges from -70° to +165 ° Fahrenheit with a +/- 1 ° Fahrenheit accuracy; relative humidity can range from 10 to 90 percent; rainfall can be produced at a rate of up to 4 inches per hour; wind speeds can be generated from 2 to 40 miles per hour. These climatic conditions can be changed rapidly. Test equipment includes two built-in 5-person treadmills per chamber. These treadmills are capable of testing at speeds up to 15 MPH with inclines of up to 12%. The two conditioning rooms are for testing of equipment and clothing.

Laser Systems can produce all wavelengths necessary to test the performance of eyewear. A picosecond laser can be used for probing the optical properties of developmental materials by utilizing such techniques as degenerate four-wave mixing, z-scan and time resolved measurements. A 2.5 kW C02 laser is also available for thermal studies. NSC has the capabilities to evaluate laser eye-protection systems at numerous wavelengths, output powers and pulse widths. Other unique capabilities include ballistic, haze and weatherometer testing of laser and ballistic eye protection systems, as well as a complete thermal data acquisition and analysis system. NSC can also evaluate the physical and optical properties of developmental materials and verify end-item compliance with American National Standards Institute (ANSI) or military performance specifications.

EQUIPMENT/FACILITIES

Thermal Transfer Measurements - through laboratory materials and clothing systems are made with our C02 laser and instrumented manikin. The data are used as input to a computer code, which calculates skin burn severity.

Environmental Corrosion Chamber allows for accelerated salt fog corrosion testing per MIL-STD-810 on items as large as 21" X 21" X 28".

Water Jet Cutting Equipment allows for the most precise and accurate cut possible on all materials. Water Jet cutting is excellent for cutting the most complex shapes, and flexible enough to use the most fragile of materials.

Prototype, Fabrication and Testing Facility employs highly qualified Model Makers (metal, wood, plastics), Instrument Makers, Machinists, Plastic Mold Makers, Sheet Metal men, Welders and Electricians to fabricate and aid in the design and construction of projects. A computerized Turning Center assures that the material being machined is precise and accurate.

Rapid Prototyping: The Rapid Prototype System will produce precise solid 3-D objects up to 32"L X 22"W X 20"H of unlimited geometric complexities from 3-D CAD data that is in a Stereolithography (STL) format. Larger parts can be produced in sections, then fastened together. Objects of unlimited geometric complexity can be produced with tolerances of +0.002 inches.

The Textile Pilot Plant has the full capability to dye, print and apply functional finishes to textile materials. It can produce printed camouflage patterns based on standard and experimental designs. The plant provides development work in support of combat clothing and textile based individual equipment, e.g. backpacks and tentage. The facility is used to support the needs of the U.S. Navy, U.S. Marine Corps, U.S. Air Force and Special Forces.

The Raincourt Facility is approximately 40 feet by 40 feet, and can simulate naturally occurring rainfall at 0.2, 1.0 and 3.0 inches per hour. This information is used to support the development of field items that will keep the soldiers dry and comfortable during military operations in a wet environment. It is used to screen candidate water repellent treatments and textile materials, evaluate seams for water resistance, and identify reason for field failures.

Tentage Prototype Shop: Tentage Prototype Shop Design and prototyping of fabric structures interface kits and accessories using heat sealing, ultrasonic welding, radio frequency welding, sewing, etc.

The Camouflage Evaluation Facility (CEF) provides the ability to evaluate current and experimental camouflage patterns year round. The settings consist of scenes that serve as a controlled background for evaluating camouflage. Four environmental settings are represented: desert, woodland, urban and arctic. Live plants and desert sand add realism for in-house measurements. The facility is equipped with special lighting that can be adjusted to simulate different levels of moonlit and moonless skies. The CEF offers a baseline that everything in the facility can be measured and compared against on a "standardized" basis. Unlike outdoor test sites, which are never constant and continually changing, in-house measurements improve data reliability and validity.

Design and Pattern Grading Facility designs and develops Ballistic Protection, Chemical Protection, Combat and Dress Clothing, fabricates representative prototypes, and furnishes computerized graded patterns. The facility has the various sewing machines, presses, fusing machines, and ultrasonic machine necessary to accomplish this mission.

EQUIPMENT/FACILITIES

Utilization of an Apparel Design System provides a nearly endless variety of menu driven software choices for pattern manipulation, grading, marking, plotting and cutting. For pattern output the system provides patterns utilizing a plotter or fabric/oaktag pattern-cutting table.

The Microscopy Laboratory has the capability to analyze fiber and fabric blends to aid in both research and development.

Shade Room: This facility is set up to visually and instrumentally evaluate color and discriminate color differences on textile materials. The visual color-matching table is set up in accordance with the standards established by ASTM for discriminating color differences. This facility is used widely to establish shade standards and tolerances supporting the Army, Postal Program, AAFES, SOF, industry and academia.

The Helmet Impact Tester is an ANSI standard monorail impactor capable of simulating crash conditions for head impacts. The impact tester is used to assess new impact protective configurations in support of headgear research and development. Helmets are simply mounted to the test head form, raised to the required height (and corresponding drop velocity), and dropped onto a steel anvil. Velocity and deceleration measurements are taken to quantify the impact protective qualities of the helmet system.

Ballistic Evaluation of eye armor is obtained via a ballistic gun that projects fragments at speeds consistent with ANSI Z-87.1 and MIL-STD-662 specifications. Eye armor can be exposed to various weather scenarios in a weatherometer and then tested at extreme temperatures ranging from -73° to 200 ° C in a computer controlled environmental chamber.

Biomechanics Laboratory: The joint Natick Soldier Center/USARIEM research program in biomechanics studies forces in and on the human body, and the effects produced by those forces. The Biomechanics laboratory is unique in DoD. It consists of a 7,500 square foot dedicated laboratory outfitted with state-of-the-art equipment for three-dimensional analysis of human movement, measurement of external forces on the body, monitoring of muscle activity, and real-time mapping of pressure patterns associated with wear of clothing and equipment. Spectrophotometer Evaluation of materials is accomplished with a Lambda 9 UV/VIS spectrophotometer. Optical densities up to 5.0 can be obtained as well as corresponding photopic, scotopic and P-43 phosphor transmissions.

The 3-D Digitizer is used to capture the 3-D data points necessary to define a solid object. Using the Digitizer, engineers and technologists are able to construct a 3-D model, which can be imported and manipulated by CAD/E software. This technology is particularly useful for items that have complex shapes and geometries.

Materials Testing Laboratory: Scientists test packaging material for critical physical properties such as tensile/ seal strength and barrier properties such as water vapor and oxygen transmission rate. Equipment includes: an Instron Tensile Strength/Seal Strength Tester; a Mocon Water Vapor/Oxygen Transmission Rate Tester; and a Headspace Oxygen Analyzer.

Flexible Packaging Laboratory provides prototype capability of new packaging system designs. Equipment includes: a Metal Traycan Sealer/Poly Traycan Sealer; a Vacuum/Gas Flush Heat Sealer; and a Pouch Maker.

EQUIPMENT/FACILITIES

The Container Testing Laboratory utilizes Environmental chambers in conjunction with shipping tests to ensure the durability of military rations. Tests are conducted on shipping containers with assembled rations and pallet loads. Equipment includes: a Vibration Table; Environmental Chambers; a Drop Tester; a Horizontal Form-Fill-Seal Machine; and a Compression Tester.

Advanced Food Processing Laboratory: Offering pilot plant scale production equipment includes: Temperature controlled meat-processing chamber; starch research and baking area with commercial scale ovens and proofers; freeze dryers; microwave assisted dryer; steam retort providing microwave assisted high temperature/short time processing; computer controlled twin screw extruder; continuous processor/sealer system for production of pureed foods in collapsible tubes.

LABARATORY ENCRUSTER RHEON MODEL KN300: Available for piloting plant test: One Rheon Model KN300 Encruster. This equipment can extrude three components together to form a wide variety of food products with varying levels of the components.

Food Chemical Analysis Laboratory offers chemical, structural, and textural characterization of food samples, and includes a glucometer, pressurized microwave heater, chemical reaction calorimeter, molecular separator, low field nuclear magnetic resonance analyzer, texture analyzer, scanning confocal microscope, and viscometer.

Small Burner Test Facility allows combustion test and analysis of fossil fuel burners. Consists of exhaust hoods, thermal imager providing visual and digital infrared temperature profiles, combustion gas analyzer and sonic flowmeter. It can also perform sound measurement, combustion gas analysis, thermal performance, and heat exchanger efficiency.

Remote Controlled Ultralight Parachute Airdrop Aircraft can carry up to 900 pounds to a height of 5,000 feet with an airspeed of up to 125 miles per hour and release the load. This is a very cost-effective means for testing small size scaled parachute canopies. With onboard instrumentation, data is recorded and analyzed simultaneously.

Roller Test Facility simulates a C-141 aircraft roller bed. It has 136 instrumented rollers that are able to measure point loading of cargo within an airdrop aircraft. The Roller Test Facility is also equipped to simulate up to 80,000 lbs. of parachute extraction force.

A 45 foot high Drop Tower is available for the lifting and releasing instrumented airdrop loads up to 100,000 lbs. The Drop Tower is used to simulate the impact shocks that are exerted on parachute loads when they impact the ground.

550,000-Pound Capacity Servo-Hydraulic Type Tensile Compression Machine applies controlled tensile/compressive loading to objects while measuring force and linear displacement. This machine provides uniform Forces / displacement throughout its 20 inch stroke and provides the capability to apply load or displacement in monotonic or cyclic control commands.

112,000 pound Capacity Screw Type Tensile/Compression Machine applies controlled tensile/compressive loads to objects while measuring the force and displacement. This machine provides uniform displacement throughout its nine-foot stroke.

EQUIPMENT/FACILITIES

Horizontal Impact Machine measures energy attenuation characteristics of materials during impact. This Machine applies dynamic impact (mass and velocity) loads to energy dissipating materials and measures material compression and acceleration characteristics.

Sensory and Consumer Testing Laboratory: This laboratory is capable of conducting a wide range of studies to characterize the sensory properties of and consumer responses to foods, beverages, fabrics, clothing items, and other consumer products. The laboratory makes use of other in-house facilities, including sensory descriptive panel rooms, focus group rooms, and two environmentally-controlled fabric conditioning rooms. Trained flavor, texture, and handfeel panels are available for descriptive sensory testing. Extant human use protocols enable testing of a wide range of FDA-approved and experimental products, and a large volunteer consumer panel (~350 individuals) is available for use in consumer testing protocols.

Soldier and Biological Chemical Command
Aberdeen Proving Ground, MD 21010
(410)436-5501

Technical Director: Jim Zarzycki

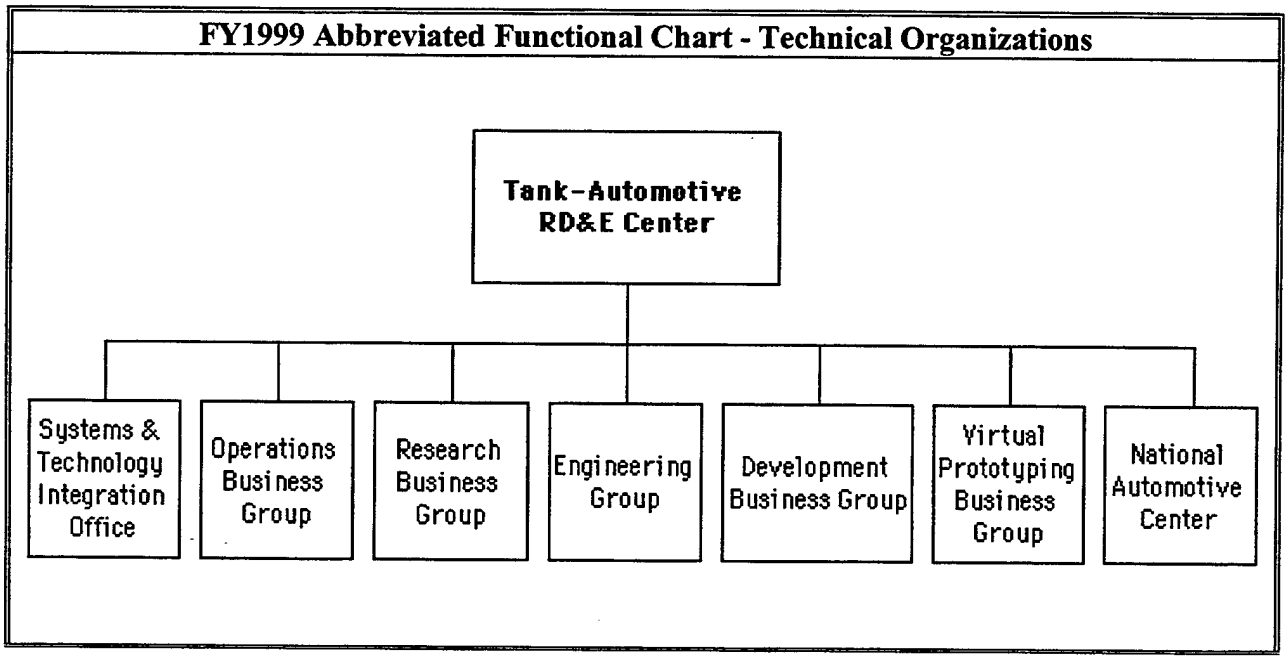
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.555	N/A	N/A	1.555
6.1 Other	2.354	0.063	1.675	4.092
6.2	25.254	0.904	28.216	54.374
6.3	6.899	0.768	32.765	40.432
Subtotal (S&T)	**36.062**	**1.735**	**62.656**	**100.453**
6.4	6.162	0.192	3.758	10.112
6.5	3.615	0.599	9.808	14.022
6.6	3.430	0.235	7.844	11.509
6.7	1.006	0.012	0.363	1.381
Non-DOD	2.701	0.042	2.101	4.844
TOTAL RDT&E	**52.976**	**2.815**	**86.530**	**142.321**
Procurement	1.965	N/A	10.627	12.592
Operations & Maintenance	50.149	N/A	54.337	104.486
Other	14.610	N/A	3.016	17.626
TOTAL FUNDING	**119.700**	**2.815**	**154.510**	**277.025**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	2	13	50	**65**
CIVILIAN	45	554	842	**1441**
TOTAL	**47**	**567**	**892**	**1506**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1221.747	**REAL PROPERTY**	189.041
ADMIN	375.836	* NEW CAPITAL EQUIPMENT	0.000
OTHER	485.246	**EQUIPMENT**	137.766
TOTAL	**2082.829**	* NEW SCIENTIFIC & ENG. EQUIP.	23.330
ACRES	**58**	* Subset of previous category.	

Tank Automotive Research, Development and Engineering Center



Tank Automotive Research, Development and Engineering Center
Warren, MI 48397-5000 Commander: MG John S. Caldwell, Jr.
(810)574-6144 Director: Jerry L. Chapin

MISSION

Conduct research, development, and engineering and leverage advanced automotive technology to provide our soldiers with the world's technologically superior ground vehicle systems and logistics support equipment.

Provide the life-cycle management, engineering, and technical support necessary to guarantee continuous system readiness.

Serve as the Army's focal point for the development of dual-needs automotive technologies and their application to military ground vehicles.

Serve as the lead DOD agency for land based water supply, inland petroleum distribution, and fuels and lubricants for ground systems.

Respond to our customers and the broad concerns of the public while providing a safe working environment for our associates.

Conduct our operations prudently and provide quality products and services which meet our customers' expectations.

CURRENT IMPORTANT PROGRAMS

In FY99, TACOM-TARDEC was responsible for six Defense Technology Objectives (DTOs) as well as 13% of the Army's 200 Science Technology Objectives (STOs) which include two Advanced Technology Demonstrations (ATDs). The DTOs for ground vehicles are: Future Scout and Cavalry System, Future Combat Vehicle, Ground Vehicle Electronic Systems, Advanced Ground Vehicle Mobility Systems, Combat Hybrid Power Systems, Forward Deployed Robotic Unit, Tactical Mobile Robotics, and Integrated Hit/Kill Avoidance Optimization. The two ATDs are the Future Scout and Cavalry System (FSCS) ATD and Crew Integration and Automation Test Bed.

ADVANCED TECHNOLOGY DEMONSTRATIONS (ATDs) focus TARDEC's Science and Technology (S&T) programs on current and future customer requirements while showcasing technological opportunities for advanced ground vehicle warfighting capabilities.

Future Scout and Cavalry System (FSCS): Proposals from two international industry consortium teams competing during this phase of the program were received in October 1998. SIKA International is a joint venture between British Aerospace (BAe) and Lockheed Martin (LM), with General Dynamics Land Systems (GDLS) and Vickers Defense as major subcontractors. The LANCER team is managed by GEC Marconi as the prime contractor, with United Defense Limited Partnership (UDLP), Raytheon and Alvis as major subcontractors. After an accelerated source selection evaluation process, contracts were awarded in January 1999. Each contractor team has identified what will be demonstrated on a vehicle platform using an integrated demonstrator, in a Systems Integration Laboratory or a virtual environment. Each contractor team will also employ other methods of reducing technical risk while planning for technology growth and transitioning from the ATD phase to Engineering and Manufacturing

CURRENT IMPORTANT PROGRAMS

Development (EMD) and production. Since the integrated demonstrators from the two contractor teams will be somewhat different, they will be evaluated against the FSCS Technical Requirement Specification (TRS) and exit criteria rather than each other. A major activity, which began in FY99, is preparation for the Three Star Affordability Review (AR), scheduled to be held in January 2001. The aim of the AR is to examine different FSCS/TRACER concepts, and a range of associated issues, in order to focus the remainder of the program and Information Surveillance Targeting Acquisition Reconnaissance (ISTAR) Balance of Investment (BOI) on a program which is both cost effective and affordable. The AR will result in a refined Combined Operational Requirements Document (CORD) and TRS, which will be used by the consortia to focus their remaining ATD effort, as well as to prepare their EMD proposals. The consortia will be submitting performance and Life Cycle Cost data in October 1999, and additional information in September 2000 to aid the Operational Analysis (OA) community in preparing the documentation for the AR.

Crew Integration and Automation Test Bed (CAT): The purpose of the Crew integration and Automation Test bed (CAT) Advanced Technology Demonstrator (ATD) is to demonstrate the crew interfaces, automation, and integration technologies required to operate and support future combat vehicles. The Crew integration and Automation Test bed (CAT) ATD will consist of two identical advanced-technology crew stations, along with a safety driver crew station, integrated into a modified Bradley chassis. There will be an evaluation of alternative positions of crew stations; both front to back and side by side positioning. The CAT will demonstrate a 100% increase in overall crew efficiency or a 50% reduction in crew size, a 30% reduction per source line of code, and a 10-time increase in architecture performance. Specific technologies to be integrated include: helmet-mounted displays, head trackers, panoramic displays, intelligent driving decision aids, semi-autonomous driving technology suite, automated route planning, an object oriented software backplane, and a combat vehicle graphics map toolkit. By FY00, we will complete technology suite system engineering and design. By FY01, we will develop baseline semi-autonomous driving, route planning. By FY02, we will adapt and develop mission planning and rehearsal technologies and cognitive decision aids.

TECHNOLOGY DEMONSTRATIONS include TARDEC's non-ATD S&T programs and are formulated by Army agencies as a Science and Technology Objective (STO). Individually approved by the warfighting customer, each STO delivers a measurable new warfighting capability or a cost saving method to streamline ground vehicle acquisition and support investments. TARDEC STOs include; Full Spectrum Active Protection, Integrated Armor Structure for Light Weight Vehicles, Combat Hybrid Power System, Advanced Signature Management for AAN, Ground Propulsion and Mobility, Intra-vehicular Electronics Suite, Detection Avoidance, Laser Protection for Ground Vehicle Vision Systems, Tank Mobility Technology, Combat Vehicle Concepts and Analysis, and Future Light Vehicle Ballistic Protection. Other non-STO efforts included robotics and Halon replacement in addition to a significant increase in both collaborative technology with industry and classified efforts. Three Science and Technology Objectives (STOs) for Petroleum and Water were approved during the FY99 STO Review. Two of the STOs, Advanced Tactical Fuels and Lubricants and POL Quality Analyzers and Sensors were approved as FY00 starts

TECHNOLOGY DEVELOPMENT: The Ground Vehicles subarea of the 1999 DoD Ground and Sea Vehicles Defense Technology Area Plan (DTAP) identifies unique technology efforts, called Defense Technology Objectives (DTOs), critical to the fielding of technologically superior warfighting systems. Current DTOs are Future Combat Vehicle, Future Scout and Cavalry System (FSCS), Ground Vehicle Electronic Systems, Advanced Ground Vehicle Mobility, Integrated Hit/Kill Avoidance Optimization, Tactical Mobile Robotics, Reconnaissance, Surveillance and Targeting Vehicle, Combat Hybrid Power Systems (CHPS).

CURRENT IMPORTANT PROGRAMS

ROBOTICS: The Forward Deployed Robotic Unit (FDRU) will demonstrate advanced robotic capabilities on a User/PM selected set of combat and combat service support vehicle concepts. Leveraging the investment of the OSD Joint Robotics Program Demo III efforts in autonomous mobility, architecture, sensor and robotics system integration: FDRU will advance the field demonstration/application of the technology suite. FDRU will also leverage technology advances in the DARPA lead TMR program and the NAC intelligent transportation projects. ARL through its robotics Federated Lab will continue the advancement of the autonomous technologies feeding the TARDEC lead vehicle integration demonstrator(s). Concepts across the TRADOC schools will be evaluated for depth of user requirements, applicability across TRADOC schools, compatibility with technology availability, and potential for PM transition

VEHICLE PERFORMANCE SIMULATION/VIRTUAL PROTOTYPING efforts are centered on exploiting advances in High Performance Computing and Simulation software to analyze and assess wheel and track ground vehicle performance over the entire life cycle of the vehicle system, from concept design through fielded system support. Our expertise in multi-body/flexible body analysis as well as finite element/structural analysis is used to analyze engineering issues as finite as individual component performance, on up to whole vehicle system performance. Our expertise is used extensively to provide new vehicle system Source Selection Authorities additional insight into how proposed vehicle designs will perform while carrying out their directed missions. We are also called in to support Weapon System Managers, Program Managers and other decision makers to provide engineering solutions to problems in the field which preclude their system from meeting its mission requirement. Many of the state-of-the-art simulation tools we have at our disposal have been developed by TARDEC's Virtual Prototyping Group's researchers as part of our ongoing research program that keeps the Army's Simulation capabilities on the cutting edge of the technology. This technology allows TARDEC to provide vehicle system decision makers with timely, accurate answers to their real world engineering questions, thereby keeping the Army's vehicle fleet the safest and most effective in the world.

US- JAPAN PROGRAM (part of the Ground Vehicle Mobility DTO): The U.S.-Japan Fighting Vehicle Propulsion Technology Using Ceramic Materials Cooperative Research Project (Ceramic Engine) is aimed at developing advanced engine technology which will permit a significant breakthrough in advanced combat vehicle propulsion systems. Critical elements of this project include advanced materials (to include ceramics), high temperature combustion optimization, low heat rejection technology and advanced technology for lubrication, friction and wear. The overall work tasks include analysis, engine demonstration, component optimization, reliability assessment and joint material component exchange and evaluation. The work offers an excellent opportunity to leverage U.S. and Japanese technology in order to accomplish aggressive objectives. DoD/Army benefits from this collaborative effort in the advanced monolithic ceramic material area in which Japan excels and is the perceived world leader. The project also addresses TARDEC corporate goals to significantly reduce propulsion system volumes for future combat vehicle applications.

FUTURE COMBAT VEHICLE (FCV): On 1 June 1999, the Department of the Army and DARPA established the Future Combat Vehicle Program (Provisional) as a major science and technology program reporting to the Director of DARPA and the Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology. The program began as a "seedling study" designed to determine whether there was truly a compelling need for a separate science and technology program for the development of a future ground combat system. The result of the seedling study resulted in the official sanctioning of the FCV Program on 1 October 1999.

CURRENT IMPORTANT PROGRAMS

The FCV is designed to respond to the stated needs of the Army for a highly lethal, survivable and deployable ground combat system capable of meeting the nation's needs for force projection. As a minimum the system must provide the Army with a significant combat overmatch against all foreseeable enemies on the battlefield in 2010 - 2025, with its first unit equipped (FUE) date in 2012. The system must provide for rapid unit deployment and successful offensive, defensive and stability and support operations while using smaller combat formations capable of very high operational tempo while requiring a significantly lower logistical support structure. The FCV force must provide unrestricted transportability (<20 tons) and deployability that enables a brigade size force to deploy in 96 hours or less and conduct operations without pause for preparation or resupply. The introduction of the program to industry is scheduled for 10/11 Jan. 2000, with the award of the initial concept contracts during 3Q00.

ADVANCED SYSTEMS are based on concept study recommendations of the TARDEC's Advanced Concepts Team working with proponents in the US Army Training & Doctrine Command (TRADOC). ICT's this year focused on the following future systems: Future Combat Vehicles (FCV), Future Scout and Calvary System (FSCS), Simulation Throughout the Life Cycle (SimTLC), and Future Heavy Tactical Truck (FHTT).

- Innovative, computer generated FCV concept alternatives were provided to illustrate potential future capabilities. These concepts were used as reference points in the development of the FCV solicitation and the development of Modeling and Simulation Strategy.
- FSCS concepts were developed for the Analysis of Alternatives (AOA). The concepts included wheeled, tracked, and weapon station options.
- A new Web based concepts process to define future vehicle development requirements definition, technology development, and trade studies was initiated for the SimTLC National Automotive Center (NAC) program.
- Future Heavy Tactical Truck (FHTT) concepts and analysis were performed to analyze the performance capabilities of between a new, future truck and based on the Army's Tech base program vs. a commercially available future truck. A new science and technology objective was established for tactical vehicle concepts. This will provide for analysis of future truck programs and help plan tech base programs for tactical vehicle innovations for the Army.

EMERGING SYSTEMS are based on recommendations of warfighter-lead Integrated Concept Teams (ICTs) sponsored by the US Army Training & Doctrine Command (TRADOC). ICTs this year focused on future systems which include the Future Combat Vehicle (FCV) and Future Scout & Cavalry System (FSCS). During FY99 a TRADOC Robotics ICT focused on the use of unmanned vehicles.

ADDITIONAL SIGNIFICANT TECH BASE ACCOMPLISHMENTS:

- Advanced Protection and Protection Design Technology: Developed an armor virtual prototyping system, which will reduce armor test costs by 25%. We are demonstrating an advanced armor system against KE threats at 65% the weight of Abrams.
- Non-Ozone Depleting Substance Technology: Complete performance testing and long-term toxicology studies of 6 alternative, fire extinguishing systems. Completed breakdown product studies of 8 alternative agents to Halon 1301 as acceptable fire suppressants for both combat vehicle engine and crew compartments.
- Laser Eye Protection: Produced a design concept for the replacement of combat vehicle periscopes that will protect the crewman against agile frequency laser threats.
- Mine Blade Control: Demonstrated a non-contact blade sensing system to control the blade depth of the Grizzly mine plow. This system will increase vehicle mine clearing speed, reduce power required and increase the effectiveness of the Army's principal mine clearing vehicle.

CURRENT IMPORTANT PROGRAMS

- Robotics: Demonstrated an innovative intelligent mobility robotic system for small robotic vehicles. This system combines computer control with a suspension and drive system with increased degrees of freedom over conventional drive systems. Increased maneuverability in tight situations, particularly in the urban environment will result.
- Electromagnetic Fully Active Suspension: Completed the design and fabrication of an electromagnetic regenerative fully active suspension test vehicle on a HMMWV chassis. This technology provides increased chassis stability, higher cross country speeds, greater platform stability for gun and sensor accuracy. The regenerative feature increases fuel economy and reduces vehicle signature. The vehicle can be raised and lowered for signature management and the platform automatically leveled for sensor mast performance.
- Vehicle Detectability: Completed a physiologic detection model for vehicle detection that has transitioned to a classified army program. This model represents human detection to low observable vehicle technologies. This model will reduce test requirements and decrease development time.
- Virtual Prototyping: Completed an initial demonstration of an integrated virtual prototyping system for conceptual vehicles. This integration permits multiple models (signature, mobility, ballistic) to use a common geometric database allowing an integrated design environment.
- Band Track: The band track delivered a 50% weight reduction over conventional steel track. At the 15 ton weight class, the track exhibited little wear after 3000 miles testing, an improvement over steel track. The design for the 25-ton weight class is complete and fabrication is initiated.
- Semi Active Suspension: The Bradley test rig completed 800 miles durability testing at Yuma Proving Grounds. This new external suspension saves 800 lbs. from the standard torsion bar suspension. The electronically controlled damping decreases vehicle pitch by over 50% in some scenarios. This results in greater gun accuracy, lower crew fatigue and faster vehicle speeds cross-country.
- Bradley Electric Hybrid Demonstrator: In conjunction with DARPA, completed the fabrication of an electric hybrid drive system for the Bradley vehicle. This state of the art drive system will provide increased fuel economy, greater performance and increased vehicle design flexibility over conventional drive systems.
- Commander's Decision Aide: Completed transition of the software and circuit card assembly for vehicle integrated defense to PEO-GCSS.
- Active Protection System: Demonstrated the successful defeat of a tank-fired, long-rod penetrator using an innovative blast effect countermeasure in a test environment.
- Signature Management: Completed demonstration of a new generation of signature managed vehicle in field trials with soldiers. Results are classified.
- Survivability Modeling: Doubled the threatbase and model capacity of the Army's primary screening tool for survivability technologies. This model is in daily use by all TACOM vehicle prime manufacturers.
- Vetronics Technology Test bed: Completed first drop of the crewstation software. This vehicle-ready software enables the field demonstration of many of the technologies characterized by the Crewman's Associate ATD which resulted in a 50% reduction in crew task loading over the Abrams tank.
- Combat Hybrid Power System: Completed the first laboratory demonstration of the electronic control and power system for a future all electric combat vehicle. The initial demonstration included advanced batteries, flywheel energy storage, multiple power busses and simulations of electric armor and weapon.
- Aluminum Metal Matrix Track: Completed the fabrication and initial laboratory tests for a lightweight track system that reduces track weight 30% and increases durability 30% in a Bradley and FSCS weight class vehicle.

CURRENT IMPORTANT PROGRAMS

- Advanced Fuels and Lubricants: Began evaluating biodegradable grease and hydraulic fluids. Field-testing was completed on both biodegradable products. One year of field tests proved the ability of both products to meet intended applications and no problems were identified. The bio-hydraulic fluid specification will have a variety of grades to select from to meet particular application needs.
- Joint Robotic Development Program on Ground Vehicle Survivability: Demonstrated scalability of 100 and 1000 pound weight class unmanned ground vehicles (UGVs) to man-portable robot applications. Upgraded 100 pound UGV with omni-directional steering capability for 6-degree of freedom wheel control. Upgraded the 1000-pound UGV intelligent path planning and control algorithms.
- IR Imaging Spectraradiometer: Development of an IR imaging spectraradiometer for combustion product analysis in real time.
- Active Suspension Previewer: Successfully demonstrated a HMMWV active suspension system with an integrated millimeter wave radar preview sensor.
- Support Vector Machine: Implemented a support vector machine with recognition algorithm for suppressed targets in cluttered visual and IR backgrounds. Substantially enhances target recognition.
- Directed Energy Performance Material: Developed a model to predict the performance of directed energy limiter materials.
- Large Scale Combustion Model: Evaluated the Large Scale Combustion Model using TARDEC data from the Cummins VTA903 single cylinder engine.

SUPPORT TO PEO's included M1A2 System Enhancement Package (SEP), Bradley M2A3, Digitization of the Battlefield, Heavy Dry Support Bridge, Tactical Vehicle Mine Protection, Heavy Assault Bridge and Breacher (Grizzly).

WEAPON SYSTEM MANAGEMENT and CONFIGURATION CONTROL for 19 systems in development, 34 systems in production/deployment and 2801 systems in sustainment (vehicles and end items). This encompasses over 850,000 military ground vehicles, 300,000 unique spare parts equating to 2.5 billion components (average of 3,000 parts per vehicle). Configuration control was maintained via 934,000 drawings. System support includes: materiel & combat development integration, acquisition, concurrent engineering, manufacturing & producibility engineering, product assurance, engineering data management, validation of technical data, field technical assistance, specifications and standards, tech adaptation/development/integration/transition and test management.

INDIVIDUAL WATER PURIFICATION technologies are being developed through a Defense Advanced Research Projects Agency (DARPA) funded program managed by TARDEC. Three contracts are currently in progress to develop fist-size technology to produce drinking water from all raw water sources under DARPA's Mesoscopic Technology program. Prototypes have been developed under two of the contracts and are currently being evaluated. This technology has application for Special Forces, Rangers, and Medical Assistance Teams. The projects will transition to TARDEC in FY01 for further development under the Water Supply STO.

1500 GPH TACTICAL WATER PURIFICATION SYSTEM: TARDEC continued to serve as the lead materiel developer on the 1500 Gallon Per Hour Tactical Water Purification System (TWPS) program. This program is a joint effort with the Marine Corps to develop the next generation water purification system to replace the current 600-Gallon Per Hour ROWPU. The Air Force and Navy have also expressed interest. The Engineering and Manufacturing Development contract was awarded in Jan 99 and the preliminary design review was completed in Jul 99. The production contract award is planned for Mar 01.

CURRENT IMPORTANT PROGRAMS

BIODEGRADABLE PRODUCTS: TARDEC's Fuels and Lubricants Technology Team completed field-testing on both a biodegradable grease and biodegradable hydraulic fluid. Products require a 60% biodegradability to be acceptable and are less toxic both to the environment and personnel. Field tests of the biodegradable hydraulic fluid were conducted at Fort Bliss, Texas while tests of the biodegradable grease were conducted at both Fort Bliss and Fort Hood, Texas. One year of field tests proved the ability of both products to meet intended applications with no operating problems identified. Furthermore, both products showed improved compliance with environmental requirements. The requirements for the biodegradable products will be incorporated into performance specifications.

TECHNOLOGY TRANSFER EFFORTS: The Army chartered the National Automotive Center (NAC), a business group of the TARDEC, in 1993 to be the Army's focal point for automotive technology transfer efforts, collaborative research and development with industry, academia and other government agencies. The NAC matches the needs and capabilities of government with the capabilities and needs of industry. The NAC is the Army's principal catalyst for the execution of collaborative research and development in dual-use automotive S&T programs. The NAC's technology transfer strategy is embodied in five major technology programs: Improved Fuel Efficiency; Automotive Vehicle Modernization; Automotive Occupant Safety; Automotive Maintenance and Logistics; and Automotive Manufacturing Innovation. The following projects highlight some relevant initiatives the NAC has undertaken in implementing its technology transfer initiatives:

- Established a cooperative agreement with two major U.S. automobile manufacturers for a joint military/commercial light truck demonstrator program, using advanced commercial technologies. This program is considered a possible near-term solution for light tactical vehicle needs of the Army as well as other government organizations.
- Demonstrated technology in thermal imaging in evaluating the performance and condition of tactical vehicle tires, brakes and wheel bearings.
- Continued collaboration with the Automotive Research Center, composed of eight universities, and a U.S. Army Center of Excellence in modeling and simulation of ground vehicles.
- Continued development, demonstration and deployment of the Automotive Product Development Framework (APDF), a comprehensive, integrated virtual prototyping system for ground vehicles with advanced capabilities to automatically integrate and operate existing, dissimilar software products in a unified operating environment.
- Demonstrated military ground vehicle and missile applications of selectively reinforced, silicon carbide whisker-aluminum metal matrix composite (AL-MMC) materials.
- Continued joint TARDEC/industry projects to prolong lead-acid battery life and to reduce their use, through ultracapacitor starting aids, smart electronic battery management, and modeling tools which improve vehicle electrical system behavior.
- Transitioned Collision Avoidance technology System (CAS). New CAS requirements are being integrated into the Operational Requirements Documents for the M915/M916 and the HEMTT.
- Initiated development of an environmentally friendly, low-cost waste oil disposal system with recovery of residual waste oil energy for vehicle use.
- The Petroleum and Water Business Area established a CRADA with the Pall Corporation to develop innovative filter separators that could operate with the Air Force's JP8+100 fuel.

EQUIPMENT/FACILITIES

TARDEC is the only Army/DOD Tank-Automotive Research, Development and Engineering Center committed to overall ground vehicle technology and integration.

NATIONAL AUTOMOTIVE CENTER, a joint venture with the American automotive industry and TARDEC is leading the way in 'dual use' of critical technologies.

PETROLEUM AND WATER CENTER laboratories and test facility were designated a National Water Center under the National Centers for Water Treatment Technologies program on 5 October 1998. TARDEC is one of only 5 National Water Centers in the country and the only DOD agency. The TARDEC Petroleum and Water Center facility includes state-of-the-art water quality and instrumentation laboratories, a test bay, and a separate test facility on the Lake Saint Clair shore with an enclosed boat well for protected source water access. The National Centers for Water Treatment Technologies program was established by the Department of the Interior's Bureau of Reclamation and the National Water Research Institute (NWRI). The purpose of the Centers is to facilitate research, development, and technology transfer between government, academia, and industry, in the areas of water supply, treatment and reclamation. It also promotes increased utilization of existing lab and research facilities, to allow industry and academia to leverage scarce resources.

PROPULSION LABORATORY: Provides a centralized physical test support capability for engineering experiments, test programs, and evaluation services in support of the Army's Research, Development, and Engineering programs associated with tracked and wheeled ground vehicle propulsion systems. Comprised of six computer-controlled engine, transmission, and driveline dynamometer equipped test chambers, an Air Flow Lab dedicated to air cleaner, heat exchanger, and ballistic grille evaluations, and three dynamometer-equipped test chambers dedicated to wheeled and tracked vehicle evaluations. This laboratory features a unique environmentally-controlled tracked vehicle dynamometer equipped test chamber with wind, ambient temperature, and solar radiation simulation capabilities. Complete propulsion systems and components testing capabilities are available to address customer requirements during all engineering design phases.

TIRE LABORATORY: Provides full range of tire and roadwheel performance, endurance, and shock testing capability.

TRACK and SUSPENSION LABORATORY is used to conduct testing and evaluation of current and prototype combat vehicle components. Specific test systems include a track pad test machine, 1/4 HMMWV suspension test platform, three degree of freedom track loading, torsion bar test and linear shock absorber test. Generic capabilities are available for high static loading and endurance/fatigue test scenarios. Available linear and rotary hydraulic components and instrumentation allow for flexible test design and configuration.

ARMOR INTEGRATION LAB performs armor system fabrication and ballistic testing.

VISUAL PERCEPTION LABORATORY augments available field test data by providing a controlled environment to measure the detectability of signature management systems using trained military observers.

LASER PROTECTION LABORATORY develops and evaluates materials and techniques to harden combat vehicle surveillance vision optics against multiple laser hazards and threats. The efforts in this

EQUIPMENT/FACILITIES

laboratory are teamed with activities conducted at the Air Force laser protection research laboratories at Wright-Patterson AFB, utilizing the strengths of each organization.

TERRAIN SENSING LABORATORY performs in-house live modeling and field test validation of sensor technologies for high-speed, high-definition terrain contour mapping. This capability can be applied to high-speed mobility, robotics vehicles and hit avoidance solutions while current efforts are focused on a solution for Grizzly Automatic Depth Control.

ENVIRONMENTAL TEST CELL performs high-temperature performance tests on vehicles.

VEHICLE ELECTRONICS (VETRONICS) LABORATORIES include: Combat Vehicle Systems Integration Lab composed of ADA- based vehicle-ready electronics, computer systems, and crew stations for proof-of-principle demonstrations of advanced and open electronic architecture approaches; Crew Station Simulator Lab composed of the following DIS compatible man-in-the-loop virtual simulators and support environments: 2/3 Man Tank, M2A3 HMMWV, MODSAF, ITEMS and virtual world/terrain modeling; Drivers Automation Lab composed of several tactical wheeled and combat vehicle systems with a variety of autonomous and semi-autonomous driving aids and sensors (e.g. collision avoidance system) and a base station for tele-operated field demonstrations.

COMBAT VEHICLE COMMAND AND CONTROL FACILITY provides an automated command and control system for armor/infantry vehicles, a tactical situation display in all vehicles, and supports the Army Horizontal Technology Insertion Program.

TACOM GROUND VEHICLE SYSTEMS SIMULATION LABORATORY houses national resources for full-scale motion based vehicle simulation. The laboratory consists of a variety of simulators to perform man-in-the-loop crew stations turret motion base simulator CS/TMBS is the centerpiece of this laboratory. This unique 6-degree of freedom simulator is used to reproduce dynamic conditions encountered by combat vehicle crew stations and turret systems (up to 25 tons) and traverses a variety of terrain environments. In addition to the CS/TMBS, a ride motion simulator, a single crew person, six DOF high fidelity simulator, offers the capability of recreating the ride motion of any land based military vehicle system. In order to perform durability schedules, reconfigurable "poster" simulators are used to provide dynamic load inputs to ground vehicle systems and/or subsystems (tanks/trucks, hulls, frames, etc). In order to better test trailer systems, the laboratory has yet another unique one-of-a-kind capability: the Pintle Motion Base Simulator (PMBS). The PMBS is capable of providing both terrain disturbance inputs and dynamic pintle loads due to truck/trailer interaction.

LIGHTWEIGHT STRUCTURES LABORATORY performs materials test and structural tests, characterization and assessment of advanced composite materials using state-of-the-art ultrasonic test equipment, Dynatup impact tester and INSTRON high-capacity fatigue testing machine provided with automated advanced data acquisition and testing programs. This laboratory has also Vacuum Assisted Resin Transfer Molding (VARTM) equipment for making composite structural parts for automotive applications. The laboratory facilities are being used for conducting In-house Laboratory Independent Research (ILIR) programs on Composite Joints, Metal Matrix Composites (MMC) and Impact Dynamics. Additionally, the laboratory has the capability to prototype and analyze innovative lightweight vehicular structures.

JANUS SIMULATION LAB is used for the evaluation of Advanced Vehicle Technologies in operational scenarios. The lab consists of one server and two player stations allowing up to three players to simultaneously evaluate new system concepts/technologies in force-on-force scenarios.

EQUIPMENT/FACILITIES

The **HIGH PERFORMANCE COMPUTING CENTER (HPC)** operates a 64-processor Power Challenge Array (PCA) Parallel Processor computer and is collocated in this facility. It is one of only eleven DoD national shared-resource high-performance computer centers. In addition, this center provides computational capability for real-time inputs needed by the Ground Vehicle System Simulation Laboratory.

VIRTUAL PROTOTYPING LABORATORY is capable of displaying interactive computer-aided design solid model virtual mock-up of present and future ground vehicle systems. A wide range of state-of-the art 3-D stereo display devices (helmet, boom, projection, and holographic) are used for interactive virtual mock-up of vehicle systems and manufacturing facilities. In addition state-of-the art CAD workstations directly networked to the HPC PCA will allow real-time interactive immersive environments for virtual mock-up of vehicle systems.

BRIDGE TEST FACILITY is used for testing static or dynamic cyclic loads on various bridge designs. The purpose of this project is to provide a capability for conducting physical simulation testing of full-scale hardware and to reduce system development testing cost to the customer. The goal is to provide a facility that can simulate durability vehicle crossings over mobile military bridges, structural strength testing in accordance with the Trilateral Design and Test CODE for Military Bridging and Gap Crossing Equipment (CODE) and for performing engineering test on advanced concepts. The system will use advanced software and an acquisition system, which will duplicate and maintain the strains/loads, as experienced during actual crossings, to meet the required statistical number of crossings. The system will also have the capability to apply loads up to and including 1.5 times the working load in order to validate the design in accordance with the CODE, to achieve materiel release and to provide a Military Load Classification (MLC) value. The system will also have the flexibility to simulate experimental loading conditions and loading profiles.

WATER QUALITY AND WATER TEST CELL LABORATORIES are used for the testing of various water filter elements, water filter systems, and providing chemical analytical support to water purification engineer functions.

FUEL EQUIPMENT TEST LABORATORY is used for testing and evaluating fuel pumps, fuel filter elements, fuel filter separators, fuel nozzles and engine fuel filter elements.

GREASE AND FLUID LABORATORY performs development, evaluation, and environmental compliance assessments of hydraulic fluids, semi-solid lubricants, solid lubricants, antifreeze, and solvents to enable introduction of new technologies and development of new performance standards.

FUELS AND POWERTRAIN LUBRICANTS LABORATORY performs development, evaluation, and environmental compliance assessments of fuels, alternative fuels, and powertrain lubricants (i.e., engine oils, gear lubricants, and transmission fluids) to enable introduction of new technologies and development of new performance standards.

FUELS AND LUBRICANTS RESEARCH FACILITY (SwRI) a Government-owned, contractor-operated facility at the Southwest Research Institute in Texas, is a one-of-a-kind resource where integrated fuels-lubricants-engine systems research and development programs involving combustion, performance characterization, engine cleanliness, vulnerability assessments, and tribology can be performed.

EQUIPMENT/FACILITIES

ROBOTICS LABORATORY is a subscale autonomous locomotion laboratory, which evaluates small vehicle mobility and autonomous vehicle obstacle avoidance algorithms. Research is conducted in automated route planning and obstacle avoidance.

CONCEPTS LABORATORY provides 3-D CAD future vehicle concepts, design, and analysis up to and including Secret, Special Access programs (SAP), and Top Secret studies.

OTHER facilities and equipment include: software engineering, signature, dynamic motion simulator (seat simulator), fabrication, computer-aided design, Laminate Object Manufacturing (LOM) rapid prototyping system, packaging engineering, model shop, metallurgical, mechanical test, animation capabilities used in support of virtual prototyping, rapid prototyping, visualization capabilities, sheet/metal welding, machine shop, assembly shop, electrical, battery test, instrumentation, IR imaging, thermal wave microscopy, applied engineering, scanning electronic microscope, and material spectrum analyzer.

Tank Automotive Research, Development and Engineering Center
Warren, MI 48397-5000
(810)574-6144

Commander: MG John S. Caldwell, Jr.
Director: Jerry L. Chapin

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.972	N/A	N/A	0.972
6.1 Other	0.638	0.000	2.406	3.044
6.2	11.905	6.506	40.494	58.905
6.3	0.090	13.858	44.858	58.806
Subtotal (S&T)	**13.605**	**20.364**	**87.758**	**121.727**
6.4	1.590	0.197	2.030	3.817
6.5	3.840	0.063	3.441	7.344
6.6	3.257	0.000	9.767	13.024
6.7	2.581	0.000	2.209	4.790
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**24.873**	**20.624**	**105.205**	**150.702**
Procurement	19.415	N/A	2.156	21.571
Operations & Maintenance	16.844	N/A	13.880	30.724
Other	15.041	N/A	8.615	23.656
TOTAL FUNDING	**76.173**	**20.624**	**129.856**	**226.653**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	4	6	**10**
CIVILIAN	28	616	406	**1050**
TOTAL	**28**	**620**	**412**	**1060**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	513.949	**REAL PROPERTY**	137.050
ADMIN	174.870	* NEW CAPITAL EQUIPMENT	3.425
OTHER	22.202	**EQUIPMENT**	259.738
TOTAL	**711.021**	* NEW SCIENTIFIC & ENG. EQUIP.	4.652
ACRES	**95**	* Subset of previous category.	

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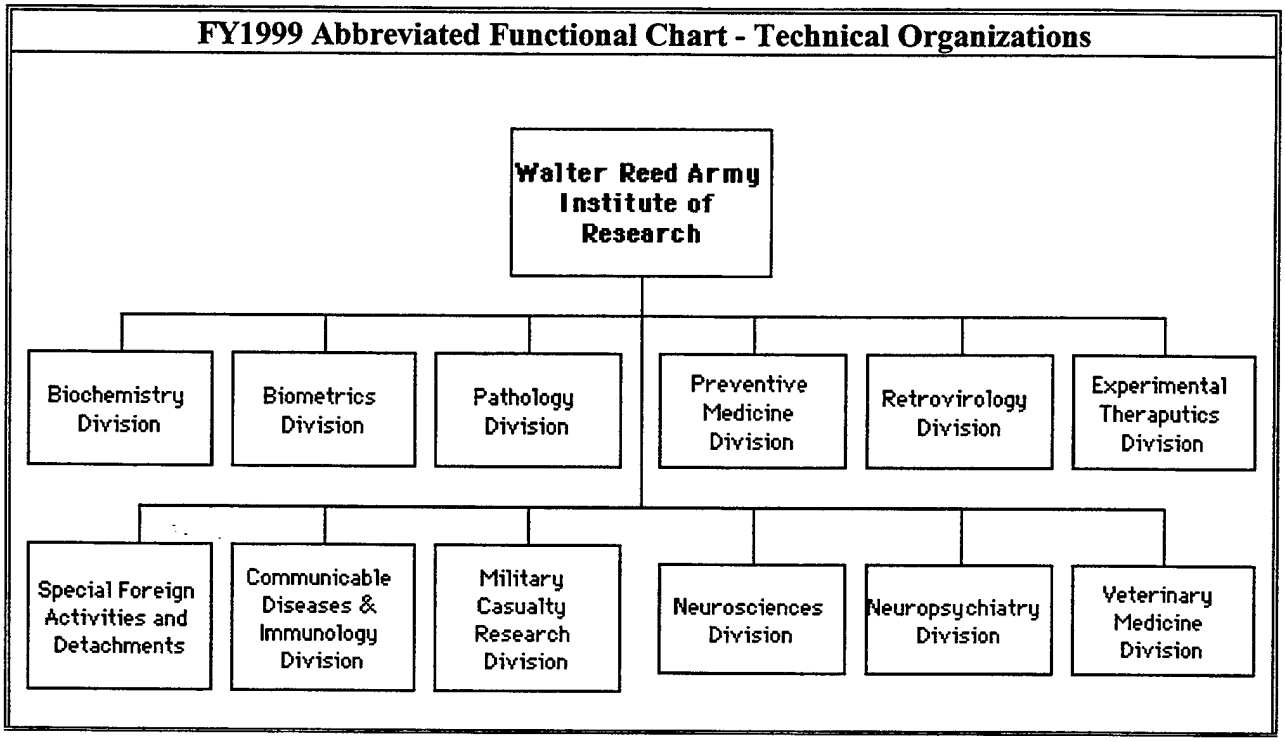
Walter Reed Army Institute of Research



Walter Reed Army Institute of Research
Washington DC 20307-5100
(301)319-9100

Director: COL Martin H. Crumrine
Deputy Director: COL Daniel L. Jarboe

MISSION

The Walter Reed Army Institute of Research (WRAIR) has one primary mission: biomedical research focused on soldier health and readiness. Whether in full-scale war or in other operations, the WRAIR provides America's fighting men and women with the tools and knowledge to survive in hostile, disease-ridden, and health-threatening environments. The Institute fulfills its mission by conducting innovative research in naturally occurring infectious diseases, combat casualty care, operational health hazards, and medical defense against chemical and biological weapons.

CURRENT IMPORTANT PROGRAMS

Conduct research and develop drugs and vaccines to protect against infectious diseases to deployed soldiers.

Conduct research and develop means to prevent operational stress in the combat environment.

Conduct research and develop technologies for far forward combat casualty care and evacuation.

Conduct research and develop strategies and technologies to prevent injuries from blast and directed energy sources and prevent progressive damage following traumatic wounds.

Conduct research to develop medical strategies for the protection of soldiers from chemical and biological warfare threats.

Evaluation of military health hazards of Army weapon systems and manpower programs, in coordination with AMC, TRADOC, and ODSCPER.

Transfer military medical science and technology into commercially viable products through cooperative research and development agreements, (CRADAS) outreach programs, and patent licensing, such as CRADAS with commercial companies on the development of drugs and vaccines to prevent malaria.

There are approximately 21 persons assigned to WRAIR under CRADAs.

EQUIPMENT/FACILITIES

Facility Locations:

A. WRAMC AND FOREST GLEN

Headquarters and site of main research programs. The full spectrum of biomedical research is conducted to include: infectious disease and vaccine development research, HIV research, operational medicine, combat casualty care, and medical and chemical biological defense research.

B. CONUS DETACHMENTS

- Wright Patterson Air Force Base - Occupational toxicology research.
- Brooks Air Force Base - Medical effect of laser and microwave irradiation.
- Blood Storage Preservation Research - located in leased space in Rockville.
- Dental Research Detachment - Great Lakes, IL (Naval Base).

C. OCONUS DETACHMENTS

- US Army Medical Research Unit (USAMRU) - Germany - Operational Stress and Human Dimensions Research related to Operational Medicine.
- USAMRU - Kenya - Infectious diseases endemic to Sub-Saharan Africa.
- Armed Forces Research Institute of Medical Sciences (AFRIMS) - Bangkok Thailand - Infectious diseases and vaccine development for those diseases endemic to Southeast Asia to include malaria and HIV.

Walter Reed Army Institute of Research
Washington DC 20307-5100
(301)319-9100

Director: COL Martin H. Crumrine
Deputy Director: COL Daniel L. Jarboe

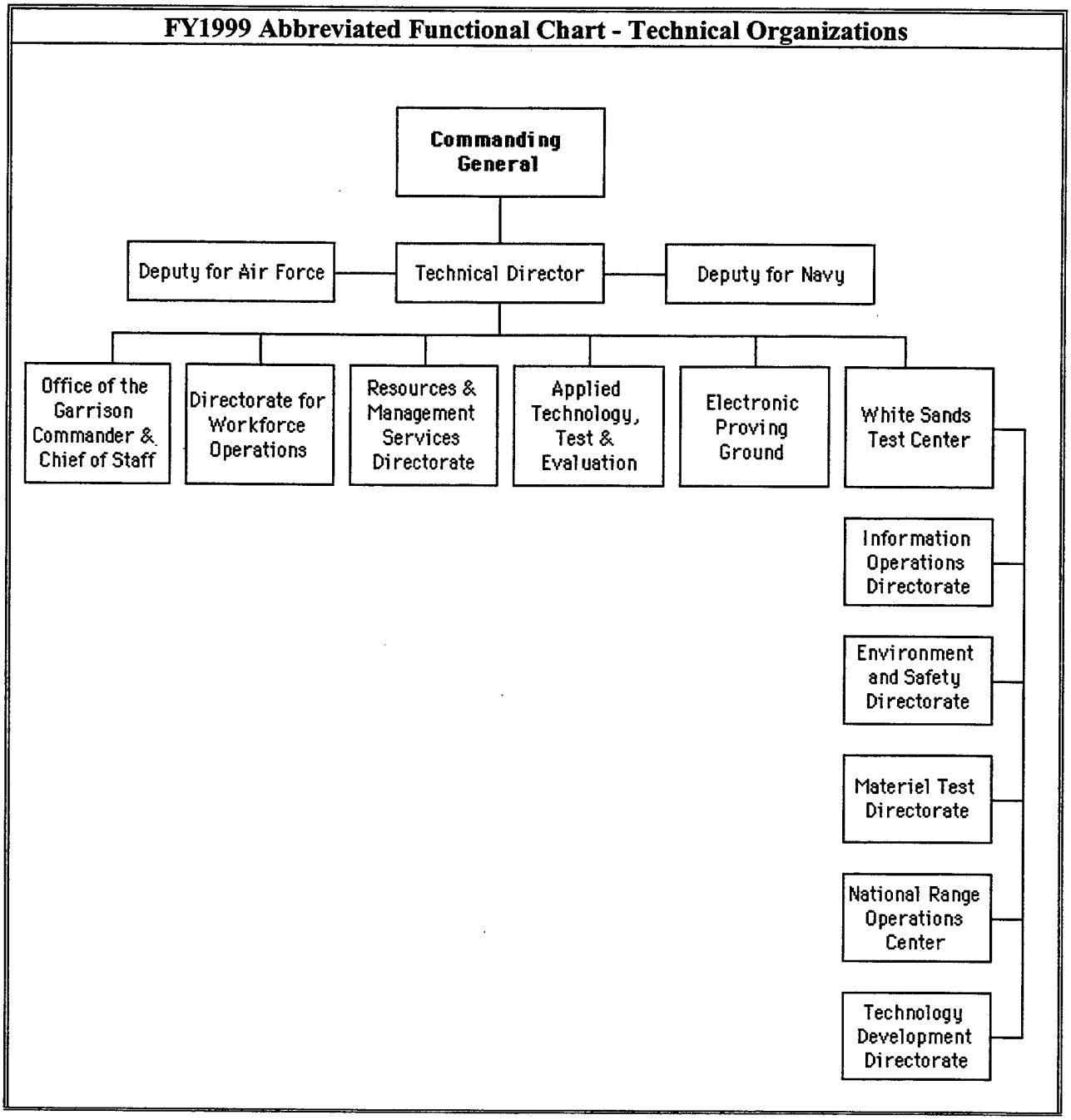
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	2.051	N/A	N/A	2.051
6.1 Other	9.564	0.000	0.000	9.564
6.2	28.636	0.000	0.000	28.636
6.3	11.147	0.000	0.000	11.147
Subtotal (S&T)	**51.398**	**0.000**	**0.000**	**51.398**
6.4	3.595	0.000	0.000	3.595
6.5	0.153	0.000	0.000	0.153
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**55.146**	**0.000**	**0.000**	**55.146**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	9.332	N/A	0.000	9.332
Other	1.026	N/A	0.000	1.026
TOTAL FUNDING	**65.504**	**0.000**	**0.000**	**65.504**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	63	93	203	**359**
CIVILIAN	93	165	135	**393**
TOTAL	**156**	**258**	**338**	**752**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	894.262	**REAL PROPERTY**	12.882
ADMIN	55.400	* NEW CAPITAL EQUIPMENT	0.000
OTHER	0.895	**EQUIPMENT**	41.800
TOTAL	**950.557**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**0**	* Subset of previous category.	

White Sands Missile Range



White Sands Missile Range
White Sands, NM 88002-5000
(505)678-1101

Commander: BG Steven W. Flohr
Technical Director: George A. Orlicki

MISSION

The U.S. Army White Sands Missile Range provides quality test & evaluation, research, and other technical services to the Army and Department of Defense acquisition programs. White Sands Missile Range, a unique and strategic national asset, is "America's Range" for the 21st Century. We will ensure our warfighters have the best military equipment possible by providing the highest quality and most cost effective test, evaluation, research, and technical services. We will continue to emphasize customer focus, sound resource management, innovative use of technology, modernized infrastructure, stewardship of our land, and superior quality of life.

CURRENT IMPORTANT PROGRAMS

Patriot
Theater High Altitude Area Defense (THAAD)
Force Battle Command Brigade and Below (FBCB2)
Army Tactical Missile System (ATACMS)
Near Term Digital Radio, Contractor Test
Multiple Launch Rocket System (MLRS)
Navy Research Rkts
Global Positioning System (GPS) Program Support
Advanced Medium Range Air to Air Missile (AMRAAM)
Air Force Special Tasks
Theater Missile Defense (TMD) Countermeasures
Prophet General Support
Bright Eyes
Airborne Early Warning / Ground Environment Integration
Joint Air-To-Surface Standoff Missile (JASSM)
Seasparrow Vertical Launch system
Big Crow, Operations
Guardrail Common Sensor 2 - Emitter Support
Counterdrug Technology Assessment Center Support
FY99 Central Test & Evaluation Investment Pgm (CTEIP)
M1A2 System Enhancement Program
VPG: Covert Remote Electronic Warfare Simulator
Space Shuttle Support
OPM SINCGARS Nuclear Test Support
All Source Analysis System (ASAS) Block II Cap
Non-Line-of-Sight (NLOS) System
Stinger Product Improvement Test Bed
Unmanned Aerial Vehicle (UAV)
SSDC Kill Assessment Program
Aerial Cable Services Provided Air Force Customers
Japanese CHU-SAM Missile (Hawk Replacement)
SCORPIUS SR-1 Suborbital Rocket Test Program

EQUIPMENT/FACILITIES

White Sands Missile Range, including the Electronic Proving Grounds (EPG), Fort Huachuca, AZ, has a variety of: (1) test facilities, (2) instrumentation, and (3) features that make it a premier test range. These features include the largest overland test range, White Sands managed restricted airspace, and varied terrain features. White Sands also has range instrumentation which includes instrumentation & airspace surveillance radar, fixed & mobile telemetry instrumentation, remote-controlled optical tracking mounts, modeling & simulation development facilities, and range & target control instrumentation. White Sands also has a complete environmental and scientific laboratory including a Microbiological Test Chamber, Large Environmental Test Chamber, Cemistry Lab, Mettallurgy Lab, and Dynamics Lab. The Directorate of Applied Technology, Test, and Simulation (DATTS) has testing facilities such as the Solar Furnace, Electromagnetic Pulse, Linear Electron Accelerator, Electromagnetic Radiation Radiation Effects transmitters, and the Large Blast Thermal Simulator. Big Crow is an airborne electronic warfare asset that includes a three mile cable suspended from two mountain peaks. At our EPG site we conduct comprehensive testing of C4I equipment and systems. We use a combination of field testing, bench-type testing, and modeling & simulation to test the large distributed digital systems being proposed for and fielded with the Army digital divisions of the future. We also test Unmanned Aerial Vehicles (UAVs), GPS receivers, emergency beacon systems, individual radios, intelligence systems, and the functioning of various navigation systems. Facilities available include a state-of-the-art antenna facility, EMI/EMC/Tempest test facility, computer modeling & simulation capability, communications test bed, and an instrumented test range. EPG is also the site of a 12,000 foot runway, a number of short UAV runways, and the US beacon testing facility for the verification of commercial emergency rescue beacons. White Sands and EPG are both developing the Virtual Proving Ground, which is a modeling and simulation capability to perform testing using a combination of virtual, live, and constructive entities.

White Sands Missile Range
White Sands, NM 88002-5000
(505)678-1101

Commander: BG Steven W. Flohr
Technical Director: George A. Orlicki

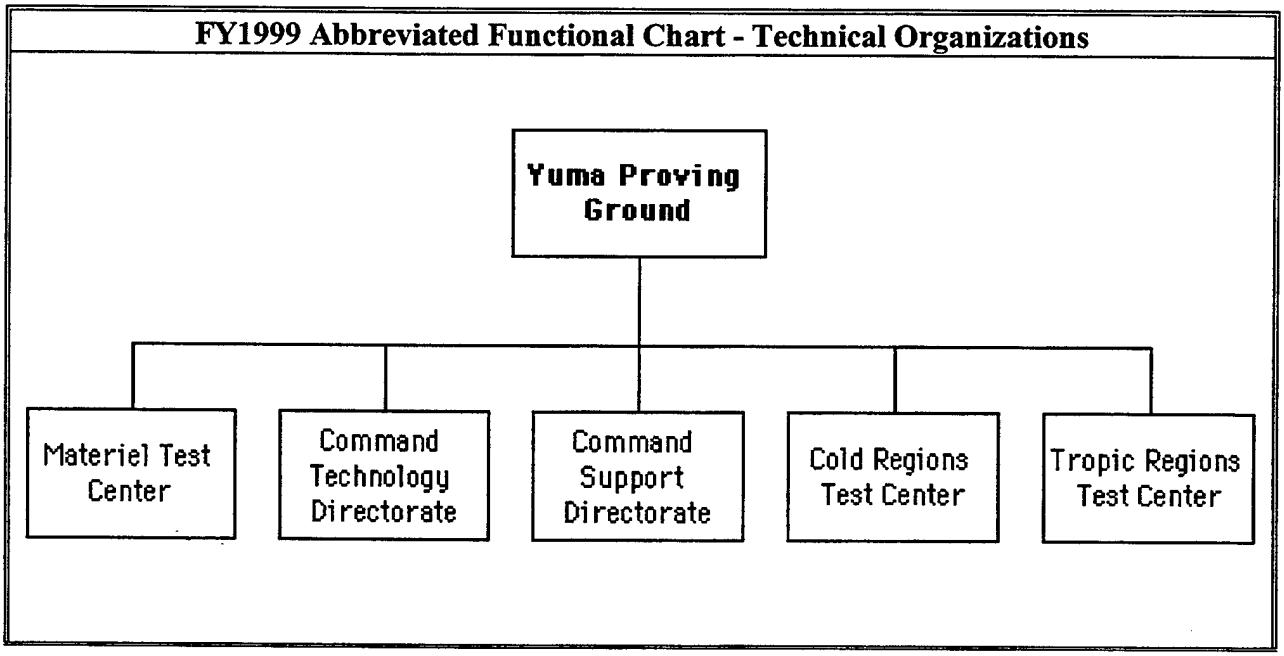
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.513	0.000	0.310	0.823
6.3	4.325	0.000	2.733	7.058
Subtotal (S&T)	**4.838**	**0.000**	**3.043**	**7.881**
6.4	4.320	0.000	4.523	8.843
6.5	136.644	0.000	72.809	209.453
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	14.034	0.000	69.345	83.379
TOTAL RDT&E	**159.836**	**0.000**	**149.720**	**309.556**
Procurement	14.987	N/A	2.985	17.972
Operations & Maintenance	5.540	N/A	3.250	8.790
Other	3.082	N/A	0.313	3.395
TOTAL FUNDING	**183.445**	**0.000**	**156.268**	**339.713**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	3	0	281	**284**
CIVILIAN	12	514	1284	**1810**
TOTAL	**15**	**514**	**1565**	**2094**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1603.007	**REAL PROPERTY**	479.201
ADMIN	951.957	* NEW CAPITAL EQUIPMENT	28.423
OTHER	2813.131	**EQUIPMENT**	498.383
TOTAL	**5368.095**	* NEW SCIENTIFIC & ENG. EQUIP.	0.115
ACRES	**2281659**	* Subset of previous category.	

Yuma Proving Ground



Yuma Proving Ground
Yuma, AZ 85365-9101
(520)328-2163

Commander: Robert C. Filbey, Col, OD
Technical Director: James L. Wymer

MISSION

Our focus is on the planning, execution, and reporting of development and production testing of artillery, direct fire, automotive, aviation systems, mines and countermines, UXO systems, air delivery and soldier equipment. We do this in diverse world-wide operating environments (desert, tropic, and cold regions) through application of our experience throughout a system's life-cycle.

CURRENT IMPORTANT PROGRAMS

Crusader.
M1-A2/A3 Abrams Tank.
M-2 Bradley IFV.
Palletized Load System (PLS).
Search and Destroy Armor (SADARM).
Tank Main Armament System (TMAS).
C-17 Cargo Aircraft and Air Delivery System (Advanced Tactical Parachute System, Dual Row Airdrop System, Universal Static Line, Canadian Retrieval System, Short and Long Range Air Launched Target programs, NASA's Assured Crew Return Vehicle).
OH-58D Kiowa Warrior.
Unmanned Aerial Vehicle Close Range (UAV-CR).
RAH-66 Comanche Target Acquisition Systems.
AH-64D Apache Longbow.
Wide Area Mine (WAM).
Cold Weather Clothing and Equipment.
Foreign Military Testing (SP2000, 120MM MORTAR, Shielder).
Navy's Extended Range Guided Munitions, ICM Projectile and MARK 399.
Munitions and Weapons Testing (GPS-Projectile; XM982 155MM;
M782 Multi-Option Fuze Artillery).
Anti-personnel Landmine Alternative Program (ALAP).
Production Acceptance of projectiles, charges, and fuzes.
Cooperative Research and Development Agreements the following: Arizona Public Service for Solar Power Research; Argonne Laboratory for environmental investigation; Los Alamos on laser cutting/hydrolysis of energetic materials; Republic of Panama City of Knowledge for tropic testing; ARO for natural environment study, UXO; and ARL for HSTSS and Instrumentation.
VPG Programs: IMAPS; Desert, Cold Regions, Tropic MERS;
Aerial Weapons and Air Delivery M&S; Cooperative integration of IMAPS with DMSO weather M&S.

EQUIPMENT/FACILITIES

a. Laguna Army Airfield Complex: Includes Laguna Army Airfield (C-5/C17 capable), facility hangar, weapons test hangar, Reeder Air Delivery test facility, and Castle Dome Heliport.

b. Cibola Test Range Complex: Includes UAV test complex, aviation instrumentation systems, 11 drop zones, 7 weapons ranges, weapons arming sites, wire and fiber optic communication networks, improved and unimproved roadways, and a tactical assault landing strip.

c. KOFA Industrial Complex: Includes weapon & vehicle maintenance facilities, armament and fabrication shops, environmental simulation facilities, ammunition disassembly, storage, and management facilities; 2 ammunition plants; and Range Operations Center.

d. KOFA Range Complex: Includes Armament Operations Center; over 300 gun positions; 10 dedicated impact fields; mine/countermine demolitions complex; ballistic instrumentation system; wire and fiber optic communications, improved and unimproved roads; dedicated direct fire ranges. Complex offers up to 55 miles range with unlimited restricted airspace. Facilities for production testing for ammunition.

e. Automotive Test Course Complex: Includes automotive operations center; armor operations center; automotive instrumentation facility, tank hills road course, dynamometer course; dust and mud courses; cross country course; Middle East course; water fording/swimming; 200+ miles road courses; sand dunes & paved mountainous terrain courses available.

f. Future Technology Support: Smart Weapons Test Range is dedicated to advanced, intelligent munitions, UXO detection and remediation, and solar power research. Combat Systems Test Range is dedicated to fire and movement testing of combat vehicle weapons systems; Electric Gun facility was built to accommodate ARDEC choice of YPG as Electric Gun Test Site.

g. Cold Regions Test Center: Includes Bolio Lake Test complex with cold and temperate natural environment testing for aerial, mobility, combat, artillery & rocket, and individual clothing & equipment systems and selected subsystems.

h. Desert/Cold Regions/Arctic Natural Environmental Test capabilities: Includes a suite of master environmental reference sites for VV&A of modeling and simulation requirements; Provides capability to test systems under MILSPEC climate extremes.

Yuma Proving Ground
Yuma, AZ 85365-9101
(520)328-2163

Commander: Robert C. Filbey, Col, OD
Technical Director: James L. Wymer

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	0.577	0.010	1.556	2.143
6.3	1.599	0.027	4.309	5.935
Subtotal (S&T)	**2.176**	**0.037**	**5.865**	**8.078**
6.4	1.226	0.021	3.304	4.551
6.5	0.678	0.011	1.826	2.515
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	11.833	3.166	81.102	96.101
TOTAL RDT&E	**15.913**	**3.235**	**92.097**	**111.245**
Procurement	1.031	N/A	2.750	3.781
Operations & Maintenance	3.744	N/A	1.821	5.565
Other	1.646	N/A	0.277	1.923
TOTAL FUNDING	**22.334**	**3.235**	**96.945**	**122.514**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	32	**32**
CIVILIAN	0	107	519	**626**
TOTAL	**0**	**107**	**551**	**658**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	22.030	**REAL PROPERTY**	176.439
ADMIN	126.671	* NEW CAPITAL EQUIPMENT	6.019
OTHER	2068.708	**EQUIPMENT**	192.981
TOTAL	**2217.409**	* NEW SCIENTIFIC & ENG. EQUIP.	1.231
ACRES	**1008904**	* Subset of previous category.	

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DEPARTMENT OF THE NAVY

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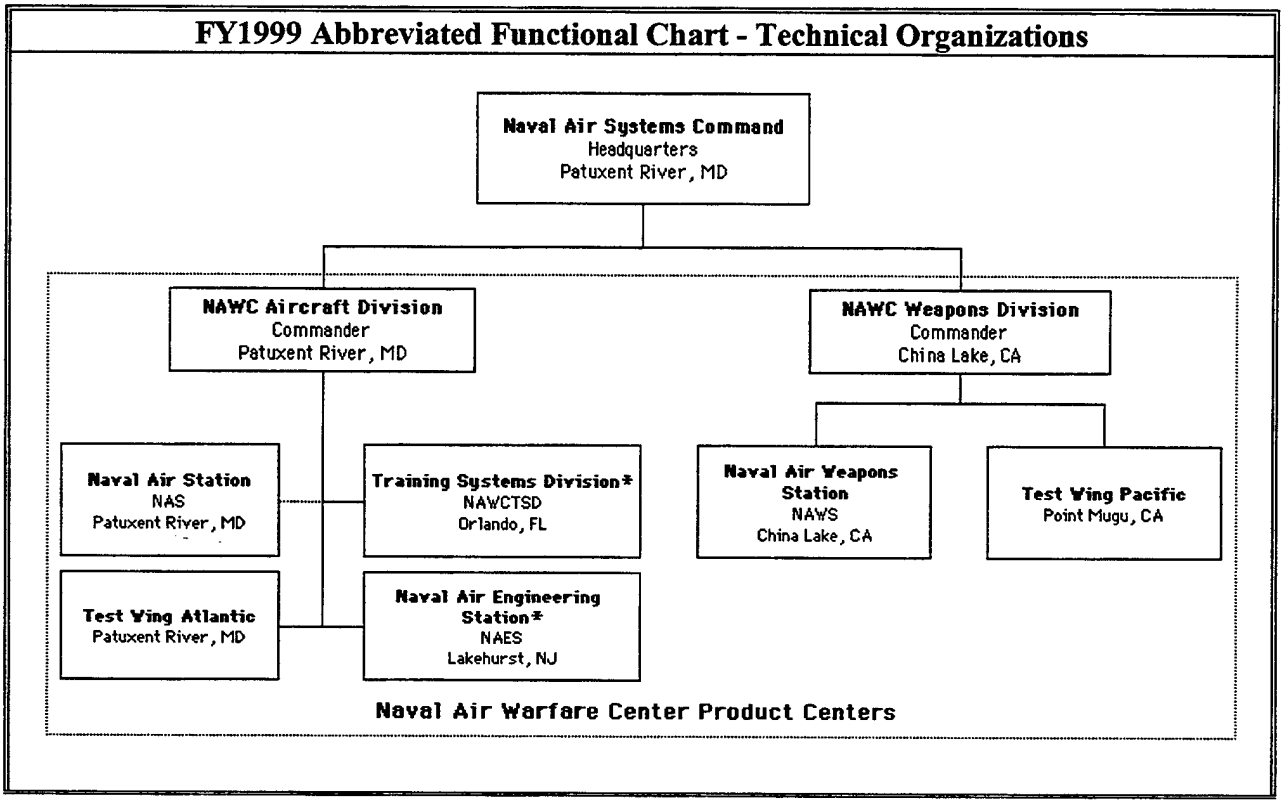
DEPARTMENT OF THE NAVY

The Navy's ten (10) In-House RDT&E Activities are:

Naval Air Warfare Center 3-2
Naval Facilities Engineering Services Center 3-24
Naval Health Research Center 3-28
Naval Medical Research Center 3-44
Naval Research Laboratory 3-58
Naval Surface Warfare Center 3-76
Naval Undersea Warfare Center 3-94
Navy Clothing and Textile Research Facility 3-106
Navy Personnel Research and Development Center 3-110
Space and Naval Warfare Systems Center, San Diego 3-114

**Note: The four Naval warfare centers provide full spectrum research, development, test and evaluation, engineering, and fleet support services and perform a substantial amount of non-RDT&E work. Prior to FY1998, the Navy reported each warfare center in its entirety, even though a considerable amount of the reported end strengths, funding, and other resources were devoted to other than RDT&E programs. For purposes of more accurately reflecting RDT&E In-House resources in this report, the Navy has applied the established RDT&E In-House criteria (i.e., a minimum of 25% of total funds is RDT&E and a minimum of 25% of in-house effort is devoted to RDT&E) at the division or major site level rather than reporting all warfare center sites, regardless of their level of RDT&E work. As a result, some warfare center entities have been eliminated from this report because they are below the 25% RDT&E threshold for inclusion in this report.*

Naval Air Warfare Center



**As a result of applying the In-House RDT&E Activity criteria at the division or major site level (see NOTE on page 3-1), NAWC Training Systems Division and NAWC Aircraft Division Lakehurst Activity data is not included in the FY1999 report. The additional business base contributed by these two activities is $1.01B for Training Systems Division and $0.46B for Lakehurst.*

Naval Air Warfare Center
Patuxent River, MD 20670-1547
(301)757-7692

CMDR, NAVAIR: VADM John A. Lockard
DEP CDR,NAVAIR: Dr. Alan Somoroff

MISSION

The Naval Aviation Systems Team, in partnership with industry and academia, serves the Nation and the Navy by developing, acquiring and supporting naval aeronautical and technologically related systems with which the Operating Forces, in support of the Unified Commanders and our Allies, can train, fight, and win.

As part of that Team, the Naval Air Warfare Center, provides our forces with effective and affordable integrated warfare systems and life cycle support to ensure Battlespace Dominance from the sea. The Naval Air Warfare Center is the Navy's principal research, development, test, evaluation, engineering, logistics, and fleet support center for information technologies, air platforms, autonomous air vehicles, aircraft engines, free-fall and glide weapons, missiles, energetic materials, precision guided weapons, targeting sensors, crew and aircraft survivability systems, mission and planning support systems, electronic combat systems, and acquisition and support of fleet training systems. The Naval Air Warfare Center actively participates in all phases of the aircraft system's life cycle, including acquisition support, technology demonstration and validation, engineering and manufacturing development (EMD), production and deployment, fleet operations, fleet in-service engineering, system configuration upgrades, modeling and simulation of integrated warfare systems, and demilitarization of retired systems.

CURRENT IMPORTANT PROGRAMS

AIRCRAFT DIVISION

Navy launches its first improved Hellfire missile: The H-60 Armed Helicopter Integrated Product Team completed two major milestones in enhancing the offensive capability of naval helicopters.
Crews from the Naval Rotary Wing Aircraft Test Squadron (NRWATS) and Operational Test and Evaluation Squadron One (VX-1) completed the final development test firings of AGM-114B Hellfire missiles for the SH-60B Armed Helicopter Program. The VX-1 aircraft laser designated a target boat while the NRWATS aircraft launched the missile. The laser-guided missile homed on the laser designation signal, striking the remotely operated target boat. Within seconds another missile was launched at a second target boat; this shot was laser self-designated by the NRWATS aircraft. The event was preceded by a test event in July where a crew from NRWATS launched an AGM-114K Hellfire missile from a SH-60B Seahawk helicopter. This was the first Navy launch of a Hellfire missile using the Pulse Interval Modulation capability, a form of laser counter-countermeasures.

Facility tests Coast Guard HH-60J module: The Helicopter Transmission Test Facility (HTTF), in the Propulsion Systems Evaluation Facility (PSEF), officially commenced testing recently after its move to Patuxent River, MD from Trenton, NJ. The PSEF houses many aircraft test functions that moved from Trenton as a result of 1993 Base Realignment and Closure Commission mandates that expanded Atlantic Ranges and Facilities research, development, test and evaluation (RDT&E) capabilities. The first item tested at the HTTF was a Coast Guard HH-60J main transmission input module, which exhibited high vibrations at one-half the input gear mesh frequency. This anomaly, which could be caused by an improperly cut gear, is such that only half the teeth in the gear make contact and carry the load, reducing the service life of the part and raising operating costs. The vibration has been successfully reduced in the past by rotating the pinion by one tooth, thereby changing the gear's mating teeth. This procedure was also successful in this case and reduced the vibration to well below the Navy limits.

Pax team tests escape system for Air Force: A team of engineers at Patuxent River, MD completed a series of tests on an emergency escape system, being considered for an Air Force developmental aircraft, at the Naval Air Systems Command Ejection Tower Facility.

CURRENT IMPORTANT PROGRAMS

The Naval Air Warfare Center Aircraft Division In-Flight Escape Systems Branch of the Crew Systems Department tested a new arm and leg restraint configuration for an Air Force F-22 ejection seat at the Pax River Facility. The F-22 fighter aircraft is being developed as a replacement for the F-15. Its engines produce more thrust than any current fighter engine in the air force inventory and this allows the F-22 to efficiently cruise at supersonic airspeeds without using afterburner, an enhanced capability that expands its operating ability in both speed and range over current fighters. The Patuxent River team was tasked with testing the ejection seat's restraint features. Thirteen ejections were performed during two weeks of developmental testing. Engineers focused on the arm and leg restraint system during the catapult phase. This is the first phase of an ejection and lasts less than a half of a second in its entirety. Conducting the tests at Patuxent River allows engineers to identify problems early in subsystems before more expensive, full-system testing is performed.

ASIL hosts first E3 tests: The Aircraft System Integration Laboratory (ASIL) hosted its first full-scale Electromagnetic Environmental Effects (E3) tests on an S-3B Viking aircraft recently modified with a new communication suite. Electro-Magnetic Compatibility (EMC) tests were conducted in the ASIL on the first S-3B Communication Improvement Program (CIP) prototype aircraft. All E3 tests using this facility are conducted in a secure, free-space environment, unencumbered by extraneous electromagnetic influences because of the design characteristics of the ASIL. The ASIL main building contains a shielded anechoic chamber along with several internal and external support areas. The S-3B CIP is the first project to benefit from the improved chamber and capitalized on a number of aspects of the new facility. Testing in the ASIL allowed operation of the S-3B Link-11 and satellite communication (SATCOM) systems for long periods of time which would otherwise have been limited and costly. A new SATCOM simulator, operated by the Communication, Navigation & Identification (CNI) Laboratory, also was successfully used in the chamber to provide continuous net controller access signals.

P-3C Upgrade Improvement Program (UIP): Completed system acceptance testing on second Royal Norwegian Air Force UIP aircraft.

Electronic Flight Display System (EFDS) - Instrument panels were completely redesigned. The final instrument fit check was completed, and the first set of panels will be sent to Jacksonville for the VP-30 trial kit installation. P-3 retrofits ARC-210 radio evaluation TEMPEST and EMI/EMC testing was conducted the week of 20 September 1999, with flight tests scheduled to begin at Patuxent River in early October 1999.
The Patuxent River Airborne Low Frequency Sonar Flight Test Team completed DT-IIB testing.
Helicopter aircrew breathing device cold-water problems were resolved. A retrofit will be ready, soon with an interim aircrew system change to be introduced to the fleet.

F-14: BOL-IR flight tests were completed with satisfactory results. A message report was released recommending a flight clearance for this system to proceed to operational testing.

DFCS - Efforts in FY99 resulted in the first fleet installations of F-14B (Upgrade) and F-14D DFCS suites. Simultaneous flight test using our assigned DT&E platforms resulted in continued improvement in envelope expansion, autopilot performance and flying qualities in the TARPS configuration.

GBU-24E/B - An enhanced design to the original GBU-24, this project began with fit checks, ground vibration data and two captive carry flights in FY98. FY99 work involved a series of test strand drops to determine pull force data and MILSTD 1760 cable reliability. The GBU-24E/B is designed to interface directly with the global Positioning System (GPS) on the host aircraft. Design of the F-14 interface wiring was essentially complete in FY99 and installation and subsequent flight test is planned for FY2000.

BOL-IR: This project originally started in Apr 98 with some temporary wiring mods to SD 205 to give it the necessary BOL dispensing capability. Flight test commenced on 06 May 98 and continued with intermittent delays for packet redesign throughout 1998. Testing was finally completed on redesigned packets on 14 Oct 98. (one flight in FY-99). Although safe separation of these packets was adequately evaluated during this period, it was found that -in an operational environment- the existing packets would

CURRENT IMPORTANT PROGRAMS

sometimes fail to disperse properly, particularly at cold temperatures (below -20 deg F). This led to another redesign of the MJU-52/B packets. Two safe separation evaluation flights and a single Radar Cross Section evaluation flight were flown on the redesigned packets in Aug 99.

Carbon Brakes: A pop-up project necessitated by the fact that Aircraft Braking Systems -the manufacturer of F-14 Carbon Brakes- transitioned from acquiring their carbon from a sub-contractor to producing it themselves. In this transition process, they also developed a different method for producing the basic carbon material. Since this process (designated 6012 carbon) differed from the original specification (4430B carbon), the new brakes had to be recertified. SD 231 instrumentation commenced in Dec 98 and the first dedicated taxi test took place on 19 Jan 99. We had difficulties with the brakes pulling all through January 99. By alternating the new brakes from one main mount to another we ultimately determined that the new material had better gripping properties and any attempt to install them on with original material brakes on the opposite side would result in pulling (toward the new process material). We proved this theory by installing the new stack on both main mounts of SD 231 and finally completed these tests on 13 March 99.

T-45: ECS Improvement recurring hardware and instrumentation problems were resolved, and testing should start soon.

F/A-18A-D: Ground tests on the latest EGI software (95H-LEHU) were completed, along with navigation performance flights.

Joint Paintless Aircraft Program Part 2: Applique environmental flight testing at China lake completed 29 July 1999 with good results. No flights delayed or cancelled due to applique maintenance, and surface held up very well, requiring only minor repairs.

APU oil temperature ground tests completed 28 July 1999 for oil temperature comparison with F/A-18E/F to determine if high oil temperature problems are anticipated with that APU.

Crash Survivable Flight Incident Recorder System installed on squadron aircraft. Joint E3 testing with Joint Helmet-Mounted Cueing System and Tactical Aircraft Moving Map Capability planned to start.

EP-3: Special Missions DT-III Phase 2 Sensor Systems Improvement Program EP-3E testing is approximately halfway complete.

S-3B: B4.4.3 Software Verification - Completed ground testing and three flight tests of a West Coast S-3B (VS-29) equipped with a baseline navigation system.

V-22: Flight test substantiated flight envelope for operational test and evaluation.

EMD aircraft 7&8 completed flight loads and structural landing surveys and initial external load testing.
EMD aircraft 9 demonstrated sub-systems capabilities.
EMD aircraft 10 successfully completed initial sea trials and dynamic interface testing aboard the USS Saipan and the USS Tortuga.

At-sea Precision Approach and Landing System (PALS) verification testing on USS ABRAHAM LINCOLN is complete. The final situation report was issued for Mode I clearance on AN/SPN-46 Channel A and Mode IA for AN/SPN-46 Channel B. The support plan for the AN/SPN-46 (V) Product Improvement Program was approved on 20 September 1999, and the first flight was conducted on 22 September 1999 with F/A-18 SD 110 for 1.0 flight-hours. Both channels and both computers were exercised, as well as dual-channel operations.

CURRENT IMPORTANT PROGRAMS

F/A-18E/F: FY99 saw the completion of the F/A-18E/F EMD program in April and the commencement of the follow-on test and evaluation program. Nearly 1200 flight hours were accomplished on the test aircraft during this time. Major accomplishments included completion the High AOA program, flutter program, performance and flying qualities demos, CVS demo, loads, noise and vibration testing, follow-on sea trials, and envelope expansion for smart weapons. Approximately a half of a million pounds of ordnance totaling nearly 20 million dollars was released for weapon separation/ compatibility. Flight-testing included releases/live firings of the following: MK-82 BSU-86 CVER, MK-83 BSU-85, MK-83 CVER, MK-84, MK-20, MK-76, AIM-120C, HARM, MAVERICK, and AIM-7. As the EMD program entered its final months, hundreds of engineering deficiency reports were reviewed for status and corrective action. The ITT and their IPT counterparts coordinated closely with INSURV, N-880 and N-912 to resolve major deficiency status and make recommendations for OTRR. These were agreed upon and accepted at the N-88 level, supporting the certification of readiness for operational test and successful commencement of OPEVAL. The ITT continued to work remaining technical issues, validating the correction of current deficiencies and commencing the effort necessary to support fleet deployment and FOT&E requirements.

Joint Strike Fighter: NAWCAD has supported the JSF Program including facilities preparation to support summer FY00 Concept Development flight test program. Supported JSF Joint Model Spec for the JSF EMD Program. NAWCAD has supported extensive modeling and simulation work in support of JSF Requirements Processes and has supported numerous Technology Maturation Development efforts.

WEAPONS DIVISION

"OPERATION ALLIED FORCE" SUPPORT

Electronic Warfare:
A star performer during the Kosovo operations was the EA-6B, which escorted virtually every strike group while performing jamming and employing HARM against hostile radars. In support of the Suppression of Enemy Air Defense mission, the EA-6B WSSA, the ARM IPT, and the TACAIR EW IPT responded to more than 100 Fleet requests for ALQ-99 (the radar jammer used on the EA-6B aircraft) and HARM data.

The ALE-50, a towed RF decoy designed for the F/A-18E/F, F-16, and B-1B aircraft, was deployed to the Kosovo theater with the Air Force. In response to anticipated threats in the Kosovo region, NAWCWD's Survivability Division tested the decoy's effectiveness against threats on the Land Range. As a result of this test, the Division issued a decoy performance update to all ALE-50 users operating in the Kosovo area. Aviation Week & Space Technology (31 May 1999), citing Air Force officials, reported that 30 surface-to-air missiles had been fired at B-1 bombers over Yugoslavia. Of these, 10 actually locked on to the B-1s, and then were diverted to the decoy.

At the Electronic Combat Range, the tempo of operations increased dramatically. Fleet, Marine Corps, Air Force, Allied, and individual weapons programs conducted testing and training in direct support of the Kosovo operations.

Weapons:
In the early phase of the Kosovo conflict, Tomahawk played a significant role in both strategic and tactical target destruction and significantly lessened collateral damage.

The Joint Direct Attack Munition (JDAM) saw its first tactical deployment and proved its all-weather and precision guidance merits. The F/A-18 IPT responded to a request from PMA-265 and the JDAM IPT to make changes to F/A-18 software in support of Marine squadrons deploying to the Kosovo area.

Members of the Joint Standoff Weapon (JSOW) IPT supported the U.S.S. Theodore Roosevelt off Kosovo and the U.S.S. Kittyhawk (deployed in the Northern Arabian Sea in support of Operation Southern Watch).

CURRENT IMPORTANT PROGRAMS

British Harriers, Tornados, and Jaguars carried out a critical short turnaround test program of the CBU-87 combined-effects munitions and BLU-97 bomblets on the Land Range.

Targeting and Reconnaissance Systems:
In May, the F/A-18 Advanced Weapons Laboratory (AWL) was requested by MAG 31 to install the Advanced Tactical Reconnaissance Airborne System (ATARS) on a Weapons Division F/A-18 and transfer the aircraft to Operation Allied Force. The Division was also asked to supply additional ATARS equipment, instructors, and a training syllabus to train MAG-31 crews in the Kosovo theater. With strong support from Boeing and Lockheed-Martin, a 10-person military and civilian team from the AWL was in-theater to support the ATARS deployment within 72 hours of the arrival of the MAG 31 combat forces. Marines strongly praised the system's combat success.

Testing and Training:
Operational testing was adapted to better meet Allied Force requirements. During operational test and evaluation of the F-14B's Upgrade Operational Flight Program with Global Positioning System/inertial navigation system capabilities, Air Test and Evaluation Squadron Nine (VX-9) received word to accelerate the test schedule. This was necessary to support the early deployment of a Carrier Battle Group to the conflict in Kosovo. The Weapons Division responded with priority range periods and target support for six sorties, resulting in early completion of the test program.

The F/A-18 AWL responded to a request from PMA-265 and the JDAM team to make changes to F/A-18 software in support of Marine squadrons deploying to the Balkans. This urgent program culminated in a successful combined AWL/VX-9 JDAM launch, and the software was formally released late in May. NAWCWD personnel briefed in-theater aircrew and maintenance personnel on the software changes.

An EA-6B squadron from Whidbey Island, Washington, which had been unable to meet its training requirements before embarking on Roosevelt, requested support from the Sea Range. The squadron flew a HARM exercise complete with live firings and were better prepared to attack their targets when they deployed to the Adriatic Sea.

WEAPONS INTEGRATION, WEAPONS PROGRAMS, ELECTRONIC WARFARE, FLEET SUPPORT AND FMS

The Weapons Division hosted several thousand tests on the Land Range, Sea Range, Electronic Combat Range, White Sands Range, and sled tracks.

Weapon Systems Support Activities:

F/A-18: Software releases for the A/B and C/D Hornet models improved navigation and weapons-delivery capabilities. Weapons-integration developmental testing for the Model E/F Super Hornet was completed and operational testing began.

EP-3, SPA: The Special Mission Integrated Product Team (IPT) was established. The IPT provides weapon system support for the aircraft and oversees modifications for the EP-3A Joint Airborne Signal Intelligence Architecture (JASA).

AV-8B: Developmental testing of Open Systems Architecture (OSCAR) software began. OSCAR uses commercial off-the-shelf technology to enhance the Harrier's ground-attack capabilities for the Marine Corps.

EA-6B: Two new Operational Flight Programs are increasing the Prowler's threat-radar coverage and HARM capabilities.

AH-1W: Developmental testing was completed on new software that will dramatically reduce cockpit workload for the Cobra.

CURRENT IMPORTANT PROGRAMS

F-14: Development testing was completed on a software Block Upgrade for the A/B model Tomcat that enhances tactical weapons capabilities.

Missiles and Free-Fall Weapons:

Joint Standoff Weapon (JSOW): JSOW reached Initial Operational Capability in January 1999. Since that time more than 50 have been successfully used in combat.

Joint Direct Attack Munition (JDAM): The second phase of Low-Rate Initial Production was approved, and early operational deployment allowed the weapons to be used in Operation Allied Force.

Tomahawk: The Operational Test launch of a TLAM-N from a submarine on the Sea Range demonstrated the weapon's Y2K compliance.

Sidewinder AIM-9X: Live-fire developmental testing began on the newest version of the world's premiere dog-fight missile.

Rolling Airframe Missile (RAM): RAM successfully completed Engineering Manufacturing Development (EMD) developmental and operational testing, successfully engaging diving, supersonic, maneuvering, and dual targets.

Standard Missile: Final design was completed on the infrared sensor.

High-Speed Antiradiation Missile (HARM): HARM Block IIIA/V software completed developmental testing and began operational testing. The first dual-HARM launch from an F/A-18 was carried out on the Land Range.

Evolved SeaSparrow: The second and third controlled-test-vehicle flights were completed.

Electronic Warfare:

Integrated Defense Electronic Countermeasures (IDECM). Flight tests began for IDECM's Radio Frequency Countermeasure (RFCM) risk-reduction program.

Fleet Support:

Fleet Battle Experiment (FBE) Echo: FBE Echo tested major concepts of Joint Vision 2010 and examined the operational and tactical level of war in the 2005-2010 timeframe with the theme "Network Centric Warfare in the Urban Littoral and Asymmetric Maritime Dominance." The Division provided system integration for FBE Echo, conducted precision sensor-to-shooter live-fire engagements, and supported real-time-targeting and GPS-jamming exercises.

Fleet Training: The Division supported 31 weapons firing exercises on the Sea Range (121 missiles fired), 76 firings on the Land Range, and 504 missions on the Electronic Combat Range, and also supported 117 target and other threat-simulation missions.

Y2K: NAWCWD's Y2K Solutions Teams traveled to 55 Navy installations throughout the world to assist in Y2K preparedness. The teams' approach was four-fold: test all mission-critical devices, inventory the Infrastructure/facility computer systems, assess Y2K compliance, and recommend mitigation measures. Internally, the Division's Y2K Program Office ensured a minimum of disruption to employees and customers through a comprehensive assessment and remediation program.

CURRENT IMPORTANT PROGRAMS

Joint Service/FMS:

Air Force: The Sea and Land Ranges supported weapons-integration testing for the B-1, B-2, B-52, and F-16 programs.

Marine Corps: Testing of the Predator shoulder-launched weapon was conducted for the Marine Corps on the Land Range.

Japan Defense Agency: SSM-1 missile firings and training exercises were carried out on the Sea Range.

Foreign Military Sales: FMS customers included Australia, Canada, Finland, Germany, Kuwait, Malaysia, Spain, and Switzerland. In addition, several other foreign governments engaged in testing or training on the Division's ranges.

EQUIPMENT/FACILITIES

AIRCRAFT DIVISION

Patuxent River Station, MD:
Facilities include: Air Combat Environment Test and Evaluation Facility (ACETEF), Aerodrome, Air Vehicle, Aircraft Modification and Instrumentation, Aircrew Systems, Test Range Facilities, Avionics, C-7 Catapult MK-7 Arresting Gear and Takeoff Assist, Mission System, Propulsion Systems, Ship and Shore Facilities, Robert N. Becker Laboratory.

Air Combat Environment Test and Evaluation Facility (ACETEF)

The Air Combat Environment Test and Evaluation Facility (ACETEF) is a fully integrated ground test facility that allows full spectrum T&E of highly integrated aircraft and aircraft systems in a secure and controlled engineering environment. The facility uses state-of-the-art simulation and stimulation techniques to provide test scenarios that reproduce the conditions of actual combat. In ACETEF, a fully integrated weapon system, incorporating vehicle, avionics, weapons, crew, other platforms, and critical elements of the operational command/control hierarchy is immersed in a virtual warfare environment. Aircraft systems are stimulated through a combination of simulation by digital computers and stimulation by computer controlled environment generators that provide radio frequency (RF), electro-optical (EO), and laser stimuli that duplicate real signals as closely as possible. The flight crew is provided very high fidelity visual, aural, and tactical workload conditions (threats, mission objectives and constraints, communications channels, etc.)

ACETEF permits ground testing of fully integrated avionics systems in an environment that closely parallels actual combat. The data gathered by ACETEF augments that available from conventional flight testing in three ways. First, ACETEF reproduces the conditions encountered during a test flight, allowing systems engineers to study a problem under controlled conditions. Second, ACETEF subjects systems and crews to conditions that cannot be reproduced in actual flight short of real combat. Finally, ACETEF testing is secure; it cannot be witnessed by uninvited observers. The ACETEF is linked to other facilities aboard NAWCAD Patuxent River. A directional microwave link exists between the facility and the Shipboard Ground Station (SGS), allowing a Light Airborne Multipurpose System (LAMPS) MK III helicopter to be subjected to simulated combat conditions within the ACETEF, while simultaneously stimulating the LAMPS MK III shipboard combat suite at either the SGS FFG-7 installation, or (via the SGS-Chesapeake Test Range-Wallops microwave data link (MDL)) the Aegis Test Suite at NASA Wallops. The Chesapeake Test Range-ACETEF link allows a downlink of test aircraft flight data to drive the cockpit at the Manned Flight Simulator (MFS), duplicating the flight conditions in the lab in real time. Alternatively, this link allows a simulator "flight" to be monitored at the Chesapeake Test Range as if it were an actual flight. ACETEF components include:

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- Operations and Control Center
- Advanced Manned Flight Simulator
- Aircrew Systems Evaluation Facility
- Electronic Warfare Integrated System Test Laboratory
- Threat Air Defense Laboratory
- Offensive Sensors Laboratory
- Communications, Navigation, and Identification Laboratory
- Shielded Hangar
- Aircraft Anechoic Test Facility
- Electromagnetic Environment Generating System

Operations and Control Center (OCC):
The OCC is the focal point for all ACETEF integrated T&E activities. It provides central command and control for test execution and is designated lead laboratory for ACETEF tests. OCC also operates the Simulated Warfare Environment Generator (SWEG), a primary combat simulation system, which generates threat scenarios.

Advanced Manned Flight Simulator (MFS):
The MFS was designed as a tool for flight test engineers and pilots to evaluate avionics and flight control systems evaluations in a man-in-the-loop environment. The aircrew is provided with the appropriate visual, aural, and motion cues from the synergistic six-degrees-of-freedom motion system to simulate actual flight in a combat environment. The MFS facility includes high fidelity simulations within fleet representative cockpit models such as the F/A-18, F-14D and V-22 aircraft. Multi-reconfigurable cockpits are available for emulating the cockpit/displays of the F/A-18, F-14, X-31, T-45, EA-6B, UAV, AH-1W, H-60, E-2C, V-22 and AV-8B aircraft. Four simulation stations (two high fidelity and two low fidelity) are available. Three simulations can be run simultaneously.

Aircrew Systems Evaluation Facility (ASEF):
The ASEF provides the facilities necessary to evaluate the man-machine interface and the aircrew workload during ACETEF testing. Additionally, the ASEF rapidly prototypes cockpit displays and layouts, control panel display formats, and aircrew interfaces.

Electronic Warfare Integrated System Test Laboratory (EWISTL):
EWISTL is an on-line, open loop, RF generating facility used primarily to stimulate aircraft electronic warfare (EW) systems. EWISTL can gauge the performance and integration of EW systems within their avionics packages against simulated hostile conditions. The facility can simulate up to 1024 threat radar systems simultaneously. These radar systems can be located on up to 256 moving platforms to simulate surface combatants, aircraft, or missile systems. Types of systems recently tested include radar warning receivers, defensive electronic countermeasures (ECM), electronic support countermeasures, laser warning receivers, missile approach warning systems, and expendable controllers.

Threat Air Defense Laboratory (TADL):
The TADL provides closed loop hardware and man-in-the-loop hybrid simulations of specific threat radar systems to a very high level of fidelity. The simulations are used to determine ECM effectiveness, including radar tracking errors and missile miss distance.

Offensive Sensors Laboratory (OSL):
The OSL provides multi-spectral stimulation of the aircraft's offensive sensor suite and smart weapons. The facility is being upgraded to include an air-to-air and air-to-ground radar stimulator, infrared target generator, radar and infrared missile stimulators, and laser missile stimulator.

Communications, Navigation, and Identification Laboratory (CNIL):
CNIL is an independent laboratory within ACETEF which provides the capability for hardware-in-the-loop testing of actual Communications, Navigation, and Identification (CNI) systems, as well as the capability to simulate numerous CNI equipment's for realistic system level testing. The facility generates actual RF signals that can be directly coupled into a single system under test or radiated in the anechoic chamber environment. The CNIL is coupled with a threat generation software package to generate RF

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signals that simulate the command and control communications of the threat environment.

Electromagnetic Environmental Effects Division Facilities:
The electromagnetic compatibility (EMC) and electromagnetic interference (EMI) test facility is the shielded hangar complex. It provides an isolated electromagnetic environment (EME) for inter/intrasystem testing of the total aircraft. The electromagnetic pulse (EMP) simulation facility consists of a horizontal center-fed dipole and vertical monopole base-fed antennas. These antennas provide the capability to perform EMP vulnerability testing on aircraft. The Lightning/Electrostatic Discharge (ESD) facility has high voltage and high-amperage generators that provide capabilities to test effects of, and protection from, lightning strikes. This facility also houses Precipitation Static (P-Static) testing capabilities. The Test for Electromagnetic Propagation and Evaluation for Secure Transmission (TEMPEST) / Communications Security (COMSEC) Laboratory contains a full suite of automated test equipment. It is capable of communicating with aircraft and land-based stations in the HF, VHF, and UHF ranges. The capabilities and built-in flexibility of the facility have been instrumental in the research, development, and operational testing of new and modified secure communication equipment and systems.

Shielded Hangar:
The Shielded Hangar serves as the central hub for all Electromagnetic Environmental Effects (E 3) testing at NAWCAD Patuxent River. This facility provides an RF quiet environment for a myriad of E 3 technology testing, including Intra/Intersystem EMC, Emission Control (EMCON), Lightning / P-Static / ESD, TEMPEST / COMSEC, and avionics conformance testing. The hangar is capable of providing in-flight test simulation/stimulation for avionics, flight controls, weapons testing, and aircraft maintenance when required.

Aircraft Anechoic Test Facility (AATF):
The Anechoic Chamber provides a secure and realistic test environment for system stimulation. The Anechoic Chamber laboratories provide a multispectral stimulation and simulation environment for the aircraft and its systems that closely resembles actual combat. AATF is a tactical aircraft size anechoic chamber, which provides an ultra-quiet, secure RF environment to simulate realistic free-space flight. The test area is 96 feet long, 60 feet wide, and 30 feet high. A traveling hoist will accommodate test objects up to 30 tons in weight. The AATF is a focal facility for the ACETEF laboratories and provides an ideal environment for integrated systems testing.

Electromagnetic Environment Generating System Laboratory (EMEGS):
The EMEGS Laboratory provides simulation of high-intensity electromagnetic environments. This ACETEF component simulates the worldwide Fleet Operational EME, and evaluates effects on an aircraft's critical functions, mission systems, and vehicle systems. These evaluations are intersystem EMC, high-intensity radiated fields (HIRF), or Electromagnetic Radiation (EMR) tests. Since EMEGS is transportable, testing can be performed indoors on the deck of the shielded hangar or in the anechoic chamber, or outdoors on the Naval Electromagnetic Radiation Facility (NERF) ground plane adjacent to the shielded hangar parking apron.

Aerodrome - RDT&E aviation capabilities provided by aircraft, hangar facilities, maintenance, runways and airfield services. Enables the conduct of flight, ground and shipbased aircraft RDT&E.

Air Vehicle RDT&E Facilities - Provides RDT&E for air platforms with armament and stores; component systems and hardware support systems. Conducts research and development for naval airframes and air vehicle subsystems.

A Component Laboratory is:
Robert N. Becker Laboratory - Consists of 23 state-of-the-art laboratories. The extensive fabrication, processing, test, and evaluation capability that exists in these laboratories supports many division projects, as well as the Naval Aviation Systems Team and the fleet. These facilities provide a capability for the complete synthesis and characterization of existing and advanced materials and new materials concepts. Maritime environment simulation and characterization are emphasized. The 65,000 square foot Aircraft Technologies Laboratory, which began operations in the summer of 1995, supports

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Materials R&D efforts, and includes Polymer, Composites, and Coatings laboratories.

Aircraft Modification & Instrumentation Facility - Provides test laboratories and shop support facilities for engineering, technical documentation, test instrument development and fabrication, verification tests, calibration support, maintenance of instrumentation/measurement standards, and instrumentation software and hardware development. Laboratory instrument and calibration facilities support peculiar and general purpose electronic test equipment for all fleet and DT&E/OT&E activities at NAWCAD Patuxent River. Transducer, accelerometer, fluid flow, pressure and microwave frequency calibration systems are configured to interface type II and III calibration standards directly with aircraft systems. A strain gauge and structural analyses laboratory provides the capability to install and calibrate strain gauge instrumentation utilized in measuring aircraft loads during fixed and rotary wing aircraft flights. Mechanical design and fabrication facilities provide support to RDT&E and OT&E instrumentation and test project installations and fleet support requirements. Capabilities include computer aided design (CAD)/computer aided manufacturing (CAM), computerized structural analyses, traditional metal working, precision machining, all types of welding, fiberglass fabrication and composite material repair. The NAVAIR Special Flight Test Instrumentation Pool (SFTIP) was established to eliminate long lead time for acquisition of specialized airborne test instrumentation and to promote standardization.

Aircrew Systems RDT&E Facilities - The Aircrew Systems Test Facility includes nine laboratories which provide the capabilities required for T&E of escape and survival systems, aircraft environmental/electronics systems, life support systems, fluid flow and gas systems, Vertical Takeoff and Landing (VTOL)/Vertical Short Takeoff and Landing (VSTOL) downwash, human factors/man-machine interface factors resulting from the integration of all the mechanical, avionics, and environmental sub-systems of the total aircraft, internal and external lighting, and night vision systems. Component laboratories are:

- Escape and Survival Systems Laboratory
- Environmental/Electronics Laboratory
- Life Support/Fluid Flow and Gas Laboratory
- Mobile VSTOL Downwash Laboratory
- Crewstation Technology Laboratory
- Crew-Systems Integration Laboratory
- Aircraft Lighting Laboratory
- Human Factors Test and Evaluation Laboratory
- Night Combat Test Laboratory

Escape & Survival System facilities and equipment provide capabilities for test and evaluation of assembly, disassembly, inspection, and operation procedures of escape and restraint systems in normal and adverse operational conditions. Human factors facilities and equipment provide capabilities for test and evaluation of the design and operation of aircraft systems concerning the ease of maintenance and operation, efficient safe procedures, control-display relationships, man-machine interface, crew station lighting, crew accommodation, anthropometry, vision and task performance.

Atlantic Ranges - The Chesapeake Test Range facilities provide aircraft tracking, data acquisition and relay, range surveillance, targets and communications/control of multiple aircraft test events in the Chesapeake Bay and, via an MDL link, in the Atlantic Warning Areas. An integrated network of cinetheodolites, laser, and radar trackers along the western Chesapeake shore are linked to computation and control facilities at NAWCAD Patuxent River. The MDL with NASA Wallops Flight Facility (WFF) permits utilization of NASA precision radars in the Atlantic Warning Areas and relay of telemetry to NAWCAD Patuxent River. Multi-object trilateration tracking and four differential GPS receivers provide TSPI for multiple air/surface test vehicles. Special purpose instrumentation includes radar for EW Systems simulation, videographic and photographic instrumentation, mobile instrumentation, and instrumentation for shipboard test of aircraft. Air/Surface seaborne targets, short range missile fire areas, direct fire areas and sonobuoy drop areas are integrated with range facilities. Range tracking and target data are integrated in the range computation and control center which then provide space position, EW data link, and meteorological data to the Real Time Telemetry Processing System (RTPS) for correlation with aircraft telemetry data. Area frequency coordination for the Mid-Atlantic Area is performed, which

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includes coordination/scheduling of frequency assignments for test operations and shared RF usage in the 3 MHz to 35 GHz spectrum. Major testing capabilities include surface targets, aerial targets, subsonic and supersonic air space and operating areas to support a wide variety of aircraft weapon systems testing. Major test functions include Flying Qualities and Performance (FQ&P), weapon separation and delivery system performance, aircraft installed avionics performance, aircraft and mission systems performance, aircraft propulsion system flight tests, aircraft carrier suitability and ship dynamic interface testing.

Microwave Facility:
The Microwave Facility operates several MDLs, a Wallops Link, a Webster Field Link, and a Laser Site Link. The Wallops Link is a two-repeater hop, each of which receives and retransmits data. The link travels from NAS Patuxent River to Bishops Head, to Crisfield (the current leased facility), to Wallops. It is used to relay data from NAWCAD Patuxent River test operations conducted over the Atlantic Ocean using Wallops radar and telemetry tracking systems. Additionally, the LAMPS MK III program uses the link to access the Navy Aegis facility assets at WFF. The Webster Field Link is a one-repeater hop from NAS Patuxent River via the Hermanville repeater site to OLF Webster Field.

Time Space Position Information System Facilities (TSPI):
TSPI Systems measure position, acceleration, attitude, and rates of change of airborne and surface targets as a function of time. TSPI data is obtained by using radar, electro-optics, video, film, laser, multilateration using Extended Area Tracking System transponders, and/or GPS. The TSPI information from all sources is integrated in the range control center where the data is processed and displayed in real-time and recorded for post mission processing or playback. The division also provides geodetic survey using traditional and GPS techniques, and maintains and operates meteorological instrumentation for collecting and providing atmospheric data as required for test operations.

Real-Time Avionics Flight Test Facility:
The Real-Time Avionics Flight Test Facility, located within the Chesapeake Test Range, is responsible for evaluating in-flight aircraft avionics performance at the component level. This facility stimulates receiving and transmitting avionics equipment on an aircraft, with the equipment in its intended operating environment. The stimulation effects can be observed in real time. The facility also has subsystems that can be programmed or configured to support a variety of tests and multi-user requirements, providing an efficient and cost-effective use of simulation and stimulation assets. Capabilities of the facility include:

- Computer Controlled Programmable RF Emitter Simulations (Generic, Threat, Friendly) of up to 134 simultaneous RF emissions.
- Up to 32 Simultaneous Communication, Control and Coordination emitter simulations with diversity in antenna beam shapes, scan patterns, output power levels, modulation techniques, and geographic location.
- In-flight Radar Cross Section (RCS) measurement and analysis.
- EW avionics tests including: antenna patterns, direction of arrival, receiver performance, jammer technique analysis, and Jammer-to-Signal ratios shown against chaff and decoys. The Real-Time Avionics Flight Test Facility mission is directed both toward evaluations of internal aircraft avionics at the component level, as well as toward evaluations of the aircraft's radar return characteristics, such as RCS measurements.

Remote Electronic Warfare Site (Point Lookout):
The Metric and TSPI Division operates a Remote EW site at Point Lookout, Maryland. This EW facility is used mainly to achieve spatial diversity of emitters during EW tests. It is also used for surveillance radar and range clearance. By using the facilities at Point Lookout in conjunction with those at NAWCAD Patuxent River, an aircraft's ability to discern two signals from two different directions can be evaluated. Addition al testing is performed by filling the airspace with many electro magnetic signals, and trying to stress the aircraft's systems. Current testing on the EA-6B utilizes the EW facility to radiate signals for threat simulation. NASA WFF, Virginia. Seaborne targets consist of fixed target arrays, remote-controlled boats and ship hulks. Land targets include manned and remote-controlled ground vehicles and fixed targets. All targets are tailored for the needs of a particular test project by installation of applicable target augmentation devices including visual enhancement, radar, infrared, or acoustic emitters. Specific services provided include:

- Telemetry surveillance

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- Divers for test item recovery
- Target maintenance and repair
- Real-time impact scoring
- Laser designator operations
- Design and fabrication of targets

Avionics RDT&E Facilities - Provides RDT&E for the full spectrum of avionics systems. Included are aircraft and antenna towers, as well as RDT&E capabilities involving electro-optics and reconnaissance, electric systems, navigation, antenna systems, communications, radar, computer and electronic sensors.

C7 Catapult, MK7 Arresting Gear and Take-off Assist Facility - Test facilities include a C-7 catapult upgraded to a C-13 Mod 0 catapult capability, MK-7 Mod 3 arresting gear, and a configurable take-off assist ramp, all of which are representative of shipboard installations. The facilities are fully instrumented with optical and electronic measurement equipment for real-time and post-flight analysis of all desired aircraft and launch/arrest/ramp performance parameters, including structural loads and acceleration effects on airframes and related subsystems.

Mission System RDT&E Facilities - Provides RDT&E capabilities for C41, Anti-Submarine Warfare (ASW), Anti-Surface Warfare (ASUW), AEW, Tactical, VP, VS and Vertical Flight Mission areas. Includes software development and hardware integration support facilities.

Propulsion Systems RDT&E Facilities (PSEF) - The Propulsion Systems RDT&E Facilities is the only Navy Facility which provides the complete range of testing, development, reliability and fleet service engineering support for fixed and rotary wing air vehicle engines, engine components and accessories; and test and evaluation services for small engine air-breathing propulsion systems, power drive systems, fuels and lubrications. The PSEF was recently completed to house propulsion and test functions relocated to NAWCAD Patuxent River from NAWCAD Trenton. This facility houses the following activities:

- Rotor Spin Facility
- Helicopter Transmission Test Facility
- Unmanned Aerial Vehicle Altitude Test Cell for testing small reciprocating and turbine engines.
- Fuel System Component Test Facilities
- Fuels and Lubricants Test Cells
- Fuels and Lubricants Analytical Laboratory
- Aircraft Engine Emission Test Laboratory
- High Volume Fuel Flow Facility

Ship and Shore Electronic Systems RDT&E Facilities - Provides RDT&E for Air Traffic Control systems, ID systems, SPECWAR, communication, shipboard data link, & systems external communications. This facility includes: Identification Friend or Foe (IFF) Systems, LAMPS and Ship Data Link, Ship Combat and Communications Systems, Special Warfare/Joint Interoperability and Information Technology.

WEAPONS DIVISION

INTEGRATED MODELING AND SIMULATION. NAWCWD can support large-scale battlespace engineering and aircraft/weapons systems integration with a combination of inter-linked R&D laboratories and instrumented test ranges. We are developing and exploiting advanced concepts and technologies such as high-bandwidth data links, joint mission planning, and real-time targeting. We can link geographically separated and disparate facilities-such as our Integrated Battlespace Arena (IBAR), GPS Lab, the F/A-18 Advanced Weapons Lab, the Battle Management Interoperability Center (BMIC) (see below) at Point Mugu, and the ACETEF at Patuxent River into a total "virtual" battlespace.

BATTLE MANAGEMENT INTEROPERABILITY CENTER (BMIC). The BMIC links command, control, communications, computers, and intelligence (C4I) systems during live-fire test events in a controlled, closely monitored range environment. The BMIC creates theater-level environments and dynamics by linking synthetic applications (live, constructive, and virtual) on the Defense Simulation

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Internet. As well as receiving simulated threats from other facilities, the BMIC supplies other facilities with live simulations from the Sea Range. By bringing together test-and-evaluation assets with live-exercise assets, the BMIC provides a meeting place for the laboratory and shipboard environments and allows a flexible mix of laboratory control and operational dynamics. The BMIC consists of a fixed-site facility at Point Mugu as well as local and remote electronic and communications systems used to coordinate complex operations.

INTEGRATED BATTLESPACE ARENA (IBAR). Four simulation facilities aid in weapons development and testing: the Virtual Prototyping Facility (VPF), the Precision Imaging Strike Technology Integration Laboratory (PISTIL), the Missile Simulation Laboratory (SIMLAB), and the Missile System Evaluation Laboratory (MSEL). Progressively, the four laboratories provide additional realism leading up to an actual live-firing test event. The VPF is an all-digital, easily configurable cockpit environment in which entire weapon and aircraft platform systems can be simulated and evaluated for various scenarios. As the U.S. Navy's first cockpit simulation to include communications to and from the simulated aircraft to the weapons, the VPF offers one-on-one and one-on-many aircraft engagement and strike weapon capabilities for manned or unmanned aircraft. The PISTIL is a signal-processor-in-the-loop facility where every aspect of a missile's signal-processing environment can be modeled and tested using the actual hardware. Combining three-dimensional target images, missile hardware-in-the-loop (HWIL), and on-site tactical aircraft, PISTIL supports evaluation of a variety of seekers, including imaging infrared (IR), millimeter wave, laser detection and ranging (LADAR), and television. The SIMLAB and the MSEL are fully-equipped, state-of-the-art missile HWIL simulation laboratories that provide the last test check before actual flight testing. HWIL testing is used to test actual missile hardware (seekers, guidance sections, inertial units, etc.) in a test environment that simulates missile flight. SIMLAB and MSEL are used to demonstrate new missile technology, evaluate new or existing designs, and integrate new hardware or software. Each of the SIMLAB's five laboratories and the MSEL's three laboratories are equipped with a flight motion simulator table and real-time computers with input/output, targeting system, and peripheral equipment. The laboratories include five anechoic chambers and three IR facilities for testing RF, IR, multimode, and inertially-guided systems. These laboratories are equipped with targeting systems capable of generating both simple and complex target signatures and countermeasures for a wide range of missiles. The newest of the SIMLAB IR laboratories contains a five-axis flight motion simulator table capable of angular extent up to 130 degrees off boresight. This flight simulator allows for simultaneous missile and target movement and provides dynamic IR scene generation and projection to the unit under test. SIMLAB links with other laboratories to run simultaneous, real-time operations involving launch aircraft, weapons, and targets, allowing a systems-level approach to the issues.

MISSILE ENGAGEMENT SIMULATION ARENA (MESA): MESA is an indoor facility in which full or sub-scale hardware models or modified real-world sensors, fuzes, and targets-are used to evaluate the highly sophisticated interactions between air vehicles and missile sensors. The only facility of its kind in the world, MESA was designed for precision analyses of missile lethality, air-vehicle survivability, and endgame properties of both sensor and vehicle. Able to run simulations around the clock and in all weather, MESA provides a cost-effective alternative to field testing. Targets weighing up to 11.3 metric tons (25,000 pounds) are suspended in MESA's high bay, which is 46 meters wide, 123 meters long, and 27 meters high (150 by 405 by 90 feet). The targets can be suspended mid or downrange and positioned within 0.32-centimeter (1/8-inch) accuracy either vertically or horizontally in a wide variety of yaw, pitch, and roll angles. Sensors weighing up to 91 kilograms (200 pounds) are mounted on a three-axis positioner, which is accurate to within 0.1 degree. The sensors are transported past the target at speeds from 3.05 centimeters to 3.05 meters (0.1 to 10 feet) per second along the relative velocity vector. Trajectory control and a stable instrumentation radar provide repeatable testing and precise data. Processed data are provided to the customer immediately after a test; analyzed data provide information about sensor performance and missile effectiveness. Typically, thousands of intercepts are simulated during a system evaluation, providing more precise data than obtained from a missile firing.

MISSILE AND AIRCRAFT WEAPON SOFTWARE SUPPORT ACTIVITIES (WSSA): As the U.S. Navy's lead activity for fighter-attack aircraft system development and weapons integration, the Naval Air Warfare Center Weapons Division is home to six WSSAs: F/A-18 Hornet, F-14 Tomcat, EA-

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6B Prowler, AV-8B Harrier, AH-1 Cobra, and the EP-3 and SPA (Special Mission Aircraft). The WSSAs are the tools used to provide development testing; verification and validation; safety-of-flight testing; quick-response investigations of problems reported by the U.S. Naval Fleet; corrections of errors and deficiencies; investigation of changes; life-cycle weapon-system support; and integration and testing of new technology, mission systems, and weapons. Some WSSAs perform software design, coding, and development. WSSAs are the focal points for quickly deploying enhancements to existing weapon systems and for integrating new weapons and mission capabilities in response to changing battlefield requirements. The WSSAs' collocation with the Land, Sea, and Air Test Ranges provides nearly unlimited space in which to perform weapon and system integration testing. The WSSAs have met the challenge of integrating yesterday's weapons on the new generation of digital aircraft as well as developing and integrating a new generation of advanced mission systems and weaponry.

ENERGETIC MATERIALS LABORATORIES: A complex of laboratories provides facilities for energetic materials research in the fundamentals of propellant and explosives technology. Outdoor warhead test arenas are capable of testing up to 500,000 pounds of explosives.

The China Lake Ordnance And Propulsion Pilot Plant's mission is to advance ordnance-related technology (i.e., energetic materials, propulsion, warheads, bombs, and fuzing), and to design and develop weapons and weapon components that contain energetic materials. At the 56-building facility, designed exclusively for proper handing of energetic materials, the process begins with synthesis of new energetic materials and new formulations and extends from hand mixes to large-scale processing of propellants and explosives. Processing equipment includes high-shear mixers from 0.14 (1/4 pint) to 661 liters (150 gallons) in size for mixing propellants and explosives; up to 176 liter (40 gallon) slurry kettles for mixing melt cast and other explosives; pellet presses; 18.1, 45.4, and 272 metric ton (20, 50, and 300 short-ton) explosive presses; complete raw material preparation in hammer mill; Sweco grinders and fluid energy mills; injection loaders for explosives; casting facilities; ovens for curing explosives and propellants; and complete machining capability for rocket motors, warheads, bombs, explosives, and propellants.

The Detonation Physics Laboratory has highly instrumented firing bays where up to 6.8 kilograms (15 pounds) of explosive can be detonated. This laboratory has ultra-high-speed framing and streak cameras as well as electronic instrumentation to fully characterize detonation reactions. The thermal research area provides complete thermal characterization of explosives and propellants. The Pilot Plant also features a quality-assurance laboratory for determining physical properties and performing safety tests on energetic materials as well as analysis of raw materials. Explosive and propellant scrap and other excess ordnance components are disposed of on site, and a regulatory-approved explosive hazardous-waste-treatment system allows for effluent collection, treatment, and disposal. The Air-breathing Propulsion Facility static-fires and tests air-breathing engines such as ramjets, scramjets, pulse detonation engines, divert bi-propellant propulsion, and expendable turbine systems as well as engine components such as fuels, inlets, insulators, combustors, and fuel-management systems. Instrumented rocket motors and pyrotechnic devices are also static fired. Multiple test bays are available for cold flow and hot firings of liquid and solid-fuel systems. Liquid fuels formulation, development, and evaluation capabilities are available on-site, and the remote location provides unparalleled safety and security. The Skytop Propulsion Complex is used for static testing of solid-fuel rocket motors, from small motors and gas generators to rocket motors with 680 metric tons (a million and a half pounds) of thrust. The isolated test areas and facility designs enable testing of large, high-energy, high-risk systems with complete protection for personnel and minimum equipment exposure. Even in the event of catastrophic motor failure, data can be acquired and protected. Skytop has two control rooms and seven separate test bays, equipped with state-of-the-art data-acquisition and processing systems, for testing a variety of systems and components. Equipment includes flash x-ray and optical instrumentation, including metric video and high-speed motion picture cameras (up to 3048 meters (10,000 feet) per second), as well as instrumentation for recording pressure, force, strain, temperature, position, shock, and vibration. Each test bay provides thrust-vector-control hydraulic power and has a remotely controlled water quench system. Unique capabilities include real-time radiography to record internal motor ballistics during static firing, spin testing of small motors (up to 20.32 centimeters (8 inches) in diameter) in either vertical or horizontal attitude, and thrust-vector-control evaluation of motors.

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The Plume Measurement Facility gathers rocket motor performance measurements and signature-characterization data for rocket plumes, providing information to designers of weapons and countermeasures. Rocket motor test stands up to 6.1 meters (20 feet) high accommodate motors up to 76 centimeters (30 inches) in diameter and 4.3 meters (14 feet) long and with thrusts to 36,000 kilograms (80,000 pounds). The stands can restrain the rocket motor at any pitch from horizontal to a completely vertical (nozzle-up) position, and at a yaw angle fixed between zero and 180 degrees. A six-degree-of-freedom force-measurement system located between the test stand and the pad determines the motor's thrust performance. The placement and elevation of the test motor stand allows a clear line of sight to the test motor with blue-sky background from most of the surrounding 19 instrumentation sites, minimizing background clutter. Instrumentation to measure ultraviolet (UV), visible, and infrared (IR) signature data includes a 484 by 800 element UV-intensified silicon CCD camera with spectral filter and UV camera lenses; a 180element dual-band IR mercury cadmium telluride scanning imager; a 256 by 256 element indium antimonide focal plane array camera; a 500 by 800 element platinum silicide focal plane array camera; three grating spectrometers with 256 by 1024 element UV-enhanced silicon detector arrays including one with intensifier; a Fourier-transform infrared spectrometer; and three filter radiometers with cesium telluride photomultiplier tube detectors, silicon detector radiometers, and liquid-nitrogen-cooled indium antimonide detector radiometers with telescope optics. For measuring plume RF signature data, the facility has two radars with complementary capabilities: one high-power, long-range pulsed Doppler system, and one low-power, high-resolution, frequency-modulated system. The facility performs data reduction and generates test reports.

The Non-Destructive Ordnance Test Facility uses a large, high-energy computed tomography system; two-dimensional digital video data; and conventional film x-rays to inspect tactical missile systems for non-destructive testing, lot acceptance, quality assurance, environmental qualification, safety testing, and explosives and propellant research, development, test, and evaluation. Inspection and testing is performed on items ranging from small ordnance to strategic rocket motors weighing up to 59 metric tons (130,000 pounds). Warheads, fuzes, safe-arm devices, and associated subsystems can also be inspected and tested. The facility can test strategic rocket motors up to 7.3 meters (24 feet) long and 2.3 meters (92 inches) in diameter. Longer motors can be inspected with two upending evolutions. The facility also conducts helium leak testing and boroscopic inspections.

COMPOSITES AND PLASTICS LABORATORY: The Composites and Plastics Laboratory provides advanced composite development, from design and analysis methodology, materials development and characterization, and fabrication methods, through testing for tactical missile airframes and propulsion systems. The plastic and composite (fiber-reinforced) parts developed here include bulkheads, complete airframes and nozzles, liners and insulators, and rocket-motor cases. Unique design, analysis, fabrication, and test equipment are integrated for quick-turnaround projects and special one-of-a-kind solutions to customer needs. Lay-up tables, presses up to 290 metric tons (320 short tons), autoclaves (172 x 105 N/m2 (250 psi) and temperatures up to 399°C (750°F)), and curing ovens afford a self-contained capability to meet all manner of nonmetallic-parts fabrication requirements. The composite winding equipment can fabricate solid rocket-motor cases and complete airframes for tactical missiles up to 1.2 meters (48 inches) in diameter and 4.9 meters (16 feet) long.

AEROHEAT TEST FACILITY. This facility (T-Range) is a high pressure air blow-down facility capable of simulating variable Mach number and altitude flight conditions for materials characterization and testing of tactical-sized missile components and air-breathing propulsion systems. Infrared imaging cameras are available to estimate the surface temperature on items being tested. The facility is supported by experts in computational fluid dynamics and thermal and structural analysis.

RADAR REFLECTIVITY LABORATORIES: The Monostatic and Bistatic Radar Reflectivity Laboratories are used to conduct analyses, experiments and measurements in radar reflectivity, materials, and RF signatures. The Monostatic Radar Reflectivity Laboratory consists of two instrumented anechoic chambers. The larger chamber, 30.5 meters long by 12 meters wide by 12 meters high (100 by 40 by 40 feet), is equipped for performing electromagnetic scattering and radiation measurements to determine radar signatures of air vehicles as large as 4.9 meters (16 feet) and weighing up to 0.9 metric ton (2000 pounds). The chamber is polarization diverse and can measure S, C, X, Ku, Ka, V, and W bands (2 to

EQUIPMENT/FACILITIES

100 gigahertz). The second chamber, 22.8 meters long by 8.2 meters wide by 4.5 meters high (75 by 27 by 15 feet), is used primarily for development and testing of antennas and target-augmentation devices. This smaller chamber can provide monostatic near-field measurement data over the 2 to 95 gigahertz frequency range. The Bistatic Radar Reflectivity Laboratory is a one-of-a-kind facility that consists of a large instrumented anechoic chamber for performing bistatic electromagnetic scattering and radiation measurements to determine radar signatures of air vehicles as large as 9 meters (30 feet) and weighing up to 2.7 metric tons (6000 pounds). The bistatic anechoic chamber, which measures 46 by 46 by 18 meters (150 by 150 by 60 feet), is a unique facility that provides free space, far-field or near-field conditions in a secure indoor environment. The facility is polarization diverse and is instrumented to measure VHF, UHF, L, S, C, X, Ku, Ka, V, and W bands (0.1 to 100 gigahertz). Bistatic angular coverage is provided from 0 to 180 degrees (horizontal) and 0 to 90 degrees (vertical). Both laboratories provide free space, far-field, or near-field conditions in a secure indoor environment. A collimator is used to provide far-field monostatic or bistatic signature measurements. Both laboratories provide versatile target supports, radar measurements, and data-processing capabilities.

WEAPONS SURVIVABILITY LABORATORY: The WSL conducts survivability testing to provide empirical data on the vulnerability of aircraft to actual threats. Survivability tests at the WSL are conducted on hardware ranging from full-scale aircraft and subsystems to smaller-scale developmental hardware, simulators, replicas, components, and materials. In-flight airflow conditions from 74 to 1111 kilometers per hour (40 to 600 knots) are simulated with the High Velocity Airflow System (HIVAS) and the portable HIVAS. These systems allow tests that would otherwise be difficult or impossible to perform. Ballistics testing at the WSL involves nearly all calibers as well as explosively projected and gun-fired (sabot-launched) fragments at speeds of 305 meters to 2.2 kilometers (1000 to 7200 feet) per second. The WSL's 15.2 centimeter (6 inch) diameter air gun can launch 8 kilogram (18 pound) warheads and projectiles at speeds up to 457 meters (1500 feet) per second. WSL test instrumentation is comprehensive, and a variety of data products are offered. All support services are available on site, including a complete machine shop and mechanical, aerospace, and electronic engineering support.

AERIAL AND SURFACE TARGETS COMPLEX. The Aerial and Surface Targets Complex provides full life-cycle support services for aerial and surface targets. Services include target development, modification, test and evaluation, operations, maintenance, and the associated systems and in-service engineering functions. These services support full-scale targets, subscale targets, missile targets, surface targets and target augmentation/auxiliary systems. Full-scale targets include the QF-4N and QF-4S Phantom II aircraft, capable of speeds to Mach 2 and altitudes of 17 kilometers (57,000 feet). Subscale targets include the BQM-74, BQM-34, and Ballistic Aerial Target. Missile targets include the MQM-8 series Vandal targets (capable of Mach 2.1 at 3.6-meter (12-foot) altitude with terminal weave/jink end-game maneuver, and a total range of 74 kilometers (40 nautical miles)), the AQM-37 C and D targets, which can reach Mach 4.5 at 33,500 meters (110,000 feet) when air launched from the QF-4 (manned or unmanned) or the F-16 (manned only) platforms, and the MA-31 which is currently undergoing a Foreign Comparative Test program and is expected to become operational within the next year. Surface targets include Seaborne Powered Targets (SEPTARS, both 5.5-meter (18-foot) and 17-meter (56-foot)classes), target ships (powered and unpowered), and towed targets. The 80-meter (262-foot) Mobile Ship Target (MST) is highly survivable, environmentally clean, and capable of speeds in excess of 22 kilometers per hour (12 knots). Seaborne target harbor facilities at Port Hueneme provide ready access to the Sea Range and open ocean. Target augmentation/auxiliary systems, which are available for all aerial and surface target types, include command-and-control, flight termination, radar and infrared signature enhancement, threat seeker and threat countermeasure simulators, and scoring systems. The Complex has a DC-130 aircraft for aerial target launches as well as the Aerial Target Launch Ship. These allow the target capability for airborne or seaborne launches to be deployed in operations throughout the world.

OPTICS AND LASER RESEARCH FACILITY: The Optics and Laser Research Facility conducts research, development, test, and evaluation on optical materials, components, systems, and subsystems. Laboratories and equipment in this facility provide the capability for design, fabrication, characterization, evaluation, and research of new optical materials; and fabrication and characterization techniques and instrumentation. Specific areas of research include laser devices, laser interaction with matter, and protection against laser radiation. Capabilities include optical design and fabrication, diamond turning,

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optical thin films, optical characterization, laser devices and effects, laser spectroscopy, and large optics. The integrated capabilities that exist in this facility allow, for example, the combination of surface finishing by diamond-single-point machining, reactive-sputtering coating, and precision measurement of surface finish and optical performance all in a single location.

RADAR CROSS-SECTION, HIGH POWER MICROWAVE MEASUREMENT, and GPS JAMMING FACILITIES: Junction Ranch is an outdoor research facility for radar-cross-section (RCS) testing, high-power microwave (HPM) measurements, and Global Positioning System (GPS) jamming tests. The 168-square-kilometer (65-square-mile) facility offers excellent air and ground security because of its isolated location, rugged terrain, restricted airspace, and controlled borders and ground space. Precision RCS measurements are performed at two adjacent facilities: the Bounce Strip Range and the Look-Down Range. The Bounce Strip Range operates in the HF, VHF, UHF, L, S, C, X, W, Ku, and Ka bands. The range features a 12-meter (40-foot), low-backscatter stationary pylon that can hold targets weighing up to 2.7 metric tons (6,000 pounds). The pylon can be located at the 213-meter (700-foot) pit for low-frequency tests, the 1,219-meter (4,000-foot) pit for high-frequency tests, or the 610-meter (2,000-foot) pit for a combination of both tests. At the Look-Down Range, the radar looks down on the target from a range of 5181 meters (17,000 feet) and an angle of 10 degrees. Two special-purpose target test beds make this facility unique. The wet site, a 24 by 30 meter (78 by 100 foot) pond, creates a simulated sea environment used to investigate background clutter and target-to-surface interactions. The tilt deck is a 24 by 43 meter (80 by 140 foot) hydraulically-controlled platform enabling target presentations of 5 to 32 degrees in elevation. Each site has a 9 meter-diameter (30 foot-diameter) turntable capable of holding targets up to 4.5 metric tons (10,000 pounds) and rotating targets 360 degrees to expose all aspects to the radar. Junction Ranch was selected for HPM and GPS testing because of its remote, shielded location, superb technical capability, and low RF/EMI background. The facility provides the instrumentation suite, test coordination, targets, facilities, and support functions ranging from frequency allocations to construction of low observable support structures capable of handling full-scale aircraft or ground vehicles. Frequency range coverage is 30 Mhz to 18 Ghz with a spot frequency at 34 Mhz to 36 Mhz.

INFORMATION & ELECTRONIC WARFARE (I&EW) SYSTEMS LABORATORIES: The various NAWCWPNS I&EW systems laboratories provide life-cycle support for airborne EW systems, including warning receiver, jammer, EO/IR, missile-warning, countermeasures, and support systems; software support for the EA-6B aircraft as well as for prime multi-platform EW systems; and system engineering support, including system design and integration, development of information systems, and fleet system software upgrades for warning, jamming, and decoy systems.

The Electronic Combat Simulation and Evaluation Laboratory (ECSEL) is the Navy's principal laboratory complex for research, development, and in-service engineering of naval airborne electronic-warfare (EW) equipment. This modern, secure facility develops, operates, and maintains simulations that replicate the functional characteristics and performance of threat weapon systems. The ECSEL's Advanced Multiple Environment Simulator family of open-loop simulations provides a dense electromagnetic environment of land-based, naval, and airborne threat weapon systems. Frequency coverage is from 100 kHz to 96 GHz. Specific closed-loop simulators include a current threat surface-to-air missile system, the Radar Equipment Simulator, the Semiactive Test System, and the Early Warning/Acquisition system. EW systems workstations provide prime power, avionics, computer, and simulator interfaces for naval aircraft radar-warning receivers and jammers. Research and development testing of developmental EW equipment, software support for currently fielded systems, integration support, and techniques development and optimization are routinely performed in the ECSEL.

The Electronic Warfare Integration Laboratory (EWIL) provides complete end-to-end test and integration of avionics, weapons, and electronic-warfare (EW) suites aboard tactical aircraft. The facility employs the Multiple Agile Radar Threat Simulator (MARTS) and the Modular Advanced Radar Simulator (MARS) workstations, and consists of several EW laboratories integrated in one building. The Multiple Target RF Environment covers the range from 600 MHz to 18 GHz with up to 112 simultaneous emitters and 14 pulse Doppler radar simulators in a single anechoic chamber. The EW Suite Integration Laboratory contains powered, spread benches for radar warning receivers, self-protection jammers, antiradiation missile (ARM) seekers (and their associated command-launch computer), and simulated

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aircraft mission computers. The Antiradiation Seeker Development Laboratory utilizes both the Multiple Target RF Environment and the ARM system development environment. The Radar Warning Receiver Development Laboratory utilizes the Multiple Target RF Environment and the radar warning receiver system development environment. Remote terminals attached to the EW and avionics MUX bus can be fully monitored for operational flight program (OFP) development, integration, and test. The laboratory includes a data-reduction facility for flight-test data as well as data-analysis workstations. Data-reduction packages include cockpit video, digital display reproduction, and digital flight and engineering data (provided on a compact disk or other media). Software verification and validation for OFPs under development are performed on a DEC Alpha VAX system in Ada.

ELECTRONIC COMBAT RANGE CAPABILTIES: The ECR is a free-space (open-air) test range for aircraft and airborne systems and techniques designed to sense, counter, or penetrate threat air-defense systems. This is the only U.S. Department of Defense electronic-combat range with the ability to test against naval air-defense systems and combinations of land and naval systems (the littoral threat) either individually or as part of an integrated air-defense system. Operating on 2978 square kilometers (1150 square miles) of U.S. Navy land under 3108 square kilometers (1200 square miles) of unlimited-altitude restricted airspace, the ECR is a dedicated electronic-combat range. The Range is located in a region selected for its remoteness and relative absence of population and offers high security with minimum electromagnetic interference. The ECR provides for unlimited use of expendables and decoys.

MISSILE & AIRCRAFT SOFTWARE VALIDATION & TESTING LABORATORIES: Laboratories are available to support independent software verification, validation and performance testing.

WEAPON SYSTEM INSTRUMENTATION & DATA ANALYSIS: These facilities support instrumentation requirements related to tactical missile, aircraft, and other product testing areas. The data analysis laboratories provide near-real-time data extraction and valuation for timely assessment of aircraft/weapon integration and missile system performance.

AIRFIELDS: Airfields at China Lake, Point Mugu, and San Nicolas Island provide comprehensive flight services for NAWCWPNS customers. These airfields can support all types of tactical and logistical aircraft (including C-5s and 747s) and offer a full range of airfield operational capabilities and related facilities for support of research, development, test, and evaluation projects. Operational capabilities include Tactical Air Navigation (TACAN), instrument landing system (ILS) navigational aids (Point Mugu only), approach control (Point Mugu only) and control tower operations, 24-hour crash crew response, and emergency aircraft arresting gear (E-28) on all runways. Aircraft support includes aircraft intermediate maintenance facilities (China Lake and Point Mugu only), aviation supply facilities (China Lake and Point Mugu only), aviation ready fuel storage, and ground support equipment. Customs and agriculture inspections for aircraft arriving from overseas are available at China Lake and Point Mugu with prior coordination. At China Lake and Point Mugu, spaces for operating detachments are available (limited spaces for operating detachments are available at San Nicolas Island) as are first-class galleys. Limited transient quarters are available at all three airfields.

LAND RANGES: The Land Ranges are composed of multiple air and ground test ranges, specialized test areas, ordnance test facilities, and control and support facilities. The Land Ranges support test and evaluation for air and ground conventional weapons, aircraft systems, air-to-air and air-to-surface missiles, rockets, bombs, cluster munitions, cruise missiles, unmanned air vehicles, guns and artillery, fuzes and sensors, mass detonation, training and tactics development, and parachute systems. Instrumentation includes photo-optic systems; telemetry receiving and display; radar, video, laser, and global positioning tracking; meteorological data; and communications systems. A Range Control Center provides consolidated command, control, and coordination of test operations. Targets from simple billboards to full-scale aerial targets are available, including the largest array in the U.S. of "shootable" targets for antiradiation missile testing. Land within an 80-kilometer (50-mile) radius is in the public domain, and airspace over the ranges is restricted from surface to infinity, providing safe and secure air and ground range operational areas. A comprehensive land-use management plan will enable customers performing routine testing on the Land Ranges to use the existing base-wide environmental impact statement as a basis for meeting environmental analysis and documentation requirements, thereby saving

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the customer time and money. Two specialized range areas are the Coso Military Target Range and the Superior Valley Tactical Training Range. Coso Range covers 181 square kilometers (70 square miles) of rough, mountainous terrain that represents a typical wilderness combat environment and presents pilots with unexpected, realistic conditions that are not duplicated at other aircraft test ranges. Coso Range is ideal for aircrew training, weapons delivery techniques and tactics, and detecting and acquiring partly hidden or camouflaged military targets. Targets at Coso Range include a railroad, bridges, radars, tunnels, truck convoys, tanks, and a revetted surface-to-air missile site. Superior Valley is a 91-square-kilometer (35-square-mile) remote area used for aerial delivery of both conventional and nuclear training ordnance, test and evaluation of new and experimental systems, search-and-rescue training, helicopter mobile assaults, and insertion, fire fights, and extraction. Targets at Superior Valley include two bombing circles for light inert nuclear and conventional deliveries and high-angle strafe, two triangular targets for low-angle strafe, a simulated vehicle convoy, a simulated airfield complex with antiaircraft artillery and surface-to-air missile sites, and a 2438-meter (8000-foot) simulated runway, taxiway, and ramp with numerous aircraft targets.

SEA RANGE AND SAN NICOLAS ISLAND: The Sea Range off the coast of Point Mugu, California, is the United States' largest and most heavily instrumented sea/air range, encompassing more than 323,700 square kilometers (125,000 square miles) of instrumented test space and more than 123,000 square kilometers (36,000 square nautical miles) of controlled airspace. With the cooperation of other U.S. Government agencies, available test space can be expanded to more than 507,000 square kilometers (196,000 square miles). Instrumentation includes radar; photo-optics; video; surveillance; telemetry; communications; command, control, and destruct; and data processing and display. Meteorological and oceanographic data are also provided. Ground-based coverage is augmented by airborne instrumentation, including multibeam telemetry; multilateration tracking; surveillance; command, control, and destruct; range safety; long-range optics; and communications. Surface craft are provided for placing and recovering surface targets. The coastal region and offshore islands support true at-sea and littoral scenarios. San Nicolas Island (SNI), located 97 kilometers (60 miles) southwest of Point Mugu, is instrumented with metric tracking, telemetry, and communications equipment and has a 3048-meter (10,000-foot) runway; with its isolated environment and shoreline characteristics, SNI is ideal for providing littoral warfare training, including theater warfare exercises. SNI has the capability to launch subscale and unmanned full-scale targets, has launch sites for surface-launched weapons, and also has an impact area for weapons launched from aircraft or ships. An extensive array of aerial and surface targets are available at the Sea Range, including full-scale unmanned aircraft. Up to 20 targets can be engaged simultaneously, with associated metric track, telemetry, and precision scoring. Electronic warfare environments are provided by manned aircraft, unmanned aerial targets, and surface (land and sea) assets including simulations of surface and airborne electronic countermeasures threats, surveillance and targeting radars, and antiship missile seekers. Cruise missiles can be launched from the Sea Range and flown via the military instrument route known as IR-200 to ranges in California, Nevada, or Utah, more than 1600 kilometers (1000 miles) away. Some of the testing capabilities unique to the Sea Range are complex, multiparticipant, multiple-warfare-area, multinational operations; coordinated air, surface, and submarine operations; submarine-, surface-, and air-launched cruise weapons testing; long-range, large-hazard-pattern weapons testing; simulated regional conflict operations; multiple-participant live-fire exercises; and support for ballistic missile and polar satellite launches from Vandenberg Air Force Base in California. Multiple theater missile defense scenarios can be supported by the Sea Range.

NATIONAL PARACHUTE TEST RANGE: The National Parachute Test Range provides a broad spectrum of resources and capabilities for parachute testing. These include parachute fabricat ion, airborne and ground-based instrumentation, sled track operations, aircraft, live jumpers, water test areas, explosive operations, and paraloft facilities. Projects that have been tested at the National Parachute Test Range include the U.S. Naval Aircrew Common Ejection Seat (NACES), Thin Pack bailout parachute, egress system for the U.S. Space Shuttle, and components of the Mars Pathfinder.

NAVAL TEST WING PACIFIC (NTWP): The NTWP provides aircraft, project flight-test aircrews, flight-test planning, and flight-clearance management for aircraft modification to support weapons and weapon-systems development, test and evaluation, and training missions. These services can be deployed worldwide. Two Weapons Test Squadrons make up the NTWP, one at Point Mugu and one at China Lake. Both squadrons can modify test aircraft to meet project requirements and thus can

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accommodate a wide variety of weapons and weapon systems in the test and training environments. Aircraft assets include the AH-1W Cobra attack helicopter (2), AV-8B and TAV-8B Harrier (6), F-14 Tomcat (7), F/A-18 Hornet (16), HH-1N Iroquois helicopter (3), NP-3D Orion (5), QF-4N/S Phantom II (12), SA-227 Metroliner (4), T-39 Sabreliner (1), DC-130 target launch aircraft (3), and a variety of contract aircraft for logistic-support services.

OTHER SPECIAL CAPABILITIES: Specialized facilities are used for electronics research leading to complete life-cycle support of fire-control systems, guidance-and-control systems for missile weaponry, sensors, and fuzes. In addition, NAWCWPNS has unique capabilities provided by its EO/IR laboratories, RF anechoic chambers, strategic-systems propulsion test facilities, complete photographic laboratory,
and a large industrial machine shop used for weapons system engineering prototyping.

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FY1999 FUNDING DATA (MILLIONS $)*				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.200	N/A	0.000	1.200
6.1 Other	4.086	N/A	0.755	4.841
6.2	30.789	N/A	30.101	60.890
6.3	34.794	N/A	24.404	59.198
Subtotal (S&T)	**70.869**	**N/A**	**55.260**	**126.129**
6.4	80.384	N/A	30.107	110.491
6.5	128.168	N/A	120.632	248.800
6.6	265.408	N/A	105.154	370.562
6.7	136.023	N/A	77.505	213.528
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**680.852**	**N/A**	**388.658**	**1069.510**
Procurement	404.731	N/A	436.132	840.863
Operations & Maintenance	355.806	N/A	204.265	560.071
Other	294.927	N/A	148.361	443.288
TOTAL FUNDING	**1736.316**	**N/A**	**1177.416**	**2913.732**

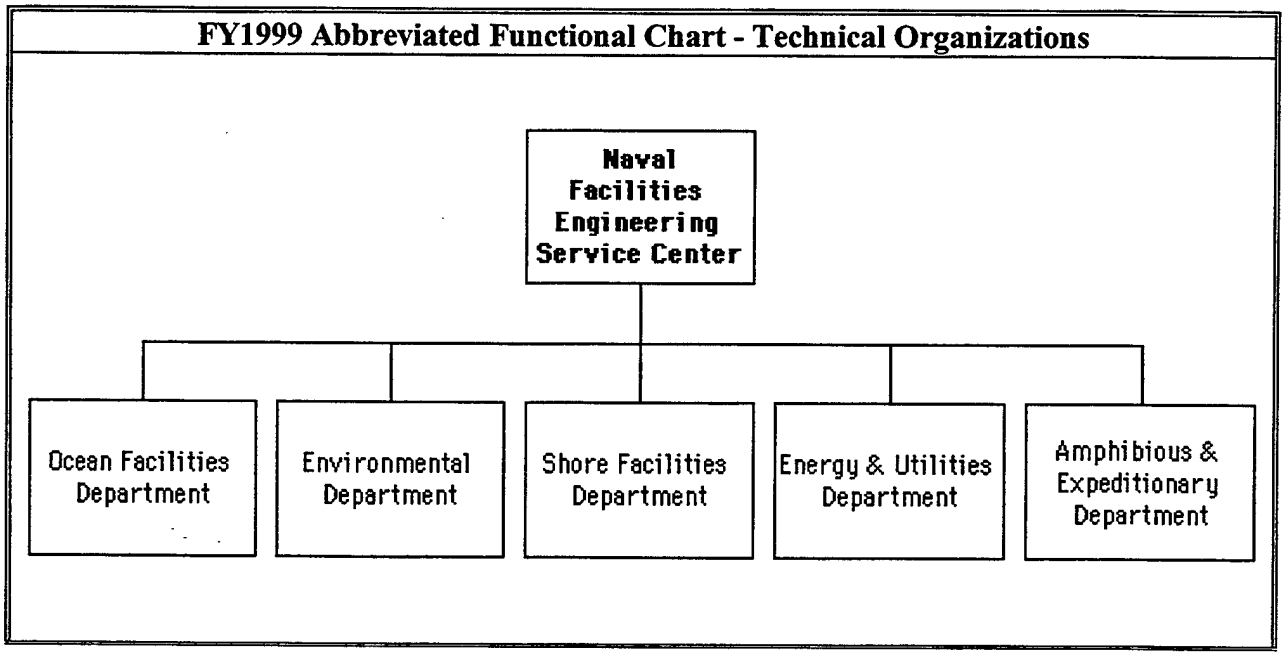
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.069

PERSONNEL DATA (END OF FISCAL YEAR 1999)*				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	4	163	1738	**1905**
CIVILIAN	207	3845	5111	**9163**
TOTAL	**211**	**4008**	**6849**	**11068**

SPACE AND PROPERTY*			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	7097.398	**REAL PROPERTY**	1401.238
ADMIN	1079.069	* NEW CAPITAL EQUIPMENT	62.801
OTHER	6890.514	**EQUIPMENT**	663.104
TOTAL	**15066.981**	* NEW SCIENTIFIC & ENG. EQUIP.	55.668
ACRES	**1140073**	* Subset of previous category.	

**As a result of applying the In-House RDT&E Activity criteria at the division or major site level (see NOTE on page 3-1), NAWC Training Systems Division and NAWC Aircraft Division Lakehurst Activity data is not included in the FY1999 report. The additional business base contributed by these two activities is $1.01B for Training Systems Division and $0.46B for Lakehurst*

Naval Facilities Engineering Services Center



Naval Facilities Engineering Services Center
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Captain: Robert J. Westberg Jr.
Commander: Doug Boothe

MISSION

Delivers specialized facilities engineering and technology products and services in Shore, Ocean and Waterfront Facilities, Environment, Amphibious and Expeditionary Operations, Energy and Utilities. Provides solutions to problems through engineering, design, construction, consultation, test and evaluation, technology implementation, and management support.

CURRENT IMPORTANT PROGRAMS

Defense Environmental Restoration Program.
Pollution Prevention Equipment Program.
Navy Shore Facilities Improvement.
Advanced Fendering Program.
Deep Ocean Technology in support of ASW.
Marine Corps Amphibious Logistics.
Mobile Offshore Basing (MOBS).
Ocean Test Ranges.
Shallow Water Test Ranges.
Ocean Moorings for Acoustic Surveillance (Std Eiger II Program).
Marine Handling Systems for Low Frequency Active Acoustic Surveillance Systems.
Undersea Cable Burial and Survivability.
Explosives Safety.
Physical Security Systems.
DoD LOCKS Program.

EQUIPMENT/FACILITIES

Deep Ocean Simulation Laboratory. Shallow Water Dive Tank. Motor Vessel Independence. Advanced Waterfront Technology Test Site. Water Purification Laboratory. Electromagnetic Pulse Test Facility. Physical Security Test Facility. High temperature pavements stand.

Deep Ocean Simulation Laboratory - This is the largest facility of its kind on the West Coast. It contains 12 pressure vessels capable of simulating the deep ocean environment under controlled conditions. It is used for certifying fleet hardware and support technology validation and testing.

Shallow Water Dive Tank - A 30-ft diameter, 65,000 gallon seawater tank for testing oceanographic equipment, diver construction techniques, diver tools and underwater non-destructive technical (NDT) equipment.

Motor Vessel Independence - A 200-ft vessel outfitted to support ocean engineering research and undersea equipment validation testing. The Independence has an A-Frame well and crane system for installation and retrieval of underwater systems.

Research Support Vessel (RSV) - A 50-foot nearshore vessel outfitted to support diving operations and oceanographic equipment testing and operations.

EQUIPMENT/FACILITIES

Remotely Operated Underwater Vehicle (ROV) - A 2000 foot capable ROV system which includes a PHANTOM vehicle, control van, handling system and experienced operating crew. May be deployed from shore or onboard surface vessels.

Advanced Waterfront Technology Test Site (AWTTS) - A half-scale 160' foot test pier with removable deck sections for testing constructability and durability (under constant stress) of waterfront construction and repair materials and systems in a corrosive marine environment. Decks can be statically loaded up to 300,000 lbs. Embedded instrumentation facilitates monitoring performance of structural components. Supports testing programs for the USA CERL, USA WES, Composites Institute and the CERF.

Linear Cable Engine (LCE) - Cable deployment system for 8000 lbs. line pull at a maximum line speed of 500 ft/min.

High Temperature Pavements Test Facility - Controlled high temperature blast facility, which simulates the jet blast of an aircraft auxiliary power unit. Used to test concrete mixtures from the effects of blasts from F-18s, B-1s and AV-8Bs.

Cable Survivability Test Flume - 100-ft by 50-ft by 3-ft deep salt water tank provides survivability testing of full-sized seafloor cabling in a flowing water environment.

Seawater Test Facility - Test site for development, test and evaluation of seawater desalination equipment and expeditionary water treatment devices for production of potable water.

Battery Laboratory - This facility supports testing and evaluation of batteries for Deep Submergence Rescue Vehicles under simulated ocean conditions in conjunction with the pressure vessels of the Deep Ocean Simulation Laboratory. Large battery chargers, load banks, cell monitoring voltage scanners and electrolyte handling equipment are used to conduct tests on silver-zinc batteries for the Navy.

Flexor Test Stand - Computer controlled test rig capable of applying cyclical test loads of up to 300,000 lbs. for dynamic barge loading tests of Flexor Pontoon connectors.

Fiber Optics Laboratory - A 2000 sq. ft facility with temperature controlled cleanrooms for preparing glass optical fibers for precision optical measurements.

Geotechnical Modeling Test Facility - The only Navy facility for controlled testing involving dragging of implements through soils at metered rates for monitoring soil behavior. The facility is used for testing model anchors, site assessment tools, cable plows, and other implements for penetrating the seafloor.

Naval Facilities Engineering Services Center
Port Hueneme, CA 93043-4328
(805) 982-1393

Captain: Robert J. Westberg Jr.
Commander: Doug Boothe

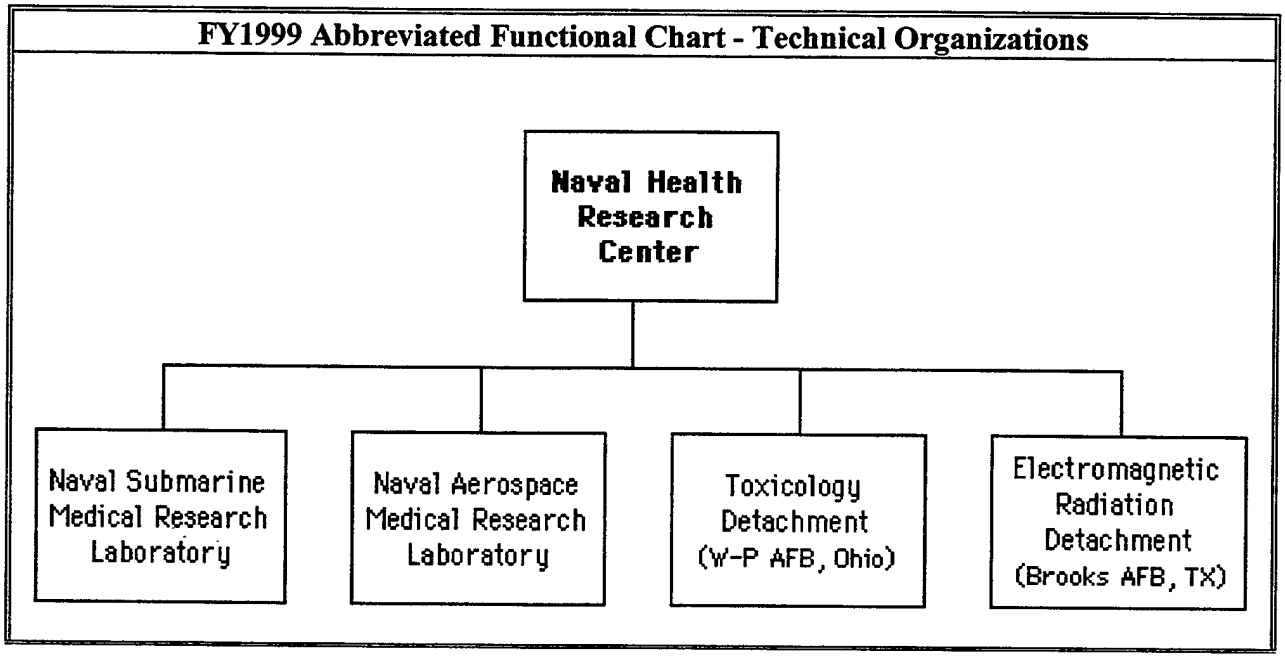
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	0.000	0.000
6.1 Other	0.000	N/A	0.000	0.000
6.2	1.482	N/A	1.708	3.190
6.3	2.265	N/A	2.647	4.912
Subtotal (S&T)	**3.747**	**N/A**	**4.355**	**8.102**
6.4	10.253	N/A	17.145	27.398
6.5	0.070	N/A	0.000	0.070
6.6	0.504	N/A	0.621	1.125
6.7	1.573	N/A	1.298	2.871
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**16.147**	**N/A**	**23.419**	**39.566**
Procurement	0.191	N/A	17.330	17.521
Operations & Maintenance	29.591	N/A	24.650	54.241
Other	23.346	N/A	21.868	45.214
TOTAL FUNDING	**69.275**	**N/A**	**87.267**	**156.542**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	0	0	9	**9**
CIVILIAN	19	310	199	**528**
TOTAL	**19**	**310**	**208**	**537**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	68.000	**REAL PROPERTY**	30.000
ADMIN	84.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	35.000	**EQUIPMENT**	8.700
TOTAL	**187.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**10**	* Subset of previous category.	

Naval Health Research Center



Naval Health Research Center
San Diego, CA 92186-5122
(619) 553-8400

CO: CAPT Thomas J. Contreras Jr.
Scientific Director: Dr Stephen Nice

MISSION

To protect the health, enhance the performance and readiness of our war fighters through focused biomedical research solutions in aviation, surface, submarine, fleet marine force and special warfare operations.

CURRENT IMPORTANT PROGRAMS

1. Naval Health Research Center (Laboratory)

The R&D mission at Naval Health Research Center (Laboratory) addresses three programmatic areas. For updated information on all NHRC programs, please visit the Programs/Publications section of our Homepage at: http://www.nhrc.navy.mil/.

Human Performance - The smaller force structure, coupled with constantly evolving mission and tactical requirements, makes it imperative that each war fighter be at peak operational readiness. This program focuses on optimizing Navy and Marine Corps operational performance through assessment of personnel performance and quantification of mission stressors that negatively influence mission success. The research includes controlled laboratory studies and studies in which researchers deploy to training locations. These research teams are widely recognized for excellence in conducting research meeting critical Fleet and Marine Corps requirements and insuring rapid technology transfer.

Environmental Extremes - With a worldwide theater of operations, Navy and Marine Corps personnel operate in environments that can substantially degrade performance. This research quantifies the effects of exposure to environmental stressors (e.g., heat, cold, -forces) and identifies, develops, and evaluates countermeasures to performance degradation. Marine Corps and Naval Special Warfare (SEAL) cold weather operations are a core area of research.

Special Operations - Recognizing the unique requirements of Naval Special Warfare and Marine Corps Special Operations Capable personnel, this program focuses on effectively enhancing mission performance under the most arduous of operational conditions. The program is strongly user oriented, with special operations personnel involved extensively in all steps of the research process.

Protective Equipment Evaluation - Protective equipment designed to safeguard personnel in hazardous environments often places substantial physiological strain on the individual. Understanding the complex interaction of protection from the environment and the resulting impact on physiology and performance is critical to developing interventions that enhance personnel safety and operational capability.

Physical Readiness Standards - This program established the Navy's physical readiness and body fat standards. While work has continued in this area, it has expanded to encompass occupation specific, gender neutral standards that focus on enhanced operational readiness for Navy and Marine Corps personnel.

Occupational and Exercise-related Injuries - These injuries have a substantial negative impact on manpower availability, cost, and combat readiness. The research focuses on identifying prevalent risk factors for musculoskeletal injury, evaluating the efficacy of rehabilitation modalities, and injury prevention. A new area of investigation incorporates cutting-edge technologies using tissue metabolism markers to predict those at increased risk of injury, thus enhancing personnel safety and reducing the burden on the medical care system.

CURRENT IMPORTANT PROGRAMS

Medical Decision Support - Systems are developed that integrate information from multiple sources to generate indices and displays for reducing information overload and facilitating rapid responses during crises.

Occupational Health Management - Methods are developed to provide occupational safety and health managers improved capability to plan and execute environmental inspections, better identify high risk conditions, and project the cost of occupational illness and injury.

Theater Medical Information - Systems are designed to capture medical information in an operational theater, compile the information needed to support the continuity of care, project the impact on medical resources, and improve medical situational awareness.

Telemedicine - Information is gathered and analyzed to assess the impact of telecommunication technology on clinical care and medical readiness in remote operational environments.

Medical Readiness Modeling and Simulation - Models and simulations are developed to project patient load in deployed operational environments, to manage the handling of casualties, and to estimate the impact on medical resources.

Operator State Modeling - Psychophysiological (e.g., electroencephalographic, eye tracking) and behavioral data are used to model states of drowsiness and cognitive overload in order to develop real-time cognitive monitoring technologies. These technologies are central to human performance optimization.

Interpersonal Violence - Data related to victimization and perpetration of aggression are collected to develop treatment, prevention, and intervention programs associated with health-care utilization.

Shipboard Health Studies - Survey data are provided by men and women serving aboard ship. Shipboard Medical Departments provided information regarding sick call visits, availability of supplies, pregnancy rates; reproductive health; stress; lifestyle factors; self-reported occupational exposures; and self-reported health conditions. These programs provide decision support for shipboard health care policy.

Persian Gulf War Unexplained Illness - Currently, 7 research studies of Gulf War veterans and their families are being conducted in the areas of hospitalizations, symptoms, exposures, physical performance, infertility, and pregnancy outcomes. The Assistant Secretary of Defense (Health Affairs) has designated NHRC as the Center for Deployment Health Research.

Global Surveillance for Emerging Illnesses - As the U.S. Navy Node of the DoD Global Surveillance and Response Program for Emerging Illnesses, NHRC is conducting epidemiologic studies of a number of pathogens which cause emerging illnesses. Active surveillance currently includes studies of the epidemiology of Streptococcus pyogenes, Streptococcus pneumoniae, Mycoplasma pneumoniae, Chlamydia pneumoniae, Bordella pertussis, adenovirus, and Ureaplasma urealyticum.

Respiratory Disease Epidemiology - This research area focuses on the epidemiology of respiratory disease in military populations, particularly in populations of trainees with a high aggregation of susceptible individuals.

Health Promotion - Addresses the Navy's need to reduce health risks and associated health care costs. Current work focuses on the effectiveness of interventions for weight management, smoking cessation, and alcohol abuse rehabilitation.

Suicide and Mental Illness - NHRC maintains a casualty record database for Navy and Marine Corps suicides since 1983. The primary objective of this research area is to provide epidemiologic information relevant to prevention programs that are targeted to military populations. Efforts are currently focused on evaluating alternative methods to document suicide information.

CURRENT IMPORTANT PROGRAMS

Musculoskeletal Overuse Injury Prevention Research - Goals: 1) determination of the operational, fiscal, and personal impact of musculoskeletal injury in training and operational forces; 2) development of predictive profiles for injury susceptibility; and 3) development, implementation and evaluation of interventions to reduce the incidence and negative impact of these injuries.

Alcohol Misuse Prevention Research - Goals: 1) develop a cognitive-behavioral intervention program to reduce heavy drinking among junior Marine Corps personnel and promote responsible attitudes toward alcohol use, with a particular emphasis on behavior during deployments; 2) develop complementary training programs for senior enlisted and officers aimed at deglamourizing alcohol use; and 3) measure the effectiveness of intervention programs using hard outcome measures, as well attitudes and behavioral intentions.

Sexually Transmitted Disease and Unplanned Pregnancy Prevention Research - Develop cognitive skills building interventions to reduce the high-risk behaviors associated with STD acquisition and unplanned pregnancy in operational military populations. This research area includes a program in HIV which is defining the epidemiology of HIV in military populations and includes molecular subtyping of HIV strains to pinpoint likely locations of acquisition of HIV infection.

Epidemiologic Research Database Development - The primary resource for hospitalization studies is the Career History Archival Medical and Personnel System (CHAMPS) Research Database which is a computerized medical (inpatient events) and career history database that provides extensive information for Naval epidemiologic occupational health research. This longitudinal database includes information for Navy enlisted personnel dating back to 1973 and is currently being expanded to include Navy officer and Marine Corps personnel.

2. Naval Aerospace Medical Research Laboratory (NAMRL)

Enhanced Hearing Protection for High-noise Environments: Current hearing protection devices can be inadequate in high-noise operational environments. We have developed and patented a new sound-attenuating technology that significantly improves hearing protection devices and sound attenuation in general. We are determining optimal engineering parameters for the new technology, applying them to hearing protectors and sound-attenuating materials, providing prototype models for formal test and evaluation, and developing design specifications for eventual manufacture.

Naval Aviation Pilot Prediction System: This project is: (1) centralizing existing training and mishap data for naval aviators from accession through winging and beyond; (2) determining the feasibility of using training and fleet-performance criteria to identify marginal performers; (3) developing predictive models for selection, classification, and review/mishap board analysis; and (4) developing a networked system for accessing the database and associated predictive models.

Spatial Awareness in Naval Aviation: We are developing tactile navigation and orientation displays that enhance spatial awareness and reduce operator workload. We have developed displays that pilots and special forces personnel can use to navigate and maintain situational and spatial awareness in the absence of visual information.

Naval Aviation Selection Tools Development: We have developed an Internet version of the Aviation Selection Test Battery (ASTB) that will improve the Navy/Marine Corps aviator selection process by reducing test administration and maintenance costs, enhancing test security, and providing new opportunities to develop and validate better test items. The paper-and-pencil ASTB is taken by approximately 10,000 examinees annually at over 200 remote sites around the world. This volume of remote testing makes the ASTB an ideal candidate for implementing in a client/server format.

Landing Craft Air Cushion (LCAC) Vehicle Navigator Selection System: In the late 1980s, LCAC operators and engineers had training attrition rates as high as 40-60%. Consequently, the Naval Safety Center asked us to develop a selection system to reduce this rate. With funding from the Naval Air Systems Command, the revised LCAC selection system was delivered in 1992, and attrition rates dropped to 10-20%. Similar attrition problems among LCAC navigators led to an additional tasking to

CURRENT IMPORTANT PROGRAMS

develop a selection system for this position. A task analysis was completed, and a selection system was developed and validated. Preliminary screening began in May 1996. The final system is in development; a full product will be delivered in October 1998.

Attention-Directing Flight Instrument Display: All current flight instrument displays require pilots to scan instruments, one after another, and mentally integrate the data to produce flight path information. We have developed a new technique that integrates flight information in a single display, thus permitting pilots to understand their positions in flight at a glance. The new display reduces time spent on instruments to approximately 15% of that required with traditional displays and almost eliminates routine scanning.

Unmanned Aerial Vehicle (UAV) Human Factors: The objective of this project is to characterize the cognitive skills needed to pilot UAVs, and to evaluate human-factors design and interface issues in UAV control systems, panels, and displays.

Night Vision for Special Warfare: We are developing a field-worthy, operationally relevant night vision test that (1) has known and definable relations to tests in the optometric literature and (2) is predictive of operational performance under a variety of nighttime conditions.

Spatial Orientation Design and Training Issues: This project is aimed at improving cockpit design standards by defining relations between control compatibility, pilot spatial awareness, and pilot performance, as well as enhancing pilot performance by developing training programs that incorporate accurate models of sensory-spatial awareness.

Approaches to Spatial Disorientation: Our task is to develop basic knowledge and models of systems involved in the control of whole-body motion relative to the earth. Current models are insufficient to predict the perceptual and sensorimotor reactions that occur in complex motion conditions. The ultimate objective is to develop mathematical models that will predict spatial orientation dynamics in complex environments of flight simulators and real flight.

Sopite Syndrome: The term Sopite Syndrome was coined to describe the extreme fatigue and drowsiness that can occur in motion and virtual environments. The project entails characterizing basic neurophysiological and behavioral effects of the syndrome, developing fleet recommendations and guidelines, and relating the syndrome to similar maladies, such as Simulator Sickness and Space Adaptation Syndrome.

Marine Corps Field Casualty Monitoring/Tracking Support: We are developing a flexible, user-friendly, information-management system for real-time correlation of tactical operation, patients, and echelons 1 through 4 evacuation and treatment resources. The system should improve medial regulating significantly on battlefields of the future.

Health Risk Appraisal of Naval Special Forces Personnel: The Department of the Navy lacks baseline epidemiological and health data needed to adequately assess and track the health status of naval Special Operations Forces (SOF) personnel. In this project, we are gathering baseline health and health risk factor data on active duty, reserve, and retired naval SOF personnel.

Performance-Based Occupational Strength Testing for Candidate Navy Pilots/Naval Flight Officers: Goals of this project are threefold: (1) to identify selected strength-critical tasks in the Joint Primary Aircraft Trainer System (JPATS), (2) to replicate those tasks on a strength-screening device, and (3) to develop strength-enhancement programs that will enable individuals to meet or exceed the strength standards (control force requirements) specified in the JPATS MIL-SPECs.

Acoustical Composites: The acoustical composites research at NAMRL has transferred material formulas and hearing protector prototypes to two private sector manufacturers for production and sale. Three projects address the following research issues: (1) the application of the Navy's technology to large surface areas (i.e., sheets); (2) the investigation of the possible application of the technology to weight-bearing structural composites and basic research into parameters germane to the technology (in

CURRENT IMPORTANT PROGRAMS

collaboration with Florida A&M/Florida State Universities College of Engineering); and (3) the field testing of initial sheet samples in a stateroom aboard an aircraft carrier (in collaboration with NAVSEA).

Digital Anthropometric Video-Imaging Device (DAVID): Anthropometric screening is important in military aviation due to the restrictive environments found in many of the airframes. We are developing a digital anthropometric video-imaging device (DAVID) to replace the current manual technique used to selectively screen naval aviation candidates. Electronic images will be transmitted from remote sites to a central location for processing, analysis, and storage. Stored files will be available for mishap investigations, quality control, additional measurements, other software applications, or any other reason review of a file is required.

Medical, Aptitude, and Personality Determinants of Isoperformance Curves and Their Impact on Naval Aviation Selection: Selection, attrition, and retention have always been concerns for decision makers who must struggle with manpower issues such as pilot training requirements in naval aviation. The approach used here is aimed at determining whether tradeoffs exist among medical, personality, and aptitude selection variables that might be used to reduce costs and improve selection, training, and fleet performance in naval aviation. As an example of an isoperformance tradeoff, one might ask if it is possible to trade lower visual acuity scores for higher aptitude test scores in such a way that overall success probabilities in flight training remain the same. The feasibility of such an approach will be assessed by determining, in the first place, the existence of candidate characteristics that permit such tradeoffs and, secondly, by creating quantitative methods of calculating tradeoffs among multiple determinants at a given probability of passing a given training phase.

Motion Adaptation Syndrome (MAS)-Gastrointestinal Aspects: The objective of this program is to examine gastric myoelectrical correlates of the deleterious effects of motion. The significance is that if gastric myoelectrical activity correlates with nausea during provocative motion, we can readily develop methods to enhance normal, 3 cycle per minute (cpm) and prevent 4-9 cpm activity. For example, evidence indicates that eating certain foods such as carbohydrates, or taking certain motility drugs may serve to minimize motion-induced nausea by increasing 3 cpm and decreasing 4-9 cpm gastric myoelectrical activity. Laboratory work is underway in which gastric myoelectrical activity is recorded prior to exposure to a provocative motion environment-specifically off-vertical rotation. Maximum exposure times and motion sickness and nausea symptoms are recorded during the course of stimulation. The correlation of gastric myoelectrical activity with nausea is then examined.

3. Naval Submarine Medical Research Laboratory (NSMRL)

Submarine Escape and Rescue: This program develops and evaluates equipment and guidance designed to maximize crew survival in submarine disasters. Projects include active and passive carbon dioxide scrubbing techniques, guidance and decision aids for submarine survivors, biomedical evaluation of planned submarine escape equipment and systems, and oxygen re-breathing devices.

Human Factors Assessment of the Submarine Rescue System-Hyperbaric Oxygen Treatment Pack: NSMRL is tasked by Navy Sea Systems Command to test and evaluate prototype closed-circuit hyperbaric oxygen treatment breathing apparatus units. The purpose of the breathing units is to produce an efficient means of utilizing hyperbaric oxygen that will reduce the amount of supplies oxygen required for the treatment cycle. Individuals undergoing recompression treatment after a submarine rescue will wear the units.

Low Frequency Active Sonar: Tactical use of low frequency active sonar (LFA) may result in unintentional exposure (ensonification) to recreational divers. This study assesses diver aversion and panic reaction to elements of the LFA signal to create an exposure guidance and provide input to an environmental impact statement. Current focus is on developing and executing a monitoring and mitigation program.

CURRENT IMPORTANT PROGRAMS

Submarine Atmospheres Health Assessment Program (SAHAP): The health and performance of submarine crews can be adversely affected by contamination with chemicals and respirable suspended particles (RSP). The goal of this project is to determine the effectiveness of contaminant control procedures by measuring concentrations of trace chemicals with novel passive diffusing monitors.

Environmental Adaptability Screening for Submarine Service (SUBSCREEN): NSMRL developed and implemented psychological and motivational screening for prospective Navy submarine School students. Research related to this project includes reliability, validity of the screening, and outcome measures. One current project is determining the predictive capability of both SUBSCREEN and a clinical inventory to identify individuals who will later be disqualified from the submarine force for a personality disorder. The goal is to provide the recruiters with additional aids to evaluate prospective recruits.

Mortality of US Navy Nuclear Submarines Serving from 1969-1982: Mortality causes and rates were studied in a cohort of over 76,000 submarines who served on nuclear submarines between 1969 and 1982. In the first phase of the study, ending in the 1980s, mortality was very low compared to the general male population and the cohort was still quite young. As 15 years have now passed, the same cohort is being studied once again to determine if mortality rates for specific causes are affected by prior exposure to the submarine environment. Project completion is expected by April 2000.

Noise Reduction Stethoscope: This project evaluates commercial off-the shelf (COTS) compact noise-reducing stethoscopes for military use, in moderately noisy environments (up to 90 dB SPL). Based upon laboratory study and field analyses, recommendations are being prepared for two COTS devices for immediate military use below 95 dB SPL. For one of the selected COTS devices, the detection advantage over a conventional stethoscope for abnormal visceral sounds is 17 dB for breath sounds and 12 dB for heart sounds.

Predicting the Detectability of Auditory Signals: This project will help the Navy estimate detection ranges for sounds emitted from submarines by modeling the human auditory capability for detecting simple and complex transient signals under conditions of low and high uncertainty. An automated algorithm that uses available data to better predict the probability of detection due to combined visual and aural monitoring would highlight the self-generated noises that pose the greatest threat of counter detection.

Evoked Otoacoustic Emissions (EOAEs) & Inner-Ear Damage from Navy Occupational Noise Exposure: This project determines what role EOAEs should play in hearing conversation programs. The project determines whether EOAEs can be a more sensitive measure of noise-induced auditory damage than pure-tone audiograms and to what extent EOAEs can be used to predict and prevent pure-tone audiometric changes.

Spatialized Audio as a Human-System Interface: This project designs and evaluate efficient adaptive signal processing techniques for customizing spatialized auditory displays. Such displays can be used in combat and training systems. It assesses the benefits of spatialized displays for improving the detection and identification of acoustic signals. (i.e., sonar and communications).

Underwater Sound Hazards for Divers: This project is focused on permissible underwater sound exposure guidance for Navy diving environments, the design and development of portable underwater sound measurements suitable for assessing noise exposure in Navy diving environments, and development of sound protective systems for divers.

Vibration Bioeffects of Low Frequency Sound on Divers: This project investigates the bioeffects of low frequency sound on divers. The goal is to determine the vibration response of the skull, measure the vibration in body structures and measure the psychological impact and effects on diver performance.

Improved Alerting and Attention Management Methods: The overall objective of this research is to design an attention allocation system that provides necessary prompting cues when critical information changes occur in a display.

CURRENT IMPORTANT PROGRAMS

Information Requirements in Submarine Combat Systems: Although computers can handle vast amounts of information, they may not prioritize information effectively in a particular real world situation or keep pace with changes in the situation. The information that submarine conning officers consider to be the most important for decision making is being studied to improve the design and usability of software and displays used aboard submarines.

Spatial Thinking Ability for Submarine Personnel: Improvements in visual displays have partially relieved the cognitive demand on the submariner in maintaining a mental representation of the world outside his own ship; however, the ability for an individual to create and maintain a mental representation of the surrounding world is still vital in the submarine environment. This program attempts to identify specific mental abilities involved in faster, more accurate decisions in submarine operations and explores methods to train these basic mental abilities.

4. Naval Health Research Center Detachment Brooks AFB (EMRDET)

Effects of Microwave Radiation on Cognitive Performance: The purpose of this project is to utilize a primate behavioral test battery to evaluate performance in monkeys exposed to microwave radiation. Dosimetry using a computer based monkey model is used to predict the influence of complex tissue composition on the development of hotspots during whole-body and partial-body exposure to microwaves. Dosimetry experiments validate the computer model using a homogeneous model and rhesus monkey cadaver. Experiments are planned to comprehensively investigate the whole-body and partial-body exposure effects of microwave radiation on complex monkey cognitive performance at many microwave frequencies. In doing so, issues concerning the interaction of cognitive performance tasks with radiation frequency, whole-body and partial-body specific absorption rate (SAR), pulsed microwaves, and duration of exposure will be investigated.

Chronic Exposure to Radiofrequency induced body currents in the non-human primate: On air capable ships, aircraft are stationed near high frequency (HF) antennas radiating in the 3-30 MHz frequency range. Recent studies have shown that HF currents are induced in flight deck personnel making contact with aircraft while loading ordinance or preparing for catapult launch. Contact with aircraft under operational conditions near HF antennas can produce a daily intermittent HF current flow in the human body as well as chronic exposure over the months of a typical aircraft carrier deployment. The primary objective of this 3-year study is to evaluate the effects of chronic exposure of the non-human primate to radio frequency fields that induce strong HF currents in the wrists and arms. Specifically, we will determine dose-response characteristics of tissue damage, grip strength, and manual dexterity during chronic HF exposure of the non-human primate to radio frequency radiation in the range of 100-200 MHz.

Millimeter Wave Absorption in the Non-human Primate Eye: The objective of this three year study is to determine contrast sensitivity functions of the monkey visual system and evaluate physical damage to the cornea and lens of the non-human primate eye exposed to millimeter wave nonionizing radiation. This study investigates the effect of repeated exposures at power densities allowed by the current safety standards including time averaged power densities. Frequencies in the range 35 GHz to 94 GHz that are continuous wave (CW) and pulsed (PW) are evaluated. Psychophysical, observational and histological techniques are used to evaluate both functional and structural changes in the cornea and lens.

Radio frequency Dosimetry of the Primate Wrist for Navy Relevant Exposure Configurations: This project is successfully providing empirical evidence to show that recently promulgated limits on RF body-to-ground and contact currents are overly conservative and unnecessarily restrictive relative to typical Navy exposure situations. As a follow-on project to our earlier study that examined RF-induced heating in the primate ankle, this project has corroborated our earlier results in showing that localized specific absorption rate (SAR)in body extremities is much less than theoretical predictions that were based on relatively crude computer models. Those predicted SARs obtained more than ten years ago, have been used to set present DOD radio frequency exposure regulations; unfortunately, they were never empirically verified until our studies with non-human primates were started.

CURRENT IMPORTANT PROGRAMS

Assessment of Radiofrequency Energy Absorption in Navy Personnel During At-Sea Flight Operations: This project uses a simulated aircraft carrier deck irradiation system in order to produce a detailed picture of the total amount and spatial pattern of RF-induced heating in Navy personnel who are irradiated during air operations at sea. The Navy's patented RF dosimetry system is used in conjunction with our intact F/A-18A airframe and a commonly used to pinpoint RF-induced "hotspots" on the surface of full-sized human models for realistic exposure situations that exist during actual at-sea flight operations.

Prediction of Laser Bioeffects Threats on the Battlefield: This program quantifies the threat from man-portable laser system on naval aviation missions (MNS from the Naval Strike and Air Warfare Center (NSAWC) dtd 06JUL98). The program developed field data collection methodologies for multiple aviation platforms and conditions (daytime, nighttime and multiple mission profiles) for laser targeting on naval flight ranges. The methodology was used to quantify hand-held laser accuracy in acquiring aviation targets. This program generated computer models for the real-time probability of aircraft detection, illumination and bio-effects to be used for mission rehearsal and planning systems, and tactics generation.

Human Visual Performance Modeling: Moderate-to-low power lasers can permanently or temporarily disable human vision and electro-optical sensors within tactically significant ranges. Even with the use of Laser Eye Protection (LEP), the level of irradiance (i.e., glare) may exceed the capabilities of the human to operate effectively. This program provides (1) the capability to evaluate, in the laboratory, operationally relevant visual performance under laser glare conditions, and (2) a laboratory T & E center for new generation LEPs and Night Vision Goggles using aviation related tasks (on-axis and off-axis dynamic acuity tasks, and heads-up-display (HUD) washout under glare conditions).

Laser Eye Injury Recovery Models: Our knowledge of laser eye injuries and functional visual recovery after injury is limited. New technologies (confocal Scanning Laser Opthalmoscopes) now allow us to visualize retinal tissues in much greater detail, combined with behavior-oriented visual tasks. This program develops a model for the real-time, simultaneous evaluation of retinal damage, visual functioning, and behavior in an awake non-human primate (NHP) following laser exposures of varying strength (i.e., glare, flashblindness & retinal damage). The model can be used to track the biological and behavioral recovery processes over time. This program will allow medical modeling of functional visual recovery in human's exposed to varying levels of coherent light from friend or foe.

5. Naval Health Research Center Toxicology Detachment Wright-Patterson AFB (TOXDET)

Acute Lung Injury Program: The acute lung injury program is focused upon examining the pathogenesis and mechanisms of Acute Lung Injury (ALI) and it's more severe from the Acute Respiratory Distress Syndrome (ARDS) related to the inhalation of toxic atmospheres that may arise in the course of Naval operations. Research is focused upon (but not limited to) examining the pulmonary response to inhaled fire environments. Pulmonary toxicity in a small animal model is examined over time using physiologic, biochemical, and histopathologic methods. Extensive physiochemical characterization and control of the exposure atmospheres permits examination of the ensuing pulmonary disease in a dosimetric manner. The objectives are to develop physiologic models of lung disease and it pathogenesis for use in predicting the risk associated with combustion atmospheres of various types. Methods developed during this effort can be used to experimentally evaluate treatment regimens for smoke related ALI and ARDS, and as a model to develop effective prevention and control programs for various operational scenarios.

Combustion Toxicology Program: The primary objective of the combustion toxicology program is to determine the health risks that are associated with the inhalation of smoke(s) evolved by pyrolysis of materials that are either commonly deployed in Naval systems or materials that are proposed for future use. Technological advances in material science have resulted in the use or proposed use of a variety of new compounds and materials in Naval systems. Prime examples are proposed new fire suppression agents and the use of composite materials in the construction of a variety of operational systems. Potential health risks associated with the pyrolysis and combustion of these materials are unknown and represent a significant threat to effective and sustained operation. The development of models useful for

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predicting potential toxicity, under deployment conditions, for advisory purposes is part of the overall effort.

Degradable Chaff Countermeasures Toxicity Program: United States military aircraft and ships currently use aluminized glass chaff as a passive countermeasure for radar guided threats. Heightened concern for the health impact of deployed chaff on human and animal habitats has led to the development of an environmentally friendly, degradable chaff (EcoChaffTM), an aluminum-coated degradable vitreous oxide material. Aluminum, the principle toxic component of EcoChaffTM, has been implicated in the etiology of at least one neurodegenerative disease, although data supporting this hypothesis are inconclusive. In an effort to assist in human health and ecological risk assessment of the geographical areas over which the new chaff will be deployed, current studies are evaluating the effects of human exposure to EcoChaffTM. Environmental analysis of the Naval Research Laboratory-Chesapeake Bay Detachment (NRL-CBD), an area over which aluminized chaff has been deployed for nearly twenty years suggests that soil bioavailable aluminum levels are not significantly different from background levels. Further studies focusing on the reactivity of the aluminum coating of various chaff forms show that chaff-derived aluminum is absorbed minimally. Results from recent experiments in vivo support this finding.

Neurobehavioral Toxicology Program: This program has developed and tested three interacting toxicology assessment batteries while investigating the real-world applications of such testing. These batteries, when transitioned for fleet application, are expected to represent the most comprehensive toxicology assessment tools available. The Navy Neurobehavioral Toxicology Assessment Battery (the NTAB) was designed to analyze toxicant-induced modulation of eight individuals, but interacting factors underlying human performance integrity. The Navy Neuro-Molecular Toxicology Assessment System (the NTAS) will represent the most comprehensive available battery of in vitro and cellular level in vivo tests for prediction of, and investigation of mechanisms underlying performance-modulating toxicant exposures. The Navy Global Assessment System for Humans (the GASH) is expected to represent the most comprehensive available system for field evaluation of toxicant-induced deficits in human performance capacity. The data and mathematical (PBPK/PBPD) models generated from real-world application of these batteries has been programmed by the military Deployment Toxicology initiative for utilization in the development and application, by FY 2028, of field and satellite-deployed toxicant sensors systems.

Toxicity Testing Program: Although environmental regulation requires manufacturers of a substance to provide data concerning the toxic effects of their products, the Navy continues to require specialized toxicity data. This data is most often in support of Navy-unique material applications or environments and may arise from by-product formation during such uses. As a result, toxicity evaluation continues to be needed to permit safe use of required materials, especially in military unique operational scenarios.

Deployment Toxicology Program: The Military Deployment Toxicology initiative for utilization in the development and application, by FY 2028, of field and satellite-deployed toxicant sensors systems is based on the development and application of newly emerging technologies whose capabilities will include the measurement of the complex chemical mixtures found in the real-world environment. However, the intelligent use of these sensors' outputs requires similar advances in the understanding of the toxicity of these mixtures and how this toxicity relates to sensor outputs. This effort is coordinating the development of methods for evaluating the toxicity of such mixtures.

Risk Assessment Program: Toxicology data provides the raw information needed to determine the hazard associated with a chemical. However, the hazard to workers involves the circumstances of their exposure. The integration of this information is the process of risk assessment that is used for reasons of both personal safety and environmental protection. Decisions affecting both personal safety and environmental impact are needed for Navy-specific chemicals and Navy-specific chemical uses ranging from operational to industrial issues. Chemical risk assessments and human health evaluations provide the basis for making these decisions.

EQUIPMENT/FACILITIES

1. Naval Health Research Center (Laboratory)

a. Occupational and Environmental Physiology Laboratory: This 8,000 square foot facility, built in 1997, provides a unique ability to address operational issues rapidly and when required, under operational conditions. The state-of-the-art equipment in the laboratory was selected to ensure high mobility and multifunction capability. Enhanced mobility allows researchers to set up temporary, yet fully operational, laboratories on site at Fleet and Marine Corps facilities, both in CONUS and OCONUS. The laboratory's proximity to the West Coast Fleet maximizes technology transfer to the Fleet and Marine Corps operational forces. A satellite laboratory for cold-weather and altitude studies is maintained at the Marine Corps Mountain Warfare Training Center, Bridgeport, CA. Equipment:

- Thermal physiology: two environmental chambers with temperature ranges of -20° to 180 ° F; humidity 20-85%, each capable of holding three treadmills for exercise studies; immersion tank allowing whole-body exposure to water between 45 ° and 110 ° F.
- Swim flume: one of the worlds largest swim flumes allows studies of immersion in static water or swimming in moving water (up to 4 knots) at temperatures between 45 ° and 90 ° F. The proximity of the flume to the environmental chambers allows research on serial wet-dry exposures such as those encountered during special operations or littoral warfare.
- Biomechanics: force plates for motion and ground reaction forces, electromyography, kinesthesiology, electrogoniometry, accelerometry, 3-D motion analysis system.
- Biochemistry laboratory: basic clinical and hormonal chemistries, tissue sample preparation and analyses.
- Body composition: anthropometry, bone densities (dual energy x-ray absorptometry [DEXA]), bioimpedence, hydrodensitometry allow determination of body composition using the four-compartment model.
- Ergometry: treadmills (2 with eccentric [downhill] capability), mechanically and electrically-braked bicycle ergometers; 7 automated and semiautomated metabolic measurement systems; incremental lifting machine; equilibrium testing; pulmonary function testing; Cybex, Kincom, and Ariel computerized muscle function testing systems.
- Thermal imaging: infrared camera for dynamic measurement of weighted and gradient skin surface temperatures. Whole body calorimetry: fluid-based tube suit for measuring heat flux from six body regions to protective ensembles or the environment.

b. Medical Information Systems & Operations Research Specific Equipment:

- Several Concurrent and Silicon Graphics computer systems form the backbone of the electroencephalographic and electro-oculographic laboratory, currently used for Operator-State Assessment projects. The systems enable multi-channel real-time signal acquisition and subsequent analysis of psychophysiological and behavioral data.
- Two ASL 4000 series video-based eye tracking systems (one remote, one head mounted optics) and an electromagnetic head tracking system.

c. Health Sciences & Epidemiology Equipment Wet Laboratory capabilities:

- Primary focus on specimen preparation, cold storage, packaging, and some limited in-house laboratory analyses. Current laboratory analytic capabilities include: viral culture, with a current focus on identification and typing of adenovirus and influenza A; culture and performance of antibiotic resistance testing on a variety of bacterial pathogens, including Streptococcus pyogenes and Streptococcus pneumoniae; serological and PCR assays for various pathogens are also performed.
- The laboratory is fully accredited by the College of American Pathologist.
- Future laboratory analytic capabilities include DNA fingerprinting of clinical respiratory isolates.

EQUIPMENT/FACILITIES

2. Naval Aerospace Medical Research Laboratory (NAMRL)

a. The Vision Laboratory includes a mobile night vision device (NVD) training facility ('NITE Lab') that can be used to train NVD users in the field. The 'NITE Lab' is equipped with numerous NVD demonstrations and training aids as well as optical testing and vision equipment. The laboratory has facilities for recording, digitizing, and mathematically filtering and enhancing visual images. In cooperation with the helicopter training facility at Whiting Field (TRAWING FIVE), the laboratory is able to noninvasively record the instrument scan patterns of pilots flying the motion based, full-scale helicopter instrument trainer.

b. The Spatial Disorientation Laboratory capability is a unique national asset consisting of many one-of-a-kind research devices, as described below:

- The Coriolis Acceleration Platform (CAP) is the only device worldwide capable of applying combined linear and angular acceleration to the human subject. It is also the only device in the DOD inventory available to study chronic exposure to altered G environments. It uses two, independently controlled power servomechanism drive systems to generate acceleration stimuli caused by rotation about an Earth-vertical axis and/or rectilinear translation along an Earth-horizontal axis. This device has enabled scientists to make accurate simulations of many bizarre combinations of force stimuli and their effects on aerospace crewmen under carefully controlled conditions. Data gathered in various studies using the CAP continue to contribute significantly to the success of the space program and to the safety and well being of astronauts.
- The Human Disorientation Device (HDD) can accelerate an instrumented human subject about two head-centered axes simultaneously. It is used to help differentiate the relative roles played by the various sensory systems involved in the production of disorientation, as well as to examine the contribution of each system and subsystem to motion sickness. The HDD is also employed to study the effects of disorientation caused by rotation and tumbling. The HDD differs substantially from the Pate device in that the axes of rotation can be made to pass through the intersection of the interaural and nasooccipital lines. This permits isolating the function and stimulation of specific portions of the organs of balance in the inner ear. The device has provided direct support for many basic and applied research projects sponsored by both the Navy and NASA.
- The Linear Angular Rotator (LAR) is a new, short-arm (6-foot), human centrifuge capable of high rotation speeds (to 80 rpm) and precise, simultaneous, linear movement of the human along the arm. It is located in a large, cylindrical chamber upon which visual stimuli can be projected. The LAR and chamber combination will permit displaying visual stimuli at various distances from the center of rotation, to about 25 feet from the subject. Due to its ability to produce accurate linear and rotational stimuli, the LAR will afford precise measurements of unilateral labyrinthine function, which should lead to improved clinical tests for detecting vestibular abnormalities. Because the device will afford linear and rotational stimuli coupled with near and distant visual stimuli, it will enable studies of visual suppression of vestibulo-ocular reflexes, and of visual information processing under conditions in which target and background stimuli vary in distance and move at different speeds.
- The Vestibular Visual Sphere Device (VVSD) is a new device for studying visual-vestibular interactions. The VVSD is a 12-foot sphere that can be rotated about two axes to approximately 29 RPM. A subject seated in the center of the sphere can rotate about two axes to approximately 57 RPM. Visual stimuli displayed on the interior of the sphere yield compelling, visually induced motion illusions. The VVSD permits displaying real, moving stimuli to stationary or moving subjects. Measurements of three-dimensional, visual-vestibular responses should provide gold-standard data for evaluating virtual-reality displays, and for evaluating the effects of these displays on stationary and moving observers. The device will also permit exploring conditions in which the visual suppression of vestibulo-ocular reflexes (hence the ability to track visual targets) is enhanced relative to normal. Findings from these studies should lead to techniques for optimizing information delivery through headmounted displays.
- The Pendular Inertial Gravitational (PIG) devices (PIG 1A and PIG 1B) are fixed on the CAP linear track and are used to position a human subject at various angles off vertical axis while the CAP room is rotated. The PIGs can be oriented in four different directions.
- The Equitest System employs computerized dynamic posturography to systematically examine

EQUIPMENT/FACILITIES

the effectiveness of visual, vestibular, and somatosensory inputs to balance and the timing, strength, and coordination of postural movements. This permits evaluating visual, vestibular, and somatosensory contribution to equilibrium.

- The Pate Device resembles a patient litter and is capable of rotating a subject about the longitudinal body axis and/or the horizontal axis through the pelvis. This apparatus has slip rings, which permit physiological monitoring, and is currently being used to study eye movements in response to rotation or perceived motion generated by moving patterns projected on a hemispheric screen in front of the subject.
- The Ocular Counterroll Device is used to measure ocular counterroll in response to total body tilting movement and provide information on possible changes related to aging.
- The Off-Vertical-Rotator (OVR) is used to gain measures of semicircular canal and otolith function and related spatial orientation performance.
- The Periodic Angular Rotator (PAR) is a novel servorotator designed for studies of the dynamic response of the vestibulo-ocular system. The PAR is a high-performance motion-inducing instrument that rotates a seated subject about the Earth-vertical axis in a wide variety of stimulus waveforms.

c. The Psychoacoustics Laboratory includes acoustical test chambers, an ANSI standards compliant Real-Ear Attenuation Test Facility, a semireverberant test chamber for simulating various Navy operational environments, and a high-level noise test chamber. In addition, equipment is available to support analog and digital signal processing, speech analysis, spectral analysis, and radio voice communications monitoring. The psychacoustics laboratory also houses unique equipment for the design, fabrication, and testing of innovative hearing protection devices and sound-attenuating materials.

d. We have three Environmental Chambers, two of which are in adjacent rooms. One is 8 x 8 ft; the other is 10 x 16 ft. The smaller chamber, used primarily for cold exposure, has active temperature control from -5 to 25 degrees C. The larger room has active temperature control from 0 to 50 degrees C. The third environmental chamber is a free-standing room 8 x 10 ft with precise temperature (0-60 degrees C) and humidity (20-80%) control.

e. This command has also developed and equipped several Mobile Field Laboratories to study the visual, vestibular, and auditory sensory systems. These tests, by virtue of the trailers' mobility, permit our researchers to collect data at training sites, in Navy and Marine Corps operational settings, and on board ships.

3. Naval Submarine Medical Research Laboratory (NSMRL)

Fully equipped auditory, visual and physiological laboratories, two man-rated hyperbaric chambers, large anechoic chamber, ten computer interfaced audiometric booths, medical research library, and graphic arts capabilities.

4. Naval Health Research Center Detachment Brooks AFB (EMRDET)

The Naval Health Research Center Detachment Brooks AFB is co-located with the Army and Air Force within a Tri-service Directed Energy Bioeffects Research Complex located on Brooks Air Force Base, San Antonio, Texas. The EMRDET facilities are comprised of four structures to include Vivarium built 1995, Lab/Technical Services building built in 1996, Ground Plane and support structure built in 1996, and Administrative/Supply building built 1997 with a total of 17,200 square feet. Of this square footage, 5,900 square feet is dedicated to Microwave and Bioengineering Lab/Support services, 4000 square feet dedicated to Laser Lab/Services, 5700 square feet is dedicated to Administrative space/storage, and 1600 square feet to Technical Service Lab.

a. Microwave Specific Research Assets: 10 MW pulsed microwave source@ 1.25 GHz (AN/FPS-7B radar transmitter), 4 MW pulsed microwave source @ 5.6 GHz (AN/FPS-26A radar transmitter), 4 MW pulsed microwave source @ 3.0 GHz (RT-624/SPS-30), 500 W pulsed microwave source @ 16 GHz (Hughes Transmitter # 1610H), large collection of RF/microwave field intensity/power density monitors and body-current meters, Stanford Linear Energy Doubler (>peak power of 5.62GHz sources by 9x), Assorted 500-1000 W CW solid state RF sources/amplifiers @ 2-1000 MHz, Two metal-clad RF/MW anechoic irradiation chambers (~10'H x 10'W x 20'L), simulated ship deck outdoor irradiation facility with intact F/A-18A airframe. Navy-patented RF/MW dosimetry system (Green-man & coffin calorimeters), high resolution IR camera system for surface temperature

EQUIPMENT/FACILITIES

measurements, twin-well calorimetry systems for whole body SAR measurements, AAALAC accredited vivarium and Brooks AFB veterinary services. Spaces include; 4 walk-in isolation chambers for non human primate behavioral training, Rhesus monkey behavioral models: visual & auditory thresholds, cognitive test battery-short term memory and attention, learning, time perception, motivation, color and position discrimination, induced body currents in wrist and ankle. Ocular evaluation capability: LKG 2000 electroretinography system (evaluation of visual performance), Humphrey Mastervue system (evaluation of corneal topography), konan clinical specular microscope (evaluation of corneal endothelium), Interzeig lens opacity meter (evaluation of lens opacity), Confocal scanning laser ophthalmoscope (evaluation of retinal morphology), VISTECH contrast sensitivity tester (evaluation of contrast sensitivity)

b. Laser Specific Research Assets: Two Coherent VERDI V-5 Diode-Pumped Lasers, Two Rodenstock confocal Scanning Laser Opthalmoscopes (cSLO) & supporting computer software, Two Coherent INNOVA 70 Argon Lasers, Laboratory Controlled F/A-18 HUD, F/A-18 fuselage and cockpit, aircraft windscreens for glare studies and Laser Research Team (engineer, computer specialist, biologist, research technician, research psychologist) with over 35 years experience in laser bio-effects research.

5. Naval Health Research Center Toxicology Detachment Wright -Patterson AFB (TOXDET)

The Toxicology Department currently uses more than 20.5K square feet in three separate buildings. These facilities include WPAFB Building 433, partial areas of WPAFB Building 824, and the Animal Research Laboratory located in the Dayton Veteran's Administration Medical Complex. Together, these facilities provide cutting edge toxicological research capabilities to support the scientific needs of the Fleet and Marine Corps. The Detachment is located aboard Wright Patterson Air Force Base and is part of the Tri-service Toxicology Consortium. This co-location has been critical in supporting the expansion of toxicological research capabilities for the DoD. NHRC/TD currently has more than $490K in scientific equipment which supports toxicological and neurobehavioral research programs. The following equipment was purchased to support changing technology and ongoing research:

a. The Neurobehavior Toxicology Program procured a Panasonic MED System and expanded their capabilities at a cost of $80K. The MED System is used to analyze active brain tissues being exposed to chemicals. This system is currently the only instrument within the DoD that can detect real time active brain changes by using electrode arrays.

b. The Combustion Toxicology Program procured more than $137K in scientific equipment during FY 99. These purchases included a Coulter Cell Counter and absorbance plate reader and have expanded the capabilities of this program. Combustion Toxicology has also expanded the capability for increased Reproductive Toxicology integration by using a Hamilton Thorne Sperm Analyzer purchased in 1998.

c. The Laboratory of Environmental Molecular Toxicology procured a Roche Molecular Systems Light Cycler to further enhance biomarker and mechanistic toxiocology research.

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CO: CAPT Thomas J. Contreras Jr.
Scientific Director: Dr Stephen Nice

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.093	N/A	0.053	0.146
6.1 Other	1.565	N/A	0.636	2.201
6.2	2.231	N/A	3.552	5.783
6.3	6.034	N/A	8.939	14.973
Subtotal (S&T)	**9.923**	**N/A**	**13.180**	**23.103**
6.4	2.155	N/A	0.638	2.793
6.5	0.436	N/A	0.258	0.694
6.6	0.000	N/A	0.000	0.000
6.7	0.000	N/A	0.000	0.000
Non-DOD	0.141	N/A	0.046	0.187
TOTAL RDT&E	**12.655**	**N/A**	**14.122**	**26.777**
Procurement	0.360	N/A	0.842	1.202
Operations & Maintenance	3.242	N/A	2.329	5.571
Other	1.804	N/A	1.204	3.008
TOTAL FUNDING	**18.061**	**N/A**	**18.497**	**36.558**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	31	5	37	**73**
CIVILIAN	21	34	57	**112**
TOTAL	**52**	**39**	**94**	**185**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	208.869	**REAL PROPERTY**	20.735
ADMIN	47.840	* NEW CAPITAL EQUIPMENT	0.000
OTHER	11.420	**EQUIPMENT**	10.935
TOTAL	**268.129**	* NEW SCIENTIFIC & ENG. EQUIP.	0.537
ACRES	**0**	* Subset of previous category.	

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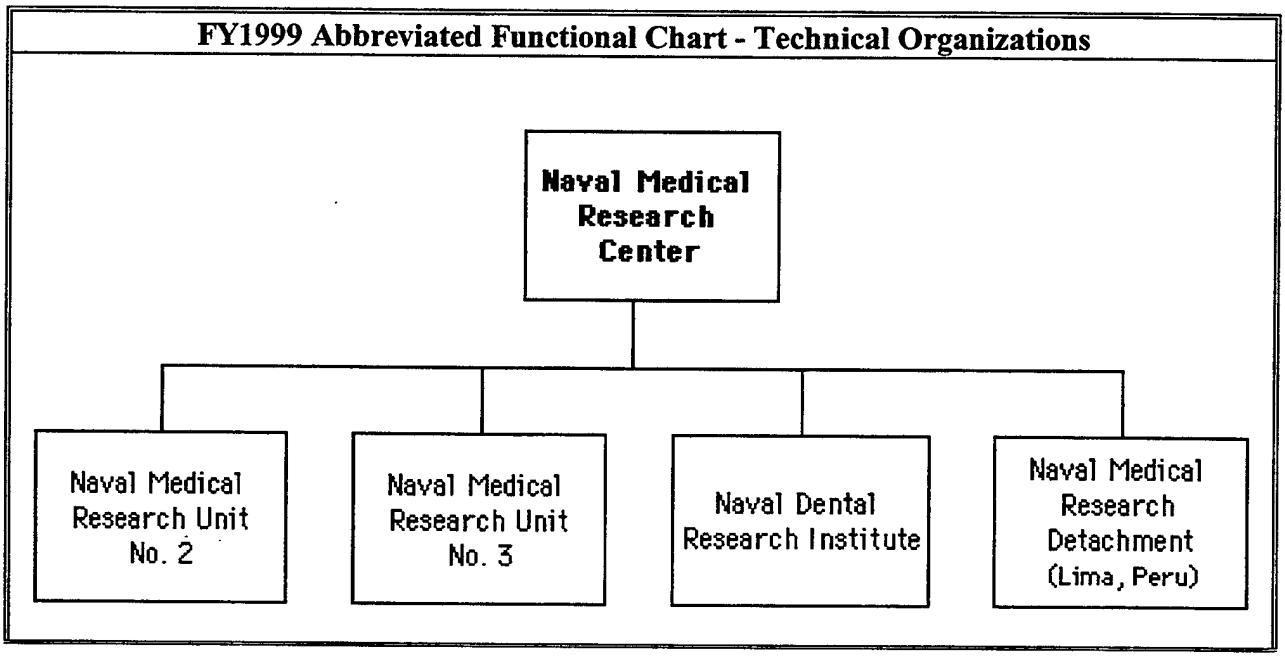
Naval Medical Research Center



Naval Medical Research Center
Silver Spring, MD 20910-7500
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Commanding Officer: CAPT Richard G. Hibbs, JR
Executive Officer: CAPT Richard B. Oberst

MISSION

NAVAL MEDICAL RESEARCH CENTER

To enhance the health, safety, readiness and performance of Navy and Marine Corps personnel, the Naval Medical Research Center (NMRC) and its subordinate laboratories conduct basic and applied biomedical research in Infectious Diseases, Biological Defense, Combat Casualty Care, Bone Marrow, and Diving and Environmental Medicine. In addition, NMRC and its OCONUS Laboratories support global surveillance, training, research and response to emerging infectious disease threats as part of the expanded DOD Mission (Presidential Decision Directive NSTC-7, June 1996).

U.S. NAVAL MEDICAL RESEARCH CENTER DETACHMENT (NMRCD) Lima, Peru

The principal mission of NMRCD is to identify and assess infectious disease threats of military relevance in the Southern Joint Command Region. Research at NMRCD is directed toward determining the most effective means of prevention, diagnosis and treatment of these threat diseases. Research efforts are designed and prioritized to meet Department of Defense goals as defined by the Science and Technology Objectives of the Military Infectious Disease Research Program and the Mission Area Materiel Plan Priority List. NMRCD programs emphasize developing collaborations, technology transfer, and information exchange with medical institutions in Peru, our host country, as well as Bolivia, Ecuador, and Brazil.

NAVAL MEDICAL RESEARCH UNIT 2 (NAMRU-2) Jakarta, Indonesia

The mission of NAMRU-2 is to conduct research, development, test and evaluation of infectious diseases to enhance the health, safety, and readiness of Navy and Marine Corps personnel in the effective performance of peacetime and contingency missions in Southeast Asia, and to perform other functions or tasks as may be directed. This mission is accomplished through the:

- Conduct of research programs in infectious diseases of operational military relevance.
- Conduct of interactive research with other DOD medical research and development laboratories in the areas of preventive medicine, epidemiology tropical medicine and infectious diseases.
- Development and evaluation of infectious diseases risk assessment information to improve prevention, diagnosis and treatment of operationally relevant infectious diseases.
- Maintenance of scientific and technological expertise in tropical medicine and infectious diseases, to provide significant advisory assistance for operational forces.

NAVAL MEDICAL RESEARCH UNIT 3 (NMRU-3) Cairo, Egypt

The mission of NAMRU-3 is to conduct infectious disease research, including evaluation of vaccines, therapeutic agents, diagnostic assays, vector control measures; and to conduct infectious disease surveillance and response activities to enhance the health, safety and readiness of DOD personnel assigned to Africa, Middle East, and Southwest Asia in the performance of peacetime and contingency missions.

NAVAL DENTAL RESEARCH INSTITUTE Great Lakes, ILL & Bethesda, MD

To research, develop, test, and evaluate new methods and materials that limit oral disease, reduce dental emergencies, maximize operational dental readiness, and promote dental wellness for Navy and Marine Corps personnel.

CURRENT IMPORTANT PROGRAMS

BONE MARROW RESEARCH DIRECTORATE

Executive Agent for the C. W. "Bill" Young Marrow Donor Recruitment and Research Program (the Department of Defense Marrow Donor Program). The Bone Marrow Research Directorate (BMRD) provides for development of military contingency support for casualties with marrow toxic injury due to radiation or chemical warfare agents. In 1986 the Navy and the BMRD initiated federal support for the National Marrow Donor Program making unrelated donor marrow transplantation practical. The directorate:

(1) performs laboratory research and nation-wide support for technology innovations that are transforming genetic testing for transplant matching to a highly reliable and cost effective DNA-based technology;
(2) recruits minorities and medially supports marrow donor volunteers throughout the DOD; and
(3) develops medical technologies and military medical recommendations to effectively support casualties with bone marrow failure.

COMBAT CASUALTY CARE DIRECTORATE

Immune Cell Biology Program
The Immune Cell Biology Program scientific efforts are centered upon the following three research thrust areas:

(1) Develop methods to suppress undesired immune responses, for special force medical applications (e.g. biological agent vaccine, transplantation, etc:
(2) Develop strategies to enhance desired immune responses so as to improve defenses against a variety of infectious threats, including HIV;
(3) Develop improved bone marrow transplantation methods for casualties with seriously injured bone marrow following exposure to CBR agents.

Resuscitative Medicine Research
Research in this program is focused upon the investigation of mechanisms responsible for cell death during hemorrhage to promote casualty stabilization and life sustainment following massive hemorrhage. Program efforts are centered upon four specific research areas:

(1) Development of treatment regimens such as hypothermia for the depression of metabolic rate to induce resistance to injury;
(2) Examination of the role of vascular endothelium and blood elements in acute inflammatory responses and subsequent tissue injury observed hemorrhagic shock;
(3) identification of methods to modulate tissue damage triggered by hypoxia/hemorrhage; and,
(4) Characterization of natural states of tolerance of hypoxia, such as hibernation.

Transfusion & Cryopreservation Research
The Transfusion and Cryopreservation Research Program centers its research efforts upon five scientific research and clinical applications, name:

(a) The development of automated systems for blood collection, anticoagulation, leuko-depletion, component separation and extended refrigerated storage of red cells;
(b) The application of the radical discovery that cold exposure causes proteins to unfold and that they do not refold to the native configuration on rewarming. This may account for the current limitation in cold storage of blood components. Appropriate stabilizers could block this effect;
(c) Apply newly developed hollow fibre separation techniques to freezing of red cells and platelets, resulting in rapid, fully automated processes;
(d) Develop understanding of the fate of leukocytes in stored red cells and platelets and the clinical implications of their breakdown products;
(e) Examination of the cell lesions developed during 4° C storage and their involvement in Disseminated Intravascular Coagulation and Multiple Organ Failure following massive transfusions.

CURRENT IMPORTANT PROGRAMS

DECOMPRESSION & ENVIRONMENTAL PHYSIOLOGY DIVISION

Oxygen Toxicity Research
The primary objective of the Oxygen Toxicity Research Program targets the etiology of neurological toxicity, resulting in convulsive seizures, by the breathing of pure oxygen under pressure. The Oxygen Toxicity Program seeks to understand the mechanism underlying this toxicity, and thereby to identify methods for prevention of oxygen-induced seizures. The program addresses the problem at various levels, from biochemical to cellular to animal models.

Thermal Stress Research
The primary objective of the Thermal Stress Program is to develop effective interventions, both physiological and pharmacological, and provide guidelines to minimize the impact of diving and extreme temperatures. Recommendations are provided to the operational community to improve both physical and cognitive performance in harsh environments. These recommendations may take the form of pharmacological, nutritive or training interventions.

Decompression Research
The primary objective of the Decompression Research Program is to perform basic and applied research aimed at finding new ways to accelerate decompression safely after long deep dives, as well as prevent and treat decompression sickness (DCS) in deep sea divers and crewmembers of disabled submarines. The program includes research procedures in decompression, DCS epidemiology and risk prediction, development of gas exchange kinetics and bubble dynamics models, biochemical decompression, DCS pathophysiology and pathogenesis, and control of contaminants in confined atmospheres. Direct tasking involve research for the Explosive Ordnance Disposal, Naval Special Warfare, and Fleet Submarine and Diving Communities.

BIOLOGICAL DEFENSE RESEARCH DIRECTORATE

Rapid Diagnostics and Detection Research
The mission of the Rapid Diagnostics and Detection Research Program is fourfold:

(1) To develop highly sensitive antibody-based hand-held assays which can identify BW threat agents in under fifteen minutes.
(2) To continue to improve on current assay systems and develop new ones based on intelligence threat lists.
(3) To develop biosensor-linked automated systems that will increase sensitivity and decrease assay time currently achievable in the hand-held assays.
(4) To transition rapid diagnostic assays to Operational Forces.

Confirmatory Diagnostics and Detection Research
The mission of the Confirmatory Diagnostics and Detection Research Program is to develop molecular-based techniques and assays which can confirm, validate and expand the diagnostic results of the rapid (15 min) immunological hand-held assays for the detection and identification of biological warfare agents.

Recombinant Antibody Research
The mission of the Recombinant Antibody Research Program is to apply molecular techniques to develop recombinant antibodies for the rapid detection and identification of biological warfare agents. Molecular techniques are also being used to improve specificity and/or sensitivity of existing monoclonal antibodies presently used in detection assays. Recombinant antibodies have been developed for several biological warfare agents and may be used in conjunction with currently available detection reagents. The program provides the in-house scientific research capability to produce and evaluate recombinant antibodies to augment current assays and create new assays for emerging threat agents in the most timely fashion possible.

CURRENT IMPORTANT PROGRAMS

Forward Deployable Laboratory Support
Military requirements necessitate the development of a scientific capability to deploy rapidly to an area of a suspected BW or Bioterrorism event and perform analyses leading to the identification of the suspect agent. The mission of the Forward Deployable Laboratory Support Program is to develop on a continuing scientific basis an actual deployable BW identification laboratory incorporating microbiological, immunological and molecular identification techniques.

INFECTIOUS DISEASES DIRECTORATE

Malaria Research
Malaria historically has posed one of the most serious threats to the health and operational readiness of deployed Armed Forces personnel. The Malaria Research Program has developed a world class laboratory regimen to meet military requirements aimed at counteracting this debilitating infectious disease threat. Two of the specific research endeavors central to the program's laboratory efforts are:
(1) the development of vaccines to prevent malaria in operating forces; and,
(2) the sequencing of the genome of Plasmodium falciparum and one other malaria parasite to facilitate malaria vaccine, drug, and diagnostics development.

Infectious Diseases Threat Assessment
The purpose of this program is to acquire systematically and assess infectious disease risk data from research projects and from collaborations with Navy CONUS and OCONUS medical treatment and research facilities for use in operational planning and research prioritization, and to develop prevention and control, diagnostic, and treatment strategies for infectious disease threats worldwide.

Enteric Diseases Research
Acute infectious diarrheal diseases are major causes of morbidity in U.S. fighting forces, posing a serious threat to the combat readiness and fighting effectiveness of deployed soldiers and sailors. To enhance the overall Force Medical Protection afforded all Armed Forces personnel, and to maintain an excellent state of health, fitness, and job performance during operational deployments, the NMRC Enteric Diseases Research Program develops and tests new methods for the diagnosis, treatment, and prevention of infectious diarrheas. The leading bacterial causes of diarrhea in deployed U.S. forces are Campylobacter and enterotoxigenic strains of E. Coli. To deter this threat, our mission is to
(1) develop a Campylobacter vaccine,
(2) improve Campylobacter diagnostics,
(3) maintain an active program of epidemiological surveillance, basic research, and vaccine development of emerging disease threats, such as newly discovered enterotoxic phenotypes of E. Coli, and
(4) work jointly with U.S. Army programs to develop a combined vaccine that will protect against the most common diarrhea threats.

Viral & Rickettsial Disease Research
This program focuses primarily on three major diseases of military importance: Dengue Fever, Scrub Typhus, and Epidemic Typhus. The four Dengue Viruses cause over 100 million infections annually throughout the tropical and sub-tropical zones of the world. There is currently no therapy and no vaccine. We are developing dengue vaccines using the new DNA vaccine technology, and using molecular biology techniques to clone live, attenuated viruses. We are screening anti-viral drugs for anti-dengue activity. We are modifying existing rapid diagnostic techniques for field hospital use. Scrub and Epidemic Typhus have caused serious problems for military forces in past wars. Current efforts include adapting rapid diagnostic tests to the field hospital setting to prevent misdiagnosis, investigating reports of emerging tetracycline resistance in scrub typhus, and developing a DNA vaccine for scrub typhus.

NMRCD LIMA, PERU:
This NMRC detachment operates two laboratories located at Peruvian Naval Hospital facilities in Lima and Iquitos, Peru. They conduct infectious disease research programs focused upon various viral, bacterial, or parasitic diseases known or suspected to be present in the region. The laboratory participates in the DoD Global Surveillance Program.

CURRENT IMPORTANT PROGRAMS

NAMRU-2, JAKARTA, INDONESIA:
The research institute is composed of scientific research programs which include the Emerging Diseases Program, Viral Diseases Program, Parasitic Diseases Program, Bacterial and Enterics Disease Program and Administrative and Logistical Support. These scientific programs have state of the art equipment to support the numerous ongoing infectious disease research projects at NAMRU-2.

The Emerging Diseases Program conducts field studies throughout the Indonesian archipelago and other countries in Southeast Asia such as Vietnam, Laos and Cambodia. The efforts of this program are primarily focused on surveillance for new, emerging and re-emerging infectious diseases using NAMRU-2's extensive infectious disease diagnostic and epidemiological capabilities.

The Parasitic Diseases Program conducts basic and applied research on malaria. Research efforts include: evaluation of new diagnostic assays, evaluation of new prophylactic and therapeutic drugs, characterization of the immune response to malaria infections to facilitate the development of potential vaccines for malaria and development and characterization of field sites for new malaria vaccine evaluations. This program utilizes sophisticated equipment such as a flow cytometer, DNA sequencer and DNA thermocyclers to conduct basic immunology and molecular biology studies of malaria. The program also has an extensive entomology capability which includes the in house breeding of mosquitoes.

The Bacterial and Enteric Diseases Programs conducts research to; determine the causes of acute diarrheal disease in Southeast Asia, evaluate vaccines for cholera and to support emerging disease surveillance with a comprehensive diagnostic medical microbiology capability which includes sophisticated equipment and reagents necessary for the biomolecular identification and characterization of microbial pathogens.

The Viral Diseases Program conducts research on the molecular biology and epidemiology of HIV and several viral diseases including dengue, hepatitis, influenza, Japanese encephalitis and Chikungunya. The program supports NAMRU-2's emerging disease surveillance efforts with extensive diagnostic capabilities for the isolation and identification of human viral pathogens. The Viral Diseases Program also includes a modular Biosafety Level 3 Containment Laboratory which when fully operational will exceed all current requirements for work with Biosafety Level 3 pathogens. This laboratory is the only one of its kind in Southeast Asia and will allow NAMRU-2 personnel and Indonesian collaborators to work safely with samples potentially containing BSL-3 agents.

NAMRU-3, CAIRO, EGYPT:
Enteric Diseases Research Program

- The mission of this program is to describe the epidemiology of enteric pathogens in the region and evaluate vaccines, therapeutic agents and diagnostic assays.
- A three year community-based, prospective cohort study in Abu Homos to examine the epidemiology of diarrhea in Egyptian children was completed in 1998. This study yielded comprehensive data on the age and pathogen specific incidence of diarrhea, relative pathogenicity of bacterial agents, and measures of natural immunity.
- Four Phase 2 (safety and immunogenicity) trials of an oral vaccine against ETEC (enterotoxigenic E. coli) were conducted over the past three years. During the course of this study, done in partnership with the Egyptian MOHP and U.S. NIH, the infrastructure was developed to conduct large scale intervention studies.
- An enterotoxigenic E. coli vaccine efficacy trial was initiated at Abu Homos, Egypt during October, 1998.
- A new study, funded by NIH, will be the first comprehensive birth cohort study of H. pylori epidemiology in the world. This study will yield important information on the incidence and risk factor for H. pylori and other diarrheal pathogens.

Virology Research Program

- The mission of this program is to describe the epidemiology of viral pathogens, and to genetically and antigenically characterize virus isolates, and evaluate vaccines and diagnostic assays.

CURRENT IMPORTANT PROGRAMS

- HIV-1 genotyping is ongoing in regions where military personnel may be deployed in sub-Saharan Africa, the Middle East, and eastern Europe.
- Similarly, an influenza surveillance program has been established in three sites in Egypt and two sites in Syria. Influenza isolates are sent to WHO for evaluation and possible incorporation into the prototype influenza vaccine for the next year.
- To support the DoD HEV vaccine program, hepatitis E viruses collected from regions of the Middle East and eastern Europe are analyzed for genetic diversity. Disease Surveillance Program
- The mission of this program is to identify, characterize and evaluate risk factors for the most important infectious disease threats in the region.
- Established a sentinel surveillance network of 6 hospitals for priority infectious diseases (meningitis, encephalitis, hepatitis, undifferentiated febrile illness, hemorrhagic fevers, influenza and dysentery), antibiotic resistant pathogens, and to establish prospective community-based surveillance for selected diseases.
- Conducted external training to facilitate the establishment of a community-based surveillance network throughout North Africa.

Disease Surveillance Program: Malaria Division

- The mission of this division is to develop and maintain a field site in a malaria endemic area to evaluate vaccines, and chemoprophylactic and therapeutic agents. This research is in support of the larger objective to reduce the risk of malaria disease to non-immune troops in the face of a world-wide resurgence of multi-drug resistant parasites and mosquito resistance to insecticides.
- A field site, located in the upper east region of northern Ghana, is being developed as a site to evaluate candidate malaria vaccines.
- In collaboration with the NMRC Malaria Program, Navrongo Health Research Center, the Noguchi Memorial Institute of Medical Research in Ghana and USAMMDA, a two-year detailed study of malaria attack rates in three cohorts was completed as well as a study of Tafenaquine for the chemoprophylaxis of P. falciparum in adults. These studies have also laid the groundwork for future vaccine trials and drug efficacy studies.

Vector Biology Program:

- The mission of this program is to identify arthropod vectors, detect pathogens in vectors, evaluate control measures for vectors and assess vector-borne disease risks in the region.
- In collaboration with the Virology Program, arthropods have been collected for virus isolation studies in areas with historical outbreaks of Rift Valley Fever and West Nile virus.
- Repellent and insecticide testing is done on vectors of local importance as a means of identifying an effective alternative to DEET and for detection of emerging insecticide resistance.
- A novel method of controlling sand flies by feeding the rodent host a "feed through insecticide" is also being evaluated. The insecticide works by interfering with a metabolic pathway present in insects, but not in mammals.

NDRI, GREAT LAKES, IL:

1. Continue advanced development of rapid chairside risk assessment tests for dental caries, advanced prototypes completed. Patents awarded, License pending.
2. Continue advanced development of fluorescence polarization as technique for rapid diagnosis. Patent awarded. License pending.
3. Develop rapid non-invasive salivary assays for presence of antibodies to tuberculosis and other infectious diseases.
4. Develop tests for genetic biomarkers for periodontal disease.
5. Develop protein pattern recognition technology for periodontal disease.
6. Develop far-forward dental restorative material.

CHEMICAL AND BIOLOGICAL CONTAMINANTS IN DENTISTRY

1. Develop systems and apparatus to remove mercury from dental waste water. Patents awarded. Industrial mercury recovery compound adapted for dental use with Nalco, Inc. Continue transition of this technology to war zone/afloat system applications.
2. Develop biochemical techniques to test salivary levels of bis-phenol A associated with oral resin

CURRENT IMPORTANT PROGRAMS

systems in collaboration with National Institute of Dental Research (NIDR) and ADA.

DENTAL CARE DELIVERY TECHNOLOGIES

1. Develop interim dental restorative materials for use by the IDC in the War-zone that will result in dental casualty return to operational assignments within 30 minutes.
2. Develop clinical protocols to minimize post-surgical complications in women.
3. Continue evaluation of the Navy-Wide Managed Dental Care delivery system.
4. Develop miniaturized dental delivery system in support of U.S. Army Dental Research Detachment project.
5. Deploy multimedia dental diagnostic and treatment system for war zone/r emote site use by IDCs. Transition software to the HTML format.

DENTAL HEALTH RELATED STUDIES

1. Investigate possible relationship between oral spirochetes and Alzheimer's Disease.
2. Develop techniques for dental materials fracture analysis/prediction with National Institute of Standards and Technology (NIST).
3. Collect and analyze dental epidemiologic data as requested by higher authority.
4. Collect and analyze operational dental emergency data.

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS:

The Institute for Genomic Research (TIGR) - The broad intent of the work performed under the auspices of this agreement is to obtain the entire DNA sequence of at least two species of malaria parasites, of the genius Plasmodium. The DNA sequences will provide the foundation for the discovery of new antimalarial drugs, vaccines, and diagnostics, and for greater elucidation of the biology of malaria parasites.

Integrated Diagnostics, Inc (Indx) – Serological testing on Dengue patients.

MicroCarb, Inc. (Antex Biologics) – Large-scale production of a safe an effective vaccine for the prevention of diarrhea caused by the enteropathogenic Campylobacter in humans.

SmithKline Beecham Corp. - Research, development and commercialization of a genetically engineered bacterial toxin, LT-R192G, for use as a safe and efficacious mucosal adjuvant (immune enhancer) to be administered with oral vaccines.

SmithKline Beecham Corp. - Development of chimeric and humanized anti-bodies useful for the prevention of malaria.

Cel-Sci Corporation - to develop and test heteroconjugate peptide-based Plasmodium vaccines which contain B or T cell epitopes of the Plasmodium yoelii circumsporozoite protein (CSP) or sporozoite surface protein 2 (SSP2) and T cell binding ligands. These vaccines will be tested for their efficacy in the prevention of sporozoite induced malaria.

The University of Illinois - to investigate the interactions of human and nonhuman primate hematopoietic stem cells (HSC) with porcine brain microvascular endothelial cells (PMVECs).

Chembio Diagnostic Systems, Inc - to develop rapid serological diagnostic tests including detection of specific IgM antibody and total immunoglobulin against rickettsiae.

Biogen - to specifically prevent the rejection of organs or tissues transplanted from one individual to another. For the joint effort, the ICBP brings experience and scientific expertise in molecular and cellular immunology, and in animal models including primate transplant models. BIOGEN's participation is to provide sufficient quantities of an agent that modulates the function of the cell surface receptor pair called CD40: CD40L, and to provide partial financial support for the primate transplant studies planned.

CURRENT IMPORTANT PROGRAMS

CpG Immunopharmaceuticals Incorporated - to develop and test the clinical application of oligonucleotide sequences for enhancement of immunogenicity and efficacy of anti-malarial vaccines for the prevention of malaria.

Biosource Technologies - NMRC/ICPB has developed a novel patented porcine microvascular endothelial cell line growth medium to expand human stem cells. Biosources Technologies, Inc. will utilize its capabilities to work with NMRC/ICPB isolating and identifying the specific peptide(s) responsible for the unique growth factor properties of the growth medium.

Corixa - to collaborate in the evaluation of LeIF, a novel adjuvant from Corixa Corporation, for potential efficacy as a component of malaria vaccines.

Nextran - Both partners wish to develop therapies to specifically prevent the rejection of organs or tissues transplanted from pigs into man.

Dyad Pharmaceuticals - to design and investigate the protective effects of antisense molecules against the inflammation associated with septic shock and inflammatory diseases in animals, cell cultures, and human subjects with the results and processes made available for public use.

OraVax, Inc. - Research and development of a native labile toxin and a mutant recombinant toxin as adjuvants for a H. pylori vaccine in humans.

Integrated Diagnostics Inc. - Serological test for pathogens of Dengue.

Vical, Inc. - Evaluation of novel vaccine approaches for prevention of malaria using genetic material encoding malarial protein antigens.

Entremed - Development and testing of DNA-based Plasmodium vaccines.

Henry M. Jackson Foundation – Cryopreservation Research

PHARMINGEN, Inc – originally a patent application for DSI cell line

University of Tasmania at Hobart – material transfer agreement

NIHTM Bulgaria – extended storage of refrigerated red cells

AMGEN – transfer K6.1 antibody, 1MG

University of California – transfer of research grade anti-CD3/28 coated microspheres

Astra Research Center Boston (ARCB) Astra (Sweden) – Sequence analysis of plasmid to determine the extent of homology to H. pylori.

Institute for Rheumatic Diseases and Pharmac – transfer of in fab fragments from the anti-CTLA monoclonal antibody clone 3D8

University of Miami – Ex-vivo expansion of primate hematopoietic stem cells using endothelial cell monolayers for induction of immune tolerance in pri

University of Wisconsin - transfer of porcine brain microbascular endothelial cells to Univ of Wisconsin

Ribozyme Pharmaceuticals, Inc. -receipt of proprietary cytofectin reagents from Ribozyme Pharmaceuticals, Inc.

Univ of Penn. School of Medicine - transfer of mouse strains (CD40LKO x ICAM-1KO) and CD28 Transgenic

CURRENT IMPORTANT PROGRAMS

University of Miami - the role professional antigen presenting cells in the control of immune responses.

University of Pennsylvania – Navy/Penn Costimulation Program

Synzyme Technologies, Inc. - evaluation of polynitroxylated hemoglobin (PNG) based therapeutics for battle field casualty care and civilian health care application

University of Pennsylvania - transfer "CD28/ICAM knockout mice

MICROCARB (Antex Biologics) - campylobacter vaccine

University of Texas Medical Branch at Galveston - cooperative agreement of U of Texas and NAMRID-Lima

NIH National Heart Lung and Blood Institute - viral assays and isolation of virus strains or viral genes

MRL Diagnostics - transfer of 500mg of each of four serotypes of Dengue virus

CPG InnumoPharmaceuticals - receipt of CpG enhanced plasmids

Astra Researach Center Boston (ARCB) Astra (Sweeden) – sequence analysis of plsamid to determine the extent of the homology to H. pylori

Panbio Pty LTD Brisbane Australia - transfer of Dengue and Rickettsial Antigens

MRL - transfer of plasmids capable of experssing Dengue fever virus specific recombinant rusion pr

SmithKline Beecham - Dr. Ching request for pR1952

Integrated Diagnostics (INDX) - Rapid Diagnostics Test

Smithkline Beechem #2 - Malaria CRADA

Genetics Institute - Interleukin-12 prophylaxis against malaria

PMC - evaluation and development of vaccines for the prevention of malaria

CpG ImmunoPharmaceuticals Inc. - development of Immunostimulatory Oligonucleotides as adjuvants for anti-malarial vaccines

ORAVAX - Assessment of LeIF as an adjuvant in malaria vaccines

Genetics Institute - Recombiant Human Interleukin-12 (rhIL-12) Clinical Trial

IMMUNEX Corporation - transfer of CDNA for murine FLT3 ligand

IMMUNEX Corporation - transfer of monoclonal antibodies and murine CD40L FLT3L, and GMCSF

Virogenics Corp/PMC SV - receipt of ALVAC donor plasmids

Bioject Inc - delivery system for malaria vaccine

Epimmune Inc - Epitope-based malaria vaccine

Biodelivery Sciences, Inc. - cochleate DNA vaccines for malaria

CURRENT IMPORTANT PROGRAMS

Vaxin Pharmaceuticals - Skin-Targeted Non-Invasive Vaccine Delivery System

Scanalytics - development of an automated image analysis system for biological and laboratory assays

Commonwealth Biotechnologies, Inc. - transfer of encoding sequence and bacterial plasmid containing the encoding sequence of PfLSA3

BHP Minerals - assessment of malaria and other infections diseases

Glaxo Wellcome - A rondomized, double-blind, placebo-controlled trial to compare Malarone with primaquine for prophylaxis against P. vivax and

Pfizer - comparison of azitheromycin and ceftriazone in the chemotherapy of uncomplicated pediatri

Specialty Laboratories - six vs twelve-month therapy for the treatment of tuberculous meningitis

EQUIPMENT/FACILITIES

The main NMRC complex consists of 9 buildings (1 off site) containing approximately 242,805 square feet of laboratories with a real property value of $8,700K and equipment value of $2,260K. These laboratories include the following specialized facilities or equipment:

- **Man-rated, Deep-dive Hyperbaric Research:** Chamber Complex: A DOD unique diving medical research chamber capable of reaching simulated depths of 300 meters, with full research quality level support systems, and composed of 5 separate, interconnected chambers, one with wet-pot capability.
- **Large Animal Hydrogen Diving Chamber:** A DOD unique chamber capable of accommodating large animals and using Hydrogen/Oxygen gas mixtures. Designed for use in the study of novel enzymatic decompression techniques.
- **Emergency Hyperbaric Treatment Chamber:** Special chamber designed for treatment of hyperbaric injuries or other clinical hyperbaric treatments.
- **AAALAC accredited animal research facility**
- **Electron microscopy**
- **Advanced laboratory assets fpr DNA cvaccine research**
- **Rapid and confirmatory detection of biological threat agents**
- **Biological level 3 facility**
- **Forward deployable laboratory support**
- **Digital imaging systems**
- **National Registry for Bone Marrow Program**

NMRC-DET Lima
The NMRC Detachment, Lima, Peru is comprised of 3 buildings with approximately 33,000 square feet total. This detachment operates its main laboratory at the Peruvian Naval Hospital compound in Lima, Peru, and a field station located with the Ministry of Health in Iquitos, Peru, along the Amazon River. The detachment maintains an AAALAC accredited animal research facility.

NAMRU-2
The Naval Medical Research Unit No 2 (NAMRU-2) is located in Jakarta, Indonesia on the compound of the National Institutes of Health (LITBANGKES), Indonesian Ministry of Health. Research laboratories, administrative offices and logistical support spaces are integrated into buildings owned by the Indonesian Ministry of Health. NAMRU-2 currently has 18.1 k sq ft of laboratories, 11.8 k sq ft of administrative offices and 33.6 k sq ft of logistical support spaces. NAMRU-2 maintains:

- AAALAC animal facility
- BL-3 Laboratory
- Electron Microscope facility with both transmission and scanning microscopes
- Scientific library

EQUIPMENT/FACILITIES

- In house maintenance facility and motorpool
- Facility electrical backup system (5 diesel generators with total of 1,170 KW

NAMRU-2's field laboratory in Jayapura, Irian Jaya, which is 4,500 Km from Jakarta, has 4.5 k sq ft of lab space, a guest house, electrical generator backup and vehicles used for transportation to remote field sites, related laboratory assays and capability to process research specimens for shipment to the Jakarta lab.

NAMRU-3:
Naval Medical Research Unit #3 in Cairo, Egypt maintains the following:

BIOMEDICAL RESEARCH SCIENCE BUILDING: Six-story state-of-the-art building completed in 1983. Clinical and Applied Research Laboratory. 2,750 sq ft Biosafety Level-3 Laboratory. Backup emergency generators and modern ventilation and waste disposal design.

LIBRARY: Heavily used by local scientists/physicians as well as NAMRU-3 staff. Subscriptions to over 75 scientific journals. Houses over 7,000 books.

INSECTARY: Supports colonies of disease vectors such as ticks, mosquitoes and sand flies.

ANIMAL FACILITY: Directed by U.S. Army Veterinarian and enlisted (91T) Veterinary Technician. AAALAC-International accredited state-of-the-art animal facility houses rodents, sheep, rabbits and pigeons; it has a barrier facility for breeding inbred mouse strains.

PUBLIC WORKS FACILITY: Directed by U.S. Navy Civil Engineering Corps Officer. Responsible for engineering, maintenance, construction, design, transportation. Shops: automotive, electrical, mechanical, sheet metal, carpentry, paint and plumbing.

OTHER SUPPORT FACILITIES: Administration, Finance, Supply, Medical Equipment Repair, Safety, Occupational Health, Management Information and Post Office.

ACCESS TO ABBASSIA FEVER HOSPITAL: The largest Ministry of Health infectious disease hospital in Egypt with 1,500 beds is adjacent to NAMRU-3. NAMRU-3 conducts clinical studies in the Meningitis and Fever of Unknown Origin (FUO) wards.

FIELD SITES: The field sites for the Enteric Diseases Program are located in Abu Homos and Benha, Egypt. Virology Research Program has field sites in Syria, Egypt, Djibouti, and Czechoslovakia Republic. Malaria field studies are being conducted in Navrongo, Ghana.

NDRI:
The Naval Dental Research Institute at Great Lakes Naval Station in Illinois is a 13,000 square feet AAALAC-accredited animal colony. NDRI maintains a comprehensive dental research library, numerous volumes and journals with direct online access to a variety of literature search services and has extensive computer and data processing facilities. NDRI has direct access to large military populations. Located at the Navy's only Recruit Training Center, it also has direct access to the American Dental Association, three university dental schools, two large VA hospitals, a large Naval Hospital, a major Naval Dental Center which serves as headquarters for nearly 50 leading dental organizations. Other equipment capabilities and special features include :

- a gas chromatography microbial identification system
- Atomic Absorption Spectrometer
- direct access to the National Institute of Dental Research, National Library of Medicine and the National Institute of Standards and Technology
- Illinois EPA Certified Waste Water Testing Facility for mercury
- co-located with U.S. Army Dental Research Detachment
- total facility capacity = 75,000 sq. ft.

Naval Medical Research Center
Silver Spring, MD 20910-7500
(301) 319-7400

Commanding Officer: CAPT Richard G. Hibbs, Jr
Executive Officer: CAPT Richard B. Oberst

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.609	N/A	0.000	0.609
6.1 Other	0.911	N/A	0.347	1.258
6.2	0.461	N/A	0.498	0.959
6.3	9.046	N/A	2.404	11.450
Subtotal (S&T)	**11.027**	**N/A**	**3.249**	**14.276**
6.4	0.758	N/A	0.000	0.758
6.5	5.151	N/A	0.000	5.151
6.6	1.977	N/A	0.000	1.977
6.7	0.000	N/A	0.000	0.000
Non-DOD	1.882	N/A	1.603	3.485
TOTAL RDT&E	**20.795**	**N/A**	**4.852**	**25.647**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	11.558	N/A	8.720	20.278
TOTAL FUNDING	**32.353**	**N/A**	**13.572**	**45.925**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	59	21	120	**200**
CIVILIAN	36	86	258	**380**
TOTAL	**95**	**107**	**378**	**580**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	306.209	**REAL PROPERTY**	25.897
ADMIN	106.005	* NEW CAPITAL EQUIPMENT	0.000
OTHER	85.639	**EQUIPMENT**	12.645
TOTAL	**497.853**	* NEW SCIENTIFIC & ENG. EQUIP.	1.813
ACRES	**8**	* Subset of previous category.	

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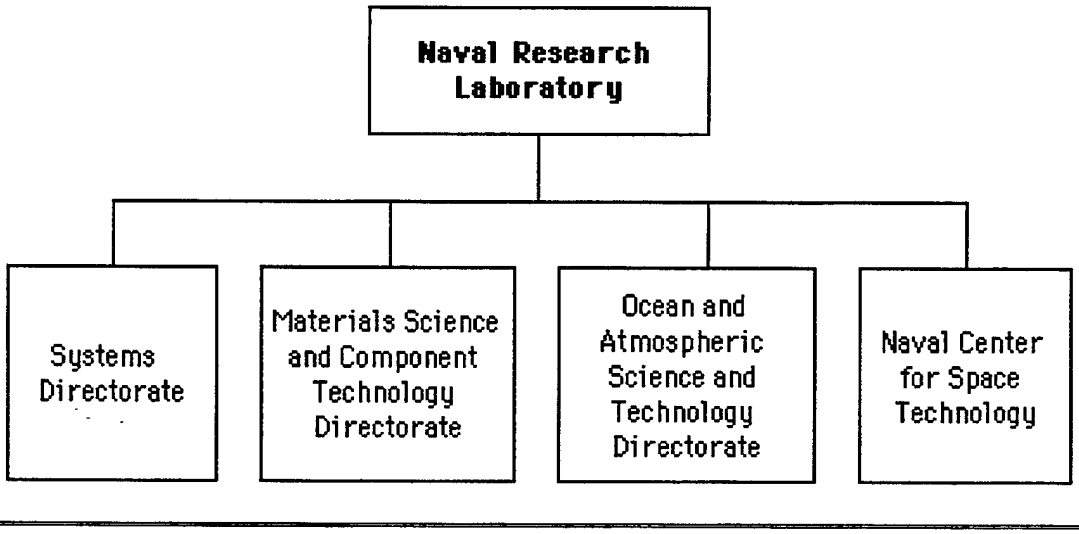
Naval Research Laboratory

FY1999 Abbreviated Functional Chart - Technical Organizations



Naval Research Laboratory
Washington, DC 20375-5320
(202)767-2541

Commanding Officer: CAPT Douglas H. Rau
Director of Research: Dr. Timothy P. Coffey

MISSION

Operate as the Navy's full spectrum corporate laboratory. To conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, equipment, systems and ocean, atmospheric, and space sciences and related technologies. In fulfillment of this mission, the Naval Research Laboratory:

(1) Initiates and conducts broad scientific research of a basic and long-range nature in scientific areas of interest to the Navy.
(2) Conducts exploratory and advanced technological development deriving from or appropriate to the scientific program areas.
(3) Within areas of technological expertise, develops prototype systems applicable to specific projects.
(4) Assumes responsibility as the Navy's principal R&D activity in areas of unique professional competence upon designation from appropriate Navy or DoD authority.
(5) Performs scientific research and development for other Navy activities and, where specifically qualified, for other agencies of the Department of Defense and, in defense-related efforts, for other Government agencies.
(6) Serves as the lead Navy activity for space technology and space systems development and support.
(7) Serves as the lead Navy activity for mapping, charting, and geodesy (MC&G) research and development for the National Imagery and Mapping Agency.

LEADERSHIP AREAS: NRL, the Navy's single, integrated corporate laboratory, provides the Navy with a broad foundation of in-house expertise from scientific through advanced development activity. Specific leadership responsibilities and expertise are maintained in the following areas:

(1) Primary in-house research for the physical, engineering, space, and environmental sciences.
(2) Broadly based exploratory and advanced development program in response to identified and anticipated Navy needs.
(3) Broad multidisciplinary support to the Naval Warfare Centers.
(4) Space and space systems technology, development, and support.

CURRENT IMPORTANT PROGRAMS

Multistatic Active Sonar Technologies (MAST); Environmentally Adaptive Sonar Technologies (EAST); Revolutionary Imaging Technology Program; High Resolution Ocean Prediction Systems; Targeted Observation Studies for Improving Atmospheric Predictability; Upper Atmospheric Program; NULKA Decoy, a joint program with the Government of Australia for the development of an active decoy to combat anti-ship missiles; Multi-Function EO/IR Countermeasure System (MEIRCMS) provides for ship self defense against modern EO/IR anti-ship imaging or operator guided missile systems; Advanced Multifunction RF System (AMRFS) combines shipboard Radar, ECM, and Communication functions into a common set of antennas.; Integrating machine learning and sensing human/robot interfaces.; 6.1 angstrom material for countermeasure lasers, low voltage high frequency RF solid state devices and IR focal plane arrays; Magnetoelectronics for nonvolatile, radiation-hard, magnetic memories; Bio/molecular self assembly for development of advanced functional materials and sensors; Hyperspectral Remote Sensing Technology (HRST) demonstration and a passive microwave ocean WIND SATellite (WINDSAT); Full Sky Astrometric Mapping Explorer (FAME); Army Airborne Command and Control System (A2C2S); Discriminating Interceptor Technology Program (DTIP); Joint Combat Information Terminal/Joint Tactical Radio (JCIT/JTR).

CURRENT IMPORTANT PROGRAMS

CRADAs ACTIVE DURING FY99

Title: Electronic Support Systems Technology
CRADA Between NRL and AIL Systems, Inc.
The objective of this CRADA is to conduct basic advanced receiver research and evaluate innovative concepts.
Signed: 4 Jan 96
Expires: 4 Jan 2000

Title: Quantitative Mobility Spectrum Analysis for Hall Evaluation Software Package
CRADA Between NRL and Lake Shore Cryotronics, Inc.
The objective of this CRADA is to develop and make available to the semiconductor community a software package based on the Quantitative Mobility Spectrum Analysis (QMSA) algorithm for evaluating magnetic-field-dependent Hall and resistivity measurements. The package may be used either as a built in component of Lake Shore Hall instrumentation or in conjunction with data acquired by any other Hall system. By providing a more accurate and computer automated analysis algorithm than has been available previously, this CRADA will lead to significantly enhanced capabilities for routinely characterizing multiple electron and hole densities and mobilities in semiconductor samples, including bulk, thin film, and quantum well materials and devices. Suitable for use by both experts and non-experts, the product will benefit Navy, other DoD, industrial, and university laboratories and production facilities involved in the development and characterization of semiconductor materials and devices.
Signed: 23 Jul 96
Expires: 23 Jan 2000

Title: Naval Environmental Operational Nowcasting System
CRADA Between NRL and Empress Software, Inc.
The objective of this CRADA is to integrate the Naval Environmental Operational Nowcasting System software (a generic, machine independent database management interface software package which handles most of the meteorological and oceanographic data types over both UNIX and PC Systems) with the Empress relational database management system software, and create a user interface for easy access.
Signed: 13 Aug 96
Expired: 13 Aug 99

Title: An Agreement to Transfer Biological Material From a SRI International to the Naval Research Laboratory
CRADA Between NRL and SRI International
Purpose of Transfer: Determination of levels of sensitivity and specificity of upconverting phosphor labeled detector antibody preparations in a fiber optic waveguide biosensor device.
Signed: 29 Apr 96
Expired: 29 Apr 99

Title: Magnicon Development at ll.4Ghz
CRADA Between NRL and Omega-P, Inc.
The objective of the Parties to this Agreement is to conduct research on a high power, high gain, high efficiency X-band thermionic magnicon amplifier tube. The magnicon is an advanced scanning-beam microwave tube that was originally invented at the Institute for Nuclear Physics in the former Soviet Union. Specifically, the objective of this research is to develop a magnicon tube with a gain greater than 50 dB, a peak power of 50 MW at 11.4 GHz, a pulse length of 1 μsec, and an efficiency of greater than 50%. This technology would have a variety of potential Navy and/or DoD applications as a high efficiency replacement for klystron amplifiers in the frequency range of 0.5 to 12 GHz. The development of magnicon amplifier tubes integrates with other programs to develop advanced microwave sources for radars, remote sensing, and other applications. In addition, the advanced electron gun that will be developed as part of the program is an enabling technology for high power microwave tube development, and supports the development of klystrons, ubitrons, and linear beam devices, in addition to magnicons.
Signed: 10 Jul 96
Expires: 31 Dec 99

CURRENT IMPORTANT PROGRAMS

Title: Research on DNA Sequencing Using an Atomic Force Microscope
CRADA Between NRL and Stratagene
The objective of this Agreement is to carry out cooperative research and development relating to the measurement of forces resulting from breaking individual DNA base-pairs in a peeling configuration and to use such forces to directly sequence nucleic acids.
Signed: 12 Dec 96
Expired: 12 Dec 98

Title: Radiation Hardness in Thin Simox
CRADA Between NRL and Ibis Technology Corporation
The objective of this CRADA is to determine optimal processes parameters to maximize radiation hardness of thin box SIMOX.
Signed: 20 Feb 97
Expires: 1 Apr 2000

Title: Proof-of-Principle Experiment of the Vacuum Beat Wave Accelerator
CRADA between NRL and Omega-P, Inc.
The objective of the Parties to this Agreement is to conduct research on the Vacuum Beat Wave Accelerator (VBWA). VBWA is an efficient scheme of charged particle acceleration that can produce high energy particle beams in significantly shorter interaction distances. The utilization of processes that can accelerate particles in vacuum eliminates many difficulties encountered when an accelerating medium is used. Development of intense lasers and the study of their interaction with plasmas and electron beams are advanced technologies with many potential Navy and/or DoD applications. In addition to advancing the forefront of scientific research in the interaction of lasers with matter, this work could also lead to new technologies in areas such as material processing, manufacturing, and characterization. The VBWA proof-of principle experiment integrates with other on-going programs at NRL that utilize intense lasers and the RF electron gun facility.
Signed: 26 Nov 96
Expires: 31 Dec 99

Title: Fiber Bragg Grating Sensors Development
CRADA between NRL and Astro Technology, Inc.
The objective of this CRADA is to examine the use of fiber Bragg grating sensors in various applications where the use of electrically passive sensors is extremely important. These include strain monitoring in liquefied gas fuel composite tanks and strain monitoring of rocket motor casings and nozzles in long term storage, and static motor testing. The CRADA will result in field testing of instrumentation in these application areas, which will enhance the understanding and knowledge of distributed strain sensor systems for other closely related Navy and DoD applications.
Signed: 29 Oct 96
Expired: 29 Oct 98

Title: Private Communications Using Chaotic Dynamical Systems
CRADA Between NRL and Dynetics, Inc.
The objective of this CRADA is to develop a prototype device and/or a market product that uses chaotic dynamics in electronics circuits to achieve a functional private or secure communications system. Research and development will focus on more secure approaches to encoding or masking information with chaotic waveforms than the simple approaches that have been tried thus far in the field.
Signed: 7 Feb 97
Expired: 7 Feb 99

Title: Fiber Optic Sensor Techniques for Blood Glucose Measuring Instruments
CRADA between NRL and Sunshine Medical Instruments, Inc.
The objective of this CRADA is to investigate modulation methods and devices for use with polarized light to improve the performance of Sunshine's prototype blood glucose measuring instruments.
Signed: 25 Nov 96
Expired: 25 Nov 98

CURRENT IMPORTANT PROGRAMS

Title: Ion Implantation Technology for GaN and Related Alloys
CRADA Between NRL and Implant Sciences Corporation
The objective of this CRADA is to develop and implement for device and IC fabrication an implantation technology for GaN and its related alloys.
Signed: 28 Jan 97
Expires: 28 Jan 2000

Title: Digital Library Research
CRADA Between NRL and Visual History Foundation
The objective of this CRADA is to conduct basic Digital Library Research and evaluate innovative concepts.
Signed: 3 Jul 97
Expires: 3 Jul 2000

Title: Liquid Crystal Material Research
CRADA Between NRL and Spatialight, Inc.
The objective of this CRADA is to couple NRL's electroclinic liquid crystal materials with the monocrystalline silicon active matrix substrates developed by Spatialight, Inc., and thereby develop and test high performance spatial light modulators for both military and commercial applications.
Signed: 5 Feb 97
Expired: 5 Feb 99

Title: High Power Fiber Amplifiers
CRADA Between NRL and Clark-MXR, Inc.
The objective of this CRADA is to test the suitability of a broad stripe diode pumped fiber amplifier to replace the Master Oscillator Power Amplifier (MOPA) pumped amplifier currently used in the Clark-MXR Erf stretched pulsed modelocked fiber laser. In the course of this work the characteristics of the amplifier will be modified to attain suitability. A further objective is to maintain a low-cost robust design of the laser amplifier. It is expected that with minor (if any) modifications the fiber amplifier developed at NRL will provide a substitute for the MOPA pumped amplifier at a substantially reduced cost.
Signed: 26 Jun 97
Expired: 6 Dec 98

Title: Diamond Based Materials Research
CRADA Between NRL and Diamond Microelectronics Corporation
The objective of this CRADA is to develop cost-effective diamond-based, high power/high frequency switches and assorted vacuum electronics.
Signed: 13 Mar 97
Expires: 13 Oct 2000

Title: Improved Methods for Generating Target Motion for Closed Loop Simulation Facilities
CRADA Between NRL and CARCO Electronics
The objective of this CRADA is to conduct joint research to gain a better understanding of CARCO's technology through participation in the testing and validation of the Dual Target Motion System at NASA's Ames Research Center. CARCO will conduct an extensive series of experiments/trials in Hanger 2 at the Ames Research Center to support the quantification, development, and verification of the Dual Target Motion System's performance. Data collected from these trials will be forwarded to NRL for analysis as to the credibility of the system for use in the conduct of advanced countermeasures research. NRL will review the data with special emphasis placed on the fidelity of target motion with respect to positioning accuracy and accelerations achieved. The results of this research activity will yield a fundamental understanding of the performance boundaries for such systems and the range of research topics to which low cost electromechanical systems could be applied as compared to higher cost of electronic systems.
Signed: 3 Apr 97
Expired: 3 Oct 98

CURRENT IMPORTANT PROGRAMS

Title: Development of Bi-Stable, High Resolution Reflective Display as a Memory Device
CRADA Between NRL and Opticom-ASA
The objective of this CRADA is to develop and build a bi-stable, high resolution reflective display using conducting polymer based plastic substrates and further, to explore technical issues involved with a high definition electrical read and write memory device using a bi-stable cholesteric display and conducting polymer substrates.
Signed: 18 Sep 97
Expired: 18 Nov 99

Title: Fiber Optic Seismic Systems
CRADA Between NRL and Optical Products, Inc.
The objective of this CRADA is to conduct basic studies and evaluate innovative concepts for fiber optic sensor systems for the marine exploration of oil and gas reserves. In particular, NRL has developed optical fiber technology for Navy towed array applications. The objective of this cooperative research is to develop and refine these fiber optic technologies for seismic applications.
Signed: 19 Nov 97
Expires: 19 Feb 2000

Title: Conversational Case-Based Reasoning Research
CRADA Between NRL and Inference Corporation
The objective of this CRADA is to evaluate possible extensions to IC's product line of CBR tools based on automated case authoring and case retrieval models. Specific goals are (1) to simplify the case authoring process so that users can more easily design and maintain high performance case libraries in diverse domains; and (2) to allow users to interact with probabilistic modeling tools so that they can improve the performance of case retrieval.
Signed: 9 Dec 97
Expires: 9 Dec 99

Title: Advanced Radar Modeling and Simulation Tool for Electronic Warfare Research
CRADA Between NRL and Photon Research Associates
The objective of the cooperative research is to develop a modular, reconfigurable, distributed, interactive radar simulation (RADSIM) that can be seamlessly integrated into the NRL ENEWS M&S framework.
Signed: 16 Jan 98
Expires: 16 Jan 2001

Title: X-Ray Absorption Analysis and Experiments
CRADA between NRL and PPG Industries, Inc.
The objective of this CRADA is to develop X-ray absorption spectroscopies (primarily X-ray Absorption Near-Edge Spectroscopy (XANES) and Extended X-ray Absorption Fine Structure (EXAFS) as tools suitable for studying low concentrations of key elements in glass and fiber glass, as well as coatings (such as automotive coatings) and other organic materials. Such information is intended to be used for analysis, quality control, and forensic science. A further objective is to explore the use of XANES and EXAFS as evidentiary tools in litigation.
Signed: 8 Oct 97
Expires: 8 Oct 2000

Title: Multi-Quantum Well Solar Cell Radiation Testing
CRADA Between NRL and University of Houston Space Vacuum Epitaxy Center
The objective of this CRADA is to study a new and very promising space cell technology, MultiQuantum Well (MQW) solar cells. These cells are currently being produced by the University of Houston, and NRL will take several cells, expose them to particle irradiation, and measure the radiation-induced degradation.
Signed: 17 Apr 98
Expired: 17 Apr 99

CURRENT IMPORTANT PROGRAMS

Title: Anti-Ship Cruise Missile (ASCM) Tactical Analysis Workstation Development
CRADA Between NRL and Sippican, Inc., Hycor Group
The objectives of this CRADA are: (1) To expand on HYCOR's tactical analysis workstation model to enable modeling of both RF and IR missile engagements; (2) To develop a graphical user interface that can be shared by both the RF and IR missiles; and (3) To perform initial verification and validation efforts on the PC-based workstation model.
Signed: 21 Apr 98
Expires: 21 Oct 2000

Title: On-Line Fiber Bragg Grating Implementation
CRADA Between NRL and Spectran Specialty Optics Company
The objective of this CRADA is to implement NRL's patented technology for producing fiber Bragg gratings in-line on the fiber draw tower in SSOC's Avon, CT facility. Under license from NRL, SSOC will manufacture and sell fiber Bragg grating arrays using NRL's patented technology.
Signed: 17 Apr 98
Expires: 17 Apr 2000

Title: Vertical Thin-Film-Edge Field Emitter Array Development for High Brightness Lamps
CRADA Between NRL and Applied Photonics Technology
The objective of this cooperative research program is to develop a prototype field emitter array for APT's application, based on NRL's invention, Navy Case No. 79,020, U.S. Patent Application No. 08/045853, filed 23 March 1998, entitled "Field Emitter Array with Vertical Thin-Film-Edge Emitters", David Hsu and Henry Gray, inventors. The prototype is intended for immediate transfer into a manufacturing environment; that is, the development work will be guided by cost, reliability, reproducibility and manufacturing considerations.
Signed: 4 Jan 99
Expires: 4 Jul 2001

Title: Commercial Development of Halloysite Controlled Release System
CRADA Between NRL and New Zealand China Clays, Ltd. (NZCC)
The objectives of this CRADA are: (1) To characterize the physical properties of existing feed stocks of NZCC materials to establish the fraction suitable for use at the least cost in a controlled delivery system; (2) To produce release rate data for both lipophilic and hydrophilic materials from selected feed stocks sufficient to provide NZCC with marketing materials and technical evaluation data for NZCC target customers; (3) To perform a market analysis for selection of initial target market; (4) To develop a best-practice paradigm for optimum production of halloysite tubules at the highest entrapment rate achievable with the production sample chosen; and (5) To develop engineering parameters for pilot plant production of commercial evaluation samples.
Signed: 27 Mar 98
Expires: 27 Mar 2000

Title: High Data Rate SATCOM Networks for Disadvantaged Users
CRADA Between NRL and Orion Network Services, Inc.
The objective of this CRADA is to develop HDR SATCOM technology using VSAT to support network connectivity to small platforms (ships, aircraft, forward deployed forces) and commercial installations where antenna size is a limiting factor. Additionally, bandwidth efficient modulations and efficient networking schemes will be developed to support efficient use of the satellite transponder asset.
Signed: 22 May 98
Expires: 22 May 2000

Title: Fast Recovery Time Nuclear Quadrupole Resonance Detection
CRADA Between NRL and Quantum Magnetics (QM)
The objective of this CRADA is to incorporate fast recovery time electronics into the NRL Nuclear Quadrupole Resonance (NQR) system, evaluate the potential for improvements over current methods of contraband chemical compound detection, then incorporate the improvements into QM NQR system.
Signed: 11 Mar 98
Expired: 11 Jun 99

CURRENT IMPORTANT PROGRAMS

Title: Meteorological Satellite Application System
CRADA between NRL and Seaspace Corporation
The objective of this CRADA is to permit the efficient and timely integration of state-of-the-art satellite meteorological application software from NRL at Monterey's research and development laboratory environment to Navy operations via SeaSpace's TeraScan software package.
Signed: 14 Aug 98
Expires: 14 Aug 2001

Title: Embedded Sensors for Space Applications
CRADA Between NRL and Cytec Fiberite, Inc.
The objective of this CRADA is to evaluate new composite materials and fabrication techniques for spacecraft components. In particular, the goals of the program are (1) To apply techniques developed at NRL for embedding fiber optic sensors to a commercial fabrication method for composite parts; (2) To produce and develop prototype spacecraft components with embedded sensors; and (3) To develop the tooling and techniques required for commercial fabrication of spacecraft components with embedded sensors.
Signed: 24 Feb 98
Expired: 24 Feb 99

Title: Germanium Strip Detector System for X-Ray and Gamma-Ray Spectrometry and Imaging
CRADA Between NRL and Physical Sciences, Inc.
The objectives of this CRADA are: (1) Develop a 16 channel Application Specific Integrated Circuit (ASIC) with multiplexed output and improved features from current NRL 2-channel chip set; (2) Demonstrate low noise, multi-channel readout of Germanium Strip Detectors (GSD) using the new ASIC; (3) Develop new contact technology to replace Li diffused contacts on GSD; (4) Demonstrate 0.5 mm pitch GSD; (5) Integrate GSD and new electronics into a demonstration system; and (6) Conduct an assortment of tests to prove the utility of this technology to NASA and potential future sponsors and customers.
Signed: 4 May 98
Expires: 8 Nov 2000

Title: Virtual Enterprise Endeavor
CRADA Between NRL and Husky Labs
The objective of this CRADA is to provide a simple, easily enhanced medium which will allow NRL to acquire certain expertise in the development of the Virtual Enterprise capability for Navy programs. Utilizing NRL's experience with Navy requirements for Virtual Enterprise applications, and Husky Labs' experience with the Chakra product development, a customizable interface will be developed that is expected to ease information flow and decision-making in the coming century.
Signed: 9 Apr 98
Expired: 9 Oct 99

Title: Improved Electronic Access to Journals Published by the American Institute of Physics
CRADA Between NRL and American Institute of Physics (AIP)
The objective of this CRADA is for NRL and AIP to work together to improve electronic access to AIP-published journals. AIP will provide to NRL a group of older AIP core archival and translation journals. NRL will digitize these journals by scanning their contents into high quality PDF files. The digitized versions of these older archival journals can be made available, for example on the Web, in an electronic formal consistent with that of more recently published journals.
Signed: 14 Oct 98
Expires: 31 Dec 99

Title: Multi-Channel Integrated Optic Phase Modulators
CRADA Between NRL and Dylor Corporation
The objective of this CRADA is to build an integrated optic device with multiple phase modulation channels, capable of independent broadband operation to ~20 GHz. In particular, the goal is fabrication of an 8-channel modulator where operation of all 8 channels (4 on each side of the chip) can be

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demonstrated. The prototype device demonstration will be considered a success if functional operation of 4 channels whose electrodes all terminate on one side of the chip can be demonstrated. This successful demonstration will likely lead to subsequent collaboration. A further objective is for NRL to transfer to Dylor the technology and information necessary for them to produce such devices commercially.
Signed: 4 May 98
Expires: 4 Jan 2000

Title: Optical Marking
CRADA Between NRL and Biocode Corporation
The objective of this CRADA is the development of a class of covert inks that can be applied to both porous and non-porous surfaces using conventional printing technologies. The inks will be invisible to the naked eye but will be visualized in a discrete manner using an inexpensive, handheld infrared viewer. Several wavelength bands in the infrared will be used by selecting chemicals that have distinct absorption properties. Absorption of light at each distinct band will be detected using appropriate optical bandpass filters. This frequency agility will provide an acceptable level of security for a wide range of commercial products.
Signed: 27 Mar 98
Expired: 27 Nov 99

Title: Development of Commercial Towed-Array System Including a Man-Portable Multisensor Towed Array System (MTADS) Adjunct for Survey of Hazardous Metallic Material
CRADA Between NRL and Geometrics, Inc. (GEO)
The objectives of this CRADA are: (1) The transfer of NRL's MTADS technology to GEO to allow manufacture and full implementation of one unit of a commercial towed array system for location and identification of buried metallic hazardous material such as unexploded ordnance. Such a system is in high demand by the Department of Defense for survey and characterization of current and former military ranges; and (2) The joint development and building by NRL and GEO of one unit of a man-portable adjunct to MTADS. This system will allow GEO to provide commercial services in areas where the vehicular MTADS cannot perform normally.
Signed: 30 Sep 98
Expires: 30 Sep 2001

Title: Boundary Element and Finite Element Models for the Application of Nearfield Acoustic Holography
CRADA Between NRL and Automated Analysis Corporation
The objective of this CRADA is to develop and validate a robust algorithm to identify a noise source based on sound pressure measurements on a surface with an arbitrary shape.
Signed: 29 Jun 98
Expires: 29 Jun 2000

Title: Development of Metal-Insulator-Metal Ensemble Materials for Chemical Sensing
CRADA Between NRL and Microsensor Systems, Inc.
The objective of this CRADA is to explore organic ligand stabilized metal clusters as the critical absorbent and transducer element in a new class of solid-state vapor sensors.
Signed: 18 May 98
Expires: 18 Dec 2000

Title: Fiber Optic Sensors for Oil Exploration
CRADA Between NRL and Schlumberger Technology Corporation (STC)
The objective of this CRADA is to develop high performance fiber Bragg grating sensor systems for oil exploration and production for land and offshore applications. STC has also licensed the Navy's high performance fiber Bragg grating interferometric receiver system and desires to develop state of the art sensor systems using this license rapidly.
Signed: 12 Aug 98
Expired: 12 Aug 99

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Title: Investigation of Geobat Concept for Naval Applications
CRADA Between NRL and Geobat-FS Aviation, Inc.
The objectives of this CRADA are: (1) To obtain a greater understanding of the fluid flow and the aerodynamic characteristics of the Geobat concept via wind tunnel testing; (2) To understand the effects of scaling the concept, thereby obtaining an understanding of the suitability of the concept for Naval/DOD/military applications; (3) To obtain an improved, more efficient aircraft design using the Geobat concept; and (4) To verify the improved design through limited radio controlled flight tests.
Signed: 13 Jul 98
Expired: 13 Apr 99

Title: Industrial Applications of Mie Scattering
CRADA Between NRL and Rohm & Haas, Inc.
The objective of this CRADA is to adapt NRL-developed wave propagation and scattering algorithms and computer programs to compute the field of light scattered by irregularly-shaped colloidal particles whose size is comparable to the wavelength of the light (Mie scattering).
Signed: 30 Jun 98
Expired: 31 Aug 99

Title: X-Ray Fluorescence Analysis of Cobalt Fluorides
CRADA Between NRL and Mine Safety Appliances Company
The objective of this CRADA is to develop optimal sample preparation and data analysis methods for determining the fluorine content of cobalt fluorides using XRF.
Signed: 27 Jul 98
Expired: 27 Jul 99

Title: Development of the Matrix Assisted Pulsed Laser Deposition (MAPLE) Direct-Write Approach to Circuit and Sensor Element Fabrication
CRADA Between NRL and Potomac Photonics, Inc.
The objective of this CRADA is to carry out the cooperative research necessary to develop the MAPLE laser-writer approach to direct-writing of circuit and sensor elements into a system which will meet the specifications of the DARPA MICE program.
Signed: 27 Jul 98
Expired: 27 Jul 99

Title: Structural Acoustics of Aircraft Interiors
CRADA Between NRL and Cessna Aircraft Company
The objective of this CRADA is to carry out research toward the development of a structural acoustic model of aircraft interior acoustics with the ultimate goal of creating design guidance and tools for a quieter business jet.
Signed: 12 Aug 98
Expires: 12 Aug 2000

Title: Development of High-Power, Long-Pulse, Large-Diameter, Annular Electron Beam Diodes for Microwave Generation
CRADA Between NRL and Mission Research Corporation
The primary objective of this CRADA is to conduct research to develop practical, reliable electron beam diodes that can power gigawatt-class relativistic kystrons for pulse durations of at least a microsecond. Secondary objectives are to develop a better understanding of the physical processes responsible for limiting pulse duration in high-power electron beam diodes and to demonstrate approaches to overcome these problems.
Signed: 13 Aug 98
Expired: 13 Feb 99

Title: Measurement and Analysis of the Radiation Response of InGaP/InGaAs Solar Cells in Terms of Displacement Damage Dose
CRADA Between NRL and Essential Research, Inc. (ERI)

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The objective of this CRADA is to study the radiation response of ERI's innovative solar cell technology consisting of InGaP/InGaAs dual-junction semiconductor layers with bandgaps tailored to match the solar spectrum. In particular, the bottom InGaAs cell of the dual-junction technology will be investigated in-depth. The specific goal of this collaboration is to gain an understanding of the basic radiation response mechanisms for this new cell technology. The ultimate goal of the research is to develop high efficiency, radiation-hard solar cells that may be used in space-based systems such as those used in communications, navigation, environmental monitoring (oceanography, weather, topography), surveillance for over-the-horizon targeting support, tactical warning, and situational awareness/monitoring.
Signed: 12 Aug 98
Expires: 12 Aug 2000

Title: Evaluation of the Sweat Patch Substance of Abuse Detector for Alcohol Detection
CRADA Between NRL and Pro Tech Monitoring, Inc.
The objective of this CRADA is to transfer the Sweat Patch Substance of Abuse Detector technology to the marketplace. Specific goals include modification of the frequency of the Sweat Patch Substance of Abuse Detector transmitter, evaluation of the ability of the detector to detect alcohol and identification of the level of effort required to optimize detection of cocaine, opiates, and amphetamines.
Signed: 28 Sep 98
Expired: 28 Sep 99

Title: Leo One Advanced Satellite System Development
CRADA Between NRL and Leo One USA, Inc.
The objective of this CRADA is to apply NRL's expertise and technologies such as gravity-gradient stabilization employing active magnetic control, tethered wire de-orbit techniques, and multi-satellite constellation phasing and maintenance techniques to the Leo One low earth orbiting satellite constellation for non-voice messaging and paging services.
Signed: 12 Aug 98
Expired: 12 Feb 99

Title: Commercial Radiation-Tolerant Deep Submicron CMOS Microelectronics
CRADA Between NRL and Mission Research Corporation
The objectives of this CRADA are: (1) To implement and optimize minimally invasive process and design methodologies to improve the radiation tolerance of commercial deep submicron CMOS microelectronics, including the preparation of test samples using these techniques; (2) To assess the scaleability of these approaches to evolving CMOS technologies; and (3) To perform total dose radiation effects testing on test structures, including capacitors, transistors, and circuits.
Signed: 8 Sep 98
Expires: 8 Jul 2001

Title: Space Global Positioning System Technology
CRADA Between NRL and Innovative Concepts, Inc.
The goal of this cooperative research program is to design a space-qualified global positioning system (GPS) receiver capable of operating in low earth orbit in a high radiation dosage environment. Initial work will be directed toward a Standard Positioning Service (SPS) receiver with basic GPS performance. The design will include sufficient flexibility to allow the basic capability to be enhanced later to Precise Positioning Service and higher precision measurements and navigation.
Signed: 23 Oct 98
Expired: 23 Apr 99

Title: Polymer Selection and Deposition Techniques For Resistive and Capacitive Mode Chemical Sensor Arrays
CRADA Between NRL and Cyrano Sciences, Inc.
The objective of the study is to determine the optimum materials and deposition techniques for the fabrication of chemically sensitive resistor arrays with particular focus on the rapid detection of TNT.
Signed: 20 Apr 99
Expires: 20 Apr 2000

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Title: Radiation Dosimetry Badges Using Optically Stimulated Luminescence Glass
CRADA Between NRL and ICN Biomedicals, Inc.
The objective of this cooperative research program is to determine if the optically stimulated luminescence (OSL) dosimeter developed at the NRL can be a commercially viable radiation dosimeter that may be subsequently offered for sale by ICN. The OSL dosimeter must satisfy a number of requirements to be considered for commercialization as follows:

(1) The OSL dosimeter must have the appropriate density and thickness to allow accurate measurement of shallow dose equivalent (SDE), eye dose equivalent (EDE) and deep dose equivalent (DDE) resulting from exposure to beta, gamma, and X-ray radiation;
(2) The sensitivity of the dosimeter should permit measurement of 1.0 mrem or lower over a period of up to nine months, measured using standard National Voluntary Laboratory Accreditation Program (NVLAP) and Department of Energy Laboratory Accreditation Program (DOELAP) beta, gamma and X-ray radiation energy ranges;
(3) The OSL dosimeter will have average fading of 3% per month or less compared to the reading obtained at 48 hours after exposure;
(4) The OSL dosimeter can be used repeatedly without changes in the sensitivity;
(5) The OSL dosimeter will be resistant to ambient environmental influences including moisture, temperature and dirt. Note that the OSL glass is light sensitive and must be protected from unwanted light exposure. The ruggedness of the OSL dosimeter will be a function of the plastic housing and not the OSL glass.
(6) The dosimeters constructed using OSL material will be mechanically rugged and will not break if dropped from the height of two meters to a hard, unyielding surface;
(7) The OSL dosimeters will have uniform quality;
(8) The OSL dosimeters can be fitted into existing Panasonic or Harshaw TLD badges and the badges can be read on existing readers with minimum modifications.

Signed: 20 Nov 98
Expired: 20 May 99

Title: Field Emitter Array Development for Power Grid Switching Applications
CRADA Between NRL and Diamond Microelectronics Corporation
The major objectives of this cooperative research program are the following: (1) Demonstrate that the NRL vertical thin-film-edge field emitter array (FEA) can be fabricated into a working device by using a high resistivity n-type silicon substrate; (2) Demonstrate 5 microamperes DC per cell from a small array of FEA cells; and (3) Demonstrate an emission area uniformity of 50% from a small array of FEA cells.
Signed: 9 Nov 98
Expires: 9 Dec 99

Title: Advanced Receiver and Signal Processing Research
CRADA Between NRL and Lockheed Martin Corporation - Ocean, Radar and Sensor Systems (LM-OR&SS)
The objective of this cooperative research program is for NRL and LM-OR&SS to design, develop and demonstrate an advanced receiver/signal processor for use in performing Electronic Warfare Support Measures functions. In particular, the goal of this integration experiment is to demonstrate the potential for improved performance through combined application of advanced receiver concepts and digital signal processing. Furthermore, reducing size and projected cost will be demonstrated within a single printed circuit board implementation, which will be functionally validated by NRL to be compliant with applicable requirements and national standards.
Signed: 1 Apr 99
Expires: 1 Apr 2002

Title: Inorganic-Organic Hybrid Polymers for Aircraft Engine Applications
CRADA Between NRL and United Technologies Corporation-Pratt & Whitney Division
The objective of this cooperative research program is to synthesize, characterize and test the high temperature properties of a series of inorganic-organic hybrid polymers in order to assess their suitability for application in aircraft components that must withstand high temperatures. A further objective is to develop scaled-up synthesis, curing and molding procedures in anticipation of commercialization.
Signed: 30 Mar 99 / Expires: 30 Sep 2000

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Title: Advanced Shipboard IR Decoy Development
CRADA Between NRL and Sippican, Inc. - Hycor Products Group
The objectives of this cooperative research program are to: (1) Develop an advanced decoy to enhance the performance of a selected shipboard IR decoy, as mutually agreed between NRL and Sippican; (2) Develop alternate payload materials for IR decoys with the required spectral, temporal and intensity time requirements; (3) Devise new payload deployment techniques; (4) Fabricate prototype hardware devices; and (5) Perform tests and evaluation of prototype hardware against current threats and possible future threat technologies.
Signed: 13 Apr 99
Expires: 13 Apr 2000

Title: Project Starshine
CRADA Between NRL and Utah State University (USU)
The objective of this cooperative research program is for NRL and USU to support the construction and orbit of the Starshine satellite as part of the Project Starshine educational program to give school-age children hands-on experience with space science.
Signed: 8 Mar 99
Expires: 8 Mar 2002

Title: Foreign Asset Exploitation Support
CRADA Between NRL and Jaycor
The objective of this cooperative research program is for NRL and Jaycor to work together to develop electronic attack techniques to defend against threat assets.
Signed: 20 Apr 99
Expires: 20 Apr 2000

Title: Demand Assigned Multiple Access/High Frequency (DAMA/HF) Waveform Development
CRADA Between NRL and Rockwell Collins Government Systems (RC)
This cooperative research program is aimed at three objectives.

- First, RC will develop two application programs that will run on the Joint Combat Information Terminal (JCIT) hardware. These application programs will give the JCIT the capability to emulate an ARC- 220 and a SATCOM DAMA radio. This will give the Army additional waveform capabilities without having to make a significant capital investment.
- Second, although RC has a number of experts who are familiar with the functions of ARC-220 and SATCOM DAMA radios, they are new to the area of software programmable radios. NRL will provide them a test bed and instruction on the operation and design of software programmable radios. This will significantly help them to develop a software programmable radio capability and get new products to the market.
- Finally, by exposing RC to the JCIT architecture and infrastructure, NRL increases the possibility of a major radio vendor adopting the JCIT architecture and successfully transitioning the lessons learned from the Army Airborne Command and Control System (A2C2S)/JCIT development to industry.

Signed: 9 Apr 99
Expires: 9 Apr 2001

Title: Blossom Point Dual Use Technology Study
CRADA Between NRL and AlliedSignal Technical Services Corporation (ATSC)
The objectives of this cooperative research and development agreement are to study and report the feasibility of transferring ground station technology developed by NRL to ATSC and to compare capabilities available at the Blossom Point facility with the requirements of a ground station in the DataLynx® network. The feasibility of sharing resources available at the NRL facility with a private company will also be determined.
Signed: 17 Aug 99
Expires: 17 Dec 99

CURRENT IMPORTANT PROGRAMS

Title: Advancing the Development of a YSI Microfluidic Sensor Platform
CRADA Between NRL and YSI, Inc.
The objective of this study is to determine the optimum deposition techniques for the fabrication of a biosensing microfluidic platform with particular focus on a glucose sensing application.
Signed: 20 May 99
Expires: 20 Feb 2001

Title: Vertical and Near-Vertical Alignment of Liquid Crystals
CRADA Between NRL and SpatiaLight, Inc.
The objective of this research is to develop and optimize a method for fabricating alignment layers with perpendicular or near-perpendicular orientation for liquid crystal displays.
Signed: 7 Apr 99
Expires: 7 Apr 2000

Title: Nuclear Magnetic Resonance of Deep-Sea Gas Hydrate Formation
CRADA Between NRL and Monterey Bay Aquarium Research Institute (MBARI) and Schlumberger Technology Corporation (STC)
The research has the following objectives: (1) To explore a fundamentally new approach using Nuclear Magnetic Resonance (NMR) to investigate gas hydrate formation over long durations in the marine environment; (2) To begin providing experimental results that can be used to assess the realism of theoretical models of hydrate formation based on considerations of fluid flow in porous media, etc.; (3) To gain experience for future possible applications from the first use of NMR in the deep-sea environment.
Signed: 23 Sep 99
Expires: 23 Sep 2000

Title: Tripod Operators for Determining the Pose of Industrial Parts in Six Degrees of Freedom (6-DOF)
CRADA Among NRL and the following Non-Navy Parties:
Perceptron, Inc., The Ford Motor Company, Microdexterity Systems, Inc., and the National Center for Manufacturing Sciences, Inc. The objective of this research is to develop software which can, using range data, estimate the pose in Six Degrees of Freedom (6-DOF) of an industrial part with sufficient accuracy and speed to allow the successful and timely grasping of palletized parts during an automotive assembly operation.
Signed: 28 Sep 99
Expires: 28 Sep 2000

Title: Fiber-Optic Oil Well Sensors
CRADA Between NRL and Halliburton Energy Services, Inc.
The objective of this research is to develop a high-performance fiber optic sensor system for monitoring conditions in oil wells, particularly pressure and temperature.
Signed: 15 Jul 99
Expires: 15 Jul 2000

Title: Digital Emergency Medical Service Satellite Networking
CRADA Between NRL and The University of Texas Health Science Center at Houston
The objective of this research is to develop a prototype satellite-networked system capable of two-way audio, video, and data communication between an ambulance and a hospital trauma center, and to test it in the Houston area with the Digital Emergency Medical Services network.
Signed: 5 Aug 99
Expires: 5 Feb 2000

CURRENT IMPORTANT PROGRAMS

Title: Displacement Damage Dose Analysis of the Radiation Response of Multi-Junction Space Solar Cells
CRADA Between NRL and Lockheed Martin Missiles and Space
The objective of this research is to characterize the radiation response of state-of-the-art solar cell technologies and to provide damage analysis that can be used to both predict on-orbit performance and provide feedback for optimizing such performance.
Signed: 20 Jul 99
Expires: 20 Feb 2000

Title: Ka-band Phased Array Antenna
CRADA Between NRL and Paratek Microwave, Inc.
The objective of this CRADA is to demonstrate a phased array antenna that operates at Ka-band frequencies based on a voltage-tunable dielectric lens.
Signed: 27 Sep 99
Expires: 27 Sep 2000

Title: LOCUTUS Software Support
CRADA Between NRL and Fred Griswold Engineering, Inc.
The objective of the Parties to this Agreement is to develop a bug-free, accurate, user-friendly program with non-critical hardware demands. Each party will provide expert consultation and technical data to the other, with the intent to integrate the Local User Terminal Upgrade System (LOCUTUS) with a number of Local User Terminals (LUTs) that are tuned into the frequency of antennae or receiving dishes of Low Earth Orbit (LEO) satellites. If the cooperative R&D is successful, NRL-SSC will transition a Graphic User Interface (GUI) to the Naval fleet to enhance tactical operations through the manipulation of oceanographic and meteorological data on a real-time basis in a combat or exercise environment. FG intends to market LOCUTUS-based LUTs to university and Government scientists who acquire environmental data for LEO satellites, and to the commercial fishing industry.
Signed: 19 Nov 96
Expired: 19 Nov 99

Title: Deep-Towed Acoustic/Geophysical System
CRADA Between NRL Stennis and Seafloor International, Inc. (SSI)
The objective of this cooperative research is to improve the State of the Art of Deep-Towed Acoustic/Geophysical System (DTAGS) and the SSI developed Integrated Short Base Line (ISBL) navigation systems through research. Joint research between the Parties will determine whether coupling the DTAGS with the ISBL would improve the geographical accuracy of NRL's seismic seafloor data interpretation. The joint research would also evaluate whether the ISBL is suitable for deep ocean applications. A second objective of the research is to publish peer-reviewed articles related to basic research and exploratory development achieved cooperatively by the Parties. The goal of the research is to improve the knowledge of seafloor environmental features for Naval operations.
Signed: 9 Oct 96
Expires: 10 Oct 2002

Title: Marine Geophysical Systems
CRADA Between NRL and C&C Technologies, Inc.
The objective of the cooperative research is to optimize geoscience software and instrumentation for naval mine countermeasure missions and for commercial applications related to the petroleum and telecommunications industries. Software and instrumentation will be made user friendly to facilitate commercialization.
Signed: 10 Jan 97
Expires: 10 Jan 2000

EQUIPMENT/FACILITIES

Radar Signature Calculation Facility: NRL has a unique capability to generate computer models of very large and complex objects such as ships, and to calculate, analyze, and visualize radar signatures such as total radar cross section (RCS), high range resolution profiles, and inverse synthetic aperture (ISAR) images.

Virtual Reality (VR) Laboratory: A $1M state-of-the-art facility for research in virtual and augmented reality, computer graphics, visualization, and human-computer interaction for VR. Includes our GROTTO (a version of the CAVE[tm], i.e., a fully immersive 10X10X10-foot room), two VR Responsive Workbenches (a VR technique pioneered at NRL), head-mounted displays and other VR-related hardware.

Fleet Information Systems Security Laboratory: Used for experimentation and prototype development of future Fleet INFOSEC systems. It contains a wide variety of commercial and government-developed information security products, including multi-level secure workstations, secure local area networks, firewalls, intrusion detection systems, cryptographic devices, etc.

NRL IR Range Facility: The NRL IR Range facility consists of an ultra-dry atmosphere chamber with temperature controlled earth and & sky shrouds, versatile target mount, a mid-wave IR solar simulator, and an extended IR camera port spanning lines-of-sight from -20 to +20 degree. The facility can be used to characterize the IR signatures of scale models and test panels in a lock-down secure mode. (a) Shared Reconnaissance Pod to develop a digital framing dual band camera with a data link for real time image transmission. (b) The NRL Missile Countermeasure Facility develops and evaluates techniques for defeating missile threats to US aircraft. The facility assesses actual threat seeker hardware on a rate table to introduce the effects of free flight. Target aircraft signatures can be presented to the missile as two-dimensional images and change scale and aspect as the missile approaches and the aircraft maneuvers. Both on-board and expendable countermeasures are evaluated.

Central Target Simulator (CTS) Facility: CTS is a unique hardware-in-the-loop facility for the development and testing of EW systems and techniques used to counter the anti-ship missile threat. The facility operates in the 2 to 18 gHz frequency band with an antenna array whose field-of-view is 18.75° in elevation and 78.75° in azimuth. The facility employs a Silicon Graphics, Challenger Series, Work Station as its main processor coupled to a series of PCs. A radar seeker is mounted on a CARCO Three Axis Flight Table which represents the missile body. Closed-loop testing replicates all aspects of an ASM engagement thereby permitting EW effectiveness assessments to be performed.

Acoustic Pool Facilities: Three tanks filled with deionized water or sea-water, with in-water robotic scanners generating nearfield acoustic holography and 3-D laser vibrometry radiation and scattering databases for studying submarine and mine structural acoustics and ocean bubble phenomena and acoustic interactions.

High Frequency Acoustics At-Sea Measurement Systems: High-speed tow body system instrumented with 2 high-frequency side looking steerable sonar arrays operating over the frequency range of 75 to 450kHz. The system also has internal motion sensing (IMU) systems and a 1.2Mhz downward looking ADCP.

Navy Prototype Optical Interferometer (NPOI): Located near Flagstone, AZ, the world's largest first and only full coherent and operational imaging optical interferometer capable of high precision astrometric measurements as well as stellar imaging.

Sealab: An advanced processing facility for national systems imagery entirely devoted to S&T and development of new environmental measurement applications. It is capable of processing all current systems data and is also used for testing new systems concepts and data types

EQUIPMENT/FACILITIES

NRL's Ocean Research Laboratory (MILCON PROJECT P-006): A 52,000 square foot building located at Stennis Space Center, Mississippi, houses the Oceanography Division. The building has office spaces, oceanographic laboratories, staging area, a small machine shop, electronic and secure laboratories and computing facilities for research and development in ocean science and remote sensing. The facility was occupied 15 NOV 99 and its Dedication Ceremony was held 22 NOV 99.

Ocean Color Lab: Has the ability to receive line of site data from NOAA (AVHRR) and NASA SeaWiFS satellites. Only Navy facility to directly receive SeaWifs. Provides real-time visible (including color) and thermal infrared to investigators studying physical, optical and biological processes in coastal and open ocean areas of the globe.

Instrumented Mine: NRL has developed, tested, and demonstrated the capability to measure movement (changes in roll, pitch, heading) and percent burial (72 optical sensors) of mine-like shapes. These measurements allow the in situ characterization of mine burial during and at impact and by subsequent burial by scour, sediment dune migration, seafloor liquefaction, or beach slope alternation.

Acoustic Seafloor Classification System (ASCS): A narrow beam echo sounder with software for real-time processing of the reflected signal to predict sediment physical and geotechnical properties. The technology is adapted to mine burial prediction and, through a CRADA with C&C Technologies of Lafayette, Louisiana, to cable and pipeline route surveys.

Tactical Atmospheric Modeling System/Real Time (TAMS/RT): Deployable atmospheric prediction system which consists of 3 computers and software: (1) SGI Origin 2000 computational server which runs the COAMPS prediction system (2) HP 0200 database server which runs the NRL Tactical Environmental Data Server (TEDS) (3) SGI 02 graphic console which runs the graphical user interface, web server, and visualization software

Large Angle Spectrometric Coronagraph (LASCO) and Extreme Ultraviolet Imaging Telescope (EIT): Located in solar orbit at a position between the Earth and Sun, on the Solar and Hemispheric Observatory (SOHO) spacecraft, providing continuous monitoring of the Sun to provide an early warning of pending disruptive solar phenomena.

Nanoelectronics Processing Facility: A state of the art nanometer and micrometer fabrication and materials processing facility identified as the Nanoelectronics Processing Facility, specializing in design and fabrication of structures and devices in a class 100 clean environment for development of microelectronics and nanoelectronics technologies. The "center pieces" of the Facility are two JOEL electron beam nanowriters.

Trace Element Accelerator Mass Spectrometer Facility: An unique Trace Element Accelerator Mass Spectrometer Facility includes a Finnigan TSQ-70 triple quadrupole mass spectrometer with particle bombardment, electrospray, atmospheric pressure chemical ionization, thermal desorption, and electron ionization.

EPI Center
A completely instrumented EPI Center provides molecular beam epitaxial (MBE) film growth and in situ characterization of Group II-VI and Group III-V semiconductors.

Naval Research Laboratory
Washington, DC 20375-5320
(202)767-2541

Commanding Officer: CAPT Douglas H. Rau
Director of Research: Dr. Timothy P. Coffey

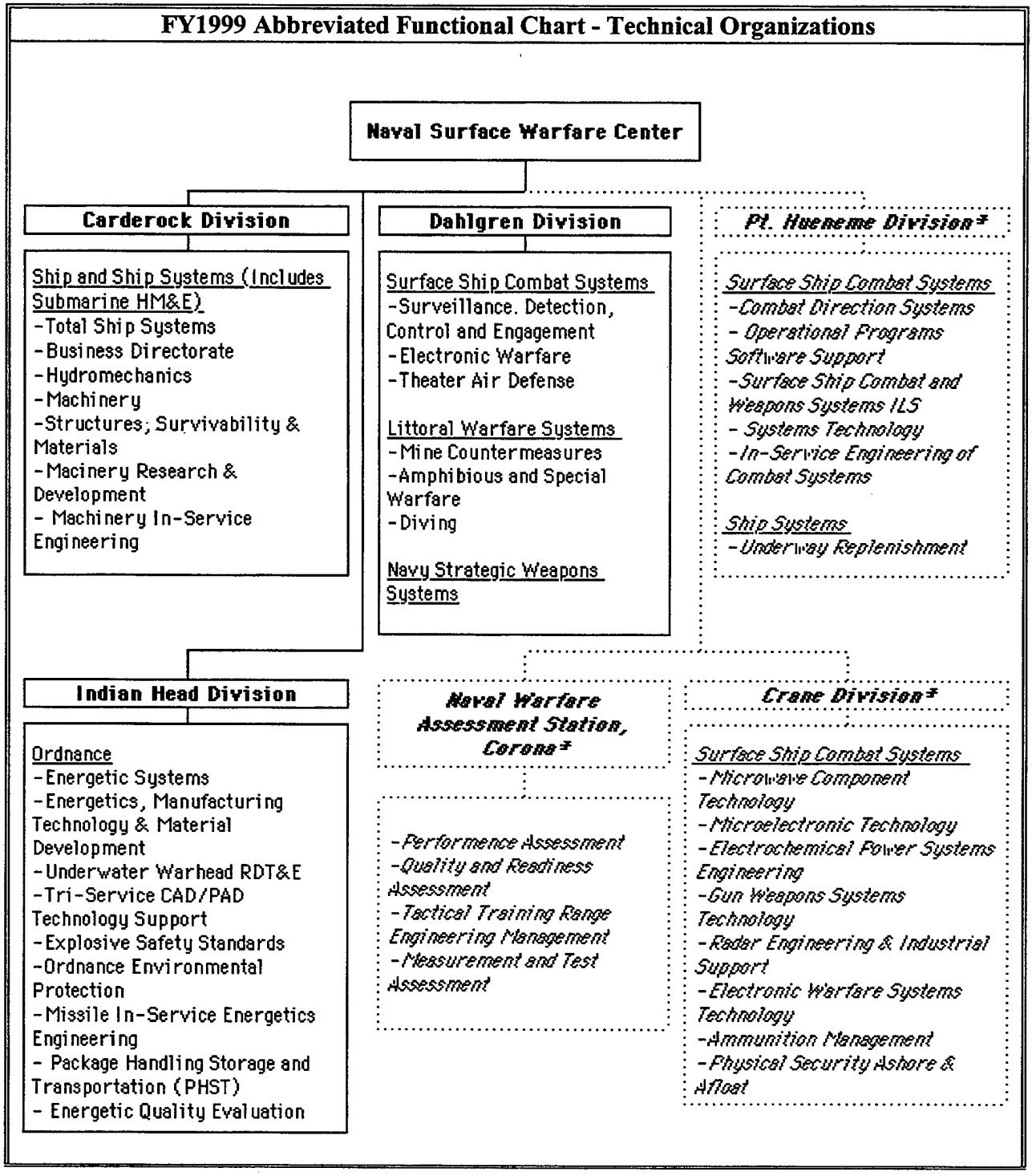
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	0.000	0.000
6.1 Other	82.977	N/A	14.067	97.044
6.2	77.212	N/A	52.796	130.008
6.3	82.592	N/A	115.979	198.571
Subtotal (S&T)	**242.781**	**N/A**	**182.842**	**425.623**
6.4	13.212	N/A	26.143	39.355
6.5	10.072	N/A	25.758	35.830
6.6	8.632	N/A	6.114	14.746
6.7	20.595	N/A	39.061	59.656
Non-DOD	41.847	N/A	38.188	80.035
TOTAL RDT&E	**337.139**	**N/A**	**318.106**	**655.245**
Procurement	19.463	N/A	26.234	45.697
Operations & Maintenance	11.988	N/A	24.474	36.462
Other	10.937	N/A	10.051	20.988
TOTAL FUNDING	**379.527**	**N/A**	**378.865**	**758.392**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	1.111

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	175	**175**
CIVILIAN	810	814	1161	**2785**
TOTAL	**810**	**814**	**1336**	**2960**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	3261.262	**REAL PROPERTY**	195.338
ADMIN	219.056	* NEW CAPITAL EQUIPMENT	0.094
OTHER	319.260	**EQUIPMENT**	491.178
TOTAL	**3799.578**	* NEW SCIENTIFIC & ENG. EQUIP.	17.085
ACRES	**532**	* Subset of previous category.	

Naval Surface Warfare Center



**As a result of applying the In-House RDT&E Activity criteria at the division or major site level (see NOTE on page 3-1), NSWC Port Hueneme Division, Crane Division, and NWAS Corona data is not included in the FY1999 report.*

Naval Surface Warfare Center
Arlington, VA 22242-5160
(703) 602-0632

Commander: RADM M. G. Mathis
Tech. Director: Dr. Daniel M. Viccione

MISSION

Operate the Navy's full spectrum RDT&E, engineering and fleet support center for ship hull, mechanical and electrical systems, surface ship combat systems, coastal warfare systems, and other offensive and defensive systems associated with surface warfare.

CURRENT IMPORTANT PROGRAMS

Carderock Division:

Major Acquisition Programs

All major ship acquisition programs including--SEAWOLF and VIRGINIA Class Submarines; DD-21 Surface Combatants; CVN-77 and CVNX Aircraft Carriers; LPD-17 and LHD-8 Class Amphibious Ships; and combatant craft and unmanned vehicles--AND all in-service ships, submarines and combatant craft (including U.S. Army and Marine Corps watercraft) are supported by Ship and Ship Systems Core Equities for Signature & Silencing Systems, Vulnerability & Survivability Systems, Machinery Systems & Components, Hull Forms & Propulsors, Structures & Materials, Environmental Quality Systems, and Ship Design & Integration Technologies. In addition, support is provided for logistics systems for inter- and intra-ship materials handling, for logistics over-the-shore, and for CALS related to major ship and weapon systems acquisition programs.

VIRGINIA Class Submarine
Provide design support and technology assessment for the new attack submarine program. Includes all hull, mechanical & electrical (HM&E) technology areas, platform related combat & weapon subsystems, as well as cost and military effectiveness analysis. Work categories include: auxiliary systems, Atmosphere Life Support systems, CAD/CAM, cost effectiveness, electrical systems, EM silencing, fairwater, hydrodynamics, propulsor development, ship control, stealth-target strength, stealth-machinery, stealth-self/radiated noise, structures/materials, survivability, management systems and program support.

SEAWOLF Class Submarine
Participate in the design, construction, testing and operation of the SSN-21 Seawolf Submarine Class. Participate in the development and assessment of technologies and designs for alternative mission variants of the SEAWOLF Class.

DD-21 Surface Combatant
Provide technical support to the DD 21 acquisition office in the areas of ship design and systems engineering, weights and arrangements, signatures, hydrodynamics, structures & materials, vulnerability, propulsion and machinery, manning, automation, habitability, environmental engineering, producibility, auxiliary systems, affordability, modeling and simulation, logistics, life-cycle management, in-service engineering, and HM&E software certification. In addition, under acquisition reform, the Carderock Division is providing support in the form of facilities utilization, testing, science and technology expertise, and other areas as tasked by Industry teams while assuring the integrity of the acquisition process by protecting competition sensitive information.

New Aircraft Carriers
Provide design support and technology assessment for the future carriers program, including CVN77 and CVNX. Includes all hull, mechanical & electrical (HM&E) technology areas, survivability analysis and design, signatures analysis, and cost analysis. Work categories include: auxiliary systems, CAD/CAM, cost effectiveness, electrical systems, propeller design, ship control, structures/materials, survivability, management systems and program support.

CURRENT IMPORTANT PROGRAMS

LPD-17
Provide design support and technology assessment for the LPD 17 program. Includes all hull, mechanical & electrical (HM&E) technology areas, survivability analysis and design, test and evaluation, and cost analysis. Work categories include: auxiliary systems, CAD/CAM, cost effectiveness, electrical systems, propeller design and testing, ship control, structures/materials, survivability, trials planning and support, management systems, and program support.

LHD-8
Provide advanced planning and program support.

In-Service Ships
Provide routine and emergent repair planning and technical management. Support FMP initiatives. Provide design support and technology assessment, including all hull, mechanical & electrical (HM&E) technology areas, survivability & signatures analysis and design, and test & evaluation. Conduct R&D as directed by program sponsors. Provide trials planning and support. Provide direct management and technical personnel support to programs.

Combatant Craft
Provide research and development, concept feasibility, design, test and evaluation, integrated logistics support, technical manuals, provisioning, construction engineering support, in-service engineering, planning yard (Army and Navy), lifecycle manager (life rafts), inventory manager, direct fleet support, special project support and total craft systems engineering and integration, U.S. Navy craft design and engineering Authority. This work is carried out for the Army, Marine Corp and Special Operations also.

Marine Corps Programs
Program manager and Technical Development Agent for USMC Maneuver, Survivability, Mine Countermeasures, Transportation/Maintenance, Corrosion Control and Advanced Technology Demonstration (ATD) science and technology (S&T) programs; manage technology transfer between USMC and other services. Supporting the following Major Programs: Advanced Amphibious Assault Vehicle (AAAV) ACAT-1D, Assault Amphibious Vehicle (AAV7A1) family, Logistics Vehicle System Replacement (LVS-R), Light Armored Vehicle (LAV) Family, Interim Fast Attack Vehicle (IFAV), Family of Internally Transportable Tactical Vehicles (IT-LTV), Light Tactical Vehicle Replacement (LTVR), Small unit Riverine Craft (SURC). We provide the following products and services: Independent design analyses for land mobility, water mobility and survivability components and systems, test and evaluation of expeditionary systems, program management support. Our customers include various USMC PMs (DRPM-Advanced Amphibious Assault Vehicle, PM-Assault Amphibious Vehicle, Director-Ground Weapons, Director-Combat Support and Logistics Equipment, PM-Light Armored Vehicle), Office of Naval Research (Div 353), and DARPA.

Logistics Programs
Major Programs Supported: Joint Service logistics programs such as JCALS, IETMs, and JLOTS; Navy and Army logistics programs dealing with ships, ship systems, vehicles, and watercraft; LPD-17, AAAV, DD-21, NSSN; CVX. Major Products Provided: Logistics RDT&E studies, concepts, designs, hardware, testing, and ISE engineering support and documentation. Automated Maintenance Environment for F/A-18; Joint Interoperability Architecture for IETMs. Customers Supported: NAVSEA, NAVAIR, NAVSUP, NAVFAC, PEOs, Type Commanders, SURFLANT, SURFPAC, etc; other governmental agencies, OSD, Air Force, Army, EPA, Department of Transportation, DARPA; and private industry.

Environmental Quality Pollution Abatement
Provide continued in-service engineering (ISE) support to NAVSEA and fleet customers in order to effectively maintain, operate and support this equipment to provide the fleet with maximum operational capabilities while operating in restricted waters. The pollution abatement systems include sanitary waste collection and treatment, oily waste management and processing, solid waste management, incineration, compaction, shredding, pulping and hazardous materials/waste management and control.

CURRENT IMPORTANT PROGRAMS

Electric Drive System
Develop affordable electric propulsion and auxiliary equipment, which maintains or improves platform capabilities and reduces acoustic noise from electrical equipment.

Acoustic Submarine Trials
Provide subsurface acoustical data on the Navy's fleet and private companies.

Electric Power Distribution System
To develop advanced electrical distribution system concepts meeting mission requirements at reduced costs.

Composite Structures
Develop and demonstrate advanced composites for application to surface ship and submarine structural systems/components and related non-marine dual-use applications.

Computational Mechanics
To perform research, development, and advanced application of computational methods and tools in the fields of structural mechanics, fluid dynamics, acoustics, and electromagnetics for solving engineering problems related to vehicle signatures, performance, and affordability. Also included are the enabling technologies of geometric and numerical modeling, optimization, visualization, and massively parallel processing.

Surface Vehicle Electromagnetic Signal Silencing
To develop and demonstrate technology in order to reduce surface ship underwater Electromagnetic (EM) Signature (0-1khz) and reduce vulnerability to magnetic mine threat for MCM and steel hull surface ships.

ACTIVE COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (FY99)

Passive Fire Protection. The objective of this Agreement is to investigate potentially superior fire protection systems for use on Naval vessels and other craft through the use of materials which have demonstrated superior performance in non-marine fire protection applications.

Pipe Fitting Fabrication Process. The objective of this Agreement is to conduct a review of the pipe fitting fabrication process and identify recommendations for coating/lubrication of fittings for bending operations.

Shock Mitigation Seat. The objectives of this CRADA are:

To directly compare the prototype shock mitigation seat developed by Purple and Green Research Inc. with a STIDD seat. The STIDD seat is a shock mitigation seat currently being used onboard the MK-V. The prototype seat will be installed onboard a MK-V so comparative testing can be conducted.
To analyze acceleration data collected from testing and determine the level of acceleration dampening that occurred on the Purple and Green Research Inc. seat as well as the STIDD seat. This data will be used to directly compare the two seats against each other and determine which seat performs best in the tested environment.
To further develop the Purple and Green Research Inc. seat by utilizing the collected and analyzed test data. Make any necessary design changes to the seat and pass the technology onto other applicable craft.

Paint Coatings Blistering Evaluation. Objective: The objective to this agreement is to conduct a review of the paint coatings applied on the trash compactor units and identify recommendations for coatings in high humidity and salt-laden environments.

Double Hull and Composite Material/Structure Technologies. Ingalls and CDNSWC will perform a cooperative research and development effort to develop composite material/structures and double hull

CURRENT IMPORTANT PROGRAMS

structures and associated subelements and technology for surface ships. It is anticipated that the work conducted will result in designs that can be realized in advanced surface combatants, retrofit activities to same, and commercial applications alike. The goals for these new designs will be tailored for each application and will include, as appropriate, reduced weight, enhanced survivability, reduced maintenance, and comparable cost, or lower. Ingalls, upon successful completion of development, intends to carry out a plan for marketing the technologies for a variety of naval and commercial applications.

Shipboard Power Systems Improvement Program. To evaluate specific applications of WI&CSD developed power and control system designs and concepts to Navy and commercial ships. Successfully proven applications may later be shared with other Westinghouse Departments to improve commercial product lines.

Study of Reduced Fire Hazard Silicone Materials For Navy Applications. To develop, document and evaluate silicone-based or silicone modified advanced fire resistant materials. Also, reformulate and optimize processing characteristics of the above polymeric materials to conform to Navy selected fabrication techniques. Facilitate successful fire resistant materials for use in commercial applications. Organize technical workshops involving Navy and Dow Corning personnel to further understand the needs and capabilities of the partners.

Modular Utility Core. The objective of this partnership is to jointly develop a modular utility core for low/moderate income housing. This core will be a prototype modular unit containing the mechanical, electrical and energy management systems for residential housing. The prototype modular utility core is intended to be fabricated at Naval Surface Warfare Center, Carderock Division --Philadelphia, PA, transported to a residential site and installed into an existing house being rehabilitated.

Intelligent Shock Mitigation & Isolation System through Applied RSPM Technology. To first perform the remaining development work to refine and upgrade RSPM control algorithms for Naval applications to meet a compelling need for Naval isolation technology; and secondly to scale up and test the fully integrated systems in mock-ups and simulators to verify the technology. The objective of the overall RSPM program is to create a commercially available family of ISMIS products through applied RSPM that will both meet the compelling need for Naval isolation technology and satisfy the uses of ISMIS in seismic protection of structures.

Light Scattering Measurement Techniques and Practices. To develop standard materials for verifying polarized BRDF measurements in the visible and infrared spectral region. Currently there are no accepted standard materials for verifying Mueller matrix BRDF measurements in general, or for unpolarized scattering measurements in the infrared. Work performed will produce well a characterized sample of materials that can be theoretically analyzed to predict the polarized BRDF which can be used to verify the experimental measurements.

Technical Assistance to CIT. The objective of this Agreement is to transfer technology from CDNSWC to those companies in the Commonwealth of Virginia that, through CIT, have requested technology assistance. It is expected that technology in the fields of acoustics, advanced materials, environmental technology, hydromechanics, machinery and ship technology will be of the most interest for Cooperative Research.

Centrifugal Casting Technology. The objectives of this agreement are to:
Develop techniques for synthesis of remeltable TiC/bronze and/or WC/bronze or both, metal matriz composite ingots.
Develop centrifugal casting procedures.
Scale up ingot size from laboratory to production size, including centrifugal casting procedures from bench scale to large size castings respectively.
Produce wear resistant full size components such as cylinder liners, bearing races, gears, flywheels and others as need arises.
Commercialize the technology and the product for U.S. markets beyond Navy (and DoD) components and applications.

CURRENT IMPORTANT PROGRAMS

Resonance Apparatus. The objective of this Agreement is to obtain resonance apparatus evaluation of twelve samples covering a wide range of frequencies by the use of time-temperature superposition of data obtained in the kilohertz region as a function of temperature. These results will be analyzed for the insight possible into the molecular mechanisms responsible for the dynamic behavior. Of particular interest is to compare the data obtained with the resonance apparatus to the data obtained from commercial equipment for the same purpose. It is hoped that the potential advantages of using the resonance apparatus will be demonstrated by these measurements.

Technical Assistance to the University of Maryland Technology Extension Service. The objective of this Agreement is to transfer technology from CDNSWC to those companies in the State of Maryland that, through UMCP, have requested technology assistance. It is expected that technology in the fields of chemical processing, testing, manufacturing technology, safety, electronics and environmental technology will be of the most interest for Cooperative Research.

Discriminate Reduction Data Processing. Objective of this Agreement is to further develop the art of Discriminate Reduction Data Processing by developing and providing software which will approximately evaluate the speed dependence of computer generated error-affected data.

Ben Franklin Technology Center (BFTC). The objective of this Agreement is to transfer technology from CDNSWC to those companies in the Philadelphia metropolitan region that through the BFTC have requested such technology. It is expected that technology in the fields of Acoustics, Advanced Materials and Structures, Environmental, Machinery Systems, and Ship Technology will be of the most interest for Cooperative Research.

Design and Analysis of Antenna Systems. The objective of this Agreement is to cooperatively perform RDT&E in the fields of sensors and C4I systems, particularly antenna systems and low observable technology.

Tech Assistance to AAI/Manufacturing Services Division. CDNSWC will review the corrosion plan for AAI/Manufacturing Services Division, which is building electric transportation buses.

Dahlgren Division:

Distributed Engineering Plant (DEP) - Using today's state-of-the-art networking technology, the Dahlgren Division team, in only four months, constructed a land-based Distributed Engineering Plant (DEP) to test and evaluate combat systems interoperability. It established a nationwide network linking 8 Navy shore-based CVN/AEGIS/DD/FFG/E2C/LHD facilities into a land-based Battle Group (BG) for the first time in Navy history. To its credit, DEP interoperability testing has been so successful in identifying war-fighting deficiencies in new and legacy combat systems that COMNAVSEA has decreed that no BG or its deploying combat system software loads shall be introduced into the Fleet without having been tested in the DEP.

Dahlgren Division Delivers DD 21 Partnering Initiatives - As acquisition reform initiatives took root in the Navy's acquisition programs, Dahlgren Division established an Industry Liaison Office to support the DD 21 program and provide the bridge to support the transfer of Dahlgren Division's substantial national investment in science, technology, requirements engineering and knowledge of the war fighters' challenges to their industry partners. This agreement with industry served as the model for all other participants and enabled Dahlgren Division to participate in trade studies and analysis, and development of a system concept design inherent in the DD 21 Phase I acquisition plan.

Extending The Littoral Battlespace - The Dahlgren Division Coastal Systems Station (CSS) was tasked by the Office of Naval Research (ONR) and USCINCPAC to participate in the Extending the Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD). ELB ACTD adapted commercial wireless network technology to determine the potential for military utility over a large geographic area. CSS designed the control cell plan, trained the military and civilian controllers, and

CURRENT IMPORTANT PROGRAMS

filled key control positions for the demonstration. Station personnel teamed and worked with an organization consisting of Navy, Marine, Army, Air Force, Joint Special Operations Force operators; Naval Reservists; ONR personnel; and Logicon/Syscon contractor personnel.

SM-3 Shipboard Telemetry - Dahlgren Division successfully designed an evolutionary shipboard telemetry receiving system for integration with the AEGIS Weapons System to allow long-range telemetry data reception and real-time relay of ship's SPY Track Data and missile telemetry data. Several innovative technical approaches have been implemented to meet the demanding Theater Ballistic Missile Defense (TBMD) requirements for intercepting TBM Targets. On 24 September, the Modular Telemetry Receiving System (MTRS)/ Very Small Aperture Terminal (VSAT) System successfully supported the AEGIS LEAP Intercept (ALI) CTV-1A missile firing exercise from the Pacific Missile Test Range, Hawaii. This exercise represented the first successful shipboard launch of a SM-3 TBMD Missile.

NBC DEFENSE TECHNOLOGY TRANSFER TO USSTRATCOM - Dahlgren Division developed new Navy technology to upgrade or replace NBC collective protection systems currently used by U.S. Strategic Command (USSTRATCOM) facility. This new technology can directly apply to underground facilities to cut costs, greatly extend filter service life, ease maintenance and logistics, and solve some of their inherent operational problems.

AN/KSQ-1 - Dahlgren Division Coastal Systems Station (CSS) assisted in demonstrating the use of AN/KSQ-1 to support Over-The-Horizon (OTH) amphibious assaults. KSQ-1 was used to track 22 precision location reporting systems (PLRS), KSQ-1 equipped platforms released over 50 miles from shore, and rental cars on land for dynamic reference support. A simulated unmanned aerial vehicle (UAV) was used as the OTH relay for the line of site PLRS network. Even without the UAV, links of up to 56 miles were established and maintained by the PLRS radios.

Versatile Exercise Mines (VEMS) - Dahlgren Division Coastal Systems Station (CSS) completed assembly and successful testing of 13 Versatile Exercise Mine (VEMS) MK 74 at Mobile Mine Assembly Unit (MOMAU) Ten, Japan, in support of Mine Warfare Readiness and Effectiveness Measuring (MIREM) 5 exercise. Twelve VEMs were deployed during Kernel Blitz 99 to support the Advanced Lightweight Influence Sweep System (ALISS) evaluation.

Submersible Delivery Vehicle - Through a cooperative research agreement, Dahlgren Division Coastal Systems Station (CSS) partnered with Stidd Systems, Inc. to develop and build a full scale, demonstrable "Reversible Submersible" Delivery Vehicle.

Solution To SATCOM EMI Problem Caused By Air Search Radar - Dahlgren Division have been working to mitigate interference from the AN/SPS-48E Air Search Radar to the AN/WSC-8 Satellite Communication (SATCOM) system. Investigations have shown that the interference is due to spurious emissions generated by the AN/SPS-48E that are inband to the AN/WSC-8 receiver. The recommended solution was to install a band-stop waveguide filter in the AN/SPS-48E. Dahlgren Division have procured a suitable waveguide filter, and have funded the AN/SPS-48E ISEA NSWCPHD, Virginia Beach to incorporate this filter into the AN/SPS-48E Radar. Dahlgren Division and NSWCPHD Virginia Beach are teaming to install these band-stop filters aboard deploying ships with both AN/SPS-48E and AN/WSC-8 systems.

AN/KSQ-1 – Due to Hurricane Georges, the JTFX exercise aboard the USS PENSACOLA (LSD 38) was interrupted. Dahlgren Division Coastal Systems Station (CSS) team members were flown via helo and assisted to complete/repair several newly installed systems.

Swimmer In-Shore Navigation Systems - Dahlgren Division CSS fabricated and delivered 12 additional Swimmer In-Shore Navigation Systems (SINS) for the Very Shallow Water Mine Countermeasures (VSW MCM) Detachment.

CURRENT IMPORTANT PROGRAMS

UAV - Dahlgren Division Dahlgren successfully demonstrated the use of Tactical Control System (TCS) in support of Command and control of the Predator, Prowler II, and Outrider Unmanned Aerial Vehicles (UAV's). This marked the first time that TCS was used for full command control of UAVs.

Y2K FLEET ASSESSMENT - Dahlgren Division Dahlgren developed and delivered to NAVSEA 05 the YEAR 2000 (Y2K) Test Plan for Navy Ships. Dahlgren has major roles, including Test Director and Technical Lead, in the execution of the AFLOAT portion of the plan for NAVSEA. All five Battle Group exercises, the CONSTELLATION, JOHN F. KENNEDY, JOHN C. STENNIS, KITTY HAWK, and DWIGHT D. EISENHOWER, have been completed and the associated Amphibious Ready Groups have been completed. The results to date confirm that the fleet missions will not be impaired by Y2K.

ACTIVE COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (FY1999)

Development of New Software Products Based on NSWCDD Supersonic Airflow Programs. (NCRADA-NSWCDDWO-90-002) The objective of this task is to develop new software products embodying (a) previously developed original work of NSWCDD on supersonic airflow programs embodied in the software package identified as >ZEUS= and (b) the derivative work embodying trade secret data received from Nielson Engineering & Research, Inc. (NEAR) making the software products more suitable for commercialization by NEAR.
POC: Frank Moore, G04

Development of a New and Improved Launcher for the Shoulder-Launched Multi-Purpose Assault Weapon (SMAW). (NCRADA-NSWCDD-95-008) The objectives of this task with CMS, Inc. are: (1) to develop and transition to production the SMAW lightweight launcher, (2) to develop and transition to production a new SMAW spotter round with acceptable ballistics and lower production cost, (3) the successful transfer of the current SMAW technical data package, and (4) to investigate and incorporate other system improvements, as appropriate.
POC: Tom Del Guidice, G30

R&D Into Epitaxial Material Processing Based Technologies. (NCRADA-NSWCDD-95-010) The overall objective of the CRADA with the Emcore Corporation is to develop an enabling technology that can resolve the problems in epitaxial material deposition and accelerate the implementation of III-nitride based technologies in practical applications. The technical objectives and proposed effort will be divided into Three Phases: PHASE I will focus on the feasibility study using the compliance layer materials that have previously been successfully employed for the epitaxial growth of II-VI and IV-VI semi conductors. The scheduled period for PHASE I is nine Months.
POC: Tak-Kin Chu, B42

PCR Destruction of Volatile Organic Compounds. (NCRADA-NSWCDD-95-011) The objective of this CRADA with Physics International is to perform a parametric study of the NSWCDD PCR in search of the least power deposited into the corona discharge per unit air flow that still destroys more than 98% of a 500 ppm toluene impurity in an atmospheric pressure air flow. Parameters involved in this investigation include (but are not limited to) voltage rise time, applied voltage pulse width, amplitude and rep-rate, and air flow through the PCR and humidity.
POC: Randy Roush, B20

Compliant Barium-Compound Substrate Technology for Chemically Deposited PbS and PbSe Monolithic Focal Plan Arrays. (NCRADA-NSWCDD-95-012) The objective of this CRADA with Sensarray Corporation is to develop an enabling technology that would allow the integration of infrared optical detector arrays and silicon electronic circuitry onto a single substrate. It should also have the capability of on-chip signal processing. The output of the sensors must be directly applicable to electronic decision-making and be commensurate with more complicated electronic processing for target detection and pattern recognition.
POC: Tak-Kin Chu, B42

CURRENT IMPORTANT PROGRAMS

Technical Assistance to the University of Maryland's Technology Extension Service. (NCRADA-NSWCDD-97-015) To transfer technology from NSWCDD to those companies in the State of Maryland that through the University of Maryland (College Park) have requested such technology. It is expected that technology in the fields of Devices and Sensors, Information and Systems Sciences, Advanced Data Processing Methods, Pulsed Power Systems Sciences, Simulation and Modeling, and Electromagnetic Environmental Effects will be of the most interest for Cooperative Research.
POC: Ramsey Johnson, B04TT

Effort to Develop an Advanced Launching System. (Raytheon Missile Systems Company). (NCRADA-NSWCDD-97-016) Design, fabricate and demonstrate the feasibility of an advanced launching system prototype. Prepare a development test plan which identifies all testing, procedures, pass/fail criteria, test sites, and number and configuration of the units to be tested. Prepare a system safety program that identifies the system safety organization; hazard identification, risk assessment process, tracking process, and resolution process; safety analysis requirements; safety testing requirements and establishes Weapons Systems Explosive Safety Review Board (WSESRB) reviews at appropriate milestones.
POC: James Talamonti, F44

The Development of Low Threshold Multi-Point Initiators. (Electronics Development Corporation (EDC)) (NCRADA-NSWCDD-97-019) Demonstrate the feasibility of using chip bridge detonators in multi-point initiator applications, resulting in a significant reduction in the threshold voltage requirements for future weapon systems. Develop, integrate, demonstrate, and evaluate multi-point initiated, low threshold Exploding Foil Initiators. The participants will provide personnel knowledgeable in the development of low threshold detonators and attachment techniques for Exploding Foil Initiators, using the NSWCDD test facility and test equipment.
POC: Nguyen Nguyen, G22

The Development of Multi-Point Initiators for Voltage Threshold Testing. (EG&G Optoelectronics Division) (NCRADA-NSWCDD-97-020) Demonstrate the feasibility of using chip bridge detonators in multi-point initiator applications, resulting in a significant reduction in the threshold voltage requirements for future weapons systems. Develop, integrate, demonstrate, and evaluate chip bridge detonators in a multi-point application. The participants will provide personnel knowledgeable in the development of low voltage threshold detonators for warhead initiation, and use the design and fabrication facilities at EG&G and the testing facility/equipment at NSWCDD.
POC: Nguyen Nguyen, G22

Reverberation Chamber Program (Lindgren RF Enclosures, Inc.). (NCRADA-NSWCDD-97-021) Design, fabricate, and test a compact reverberation chamber and demonstrate the feasibility of using it operate down to the lower frequency limit of 80MHz as specified in International Electrotechnical Commission (IEC) specification 1000-4-3.
POC: Michael Hatfield, J52

Improved Naval Gun Technology. (United Defense LP Armament Systems Division) (NCRADA-NSWCDD-97-022) The partners will:
Model advanced gun systems concepts such as utilizing composite gun barrel materials, improving propellant charge technologies and advanced munitions handling systems, and integrating of advanced future gun systems work; provide cost modeling, production planning (process/methods) and pre-production plans for advanced gun systems; and provide lessons learned information with respect to R&D gun system efforts.
POC: Donald A. Wilson, G32

Advanced Launching System Technology. (United Defense LP Armament Systems Division) (NCRADA-NSWCDD-98-025) The objective is to support the development of advanced launching systems via computer modeling and simulation, system conceptual design studies, safety evaluations, the building of mockup designs, and the use of test facilities.
POC: Kyle Jones, G21

CURRENT IMPORTANT PROGRAMS

Investigative Collaboration to Develop GUIScript Toolkit. (Apogee Software, Inc.) (NCRADA-NSWCDD-98-026) The objective is to create a commercial extension to the Universal Client and GUIScript that provides a toolkit for Web developers.
POC: Adam Simonoff, B32

White Oak Lab RDT&E. (White Oak History Corporation) (NCRADA-NSWCDD-98-027) The objective is investigative research that will support the development of a technical anthology detailing significant accomplishments of a major Navy RDT&E site over a 50-year period.
POC: Ramsey Johnson, B04TT

Automation Technology Incremental Insertion System. (General Dynamics Advanced Technology Systems) (NCRADA-NSWCDD- 99-023) Incremental development and transition to production of decision support software, expert systems, information access and control software, and supporting Human Computer Interfaces that enable drastically reduced manning of surface ship tactical systems through improved situation awareness and dramatically improved operator decision aids.
POC: James B. Howard, CD2K

Development of Advanced Launcher Concepts and Technologies. (Lockheed Martin Launching Systems) (NCRADA-NSWCDD-99-030) Collaborate to design, fabricate, and demonstrate the feasibility of advanced launcher control systems, gas management systems, and survivability technologies. Specific tasks under this CRADA have not been established, but will be implemented using a task approval procedure involving the Partners. Tasking may include: computer simulations/modeling, electronic packaging, life cycle cost modeling, manning analysis, rearming trade studies, remote trigger, production planning, platform interface, survivability, safety evaluations, mockup designs, use of test facilities, studies of rocket motors and warheads, and evaluation of canister materials.
POC: James B. Howard, CD2K

The Effects of Radio Frequency (RF) Energy on Exploding Foil Initiators (EFIs). EG&G Optoelectronics) (NCRADA-NSWCDD-99-032) The objective is to characterize the response of exploding foil initiators (EFIs) to high levels of radiated electromagnetic energy. Phase I: continuous-wave, swept-frequency illumination of instrumented EFIs/striplines at moderate field strengths to determine frequencies of maximum response. Phase II: testing of non-instrumented EFIs/striplines at the previously determined frequencies of maximum response at extremely high level (simulated) shipboard EMEs. Analysis: damage assessment and post-test functional firing verification of exposed EFIs.
POC: John L. Bean, J52

The Development of Biological and Chemical Decontamination Agents. (Cummins Industries, Inc.) (NCRADA-NSWCDD-99-034) The objective is to test decontamination agents and colloidal surfactants to design and produce a foam generating application system that can be used for military and civilian emergency response to intentional or unintentional releases of warfare hazardous chemical and biological agents.
POC: Dr. Donald T. Cronce, B51

The Development of Reactive Material for Ordnance Application. (Thiokol Propulsion Group) (NCRADA-NSWCDD-99-035) NSWCDD and Thiokol will work cooperatively to manufacture and test a strength-enhanced Aluminum/Polytetrafluoroethylene (Al/PTFE) material for future use in selected Navy ordnance applications. Demonstrate Thiokol's capability to produce Al/PTFE spheres and selected fragment-shaped parts that are equivalent in mechanical properties and reactivity to parts that have been tested by NSWCDD. Develop methods for increasing strength of Al/PTFE-based reactive material, beyond that of the material that has been tested by NSWCDD.
POC: James B. Howard, CD2K

SDV-X Test and Evaluation. (30 Sep 96 - 30 Sep 99) Columbia Research Corporation (CRC) has preliminary design concepts for a Swimmer Delivery Vehicle of interest to a foreign government. Under this CRADA the feasibility of the design will be confirmed through test and evaluation. CSS will collaborate with CRC on engineering oversight, guidance, and participate in the test and evaluation of the initial prototype unit. POC: Ron Allgood, R42

CURRENT IMPORTANT PROGRAMS

Development of Hybrid Dive/Gas Mask. (Navy Experimental Diving Unit and Diving Systems International) The NEDU and DSI entered into this agreement in order to design, construct, and perform engineering analysis of a prototype Hybrid Dive/Gas Mask. DSI intends to manufacture and market this device if it proves successful. In addition to the commercial application of this concept to the private sector, unique applications to the SEAL community have been identified.
POC: John Clarke, OOD

Submersible Boat Development and Commercialization. (CSS and Stidd Systems Inc.) The objective of this CRADA is design, fabricate, develop, integrate new componentry, improve, and test a second generation SEAL Submersible Boat for commercial development and marketing purposes. Two previously issued patents (numbers 5,377,613 and 5,632,659) are licensed in support of this CRADA.
POC: John Dudinsky, Code A31

Development of a Cold Water Regulator. (Navy Experimental Dive Unit and Scuba Technology Unit and Scuba Technology, Inc.) The objective of this CRADA is to develop an open circuit dive regulator which meets or exceeds the Navy requirements for cold water diving.
POC: John Clarke, OOD

Explosives Testing. (HITECH, Inc.) This CRADA will explore technologies available for the mine/counter mine obstacle clearance mission. The intent is to identify a system which is significantly more effective against these targets as compared with the MK 138 demolition kits. HITECH will provide explosive devices to NSWCCSS and NSWCCSS will test and evaluate them against targets.
POC: Steve Jones, A14

Hazmat Protection Ensemble. (Unconventional Concepts, Inc.) The purpose of this CRADA is to design, develop, and manufacture a hazardous material protection ensemble designed to provide constant and continuous situational awareness and battle space management capabilities. The focus will not be on protective capabilities, per se, but on the integration of communications and information management/display capabilities into existing equipment.
POC: Frank Downs, A31

Integrated Diver Display. (American Underwater Products, Inc.) The objective is to develop a prototype diver's integrated display mask. The display mask will incorporate RF technology, pressure transducers, miniature liquid crystal displays, and custom optical lenses to present a magnified image of the diver's depth, dive time, and tank pressure.
POC: Dennis Gallagher, A52

Archaeology Survey Using SINS. (Florida State University - Marine Laboratory) (NCRADA - COASTSYSSTA-96-004) Conduct a non-destructive archaeological survey of two shipwreck sites located in the Dry Tortugas National Park. The survey will be part of a course designed to offer students an interdisciplinary approach to conducting underwater research, which includes training in underwater research techniques and advanced diving technology. CSS will gain from testing a complete SINS (SEAL In-Shore Navigation System) prototype system in a working environment.
POC: Ed Linsenmeyer, R052

Night Vision Compatibility Study. (Bath Iron Works Corp.) (NCRADA-NSWCDDCSS-99-016) The objective is to analyze total lighting and control requirements for all aspects of well deck/LCAC (Landing Craft Air Cushion) operations with and without Night Vision Devices (NVDs).
POC: Ed Linsenmeyer, R052

Underwater and Terrestrial Archaeology. (University of West Florida) (NCRADA-NSWCDDCSS-99-017) The objectives are to provide specific information concerning the spatial extent of archaeological sites on NSWCCSS federal property and to provide support for University of West Florida (UWF) summer field schools.
POC: Ed Linsenmeyer, R052

CURRENT IMPORTANT PROGRAMS

Flexible, High Pressure, Underwater Pipe RDT&E. (Wellstream, Inc.) (NCRADA-NSWCDDCSS-98-018) Develop collapse resistant flexible pipe with the aid of verification testing of facilities located at the Coastal Systems Station, Panama City, FL. Conduct environmental testing of Wellstream deep water flexible pipe construction and sealing designs. Develop, integrate, demonstrate, and evaluate high pressure sealing techniques for flexible tubing under significant stresses due to internal/external pressure and those stresses due to bending of the tubing.
POC: Ed Linsenmeyer, R052

In addition to the above, NSWCDD issued 35 patents to NSWC Dahlgren Division Employees in FY1999.

Indian Head Division:

The following are new Cooperative Research and Development Agreements (CRADAs) for the NSWC - Indian Head Division (IHDIV) for 1999:

1. Research and Development of an Automated Shipboard Ordnance and Material Handling, Management and Stowage System: The objective of the CRADA is for IHDIV and Avondale Industries, Inc. to perform research and development of an automated shipboard ordnance and material handling, management, and stowage system that will be used for ordnance and supplies. This system will be an effective, low-life-cycle cost, minimally manned, fully integrated system and will be able to retrieve palletized or containerized material from the stowage areas below decks and deliver it to the main deck for transfer to another ship while at sea. The system will identify the stowage location of the material.

2. Research into Reliability Prediction Modeling and Verification for Elastomeric Shock Absorbers: The technical objective of the CRADA is for IHDIV and Rutgers University to perform research and testing on shock and vibration isolation system elastomeric shock mounts and to develop, verify, and employ reliability prediction models to project the effects of aging on elastomeric shock mount performance and service life. The expected result of this research is technology that IHDIV Detachment Earle can use to predict package, handling, storage, and transportation of equipment elastomeric shock mount service life and performance reliability. It is also expected that this research will allow Rutgers University to refine and prove their industrial engineering theories and principles relative to reliability prediction.

3. Testing of Commercial Electrical Generator Before and After Subjection to Karl M. Argetar (KMA) Process: The objective of this CRADA is for IHDIV and Alter Energy Group (AEG) to determine the "proof of concept" of an invention provided by a private small business concern, AEG, to alter and increase the energy output of various electrical devices. AEG's invention (aka the KMA Technology) is a process which would enable electronic devices (e.g., generators, battery power packs, etc.) to perform at a much higher level of output. If the AEG process proves out, then commercialization will be highly desirable for the company and the use of the KMA Technology process by the Navy and the Department of Defense may be of high critical value to saving energy consumption.

4. Research and Development of Extruded Composite Propellant Grains Incorporating Motor Case Venting Technology: The objective of this CRADA is for IHDIV and CMS, Inc. to jointly conduct research to develop an extruded propellant grain with motor case venting technology, then test and demonstrate its use in the 2.75-Inch rocket motor used in the 2.75-Inch Rocket System.

5. "Applied Research into Instructional and Information Exchange Technologies". The purpose of this Project will be for IHDIV and Charles County Community College to promote high quality local continuous training enhanced with the use of Production type manufacturing equipment. This local training availability will allow Southern Maryland workers to advance their abilities within their own community, support local manufacturing industry and attract additional industry to utilize the subsequent high-quality workforce. The resultant high-quality workforce and local manufacturing industry will be available to support the Naval Activities at Indian Head and Lexington Park, Maryland and at Dahlgren,

CURRENT IMPORTANT PROGRAMS

Virginia. Developed at the request of local employers, this program will enable students to learn employable skills within one year, utilize financial aid for tuition, and be on an educational track that could lead to an advanced career path within the manufacturing industry. Graduates will bridge the gap between mechanical and technical skills currently present in the workforce in this region.

Ten Most Important Programs at Indian Head:

MCM/DET: RDT&E for Navy and Marine Corps Mine Countermeasures (MCM) including: distributed explosives technology (DET), demonstrative/advanced countermeasure, surf zone MCM, shallow water MCM, and Explosive Neutralization Advanced Technology Development (ENATD).

NSFS: R&D of new propellants for propulsion and projectiles for the Navy's extended range guided munitions in support of Naval Surface Fire Support Systems (NSFS).

IMAD-HE: Insensitive munitions advanced development for high explosives for all Navy weapons.

MEMS (Microelectromechanical Systems): RDT&E efforts in support of Navy fuze/safe & arm devices for future underwater weapons.

RFID (Radio Frequency Identification)/MEMS Sensors: RDT&E effort in support of new technologies for predicting safe service life of ordnance.

Reactive Materials: Synthesis of new materials for undersea and mine warfare warhead applications, and R&D in use of reactive materials for neutralization of chemical/biological stores.

GEM (Green Energetics Materials): R&D of new energetic materials and manufacturing processes that are environmentally cleaner. GEM program is focused on the use of TPE (thermoplastic elastomers) for gun propelling charges, rocket motors, and pressed explosives. SERDP (Strategic Environmental R&D Program) is leading the R&D of environmentally benign synthesis, processing, and manufacturing technologies for "green" energetic materials.

CAD/PAD: Tri-Service RDT&E support for cartridges, cartridge and propellant actuated devices, and aircrew escape propulsion systems.

ONR Program: R&D of new explosives for underwater, air and surface weapons.

Continuous Processing: Development of continuous processing technology for affordable manufacturing of energetics.

EQUIPMENT/FACILITIES

Carderock Division:

Carderock Division – West Bethesda Site:
David Taylor Model Basin Complex.
Maneuvering and Seakeeping Basin.
Rotating Arm Basin.
Radio Controlled Model Facility.
Circulating Water Channel. 24-inch and 36-inch Cavitation Channels.
Dynamic Control System Simulator.
140-foot Towing Basin.
Hydrodynamic / Hydroacoustic Technology Center.
Ship Materials Technology Center.
Structural Evaluation Laboratory.

EQUIPMENT/FACILITIES

Deep Submergence Pressure Tanks.
Shock Trials Instrumentation.
Explosions Test Pond.
Simulation, Acoustic Data Analysis Center and Acoustic Trials Instrumentation.
Electro-Magnetic Signatures Facility.
Aerodynamic & anechoic wind tunnels.
Environmental Science & Shipboard Systems Lab.
Strategic Planning and Analysis Research Center.
Data and Image processing systems.
Small-Scale Fire research and air contamination facility.

Carderock Division -- Philadelphia Site:
Machinery Systems Silencing Lab.
Advanced Electrical Machinery Lab.
Machinery Technology Development Facility.
Submarine Fluid Dynamics Facility.
Electric Power Technology Lab.
Non-CFC Systems Facility.
Full-scale IPMP (SSN-21) steam propulsion land based test site.
Full-scale LSD-41 diesel propulsion land based test site.
Full-scale DDG-51 gas turbine land based test site.
Full-scale electric drive/machinery module land based test site.
Full-scale gear metrology and calibration lab.
Full-scale air compressor test site.
Full-scale submarine life support test site.
Full-scale Air Conditioning and Refrigeration test site.
Full-scale submarine generator test site.
Full-scale submarine ship service generator test site.
Full-scale conveyor and elevator test complex.
Full-scale submarine mast bending test facility.
Full-scale submarine periscope/antenna test sites.
Full-scale submarine buoy communication test site.
Chemistry and metallurgy lab.
Full-scale gravimetric flow calibration lab.
Test operations.
Full-scale Volumetric Flow Calibration Lab.
Test Operation and Analysis Center.
Analysis and control center.
Full-scale steam propulsion testing complex.

Carderock Division - Bayview, ID:
Acoustic Research Detachment.

Carderock Division - Bremerton, WA:
Fox Island Acoustic laboratory

Carderock Division - Ketchikan, AK:
Southeast Alaska Acoustic Measurement Facility

Carderock Division - Fort Lauderdale, FL:
South Florida Ocean Measurement Center

Carderock Division - Cape Canaveral, FL:
Research Vessel Hayes.

Carderock Division - Memphis, TN:
Large Cavitation Channel (LCC).

EQUIPMENT/FACILITIES

Carderock Division - Norfolk, VA:
Combatant Craft Engineering Detachment.

Carderock Division - Patuxent River, MD:
Combatant Craft Special Trials Unit.

Carderock Division - Panama City, FL:
Lauren & Athena Research Vessels

Dahlgren Division:

Dahlgren Site
Chem-Bio Sciences Complex - This complex is used for basic research in the particular field of biological science that supports molecular computing and research into the effects of chemicals on various materials. This complex includes the following state-of-the-art science labs: Molecular and Cellular Biology Lab, Molecular Computing Spectroscopy and photonics lab, Chem-Bio Instrumentation and Thermal Analysis Labs, and general chemistry labs.

SLBM Weapons Control Facility - used for the development and testing of SLBM weapons control software, fleet problem investigation, fleet procedure development, technology and obsolescence studies and for the production and quality control of fleet media (i.e. magnetic media containing weapons control software and data and strategic targeting data.

Scientific and Engineering Computing Complex - Provides high performance computing to the scientific and engineering personnel of the laboratory. The equipment available includes a CRAY Y-MP2E supercomputer (up to the secret level), and a CRAY EL98 entry level computer (unclassified only).

Aegis Computing Center - This is the designated computer program Lifetime Support Engineering (LSE) facility for supporting CG-47 and DDG-51 class ships. This facility is used to support ships during construction, operation, and modernization phases by providing the tactical computer programs, and training exercises needed to make AEGIS ships and sites operational.

Search and Track Sensor Test Site (STSTS) - the STSTS allows over water testing of individual Radio Frequency (RF) and Electro-Optical sensors or complex sensor systems during and/or at the completion of their development cycle. This facility is used in conjunction with the Potomac River Test Range (PRTR) and provides an 80,000-yard over the water, littoral, laser certified, instrumented range. Potomac River Test Range (PRTR) - The PRTR is a complex of land and water ranges used for the test and evaluation of live or inert ordnance, weapon systems, and weapon systems components. The water ranges is approximately 3 nautical miles wide and sixteen nautical miles long.

Panama City Site
Mine Warfare (MIW) Research and Engineering Complex - This is a special facility that includes the Airborne Mine Countermeasures Facility, The Mine Exploration Facility, the Countermeasures Evaluator, the Computation and Analysis Lab (CSEL), and the MIW Fleet Support module, the Sensor Development Complex. This facility is used to perform almost all US Navy Research and Development (R&D), Test and Evaluation (T&E), acquisition support and in-service engineering (ISE) of mine warfare systems, including mines and mine countermeasures.

Airborne Mine Countermeasures Complex (AMCM) - This special facility is required to conduct research and development, test and evaluation, and in-service engineering activities for the AMCM systems. This complex supports the aircraft and AMCM systems required to conduct full scale testing of AMCM systems for quick response to operational airborne MCM squads.

EQUIPMENT/FACILITIES

Mine Exploitation Complex - This facility is used to perform R&D, T&E, acquisition support, and ISE of Mine Warfare Systems. The complex is an integrated combination of special facilities designed for testing and analyzing the vulnerability of Air and Surface Mines Warfare platforms and systems, Amphibious Warfare systems, and Special Warfare systems to foreign and U.S. mines.

Amphibious Warfare Engineering and Test complex - This complex consists of five permanent buildings and thirteen temporary structures. The complex is used to conduct the majority of R&D, T&E, acquisition support, and ISE for Amphibious Warfare systems. The major buildings are the LCAC Hanger/Ramp Facility, the Amphibious Warfare Building, and three engineering support buildings.

Mine Warfare Test and Training Range - This ranges is located along the Gulf of Mexico and supports the training, test and evaluation (T&E) of those systems and technologies utilized primarily mine countermeasures (MCM), amphibious, and special warfare operations. This consists of tracking, positioning and signature measurements including acoustic, magnetic, and pressure.

Indian Head Division:

IHDIV has extensive facilities for research, development and testing of energetic materials and energetic components. These facilities are capable of taking nearly any energetic material from laboratory scale through full-scale engineering development. Some of the major facilities are:

Explosive Test Chambers highly instrumented facilities capable of testing up to 50 lbs of high explosive in a very controlled environment. These facilities are used to conduct research into detonation science and for development of advanced materials and warheads.

Energetics Formulation and Development includes a variety of facilities capable of processing all classes of energetic materials in quantities from a few grams up to thousands of pounds. Additionally, design, modeling, and simulation capabilities are available to develop advanced warhead, rocket motor and gun propulsion concepts and designs that can be made in the extensive processing facilities. The Continuous Processing development facility is a state of the art facility to develop advanced processing technology for energetic materials using a twin screw mixer/extruder. This facility can process most solid energetic materials at rates up to approximately 100 lbs/hr. The flexibility to handle multiple material feeds and materials with a very wide range of rheologies, coupled with extensive instrumentation makes this facility unique in the ability to develop future generations of energetic materials and components, affordably.

Energetic Chemicals Synthesis and Scale-up a collection of laboratories and pilot scale chemical processing facilities that are used to develop next generation energetic molecules. Batch and continuous chemical reactors, distillation, extraction, and other chemical operations are easily reconfigureable to scale-up new energetic chemicals. Extensive laboratory synthesis and analytical equipment complements the scale-up capability in a way that a new chemical can be taken from the gram scale through to a scale of hundreds of pounds quickly and efficiently.

Rocket Motor Testing facilities are capable of evaluating many aspects of rocket motor performance. Static testing and environmental test chambers are routinely used to provide data on motors in development as well as to verify performance of fleet assets. A unique capability to conduct a functional ground test of the Tomahawk missile allows the performance of a missile to be monitored throughout its entire flight cycle without the missile ever leaving the ground.

Chemical and Physical Analysis laboratories are used extensively to support the research and development of new energetics. Extensive state-of-the-art instrumentation and techniques are used to evaluate parameters such as purity, composition, structural properties, and safety, as well as to evaluate aging and service life of fielded systems. Environmental analysis is also a key component of this capability.

Naval Surface Warfare Center
Arlington, VA 22242-5160
(703) 602-0632

Commander: RADM M. G. Mathis
Tech. Director: Dr. Daniel M. Viccione

FY1999 FUNDING DATA (MILLIONS $)*				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	3.816	N/A	0.481	4.297
6.1 Other	6.869	N/A	2.300	9.170
6.2	74.106	N/A	30.343	104.450
6.3	55.819	N/A	72.659	128.478
Subtotal (S&T)	**140.611**	**N/A**	**105.784**	**246.395**
6.4	247.994	N/A	142.736	390.729
6.5	88.768	N/A	61.875	150.643
6.6	16.270	N/A	26.140	42.411
6.7	41.869	N/A	46.763	88.632
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**535.512**	**N/A**	**383.298**	**918.810**
Procurement	281.912	N/A	351.278	633.190
Operations & Maintenance	296.224	N/A	227.866	524.090
Other	196.131	N/A	110.487	306.620
TOTAL FUNDING	**1309.781**	**N/A**	**1072.929**	**2382.710**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	43.100

PERSONNEL DATA (END OF FISCAL YEAR 1999)*				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	2	30	247	**279**
CIVILIAN	365	5206	4506	**10077**
TOTAL	**367**	**5236**	**4753**	**10356**

SPACE AND PROPERTY*			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	5819.758	**REAL PROPERTY**	864.250
ADMIN	1493.493	* NEW CAPITAL EQUIPMENT	85.650
OTHER	5903.892	**EQUIPMENT**	550.190
TOTAL	**13217.143**	* NEW SCIENTIFIC & ENG. EQUIP.	36.410
ACRES	**8795**	* Subset of previous category.	

**As a result of applying the In-House RDT&E Activity criteria at the division or major site level (see NOTE on page 3-1), NSWC Port Hueneme Division, Crane Division, and NWAS Corona data is not included in the FY1999 report.*

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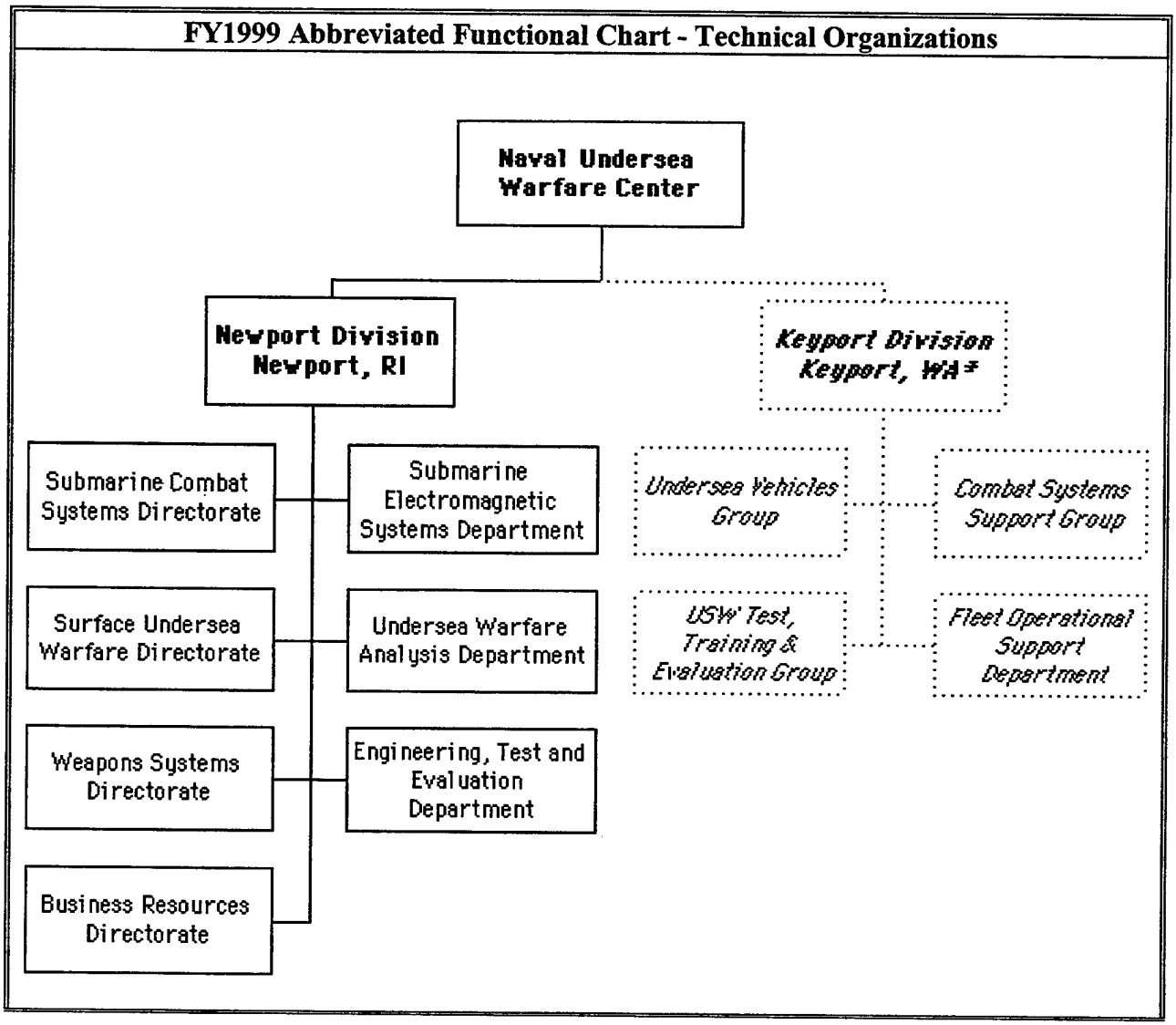
Naval Undersea Warfare Center



**As a result of applying the In-House RDT&E Activity criteria at the division level (see NOTE on page 3-1), NUWC Keyport Division data is not included in the FY1999 report.*

Naval Undersea Warfare Center
Newport, RI 02841-1708
(401)832-6761

Commander: RADM Charles B. Young
Technical Director: Dr. John E. Sirmalis

MISSION

The Naval Undersea Warfare Center (NUWC) Mission promulgated by OPNAVNOTE 5450 Ser 09B22/1U510577 dtd 23 Dec 91 is as follows:

'Operate the Navy's full spectrum research, development, test and evaluation, engineering, and fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapon systems associated with undersea warfare.'

Technical Leadership Areas:
As assigned by SECNAVINST 5400.16 of 18 December 1992, NUWC provides the Navy with leadership in:

- Undersea Warfare Modeling and Analysis
- Submarine Combat and Combat Control Systems
- Surface Ship and Submarine Sonar Systems
- Submarine Electronic Warfare
- Submarine Unique On-Board Communications Systems and Communications Nodes
- Submarine Launched Weapons Systems (except strategic ballistic missile systems, cruise missiles and related systems)
- Undersea Ranges
- Torpedoes and Torpedo Countermeasures
- Submarine Vulnerability and Survivability (except Hull, Mechanical & Electrical Ship's Equipment - - HM&E)
- Undersea Vehicle Active and Passive Signatures (except HM&E)
- Submarine Electromagnetic, Electro-optic and Nonacoustic-effects Reconnaissance, Search and Track Systems

CURRENT IMPORTANT PROGRAMS

SCIENCE AND TECHNOLOGY

NUWC conducts a comprehensive Science and Technology program in support of its mission that spans In-House Laboratory Independent Research (ILIR), Basic Research, Applied Research and participation in Advanced Technology Demonstrations. Current emphasis areas include:

- Submarine Combat Control - contact management, weapon targeting, engagement planning and advanced information management concepts, training automation.
- Submarine/Surface Ship Sonar - shallow water active classification, high gain systems, active surveillance systems, full signature processing, deployable surveillance systems.
- Torpedoes - propulsion and control systems, hydrodynamics/drag reduction, advanced arrays and signal processing, supercavitating technology noise reduction/acoustics, countermeasure technologies, UUV's, launchers; and advanced concepts.
- Submarine Communications - communication at speed and depth, mast antenna technology.

SUBMARINE SONAR

- AN/BQQ-5
- AN/BQG-5 Wide Aperture Array
- TB-16F, -23 and -29 Submarine Towed Arrays

CURRENT IMPORTANT PROGRAMS

- Submarine Sonar Advanced Development
- AN/WLY-1 AN/WLR-9
- New SSN Sonar Subsystem
- AFTAS
- RATTRAP
- Acoustic Rapid COTS Insertion
- Sonar Advanced Development
- Transducer Tech Direction/Support Program
- AN/BSY-1 Acoustics
- Submarine Ancillary Sonar Systems
- Affordable Array Technology (ATD)
- Ultra Thin Line Array
- Thin Optical Towed Array
- Acoustic Comms (ATD)
- Submarine Safety (SUBSAFE) Program
- Multi-Chip Module Laboratory
- Towed Systems ISEA
- Macintosh-Based Digital Signal Processor (MACDSP)
- Multi-line Towed Array (MLTA)
- Conformal Acoustic VElocity Sensors (CAVES)
- High Frequency Active (HFA)
- Advanced Processor Build Program
- Multi-purpose Acoustic New Technology Insertion System (MANTIS)

SURFACE SHIP SONAR AND ASW SYSTEMS

- AN/SQQ-89 ASW Combat System
- Multistatic Sonar
- Surface Ship Torpedo Defense
- AN/SQR-19 Tow Array Sonar
- AN/SQS-53 A,B,C,D Active Hull Sonar
- AN/SQQ-28 Sonobuoy Processor
- KINGFISHER
- Echo Target Classifier
- Shallow Water Active Detection Classification
- Surface Combatant 21st Century
- DD-21
- Lightweight Broadband Variable Depth Sonar
- Towed Active Receiving System (TARS)
- Sonar Insitu Mode Assessment System (SIMAS)
- Weapon System Accuracy Trails (WSAT) Program
- ASW Systems Consolidated Operability Test (SCOT) Program
- AN/SQQ-89 Support Team

SUBMARINE COMMUNICATIONS, ELECTRONIC WARFARE SUPPORT MEASURES (ESM), ELECTRO-OPTICS SYSTEMS/PERISCOPES

- Submarine Connectivity
- On-Hull Extremely Low Frequency (ELF) Antenna
- Submarine High Data Rate (HDR) Antenna System
- Large Aperture Multifunction C4ISR Mast
- OE-538 Multifunction Mast Antenna
- Submarine Integrated Antenna System (SIAS)
- Extremely Low Frequency (ELF) Communications
- Navy Extremely High Frequency (EHF) Satellite Communication Program (NESP)
- Submarine Communication Support System (SCSS)
- Integrated Electronic Support Measures (ESM) Mast (IEM)

CURRENT IMPORTANT PROGRAMS

- An/BLQ-10 Submarine Electronic Warfare Support System
- AN/WLR-8 High Probability of Intercept (HPI) Receiver
- AN/BVS-1 Photonics Mast
- Electro-Optic Sensor Development and Acquisition
- Submarine Periscopes Program
- Submarine Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP)
- EMC Advisory Boards (EMCAB)
- Plasma Excitation
- UHF Medium Data Rate Asymmetric Communications System

VIRGINIA, SEAWOLF, LOS ANGELES AND TRIDENT CLASS SUBMARINE COMBAT, AND COMBAT CONTROL SYSTEMS

- VIRGINIA
- AN/BSY-2, AN/BQG-5 Submarine Combat System
- Combat Control Systems MK 2
- Seawolf Non-Propulsion Electronics
- Trident Command and Control System
- Missiles: Combat Control
- Module Test and Repair Program
- Trainers
- Sensor Performance Computer Based Tactical Aids
- CCS Mk1 C4.2V2A
- Advanced Tomahawk Weapon Control System
- Submarine Fleet Mission Program Library
- Tactical Control Program

UNDERSEA WARFARE MODELING AND ANALYSIS

- Analysis of Undersea Warfare (USW) Contributions to Joint Vision 2010
- USW Technical Support to Fleet Battle Experiments (FBEs)
- Development of Future USW Concepts of Operation
- New USW Program Capability Assessment
- USW Investment Strategy Options Development
- Intelligence Data Assessment
- USW Requirements Analysis
- Derivation of USW Technology Goals
- Coordinated ASW Force Assessments
- Submarine and USW Synthetic Environments
- Battle Group Net Based USW
- Submarine System Engineering and Analysis
- SSN Tactical Development Support
- SSN End-to-End Assessment
- Analysis of Site-Specific ASW Performance with Selected Environmental Models
- Test and Training Enabling Architecture
- Achieving High Level Architecture (HLA) Compliance for USW Simulations & Simulators
- USW Knowledge Management System

DEVELOPMENT OF TRAINING, T&E, AND LOGICAL RANGES

- AUTEC Hydrophone Replacement Program
- Tri-Service Signature Measurement and Database System
- Pinger Program
- Undersea Battlespace
- East Coast Shallow-Water Training Range
- Atlantic Fleet Weapons Test Facility Hydrophone Replacement
- Test and Training Enabling Architecture

CURRENT IMPORTANT PROGRAMS

- Synthetic Environment Tactical Integration
- Land Sea Vulnerability Test Complex (LSVTC)
- Underwater Range Data Communications Systems (URDC)
- Foundation Initiative -2010 - Test and Training Enabling Architecture
- Offboard Advanced Systems Stimulus (OASIS)
- Distributed Engineering Plan

SUBMARINE, SURFACE SHIP AND AIR LAUNCHED TORPEDOES, TORPEDO/SONAR COUNTERMEASURES, UUVS, ASSOCIATED LAUNCHER SYSTEMS AND MISSILES

- Torpedo Mk 48/Mk 48 ADCAP Program
- Torpedo Mk 50 Program
- Torpedo Mk 46 Program
- Torpedo Mk 54 (Lightweight Hybrid Torpedo) Program
- Torpedo Mk 46/Mk 48 FMS Program
- Torpedo Alternate Fuels Program
- CBASS Program
- ISLMM Program
- Torpedo Test Equipment Programs
- Mk 30 ASW Target Program
- Near Term Mine Reconnaissance System Program
- Long Term Mine Reconnaissance System Program
- ONR UUV Program
- ADC Mk 2/3/4 Countermeasure Program
- Affordable Common Countermeasure Program
- Tomahawk Cruise Missile (Submarine-Launched)
- Encapsulated Harpoon Weapon System
- Submarine Weapon Simulators and Test Vehicles
- Integrated Diagnostic Support System
- Submarine Torpedo Tubes
- SSN-21 Launcher Systems
- Turbine Pump Ejection Systems
- Submarine Weapon Handling
- SSN-688 Vertical Launch System
- Surface Ship Torpedo Tubes
- New SSN Launcher Systems
- Submarine External Countermeasure Launchers
- Submarine Internal Auxiliary Launchers
- Elastomeric Ejection Systems
- Submarine Advanced Launch Technology
- Adaptable High Speed Undersea Munitions

TECHNOLOGY TRANSFER:
NUWC conducts an extensive technology transfer program that is structured to make technology developed for defense purposes available to the academic and industrial communities through development of partnerships that benefit NUWC and the Navy. The main mechanics for technology transfer are:

Patent Program - NUWC operates a highly efficient patent program believed to be the most productive in U.S. government (patents per scientist/engineer). In FY98, 172 invention disclosures were recorded, 80 patent applications were filed, and 134 patents were issued or allowed (128 patents and 6 classified allowances (D-10)). Some significant examples are:

- Patent No. 5,632,218 - Debris Deflector
- Patent No. 5,635,662 - Method and Apparatus for Avoiding Detection by a Threat Projectile
- Patent No. 5,637,826 - Method and Apparatus for Optimal Guidance
- Patent No. 5,654,937 - Acoustic Element Tester for an Array of Hydrophones
- Patent No. 5,673,645 - Agile Water Vehicle

CURRENT IMPORTANT PROGRAMS

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRADAs):

- Lockheed-Martin - Explore and exploit massively parallel processing as applicable to sonar processing
- MedAcoustics, Inc. - Demonstrate signal-processing algorithms to process acoustic signals within the cardiac cycle
- Precision Signal, Inc. - Develop state-of-the-art equipment to map deep- and shallow-water ocean floors
- General Dynamics/Electric Boat Division - Further the development of Computational Fluid Dynamics to meet current and future Navy needs
- Connecticut Municipal Electric Energy Cooperative
- Investigate electric vehicle electromagnetic interference, measurement and mitigation
- University of Maine - Develop a method of predicting the deformation of nets deployed in an ocean environment
- Lucent Technologies - Develop ultra-thin array technology
- Yale University School of Medicine - Bio-medical model development
- Loctite Corporation - Material property measurement
- Draper Laboratory - Co-development of unmanned underwater vehicle technology
- Foster-Miller, Inc. - Demonstrate low-cost, expendable bottom-crawling vehicles for ocean-bottom explorations
- Public Service Electric and Gas Co. - Material development, testing and evaluation for shielding capability in electromagnetic fields
- Rhode Island Technology Transfer Center - Technical assistance to Rhode Island's technically-based companies
- CytoTheraputics, Inc. - Prototype packaging for medical devices using stereolithography
- Westfall Manufacturing Co. - Design verification and representation of a static fluid mixing device for water treatment processing
- Niche Medical, Inc. - Assistance in the design of a surgical smoke plume collector
- Deep Creek Technology, Inc. - Assistance with the integrated diagnostics support system
- Michigan State University - Development and application of controllable fluids
- Automata, Inc. - Assistance with the integrated diagnostics support system
- Dr. Alan Semine - Medical image processing for breast cancer
- Flight Safety Technologies, Inc. - Modeling and simulation of the acoustic signature of atmospheric disturbances
- BENTHOS, Inc. - Transfer and commercialize the THAMES acoustic measurement system software
- D. G. O'Brien - Underwater Test and Training Ranges - Development of a family of standard cable seals for use in terminating marine cables on the Navy's underwater test and training ranges
- Madison Technology International - Development of a family of high performance preamplifier/signal conditioners
- Yale Medical School - Bio-Medical Model Development - Develop constitutive formulation and mathematical representation for several cardiac tissues including anisotropic structures with time dependence
- Loctite Corporation - Acoustic Material Measurements - Determine the acoustic impedance of various candidate materials as a function of frequency and adhesive related structural boundary conditions

EDUCATION PARTNERSHIP AGREEMENTS (EPA's)

- Oceansciences, Inc. - to provide undersea science and technology educational guidance and assistance for an ocean sciences camp and museum to further math and science education.
- The University of Massachusetts/Dartmouth - to aid in the undersea science and technology education of students and faculty.
- Yale University - to aid in the fluid mechanics, acoustics, and mathematics education of students and faculty.
- The University of Rhode Island - to aid in the ocean science, engineering, computer science and

CURRENT IMPORTANT PROGRAMS

engineering, mathematics, management, and statistics. technology, and policy applications of these disciplines to encourage student interest in these areas.
The University of Massachusetts/Lowell, Institute for Plastics Innovation - to encourage students interest in the low-density extruded plastic materials applications of their individual disciplines.

- Rutgers, the State University of New Jersey - to aid in the ocean science, engineering, technology, and policy applications of these disciplines to encourage students interest in these areas.
- Florida Atlantic University - to aid in the education of students and faculty in ocean and systems engineering.
- Bryant College - to aid in the development of future leaders and managers through business management education via Distance Learning.
- Carnegie Mellon University - to provide software engineering education to students using new Distance Learning technology.

EQUIPMENT/FACILITIES

The Naval Undersea Warfare Center maintains and continuously improves numerous facilities designed to support the Research, Development, Test, and Evaluation of Undersea Warfare (USW) systems. These facilities include:

SONAR COMPLEX
This complex is a unique set of 6 facilities that include platform independent and federated laboratories and robust simulation and stimulation used to explore the underlying science and technology common to submarine and surface ship sonars. These facilities encompass the research, development and test of acoustic sensors, transducers, and arrays for use in tactical, calibration and standards applications at sites ranging from laboratory test beds and large scale pressure vessels to inland lakes and ponds. This complex provides the Navy with the capability to explore the technologies and science associated with transduction materials, fiber optics, environmental acoustics, and measurement and analysis techniques, leading to development of hull mounted, towed, and expendable sensors and arrays. Sonar systems laboratories consist of specialized sites for the investigation of signal processing, operator displays, detection and classification algorithms, acoustic communication, acoustic intercept, system architecture, onboard trainers, and commercial off-the-shelf applications utilizing robust simulation/stimulation capabilities to perform system evaluation, performance analysis and life cycle support.

SUBMARINE LAUNCHER SYSTEM TEST AND EVALUATION COMPLEX
This complex is a unique array of 7 major facilities dedicated to the full spectrum support of submarine weapon and countermeasure launcher programs. The facilities provide the capabilities for evaluating new launcher developments and improvements, land-based acceptance testing, and troubleshooting Fleet problems. The Transient Flow Loop and Transient Flow Impeller Test Facility are the only known facilities in the world capable of conducting hydrodynamic and hydroacoustic tests of transient flow. The Submerged Launcher System Test Facility replicates full-scale launch systems on SSN-688 and SSBN-726 class submarines and is capable of firing dummy weapons at all submarine depths. Dual ejection capability allows for concurrent, side-by-side firing comparisons of any two current or future candidate ejection systems. The Advanced Submarine Launcher Facility replicates the full-scale launch system on SSN-21 and Virginia class submarines, including full scale hull section, and is capable of launcher system performance testing and measuring radiated sound pressure levels in a unique Ocean Simulation Tank. The Internal Countermeasure Launcher Facility replicates the full-scale internal CM launcher on SSBN-726 class and is capable of performance testing and launch of full scale devices at various launch depths. The Large Diameter Tube Facility replicates the SSN-21 class submarine torpedo tube; capability is provided to load/unload full scale dummy weapons and to test performance of baseline/modified stop bolt mechanisms. The Vertical Launch System facility replicates the SSN-688 class; it consists of a full scale tube, mechanisms, and tube control panel. Capability is provided to load/unload dummy Tomahawk missile capsule and to evaluate tube components.

EQUIPMENT/FACILITIES

COMBAT SYSTEMS EVALUATION & ANALYSIS LABORATORY

The Combat Systems Evaluation and Analysis Laboratory (CSEAL) is a system prototyping environment designed to support the development, integration, evaluation, and demonstration of combat system technology products, advanced development models, and engineering development models. The CSEAL provides for direct input of at-sea test data as an alternative to simulation, and it also provides a mechanism for packing and transfer of prototypes for at-sea evaluation. CSEAL comprises four major components: a comprehensive software development environment, known as the Automated Software for Applications and Prototypes, which facilitates the rapid prototyping and integration of combat system applications; a high-fidelity submarine war-gaming and platform-level simulation based on Navy-approved models; integrated and dynamically-configurable combat system baseline applications and technology products; and analysis and evaluation software for data extradition and approach/event analysis.

SUBMARINE ANTENNA TEST COMPLEX

This complex of four facilities permits full characterization of submarine exterior communications, electronic and imaging warfare systems' related antennas/sensors by using unique laboratories and in-the-field test facilities. Stimulation/ simulation equipment that replicates advanced radio frequency (RF) emitters, specialized test equipment, and RF anechoic chambers provides highly accurate measurement of systems baseline performance, transmit and receive patterns, and radar cross section signatures. An Overwater Antenna Test Facility in Newport, RI, and a remote, electromagnetically quiet, test sites both on Fishers Island, NY, and an open ocean site 900 feet offshore, are used to measure performance with antennas/sensors operating in the sea water environment simulating actual submarine operations.

ELECTRO-MAGNETIC SENSOR TEST COMPLEX

This complex is a unique combination of 8 facilities that provides full spectrum support for the development, test, evaluation, and in-service engineering for current and future submarine, periscopes and imaging systems. Facilities include the Trident Periscope Facility, Special Mission Electro-Optic Sensor Support Facility, National Periscope Maintenance Facility, EHF Satellite Communication (SATCOM) Development Terminal, Electro-Magnetic System Operational Readiness Test (EMSORT) Development and Support Facility, Photonics Mast Land Based Test Site, Imagery Archive and Video Editing Facility, and Periscope Engineering RDT&E Facility.

UNDERSEA WARFARE ANALYSIS COMPLEX

This complex has developed and maintains a suite of USW models, databases and U.S. and foreign weapon system hardware-in-the-loop simulations. These are exercised in support of requirements analysis, tactical development, concept development and performance assessment from system level through force and theater levels. This complex comprises two components: The Undersea Warfare Analysis Laboratory (USWAL) component consists of distributed Linux computer servers linked together via a high speed network and tied to a centralized file server. This architecture, combined with an intelligent queuing system provides the USWAL with a specialized simulation environment to support platform and force-level warfare mission assessments. The Weapons Analysis Facility (WAF) simulation component provides a massively parallel processing synthetic environment which integrates a variety of actual weapon hardware and software within its specialized architecture. Thus, real weapons are allowed to perform mission scenarios in the highest fidelity virtual environment the U.S. Navy has developed. The combined computing engines in this complex achieve a maximum throughput exceeding 40 GigaFlops.

UNDERSEA RANGES

ATLANTIC UNDERSEA TEST & EVALUATION CENTER (AUTEC)

AUTEC is a comprehensive open ocean test and evaluation complex located in the ocean waters off Andros Island in the Bahamas. The AUTEC ranges allow testing of aircraft, surface ships, and submarines in an instrumented, calibrated 230-square-mile ocean area with precision tracking in three dimensions of all platforms. AUTEC also provides measurement systems for basic acoustic, environmental, and oceanographic research and test programs. As part of the AUTEC complex, there is a shallow-water OPAREA that consists of a minefield adjacent to a 90 square-mile ocean area with

EQUIPMENT/FACILITIES

precision tracking in three dimensions of all platforms. The real-time positional information can be displayed on location or linked back to one of AUTEC's display centers at Andros or West Palm Beach. There is also a Portable Tracking System (50 nmi) that can be deployed in OPAREAs of opportunity and provides three dimensional precision tracking of all platforms. AUTEC's facilities are available for use by U.S. and allied foreign government organizations, private industry, and academic institutions.

NATO FORACS AUTEC (NFA)
NATO FORACS (Naval FORces Sensor and Weapons Accuracy Check Sites) is a multi-national NATO project with eight member nations: Canada, Denmark, Germany, Greece, Italy, Norway, the United Kingdom, and the United States of America. Its mission is to measure the bearing, range and heading errors of sensors on-board surface ships, submarines, and helicopters. These calibration measurements establish confidence among the member naval forces that target locations can be accurately passed from sensors to weapon systems and other NATO combatant units. The sensors that are tested include: active, passive, dipping and towed array sonars; fire control and search radars; ESM and RDF equipment; infrared, laser and TV sensors; optical sights and peloruses; periscopes, inertial navigation and positioning systems; GPS; and gyrocompasses. There are three NATO FORACS Ranges: Greece, Norway, and AUTEC. NFA is collocated within the AUTEC complex.

LITTORAL UNDERSEA WARFARE COMPLEX
The complex is a unique combination of test and tracking facilities and test environments in the Northeast. These facilities and environments represent potential areas of regional conflict (Persian Gulf, Gulf of Oman, coast of Korea) and have been well characterized, contain baseline performance data on existing systems, and can be supported cost effectively by nearby shore activities. The unique Gould Island Elevator/Launch System, deep water piers, and test areas immediately adjacent to NUWC are especially effective for testing systems in shallow water in an effective and affordable manner. Also, the decommissioned diesel submarine USS SALMON provides sonar targets for development of new systems and acts as a training aid for submarines transiting the area aiding in detection and classification of bottom targets.

PACIFIC NW RANGE SYSTEM
There are three unique, highly instrumented test sites in NUWC's Northwest Range system, with over 100 square miles of littoral and mid-depth underwater tracking area, including inshore shallow water sites. Principally used as underwater test ranges, they also have extensive surface and in air tracking capability. Water depths, specialized instrumentation, bottom recoverability, acoustic quietness, and security factors facilitate a wide range of Undersea Warfare vehicle and platform tests from Research and Development to production acceptance and Fleet evaluation/exercise. All range sites are linked to the Range Information Display Center (RIDC) at Keyport, WA, where operations can be viewed, controlled, and analyzed in real time.

- The Nanoose range site is jointly operated and maintained on a shared basis by the United States and Canada and is located in the Strait of Georgia near Vancouver Island in British Columbia, Canada. Canada also provides extensive range craft support and facilities at no cost to the United States. It is also an excellent site for countermeasure testing because of its robust, short-baseline tracking configuration and its capability to track while most countermeasures are in use.

- The Dabob Bay range site is located in Hood Canal near Naval Submarine Base, Bangor and is among the quietest and most secure instrumented underwater ranges in the world. This is especially important in the testing of new, quiet, and leading-edge technologies which are under development.

- The Quinault test site is approximately 10 miles off the coast of Washington and offers the Navy's only fully-instrumented, shallow underwater environment. It meets the NATO 40-meter shallow water requirement and can provide support for the expanding shallow water antisubmarine warfare emphasis, including mine warfare testing and training.

EQUIPMENT/FACILITIES

OTHER RANGE ACTIVITIES

NUWC is the principal provider of full spectrum Undersea Warfare Test, Training, and Evaluation services that utilize the Navy's MIDPAC and SOCAL Range Systems. MIDPAC is located within 20 nautical miles of Pearl Harbor, on the western coast of the Island of Oahu, Hawaii. This Range System consists of the Hawaiian Island Underwater Range (HAIUR), Fleet Operational Readiness Accuracy Check Site III (FORACS III), and Surface Ship Radiated Noise Measurement (SSRNM) test facilities. HAIUR is instrumented with a long baseline, asynchronous tracking system and offers depths from 2500 ft to 3500 ft. Services include test, training, and evaluation planning; test and training conduct; providing real-time, wide-area ranges and ranging alternatives; analysis, and evaluation of systems in both surrogate and real war-fighting environments. The SOCAL Range System is located in the San Diego, California area at San Clemente Island. This range system consists of the San Clemente Island Underwater Range (SCIUR), Surface Ship Radiated Noise Measurement (SSRNM) test facilities, and a Fleet Operational Readiness Accuracy Check Site (FORACS). This site offers a long baseline, asynchronous tracking system with depths to 3900 ft. Surface and air tracking capabilities are also provided.

SHIPBOARD ELECTRONIC SYSTEMS EVALUATION FACILITY (SESEF)

The SESEF program was developed to provide electromagnetic systems test and evaluation services to afloat and shore commands for the development of new and upgraded systems; to validate system performance following new construction and overhaul; and to provide real-time assessment of material readiness in an operational environment.

ACOUSTIC MEASUREMENT CALIBRATION TEST FACILITIES

The Seneca Lake and Dodge Pond acoustic calibration facilities are unique in that they provide full spectrum testing of all types of acoustic devices from small prototypes projectors to full scale arrays and systems. The facilities provide open water test and evaluation capabilities with depths ranging from 50 feet to 500 feet, test ranges to 8000 meters and lifting capacities up to 220 tons. Open year around, the facilities are accessible within close proximity of the Northeast industrial area either by highway or in the case of Seneca Lake, access from the Atlantic Ocean is possible through the New York canal system.

UNDERSEA WARFARE EXERCISE COMMUNICATIONS CENTER

The facility provides the ability for real-time and post-exercise monitoring and processing of instrumented underwater range date from the Atlantic Undersea Test and Evaluation Center (AUTEC) and the Atlantic Fleet Weapons Training Facility (AFWTF). This facility is unique in that it enables training, test and evaluation in synthetic environments. UWECC serves as the communications link between simulation and analysis laboratories, T&E and training ranges, and submarines and surface ships. Linkages between ranges, simulators and trainers, government and private laboratories (i.e. geographically separated test facilities) allows for more simulation, less live testing; virtual prototyping; integrated constructive and virtual simulation with live tests; and fully stressed threat environment in training exercises. In the mid- 2000 time frame, the Integrated Display Center (IDC) will replace the UWECC.

WEAPONS DEVELOPMENT FACILITY COMPLEX

This complex includes major facilities for design, development, test, and life cycle support of Navy torpedoes, countermeasures, unmanned undersea vehicles, and undersea targets. Torpedo and other vehicle system designs are developed and maintained in the complex. Its Propulsion Test Facility supports electric and thermal (open and closed cycle) propulsion system developments and includes the Deep Depth Propulsion Test Facility, the only land-based facility capable of testing entire torpedoes to maximum power and depth; a total containment High Energy Chamber, designed to contain the total energy content of advanced propulsion systems in an environmentally safe manner; and the Propulsion Noise Test Facility, the only land-based facility capable of measuring radiated noise of operational underwater vehicles on land. The complex also includes the world's quietest anechoic wind tunnel, a 64,000 cubic foot anechoic chamber, the largest Reverberant Acoustic Tank of its kind in the country, the Navy's only large scale sea-water tow tank (3000 feet long) and an advanced materials laboratory, all of which provide comprehensive hydrodynamic, structural and acoustic data on components, as well as on full systems. Development and evaluation of vehicle sonars, guidance and control systems and software are accomplished in the unique Torpedo Life Cycle Support Facility. It includes undersea vehicle

EQUIPMENT/FACILITIES

testbeds, allowing the capability to integrate new software with vehicle guidance and control hardware and test it under simulated in-water operating conditions.

METROLOGY & MECHANICAL INSPECTION FACILITY - C0DE 7008

The Metrology & Mechanical Inspection Facility provides 6400 square feet of modern laboratory space dedicated to the calibration and repair of electronic and mechanical test instrumentation used throughout NUWC in support of major combat control, surface ship & submarine sonar, submarine electromagnetic, and weapons systems programs. Functional support areas include: Torpedoes, Launchers, Fire Control Systems, Countermeasures, Submarine Sonar Systems, Surface Ship Sonar Systems, Submarine Combat Systems, Surface Ship Combat Systems, and Submarine Communications and ESM Systems. The facility also functions as a Type II AC/DC and Microwave Calibration Laboratory for calibration and repair of Navy standards used by IMA Depots, and other ship-based, shore-based, and DoD Calibration Laboratories. Within this facility, 1291 different standards are maintained to support calibration of all electronic, mechanical and dimensional test equipment used within the organization. A pool of over 20,000 instruments is maintained for use by the engineers and scientists for shipboard testing and applications within the many technical Facilities operated by NUWC Division, Newport.

SURVIVABILITY LAB - CODE 7014

The Survivability Laboratory has over 23,000 square feet of specialized laboratory space dedicated to survivability and environmental testing of submarine and surface ship sonar, electromagnetic communications and ESM systems, weapons systems, launcher systems, countermeasure systems, and combat systems. This modern facility supports measurements of the mechanical parameters of sonar equipment and the properties of materials used in underwater mobile and deployed sonar arrays research and development programs. The facility houses large, imbedded pressure vessels specifically designed for testing coiled towed array sonar sensors; large vibration and shock test machines with associated, imbedded seismic masses; and room-size, walk-in temperature and humidity chambers. In addition, there is a full spectrum of dedicated instrumentation and analysis equipment available to support the acoustics array combat system, and weapons testing nature of the facility. The facility is capable of conducting a broad range of tests ranging from individual, specialized experiments for various projects to full Military-Specification environmental qualifications.

INDUSTRIAL SERVICES ENTERPRISE (ISE)- CODE 7009

The Industrial Services Enterprise provides NUWC with facilities and expertise to perform engineering design, prototype development, advanced manufacturing and part verification/inspection. Emphasis is placed on providing NUWC with Manufacturing Technology support through the application of concurrent engineering and the development of capability in the areas of Computer Aided Design (CAD), Computer Aided Manufacture (CAM), Computer Numerical Control (CNC) of machine processes and advanced material selection/fabrication. At the same time, the ISE provides the manpower, skills, and machinery to fabricate prototype hardware enabling NUWC engineers and scientists to demonstrate, test and verify new concepts under development. The infrastructure for the machines and training of personnel to use those machines, are supported through a Service Cost Center.

Naval Undersea Warfare Center
Newport, RI 02841-1708
(401)832-6761

Commander: RADM Charles B. Young
Technical Director: Dr. John E. Sirmalis

FY1999 FUNDING DATA (MILLIONS $)*				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.638	N/A	0.041	1.679
6.1 Other	1.670	N/A	0.343	2.013
6.2	20.659	N/A	6.379	27.038
6.3	9.885	N/A	3.494	13.379
Subtotal (S&T)	**33.852**	**N/A**	**10.257**	**44.109**
6.4	36.485	N/A	14.973	51.458
6.5	45.396	N/A	20.146	65.542
6.6	39.935	N/A	9.420	49.355
6.7	22.131	N/A	12.936	35.067
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**177.799**	**N/A**	**67.732**	**245.531**
Procurement	117.954	N/A	115.645	233.599
Operations & Maintenance	58.488	N/A	55.513	114.001
Other	34.472	N/A	23.528	58.000
TOTAL FUNDING	**388.713**	**N/A**	**262.418**	**651.131**

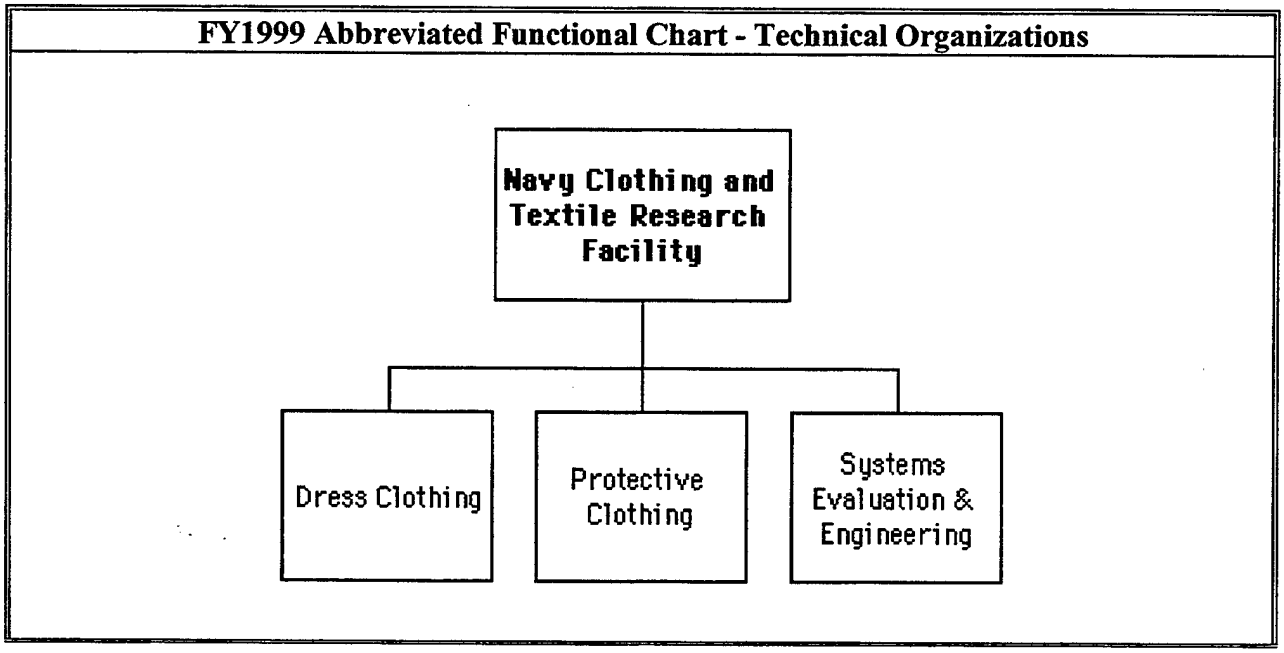
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)*				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	53	**53**
CIVILIAN	122	1763	955	**2840**
TOTAL	**122**	**1763**	**1008**	**2893**

SPACE AND PROPERTY*			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1642.000	**REAL PROPERTY**	205.500
ADMIN	297.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	565.000	**EQUIPMENT**	493.300
TOTAL	**2504.000**	* NEW SCIENTIFIC & ENG. EQUIP.	10.200
ACRES	**891**	* Subset of previous category.	

**As a result of applying the In-House RDT&E Activity criteria at the division level (see NOTE on page 3-1), NUWC Keyport Division data is not included in the FY1999 report.*

Navy Clothing and Textile Research Facility



Navy Clothing and Textile Research Facility
Natick, MA 01760
(508)233-4172

Director: Dr. Barbara Avellini
Administrative Officer: Marie Dobachesky

MISSION

Conduct research, development, test and evaluation and provide engineering support in clothing, textiles, and related fields associated with service clothing and environmental protective clothing. Our core technologies revolve around individual protection against environmental threats such as, heat, cold, accidental water immersion, fire, steam, biological-chemical exposure, hazardous chemicals, etc. The Natick site which houses both NCTRF and the U.S. Army Natick Research, Development and Engineering Center has been designated the DoD Center of Excellence for Clothing and Textiles.

CURRENT IMPORTANT PROGRAMS

Joint Protective Aircrew Ensemble (JPACE) - Joint service program to develop next generation chemical-biological protective garments for aircrew of all services. Leading garment design effort as well as assessments of material physical properties, heat stress and flame/thermal protection assessments.

Shipboard Protective Clothing Program - Provide state of the art, commercially available, firefighter's protective clothing, flame resistant utility clothing, anti-exposure suits, cold and wet weather ensembles, and life support systems and equipment for shipboard Navy personnel. Performance requirements and test procedures developed through NCTRF laboratory testing and Fleet evaluation. Testing includes assessment of materials and garments for conformance to industry standards and Navy unique requirements.

AIR WARRIOR - Support of Army program to develop improved integrated aircrew ensemble for rotary wing aircraft. Developing one-piece camouflage flight coverall and supporting overall physical integration of man-mounted equipment and clothing.

Flame/Thermal Test methodology - Developing full scale system to evaluate ability of various garments to provide protection from a variety of convective, conductive and radiant heat sources, including flame and steam. Includes articulated and non-articulated instrumented manikin development.

Personal Thermal Stress Management Materials - Evaluation of new material technologies to extend the range of comfort and protection for individuals exposed to warm and cold environments. Includes phase change materials, Composite Fabric Endothermic Materials, and carbon based conductive fibers.

Marine Corps Projects - Developing Anti-exposure suit for use by Marines during ship to shore transport on rafts. Developing improved glove for handling barbed/concertina wire for combat engineers.

NCTRF researchers were awarded a patent for variable sized footwear. Initially developed for military firefighter boots, this dual use technology is being evaluated for other commercial applications.

EQUIPMENT/FACILITIES

Major equipment and facility capabilities include:
Two thermal manikin systems used to measure insulation values of protective clothing systems. One system employs heat pipe technology to obtain measurements in an air environment; this manikin is the only known in existence utilizing this technology. The second manikin has the capability to evaluate items in both an air and water immersion environment. This is one of only four known manikins worldwide capable of being used in both water and air.

The environmental test chambers reproduce extremes from 0°Fto 130°F at 5% to 95% relative humidity, with winds up to .5 to 15 mph.

The hydro-environmental simulator with wave maker is the only known chamber within the Navy that is able to independently control both air and water temperatures simultaneously, and thus simulate any air/water interface.

A thermal flammability laboratory includes instrumentation to evaluate conductive, radiative, and convective heat.

Physiological test and evaluation equipment.

A traversing thermocouple instrumented manikin, used to evaluate fire resistant protective clothing at variable heat flux levels and exposure times, when exposed to a propane-fueled fire in an enclosed area.

A Gerber Micromark/Silhouette computer-aided design system to grade, alter, and trace patterns, and to cut hard patterns.

A shipboard laundry laboratory.

Instron testers, weatherometers, fadeometers, launderometer, tear tester, etc., used to determine physical characteristics of clothing and textiles.

Navy Clothing and Textile Research Facility
Natick, MA 01760
(508)233-4172

Director: Dr. Barbara Avellini
Administrative Officer: Marie Dobachesky

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	0.000	0.000
6.1 Other	0.000	N/A	0.000	0.000
6.2	0.330	N/A	0.055	0.385
6.3	0.000	N/A	0.000	0.000
Subtotal (S&T)	**0.330**	**N/A**	**0.055**	**0.385**
6.4	0.440	N/A	0.032	0.472
6.5	0.498	N/A	0.209	0.707
6.6	0.000	N/A	0.000	0.000
6.7	0.000	N/A	0.000	0.000
Non-DOD	0.369	N/A	0.211	0.580
TOTAL RDT&E	**1.637**	**N/A**	**0.507**	**2.144**
Procurement	0.178	N/A	0.068	0.246
Operations & Maintenance	1.616	N/A	0.189	1.805
Other	0.378	N/A	0.381	0.759
TOTAL FUNDING	**3.809**	**N/A**	**1.145**	**4.954**

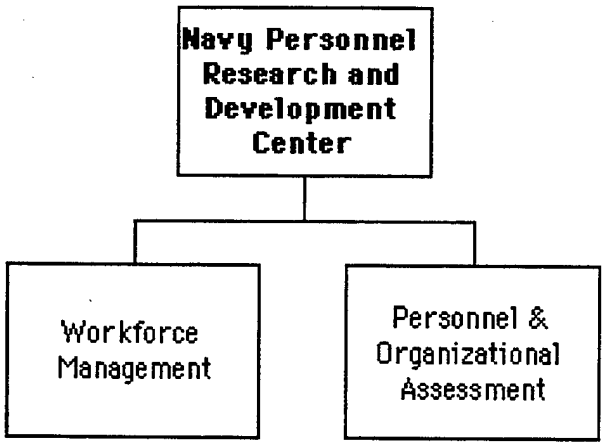
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	0	**0**
CIVILIAN	1	21	9	**31**
TOTAL	**1**	**21**	**9**	**31**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	12.667	**REAL PROPERTY**	4.300
ADMIN	16.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	0.000	**EQUIPMENT**	2.805
TOTAL	**28.667**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**0**	* Subset of previous category.	

Navy Personnel Research and Development Center

FY1999 Abbreviated Functional Chart - Technical Organizations



Navy Personnel Research and Development Center
San Diego, CA 92152-7250
(619)553-7812

CO: CDR William M. Keeney
TD: Mr. Murray W. Rowe

MISSION

NPRDC serves as the Navy's principal research laboratory for developing Manpower and Personnel technologies. We maintain and enhance fleet readiness by developing state-of-the-art technology solutions to significant operational problems in Workforce Management, and Personnel and Organizational Assessment.

The Center's R&D program encompasses Recruiting, Selection and Classification; Personnel Planning and Policy Analysis; Distribution and Assignment; Knowledge Management Systems; and Personnel Surveys and Program Evaluation. We also maintain corporate expertise in personnel surveys, multicultural and gender research, quality of life issues, productivity enhancement, and drug abuse research.

CURRENT IMPORTANT PROGRAMS

WORKFORCE MANAGEMENT - A comprehensive program to improve the Navy's management of its personnel resources. Products include suites of integrated, computer-based models, databases and systems which enable: Rapidly collecting and displaying information on personnel force characteristics in easily understood graphic and tabular forms; Testing the effects of alternative policies on the workforce by mathematically simulating force dynamics under varying test policies; Developing and updating manning plans to reflect budgetary and end-strength constraints, and statistically forecasting losses and gains at several levels of detail within the enlisted and officer workforce. Major projects include the Enlisted Strength Planning System, which enables monitoring all personnel force transactions on a daily basis; the Navy Training Reservation System (NTRS), designed to improve the way students are scheduled for Navy schools, while cutting times lost while students transition to and from schools; a Job Advertisement and Selection System (JASS), an on line information and decision system for both sailors and detailers; and Computer-Based Technology for Detailers, which: optimally matches rotating sailors to available jobs while considering moving costs, meets sailors' location preferences, and enables maximum use and reuse of individual skills. The department also provides R&D support for the Navy Drug and Alcohol Prevention Program, with tasks addressing detection, prevention, education and substance abuse modeling.

PERSONNEL AND ORGANIZATIONAL ASSESSMENT - The goal of the overall research program is to enhance both personnel and organizational readiness. Efforts in Personnel Assessment address enlisted and officer selection, personnel testing, job classification, and performance measurement. The Center has a strong program to improve the sensitivity and effectiveness of computer adaptive testing in general. Innovative measurement technologies, including computer-based dynamic measures, are also being explored for their usefulness in personnel assessment. Organizational Assessment investigates and develops organizational solutions to meet Navy goals. Research projects focus on organizational and workgroup behavior. Major projects involve personnel surveys and attitude assessment, multicultural and gender integration, the role of quality of life factors in relation to readiness, and technical innovations to enhance workgroup productivity.

BRAC REALIGNMENT - NPRDC's Workforce Management and Personnel and Organizational Assessment research programs will realign into the Navy Personnel Command, Memphis in November 1999 becoming the Navy Personnel Research, Studies and Technology Department. Upon completion of the Memphis transfer, NPRDC will be disestablished.

EQUIPMENT/FACILITIES

The Center occupies approximately 46,400 square feet of space in converted World War II barracks buildings. Much of this is configured to accommodate the social science and mathematical analysis tasks performed on microcomputers and minicomputers. The facilities include upgraded electrical capability and air conditioning of the most equipment-intensive rooms. In addition, the Center has an advance party at the Naval Support Activity Mid-South, Millington, TN. This group occupies approximately 9,000 square feet of space in a recently modernized office building in the Navy Personnel Command Campus. Some computing functions have been established in Millington, but the main computing facility will remain in San Diego until the Center is realigned into the Navy Personnel Command in FY00.

The Center's Research Computing Facility (RCF) includes a computer room with raised flooring, central air conditioning, and upgraded electrical power. It is used to develop, process, and maintain statistical and forecasting systems; very large complex personnel and training databases, and large software system applications. It provides network (internal and external) services, data analysis software, text processing support, graphics/video image processing software, and electronic mail/news services. The data analysis, text processing, and graphics/video image processing software is specialized and, in some cases, custom written for NPRDC applications. Some of the RCF services required modifications to the UNIX operating system kernel, necessitating an NPRDC source license for the UNIX operating system.

Navy Personnel Research and Development Center
San Diego, CA 92152-7250
(619)553-7812

CO: CDR William M. Keeney
TD: Mr. Murray W. Rowe

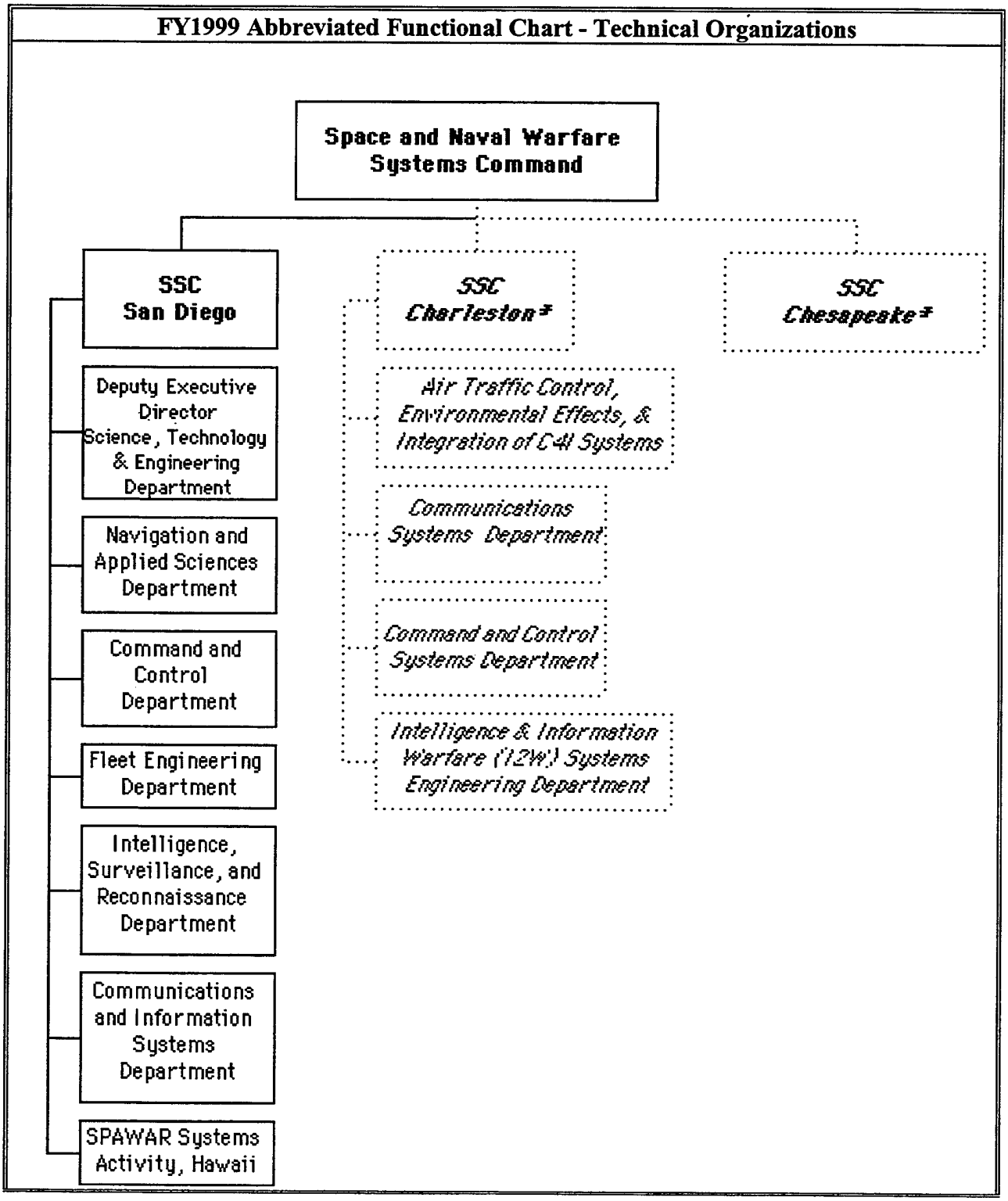
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.150	N/A	0.026	0.176
6.1 Other	0.000	N/A	0.000	0.000
6.2	1.097	N/A	0.617	1.714
6.3	2.122	N/A	1.357	3.479
Subtotal (S&T)	**3.369**	**N/A**	**2.000**	**5.369**
6.4	0.000	N/A	0.000	0.000
6.5	0.597	N/A	0.933	1.530
6.6	0.071	N/A	0.117	0.188
6.7	0.000	N/A	0.000	0.000
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**4.037**	**N/A**	**3.050**	**7.087**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	5.150	N/A	4.567	9.717
Other	0.134	N/A	0.075	0.209
TOTAL FUNDING	**9.321**	**N/A**	**7.692**	**17.013**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	8	**8**
CIVILIAN	12	25	32	**69**
TOTAL	**12**	**25**	**40**	77

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	34.500	**REAL PROPERTY**	1.000
ADMIN	16.400	* NEW CAPITAL EQUIPMENT	0.000
OTHER	4.500	**EQUIPMENT**	4.676
TOTAL	**55.400**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**3**	* Subset of previous category.	

Space and Naval Warfare Systems Center, San Diego



**As a result of applying the In-House RDT&E Activity criteria at the center level (see NOTE on page 3-1), SSC, Charleston and SSC, Chesapeake data is not included in the FY1999 report.*

Space and Naval Warfare Systems Center, San Diego
San Diego, CA 92152-5101
(619)553-3000
Commanding Officer: CAPT Ernest L. Valdes, USN
Executive Director: Dr. Robert C. Kolb

MISSION

To be the Navy's full-spectrum research, development, test and evaluation, engineering and fleet support center for command, control and communications systems and ocean surveillance and the integration of those systems which overarch multiplatforms.

CURRENT IMPORTANT PROGRAMS

SSC San Diego conducts a broad range of programs focused on integrated C4ISR. We also conduct several unique programs outside of our primary C4ISR focus. Innovative new research is encouraged through our Independent Research program. Our C4ISR programs are described on the following pages, grouped in five subsections consistent with our five Corporate Initiatives. Programs outside of our primary C4ISR focus are described in a sixth subsection: Other Programs and Research.

Our C4ISR programs focus on developing, implementing, and supporting the integrated C4ISR systems our warfighters require. Five Corporate Initiatives guide our C4ISR work. The initiatives define an evolving set of capabilities-the connectivity, information access, collaboration tools, consistent tactical understanding, and information protection-that we must incorporate in our systems to provide optimal C4ISR.

Our first initiative, Dynamic Interoperable Connectivity, will provide assured, user-transparent connectivity, on demand, to any desired location in the "infosphere," that is, the worldwide grid of military databases, fusion centers, national resources, and commercial information sources. Given this fundamental capability, our second initiative, User Pull/Producer Push, will use that connectivity to access strategically located database servers and anchor desks and provide users, at all levels, with key information. Our third initiative, Distributed Collaboration, will provide the tools necessary for warfighters and their commanders, peers, and subordinates to agree on a wide range of command-related issues. Our fourth initiative, Consistent Situation Understanding, will achieve a consistent tactical understanding of the operational situation. Our fifth initiative, Information Operations, will protect our information resources while denying our enemies the information needed to implement aggressive actions. In addition to our primary C4ISR focus, we are uniquely qualified to conduct programs in several other areas vital to the Navy: environmental quality technology/ assessment, marine mammals, ocean engineering, and robotics and physical security. We also encourage our scientists and engineers to explore new ideas and conduct initial research through our Independent Research program.

Dynamic Interoperable Connectivity
Dynamic Interoperable Connectivity is the conduit for all data and information, whether it moves a few feet or thousands of miles. Several features are critical to this connectivity:

- flexibility to accommodate changing information needs;
- interoperability for joint, allied, and coalition operations;
- diversity for connectivity to military forces world wide ashore, afloat, and airborne; and to commercial entities;
- multi-level security; and
- economy-connectivity will allow sharing of resources with consequent savings over maintenance of dedicated resources for specific users.

CURRENT IMPORTANT PROGRAMS

Joint Maritime Communications Strategy

The Joint Maritime Communications Strategy (JMCOMS) is both a technical and program strategy that implements the communications segment of the Navy's Copernicus C4I architecture. JMCOMS will implement the capability to provide tactical information to critical elements of the battle cube-the carrier battle groups and amphibious task groups-through the Battle Cube Information Exchange System. JMCOMS incorporates the latest advances in commercial and military communications technology to maximize bandwidth, enabling the sharing of information seamlessly, in real- or near-real-time, through flexible, adaptive, and interoperable systems and services. JMCOMS' rapid, reliable, and reconfigurable communications connectivity to all echelons of command and its accompanying information transfer infrastructure make the sensor-to-shooter construct a reality in the C4I environment.

The JMCOMS technical strategy consists of three elements: (1) the Automated Digital Network System (ADNS), which provides voice, video, and data applications using existing copper-wire circuits, but increases the capability of those circuits by a factor of four; (2) the Digital Modular Radio, which provides a modular, scaleable radio supporting all terminal requirements in the spectrum below 2 GHz; and (3) the Integrated Terminal Program, which provides protected low-, medium-, and high-capacity links in the spectrum above 2 GHz, using military and commercial communication systems.

The JMCOMS systems engineering team is composed of key Space and Naval Warfare Systems Command (SPAWAR), SSC San Diego, field activity, and contractor personnel focused on solving the technical challenges in designing, funding, and fielding JMCOMS elements.

Copernicus-Envisioning Global Naval Networks

The proliferation of sensor streams, different formats, protocols, organizational sponsors, complex programmatic agendas, and conflicting operational goals has made the mechanics of the military's C4I systems far too complex. In 1990, the Navy introduced an approach to solve this problem: the Copernicus Architecture. An interactive framework of pillars, Copernicus links the C4I processes of the warfighter at all echelons of command. The pillars include:

Global Information Exchange System (GLOBIXS)-ashore networks that support tactical commanders by providing access to all required information from any location through a series of wide-area Defense Communications System (DCS) networks.

Commander-in-Chief (CINC) Command Complexes (CCCs)-ashore command centers that serve as the primary gateway for communications and information flow from GLOBIXS to forward-deployed warfighter TADIXS.

Tactical Data Information Exchange System (TADIXS)-tactical networks connecting the CCCs with the TCCs.

Tactical Command Centers (TCCs)-forward-deployed command centers that disseminate information to the warfighter. As Copernicus evolved, a new pillar emerged-the Battle Cube Information Exchange System (BCIXS). The battle cube is a conceptual, multidimensional area that includes subsurface, surface, air, and space as the environment for conducting warfare. Its essential elements are the carrier battle groups, the amphibious ready groups, and the embarked Marine Expeditionary Force. BCIXS extends the Copernicus architecture to include the battle cube.

The Copernicus Architecture continues to evolve to support Joint Vision 2010; SSC San Diego continues to play major roles in its evolution.

Antenna Development

SSC San Diego provides unique capabilities for complex shipboard topside antenna design, including antenna modeling capabilities and a one-of-a-kind arch that allows empirical testing of shipboard antennas. We are also developing the Multifunction Electromagnetic Radiating System, which combines four separate information transfer systems in one device. Another system is our Advanced Enclosed Mast/Sensor System, a composite structure that eliminates the need for a variety of antennas with their own radomes on surface ships yet provides a lower radar-cross-section profile.

CURRENT IMPORTANT PROGRAMS

Antenna Integration
SSC San Diego continues integration efforts in the areas of follow-on and next-generation antenna systems, including development of performance specifications, certification plans, test plans, and interface design descriptions, and is currently supporting procurement and integration of a lightweight antenna system. In support of the Tactical Control Systems Program, the Center is testing a KU-band satellite communication antenna that permits two-way satellite voice and data communications on board ships.

SATCOM Systems and Technologies
Satellite communication (SATCOM) is central to dynamic interoperable connectivity, providing nearly all long-haul Navy/Marine Corps connectivity, as well as over-the-horizon in-theater service. SSC San Diego programs support upgrades to existing military SATCOM systems, such as the Afloat Telecommunications Service terminal upgrade in super high frequency. SSC San Diego programs support emerging services such as extremely high-frequency and super high-frequency SATCOM, and near-term implementations such as International Maritime Satellite 'B', Television-Direct to Ship, Global Broadcast Service, and Challenge Athena. They also support novel and very successful use of seemingly outdated technology through our development of high-frequency battle force e-mail, now widely used to provide capabilities from tactical operations communications to personal e-mail to families at home.

SATCOM Foreign Military Sales
SSC San Diego has traditionally been the SPAWAR point of contact for coordinating all foreign military sales field activities in the areas of satellite communications, radio frequency engineering, installation support, engineering assistance, logistics support, training, technology evaluation and testing, and the resolution of interoperability issues. Among the countries currently being supported are France, United Kingdom, Spain, Canada, Netherlands, Greece, New Zealand, Australia, Korea, Japan, North African countries, Saudi Arabia, Germany, and Turkey.

Multiservice Internet Protocols for High-Performance Networks
Commercial resources are available to provide users on land the latest in telephone technology for high-data-rate connectivity. Our challenge is to extend asynchronous transfer mode connectivity to military deployed forces anywhere in the world, instantaneously connecting moving platforms far from home in potentially hostile environments to allow them to function as part of a coordinated C4ISR capability. SSC San Diego's Multiservice Internet Protocols for High-Performance Networks program seeks to accomplish this, providing such capabilities as line-of-sight communication links between ships of the battle force, and fax, e-mail, and video teleconferencing to carrier battle groups and amphibious ready groups off-shore and to Marines ashore.

Submarine Communications
SSC San Diego has played a leadership role in development of submarine communications for decades, providing substantial improvements in low-frequency and very low-frequency capabilities that provide connectivity between submarine forces (both tactical and strategic) and command centers ashore, afloat, and airborne. SSC San Diego submarine communications programs include development of the signal reception and distribution system for the Joint Maritime Command Information System and the Submarine Communications Support System. SSC San Diego has established C4I connectivity to a number of submarines operating with carrier battle groups through deployment of Joint Tactical Information Distribution System (JTIDS) terminals on those submarines. SSC San Diego is working to increase the number of those submarines. With that capability, the submarines can operate as a much more integral part of the carrier battle group, to the point of being able to transmit periscope imagery from the submarine to the battle group commander via JTIDS.

Joint Tactical Information Distribution System
The Joint Tactical Information Distribution System (JTIDS) is an Air Force program that provides a highly capable tactical data link. The Navy is introducing JTIDS as the new Link-16 Tactical Data Link, providing connectivity among aircraft carriers and cruisers, E-2C and F-14D aircraft, and submarines. SSC San Diego provides systems engineering support to the SPAWAR Program Executive Office for Space, Communications and Sensors (PE0-SCS).

CURRENT IMPORTANT PROGRAMS

Multifunctional Information Distribution System
The Multifunctional Information Distribution System (MIDS), a lower cost, lighter weight version of JTIDS providing connectivity among five allied nations, will connect the lead U.S. platform, the Navy and Marine Corps F/A-18 aircraft, to the link. This link will operate at higher data rates, with lower probability of intercept and greater anti-jam capabilities. SSC San Diego is the primary Navy systems engineer, supporting MIDS terminal development within the inter-national community and its application in the F/A-18.

SSC-SD currently has a Cooperative Research and Development Agreement (CRADA) in place to develop manufacturing processes and integrate Polarization Independent Narrow Channel (PINC) Wavelength Division Multiplexing (WDM) fiber-optic couplers into Navy and commercial telemetry systems.

User Pull/ Producer Push
Programs within the User Pull/Producer Push initiative focus on the warfighter's need for sufficient information to act appropriately, but not so much that confusion results. Ready access to tactical data is vital to the warfighters, but our ability to collect this information and provide it in vast quantities can easily and quickly overwhelm the people it is intended to support. In this initiative, we envision repositories of current, pertinent information, located at anchor desks, with robust information servers to provide warfighter access to the right data at the right time.

Global Command and Control System-Maritime
The Navy's Global Command and Control System-Maritime (GCCS-M) is the third in a series of evolutionary initiatives to eliminate stovepipe command and control, intelligence, and cryptologic systems and achieve true interoperability. GCCS-M is the primary afloat and ashore C4I system for the Navy, Marine Corps, and Coast Guard.

SSC San Diego is working on interoperability with the other services through the Global Command and Control System (GCCS). Much of the technology that makes GCCS possible came from SSC San Diego's development of the afloat and ashore components of GCCS-M. SSC San Diego has the roles of software developer, system engineer and integrator, and software support activity for GCCS-M.

Global Command and Control System
The Global Command and Control System (GCCS) will provide joint and service component commanders with a set of automated tools and communications for operations planning, execution monitoring, and logistics sustainment of joint warfighting efforts. GCCS will be derived from the core system formed by the Global Command and Control System-Maritime. SSC San Diego is the systems engineering advisor and integrator of the core GCCS components.

Tactical Support Center-Mobile Variant
A critical requirement in the Navy's "Forward From the Sea" philosophy is establishing command and control capabilities ashore. In several programs, such as the Mobile Integrated Command Facility (MICFAC), we have developed capabilities to project the command and control capabilities as well as personnel ashore. MICFAC, for example, will provide a completely self-contained mobile command center ashore for use at any location. These capabilities now represent mobile variants of a program called the Tactical Support Center.

Eliminating Stovepipe Systems
Stovepipe System-A system, often dedicated or proprietary, that operates independently of other systems. The stovepipe system often has unique, non-standard characteristics. Historically, systems were developed to address a specific requirement with little regard for the interrelationship with other systems or supporting infrastructure. Stovepipe systems made it difficult for platforms to share information in a timely manner, causing inefficiencies, especially in joint and allied operations.

The first major step in fielding Copernicus was implementing the Joint Maritime Command Information System (JMCIS). The JMCIS architecture links command and control systems into functional categories and creates an environment for the Services to field interoperable systems with common user interfaces.

CURRENT IMPORTANT PROGRAMS

More Navy and Marine Corps C4I systems will continue to migrate to the JMCIS architecture as Copernicus evolves. JMCIS forms a kernel of the Global Command and Control System (GCCS).

GCCS supports an open-system environment for automated information processing at all warfighting levels of the Department of Defense. The GCCS, in a departure from traditional developmental programs, promotes a rapid migration strategy that cost-effectively and continuously builds on changing technology and users' information needs.

TRAP Data Dissemination System
The TRAP Data Dissemination System (TDDS) provides near-real-time global dissemination of tactically significant data from national systems. This system evolved from requirements to test another SSC San Diego development, the Tactical Receive Equipment (based on the Tactical Data Information Exchange System-B). SSC San Diego provides concept development, design, development, system engineering, documentation, and testing. TDDS is migrating into the Integrated Broadcast Service along with other narrowband tactical systems.

Integrated Broadcast Service
The Integrated Broadcast Service was created to develop a new standardized architecture that will replace the TRAP Data Dissemination System, the Tactical Reconnaissance Intelligence Exchange System, the Tactical Intelligence Broadcast Service, and the Near-Real-Time Dissemination System and meet the warfighters' requirements for a common, unified picture of the battlefield. It will provide data to any user who needs it, at the appropriate security level, and via whatever method required.

Multi-Mission Advanced Tactical Terminal
The Multi-Mission Advanced Tactical Terminal (MATT) is a multifunctional, airborne-qualified terminal for the receipt, processing, and distribution of tactical data to multiple local users. Its function is to provide near-real-time over-the-horizon threat data directly to the warfighter for mission planning, threat warning and avoidance, and enroute retargeting. MATT receives, demodulates, and decodes near-real-time surveillance data broadcast on the Tactical Data Information Exchange System-B, the TRAP Data Dissemination System, the Tactical Information Broadcast Service, and other communications networks that employ compatible transmission characteristics. SSC San Diego continues to develop software upgrades and provide customer support to users throughout the world. MATT units are used by all of the services. MATT is being integrated into a variety of Special Operations Forces (SOF) air, ground, and surface platforms such as the MH-53J helicopter, SOF Intelligence Vehicle (SOF-IV), and Patrol Coastal. Navy aircraft employing the MATT include the EA-6B and P-3C. The Air Force is using MATT in the Combat Intelligence System and the Air Force Mission Support System. A man-transportable "briefcase" version of the MATT is used by the Marine Corps.

Distributed Collaboration
We envision a future in which military operational organizations will be increasingly "virtual," meaning that geographically dispersed commands, from several of the Services (and, increasingly, from other U.S. federal agencies), at a number of echelons and a variety of levels within those echelons, will be called on to collaborate in the execution of a mission, but without ever meeting in the same place at the same time. Thus, SSC San Diego is developing tools for distributed collaboration, designed to enhance the warfighter's ability to conduct distributed C4ISR in a multi-echelon, multi-force environment. These tools will enable interoperability, analysis, and interactive mission planning.

Joint Simulation System-Maritime
The Joint Simulation System (JSIMS) will provide a simulation environment to enable realistic joint training. It supports training in both military operations and in operations other than war, and replaces earlier technologies such as Research, Evaluation, and Systems Analysis (RESA) and the Enhanced Navy Wargaming System. JSIMS- Maritime will provide the capability to simulate maritime operations in conjunction with JSIMS core services and components that represent land, air/space, intelligence, and C4I.

CURRENT IMPORTANT PROGRAMS

Developing Tools for Distributed Collaboration
SSC San Diego's Command Center of the Future-Demonstrating Future C4ISR Capabilities
The Command Center of the Future was designed and built to demonstrate, in a realistic context, future C4ISR capabilities. The center demonstrates a vision of the distributed collaboration process as it might be used in dealing with military operations or civilian natural disaster crises, or, in dealing with both simultaneously. Unique to the Command Center is the 3-D Volumetric Display System, which allows true three-dimensional visualization of digitized data.

The Navy's Maritime Battle Center-Enhancing Battlespace Capabilities for the Warfighter The Navy's Maritime Battle Center (MBC) in SPAWAR PD-13 (Advanced Technology and Prototype Systems) is being established for the co-evolution of systems, organizations, and doctrine. It provides an environment for fleet experimentation and technology insertion and maritime systems integration and interoperability. It also serves as the maritime component of the Joint Battle Laboratory. SPAWAR's technical interface to the MBC is SSC San Diego's C4ISR Systems Integration Environment (SIE) -see the Capabilities section for more information.

USACOM Joint Training, Analysis, and Simulation Center (JTASC)-Training the Warfighter SSC San Diego, with substantial collaboration with SSC Charleston, provided design and system engineering for the U.S. Atlantic Command's (USACOM) integrated training facility. Work included installation of command and intelligence centers, joint communications connectivity, a state-of-the-art modeling and simulation system, and video teleconferencing facilities to support operational planning and to distribute training both locally and to remote sites. SSC San Diego provides ongoing team support for the modeling and simulation component at JTASC.

The maritime components will satisfy Navy requirements and allow Unified Commander-in-Chief/Designated Commander Joint Task Force commands to interface with operating forces. SSC San Diego is system engineer and developer of JSIMS-Maritime.

Common Object Framework
The Common Object Framework (COF) project is evolving from a technology demonstration based on the Common Object Request Broker Architecture. It uses object request brokers to function as "middleware," allowing disparate applications and systems to talk and link together. COF facilitates battlespace awareness; indications and warning; and collaborative mission planning. It successfully integrates time-sensitive operational and intelligence data to provide a common picture to both operators and analysts in a familiar and comfortable format. Key principles of COF include commercial and government off-the-shelf product re-use; distributed environment; near-real-time facilities and capabilities; scalability for both mission and platform (a plug-and-play capability); transportability to other platforms.

Consistent Situation Understanding
Our fourth initiative, Consistent Situation Understanding, focuses on developing a shared understanding of the "operational picture," or common operating picture, across all command levels. This understanding is formed from many information resources. It involves sensors to collect tactical data, data fusion capabilities, the ability to interpret the information/situation, and the means to share the information as appropriate. The Consistent Situation Understanding initiative has three main thrusts. The first thrust is the development of new sensors to gather more data. The second thrust is the fusion of intelligence, surveillance, and reconnaissance data to produce the common operating picture. The third thrust is real-time management, display, and dissemination of the common operating picture.

Sensors and Unmanned Systems Development and Integration Networks of sensors and unmanned systems offer the military enormous potential for risk and cost reduction. Technology developments in unmanned aerial vehicles, unmanned undersea vehicles, and unmanned ground vehicles, as well as a large variety of individual intelligence, surveillance, and reconnaissance sensors provide our warfighters with unprecedented capabilities for information dominance. Each comprises a system within the aggregate of C4ISR systems; each gives access to information needed for consistent situation understanding. SSC San Diego is developing ways to integrate the information from these systems into

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the tactical picture. As an important subset to ongoing SSC San Diego C4ISR efforts, sensors and unmanned systems are being integrated into the Navy's tactical systems.

Unmanned Aerial Vehicles
Unmanned aerial vehicle (UAV) technology has matured sufficiently to make UAVs an indispensable C4ISR tool for the warfighter. UAVs provide a relatively inexpensive, low risk, and, by virtue of their small size and slow speed, covert means of advantageously positioning sensors in the battlespace. SSC San Diego is exploiting these capabilities to ensure that the sensor packages and data and the command and control links are fully integrated with Navy tactical systems, both ashore and aboard ship. SSC San Diego is also working to provide appropriate dissemination of data from the UAV control station(s) to the warfighters.

Unmanned Undersea Vehicles
Missions that will require future military unmanned undersea vehicle (UUV) systems include surveillance, intelligence collection, tactical oceanography, special warfare, counter-narcotics, and counter-terrorism, with mine countermeasures being identified as the most critical. SSC San Diego continues to develop technology and systems that support the military requirement for UUVs, including general vehicle developments, command and control systems, fiber- optic and acoustic communication links, non-metallic materials, and launch and recovery systems. In addition, SSC San Diego provides technical support to high-priority Navy UUV programs including the Near-Term Mine Reconnaissance System and the Long-Term Mine Reconnaissance System.

Tactical Sensors
The Tactical Sensors Program will develop small-unit warfare concepts of operations that include smaller, more capable forces widely dispersed throughout the battlespace. SSC San Diego performs and coordinates technology analyses that focus on comprehensive awareness, tactical sensors, real-time tasking and control of assets, robust communications, and an integrated grid of battlespace. Example programs include Internetted Unattended Ground Sensors (IUGS), Micro-IUGS, Counter-Sniper, and Low-Power Integrated Weapon Sight.

Internetted Unattended Ground Sensors (IUGS). The IUGS program will provide high-precision unattended ground sensors that incorporate greatly enhanced sensor algorithms and new sensors to provide a significant tactical advancement in target classification and tracking.

Micro IUGS. The Micro-IUGS program will develop miniature, low-power, affordable, unattended acoustic, magnetic, seismic, chemical, biological, imaging, and environmental sensor systems that can be used singularly or internetted together to provide significant detection, localization, and classification advantage for ground forces.

Counter Sniper. The Counter Sniper program will provide a low-cost, low-power, and ruggedized family of variant acoustic and/or electro-optical counter sniper systems that can detect, localize, and identify small and large caliber arms.

Low-Power Integrated Weapon Sight. The Low-Power Integrated Weapon Sight program will provide a long-range (7 to 10 km) precision targeting small-unit operations (SUO) system that will include a thermal imaging system, a low-power laser rangefinder, a high-precision digital compass, a high-precision Global Positioning System, and video transmission, and is intended to be integrated on many SUO-related platforms.

Electro Optical/InfraRed and Hyperspectral Imaging Systems Littoral Airborne Sensor/Hyperspectral (LASH). The LASH program was established to provide Fleet/Fleet Marine Force evaluation of hyperspectral technology for the detection of submarines, shallow water/very shallow water/ surf zone mines, and other littoral targets. The current approach is to provide a complete characterization and field evaluation of LASH for antisubmarine warfare. The hyperspectral mine detection data obtained will be used to support engineering analysis and design of a UAV-based LASH-Reconnaissance system, which will also be built and evaluated. SSC San Diego's Surveillance Department is the lead program manager for LASH; SPAWAR Systems Center Pacific plays a major role in the development of the integrated

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logistical support plan and the operator and maintenance training plans. Laser Intelligence Collection Sensors. The Laser Intelligence Collection Sensors program develops, tests, calibrates, and deploys electro-optic sensors to detect direct and indirect laser illumination and obtain high-value measurement and signal intelligence information to determine critical parameters of threat laser systems and to support multiple missions including real-time warning, threat identification, and countermeasure development.

Chokepoint Surveillance. The Chokepoint Surveillance program will provide the Navy with long-range electro-optic surveillance systems capable of round-the-clock operations using high-resolution cameras, intensified cameras, multi-focal-length lenses, range-gated television, and video enhancement.

Starring InfraRed. The Starring InfraRed program is driven by the operational requirement of ship point defense against sea skimming cruise missiles. The main objective is to demonstrate automatic passive detection and tracking of threats at sufficient range to enable the combat system to respond, ensuring high probability of kill.

Advanced Sensor Applications. The Advanced Sensor Applications program is investigating the application of electro-optical laser range-gated and time-resolved light detecting and ranging technology and hyperspectral imaging systems as applied to seeing through the air-water interface to detect objects in the water volume or on the bottom. Missions include non-acoustic antisubmarine warfare littoral and open-ocean environments with special emphasis on semi-enclosed seas, choke points, and bastions.

High-Frequency Surface Wave Radar
SSC San Diego's Advanced Technology Demonstration (ATD) project for development of a shipboard high-frequency surface wave radar will provide increased warning time for surface ships against low incoming threats-anti-ship missiles and aircraft. Current microwave radar technology allows detection only to the horizon. The ATD system will extend detection range to about 40 kilometers (25 statute miles) for anti-ship missiles and 80 kilometers (50 miles) for low-flying aircraft. Delayed in FY 97 by Navy ATD funding cuts, the program will be completed by March 1999. Testing on the Self-Defense Test Ship will begin in December 1998.

Undersea Surveillance
SSC San Diego has been a major participant for decades in the development of fixed, deployable, and mobile surveillance capabilities to detect and track submarines. During the Cold War, we focused those efforts on specific targets-Soviet nuclear submarines operating in deep water-and we achieved success with such systems as the Surveillance Towed Array Sensor System and Low Frequency Active. Our current challenge is to develop similar capabilities to track diesel- electric submarines operating in the littoral areas-a quieter platform operating in a much more complex sonar environment.

Integrated Undersea Surveillance System
The Integrated Undersea Surveillance System (IUSS) consists of fixed, mobile, and deployable acoustic arrays that provide vital tactical cueing to antisubmarine warfare forces. IUSS is a model for innovation and the smart use of technology. Workstations, enhanced signal processing, and modern communication technologies enable remote array monitoring, thereby reducing personnel requirements and improving efficiency.

Advanced Deployable System
SSC San Diego provides engineering support for all aspects of the Advanced Deployable System (ADS). ADS is a theater-deliverable acoustic surveillance system that will provide continuous acoustic coverage over vast ocean areas for an extended period. ADS will be capable of detecting quiet nuclear submarines, diesel-electric submarines on the battery, ships exiting or entering harbors, or mine-laying operations. The importance of this portable capability will intensify as our surveillance requirements increase, owing to the Navy's focus on the littorals, the worldwide dissemination of diesel submarines, and the downsizing of our own forces.

Deployable Autonomous Distributed Sensors
The Deployable Autonomous Distributed Sensors program will extend knowledge and control of the undersea battlespace through the development of clandestine off-board sensors. Autonomous distributed

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sensors will provide the joint force commander with surveillance options in areas where current and projected capability is either too costly, too overt, too slow to deploy, or limited by the number of manned platforms available.

Tactical Cryptologic Systems
SSC San Diego performs systems engineering, software development (integration), and test and evaluation of tactical cryptologic systems to detect, identify, and exploit signals of interest for a variety of missions. Primary current tasking is the development of Cryptologic Unified Build software configurations for the Joint Maritime Command Information System.

Standard TRE Display
The Standard TRE Display (STRED) is a low-cost tactical display processor that processes and displays Tactical Data Dissemination System, Tactical Data Information Exchange System-B, and Tactical Information Broadcast Service contact reports. STRED operates on commercially available Intel-based computers with Windows and NT operating systems and is Defense Information Infrastructure Common Operating Environment (DII COE) (Level 5) compliant. The newest module Tactical Receive Segment replaces Tactical Receive Equipment (TRE) OL-444 and has been designated as the first operational Common Integrated Broadcast Service Module, extending the useful life of existing tactical terminal radio equipment.

Tactical Jammers
The Marine Corps Radio Battalions require versatile, lightweight, tactical jammers for their radio reconnaissance teams. Traditional high-power, broadband, barrage jammers in the inventory are not appropriate for their missions. SSC San Diego is developing a smart tactical jammer that combines smart waveforms with reactive jamming to minimize jamming power and maximize covertness, and a family of low-cost, lightweight, expendable jammers. These jammers will provide capability against emerging commercial wireless systems.

Rapid Imagery Intelligence Transmission
Rapid Imagery Intelligence Transmission (RIT) is a multi-phased effort to improve production, dissemination, and display of time-critical textual information exploited from national, theater, and tactical imagery sources. SSC San Diego has installed RIT at Joint Intelligence Center (JIC) Pacific, is awaiting installation at the European Command JIC, and has conducted exercise and demonstration support deployments for Marine Corps, U.S. Forces Korea, Air Force, Army, and Pacific Command users.

db MASTER Intelligence Analyst Application
db MASTER software provides the intelligence analyst with improved methods for sorting, examining, and fusing discrete information from a wide range of intelligence sources. SSC San Diego has designed db MASTER to provide the intelligence analyst/specialist with tools that significantly enhance the ability to search a variety of intelligence database sources from a single workstation. The db MASTER software provides the analyst with an intuitive, user-friendly, graphical interface to three major intelligence databases, National Imagery and Mapping Agency digital maps, and a variety of hard-copy intelligence reference materials.

Family of Integrated Tactical Security Sensor Systems
In recent years, military security forces have operated in a climate of increasing mission complexity and diversity. In response to such challenges, the U.S. Army Training and Doctrine Command approved a concept for a Family of Integrated Tactical Security Sensor Systems to support future operations. In support of this concept, the Defense Special Weapons Agency initiated two exploratory development projects at SSC San Diego to develop an Advanced User Interface for Tactical Security (AITS) and a Tactical Sensor Internetting and Integration (TSSII) capability. These projects are complementary in approach and application. AITS addresses the human factors and display technologies needed to effectively maximize information presentation to the warfighter in a clear, intuitive manner, while TSSII is focused on architecture-based, commercial off-the-shelf components and emerging Internet standards to provide flexible networking for a scalable system that will support control of and communication with multiple tactical sensors.

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NAVSTAR Global Positioning System
Precise navigation information is critical to situation perception. SSC San Diego is the Navy leader for navigation support, and performs research and development for all the services' Global Positioning System (GPS) receivers. GPS is a space-based radio-positioning and time-transfer system consisting of a constellation of 24 satellites. SSC San Diego plays the leadership role for the user segment of GPS and provides software support for GPS receivers for Tomahawk.

Navigation Sensor System Interface
The Navigation Sensor System Interface (NAVSSI) is a shipboard navigation processor designed to integrate shipboard navigation sensors and systems and distribute a central source of highly accurate real-time navigation and time data to combat, combat support, and communication systems. NAVSSI also provides an electronic navigator's work-station to support safe navigation using digital nautical charts that will be replacing paper charts. NAVSSI is currently deployed on over 60 surface combatants, and there are plans to install it aboard another hundred.

Ocean Survey Program Survey System
The Ocean Survey Program Survey System (OSPSS) is a shipboard survey system designed to produce ocean bottom (bathy-metric) contour charts for direct use by the Trident Fleet Ballistic Missile Program. OSPSS consists of a precise navigation subsystem and wide swath sonar array sub-system integrated with an advanced data processing subsystem. SSC San Diego has implemented a continuous program to extend the capability, accuracy, reliability, and maintainability of these systems by advancing the state-of-the-art in navigation, sonar, and data enhancement techniques in response to increasingly stringent fleet requirements for bathymetry, gravity, magnetic, and other geophysical parameters.

Tactical Decision Making Under Stress
The Tactical Decision Making Under Stress program seeks to improve the human-computer interface, both by enhancing computer capabilities to provide information to the warfighter in a more efficient, more comprehensible manner, and by improving the training and behavioral responses of the warfighters to the information provided.

This program had its origin in two Navy disasters-the attack of an Exocet surface missile on the USS Stark (FFG 31), and the USS Vincennes (CCG 49) shootdown of the Iranian Airbus. These incidents emphasized the life-and-death importance of information accessibility to the warfighter, both in terms of the format in which the information is presented and the methodology employed by tactical decision-makers to employ the available information wisely.

SSC-SD currently has several Cooperative Research and Development Agreements in place as follows:

Demonstrate Navy developed excimer laser materials processing technology in a manufacturing environment, to fabricate backside-illuminated CCD imaging sensors at a greatly reduced cost, for both military and commercial purposes.

Develop and demonstrate a process to manufacture small-size, high-resolution liquid crystal display units for head mounted displays for military and commercial purposes.

Develop an ultra lightweight underwater remote acoustic sensor system for near shore and harbor areas.

Support the collection of ocean acoustic data for the use by military and civilian researchers and students through re-activation off previously de-activated Navy Sound Surveillance System (SOSUS) stations.

Develop low-cost, lightweight, compact, easily deployed autonomous off-board surveillance systems.

Develop a viable military and commercially available software algorithm for the automated and objective measurement of minimum resolvable temperature differences of thermal imagers.

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Develop a low-cost system of shallow water sensors to provide dense spatial sampling for a short period via a RF communications system.

Information Operations
Increasingly, potential adversaries can attack data (information) within databases, computers, communications links, and sensors. Information systems are vulnerable. For dominance in the information domain, we must protect our own information resources and be prepared to both affect and exploit an enemy's. SSC San Diego's focus in supporting the Department of Defense information warfare effort is the research, development, test, and evaluation of features of the information infrastructure, including automated information systems such as C4 systems that serve the needs of the National Command Authority and operating forces under all conditions of peace and war. Within the total information environment, the information infrastructure includes the aggregate of individuals, organizations, and systems that collect, process, or disseminate information, including the information itself. Automated Information Systems Security Assist Team SSC San Diego's Automated Information Systems Security Assist Team performs site surveys on ships, first determining the configuration of local-area networks (LANs) and LAN resources, and then determining network architecture and modifications required to make the system more secure. Team members then develop hardware and software solutions and install necessary products to ensure a higher level of security and to prevent contamination of databases, both from within the system and by attacks from outside, while at the same time ensuring proper information flow. In addition to the protection process, the team also "cleans up" network architectures to make them easier to maintain.

Satellite Communications Vulnerability
Navy satellite communications are vulnerable to detection, interception, and transmitter geolocation during signal transmission. SSC San Diego is studying the vulnerability of Navy ships to signal interception and exploitation, with a goal of mitigating the effects of these techniques. At the same time, we are interested in studying these techniques to improve our own signal-exploitation capabilities.

Intrusion Detection, Assessment, and Recovery
Intrusion Detection, Assessment, and Recovery is a joint SSC San Diego-Naval Research Laboratory effort directed at developing decision aids to support prevention of and reaction to information warfare attacks. Attack reports generated by detectors will be employed to project which end-user information products are likely to be affected if corrupted data propagates through a computer network. Decision-makers can then be advised when the quality of information products is suspect, while the Command and Control Warfare Commander and system managers can be better advised about information systems status in order to conduct recovery.

SSC San Diego's Information Operations Center of Excellence
-BRINGING INFORMATION WARRIORS TOGETHER WITH CONCEPTS AND TECHNOLOGIES TO EXCEL IN INFORMATION OPERATIONS

SSC San Diego's Information Operations Center of Excellence (IOCOE) was established to develop integrated strategies, concepts, and services; identify, assess, and demonstrate current and future technologies in an integrated, operationally valid environment; and, provide a "neutral" technologically sophisticated environment for helping operators with information operations policies and doctrine. A key component of the IOCOE will be the Information Operations Center of the Future (IOCOF), a flexible, modular facility able to incorporate emerging technologies, development programs, and real-world challenges into a common environment. The IOCOF will

- Facilitate information operations wargames and exercises
- Provide education and training for information operations needs
- Provide a focal point for information operations activities at SSC San Diego to support interaction with external developers and agencies
- Provide operators and acquisition managers the opportunity to "touch and feel" information operations in a forward-looking environment

With the goal of bringing information warriors together with concepts and technologies to excel in information operations, the IOCOE enhances the Center's participation in both Navy and joint

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information operations activities. Looking ahead to the 21st Century, the IOCOE is expected to serve as a highly recognized forum and facility for information operations technology, doctrine, and requirements definition throughout the information operations community.

Location of GPS Interferers
The U.S. is increasingly turning to the Global Positioning System (GPS) as its precision navigation system. SSC San Diego is developing the Location of GPS Interferers (LOCO GPSI) system to help combat the emerging threat of low-cost GPS jammers. LOCO GPSI is a short-baseline, interferometer-based system capable of direction finding on and locating these GPS jammers. The system is small enough to be widely applicable to aircraft, including unmanned airborne vehicles.

Other Programs and Research
SSC San Diego employs nationally and internationally recognized experts working to improve the Navy's capabilities in several other areas: Environmental Quality Technology/Assessment, Marine Resources, Marine Mammals, Ocean Engineering, and Robotics and Physical Security. In addition, Independent Research programs support innovative ideas proposed by SSC San Diego scientists and engineers.

Environmental Quality Technology/Assessment
Marine Environmental Survey Capability (MESC). Historically, our undersea surveillance efforts have required substantial scientific research in chemical oceanography. Our expertise in that area led to development of the MESC, a small craft providing a unique technology for on-site, real-time water quality assessment in coastal and estuarine environments. It is used to assist the Fleet in detecting potential pollution sources and in the identification of the chemical composition of that pollution.

Site Characterization and Analysis Penetrometer System (SCAPS).
SSC San Diego has adapted its environmental technology to the assessment of hazardous waste sites on land. One of the requirements for turnover of a military base to a community or civic organization is return of the land to "pristine condition." That often requires an expensive, time-consuming process of identifying long-unused and forgotten hazardous waste dumping sites. SCAPS makes the previous detection method of digging large holes at suspected hazardous waste sites unnecessary. The SCAPS probe punches a small hole (1 1/4-inch diameter) in the ground, fluoresces the soil through a sapphire window, with the return transmitted up the fiber to a support truck, where spectrum analysis determines the nature and concentration of pollutants such as petroleum-oil-lubricants. With polluted sites identified, SSC San Diego can support site remediation. One of our major technology transfer successes, SCAPS has been widely adopted throughout the country for hazardous waste detection.

Living Marine Resource Information System
SSC San Diego is designing and developing marine animal databases urgently needed by the Fleet. The Living Marine Resource Information System (LMRIS) provides monthly occurrence data for those marine species of most concern to the Fleet through a platform-independent graphical user interface. SSC San Diego is designing and demonstrating a marine animal impact assessment and mitigation capability, the System for Mitigation and Assessment of Risk Toolset (SMART). SMART supplements the LMRIS occurrence data with marine animal audiometry, source signal characterization, and propagation modeling to provide the ability to assess and mitigate risk of Fleet sonar operations on protected marine animals.

Marine Mammal Program
SSC San Diego manages the Navy's Marine Mammal Program, maintaining a cutting- edge research program and managing four operational systems employing marine mammals: Pingered Object Recovery, Swimmer Defense, and two Mine Countermeasures systems.

Pingered Object Recovery. This system employs California sea lions for recovery of objects placed on the sea floor. Sea lions do not have the remarkable sonar capability well known in dolphins, but they have exceptional underwater directional hearing and low-light-level vision. We use this capability by placing a sound source, a pinger, in an object to be placed on the bottom and later located and recovered. When recovery is desired, a sea lion carrying a grabber device swims to the bottom, attaches the grabber, and swims back to the surface, leaving a line attached for recovery.

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Swimmer Defense. SSC San Diego also maintains a bottlenose dolphin system providing swimmer defense in a manner similar to use of a guard dog at a land base, with the dolphin notifying his handlers of an intruder so they can apprehend the intruder. This system was deployed to Vietnam in 1970 and 1971 to protect the ammunition pier at Cam Ranh Bay, and again to the Persian Gulf in 1987-1988 to protect the Third Fleet flagship anchored in Bahrain. The system was also on standby at the request of the Secret Service during the 1996 Republican convention in San Diego, ready to provide a defense against a terrorist attack on the convention center, which is on San Diego harbor.

Mine Countermeasures (MCM). SSC San Diego developed and now provides in-service engineering agent, depot, and veterinary support to two mine hunting Fleet Marine Mammal Systems (MMS) assigned to Explosive Ordnance Disposal Mobile Unit Three. The Mk 4 MMS is a tethered mine hunting system and the Mk 7 MMS is a bottom mine hunting system that provides the only buried mine detection asset to the U.S. Navy. These MMS can be deployed by aircraft and have been enhanced to operate from amphibious ships. SSC San Diego is currently developing the EX 8 MMS as an ACAT IVT to provide a pre-assault MCM in very shallow water. Initial Operating Capability for this system is scheduled for FY 01.

Ocean Engineering
As a leadership area assigned to SSC San Diego by the Assistant Secretary of the Navy (Research, Development and Acquisition), ocean engineering at SSC San Diego covers the full spectrum of system acquisition from technology development through fleet support. This includes accelerated development and test and evaluation of emergent fleet requirement systems and hardware. Programs have included deployment and at-sea test and evaluation of undersea surveillance systems; the development of unmanned undersea systems and related technologies, including propulsion systems, non-metallic materials for viewports and pressure housings, underwater fiber-optic and acoustic communications links, and launch and recovery systems; and the in-service engineering, maintenance, and upgrades of manned and unmanned fleet assets (including Deep Submergence Rescue Vehicle, Deep Submergence Vehicle, Advanced Tethered Vehicle, and USS Dolphin).

Mine Neutralization System (MNS). SSC San Diego provides engineering and management support for the AN/SLQ-48(V) MNS, including the unmanned, tethered Mine Neutralization Vehicle.

Robotics and Physical Security
Waterside Security System (WSS). The WSS is an integrated, multiple-sensor security system that automatically detects and tracks waterborne targets, identifies and alerts on all threats, and aids in threat assessment and response. SSC San Diego identifies, tests, and evaluates commercially available physical security equipment having application to force protection at waterside facilities worldwide and provides engineering support to systems transitioned to the Fleet. Preplanned product improvements include a rapidly deployable configuration; uncooled thermal imagers; PC-based command, control, and communications; display element; and floating barriers.

Mobile Inshore Undersea Warfare-System Upgrade (MIUW-SU). The MIUW-SU is an upgrade program for the Naval Reserves that provides enhanced surveillance and communication capabilities for port security, harbor defense, and coastal warfare missions. The rapidly deployable system consists of mobile radar and imaging platforms, underwater acoustic sensors and processing, electronic support measures, and tactical communications equipment. SSC San Diego is design agent, production agent, and in-service engineering agent for development, production, and follow-on fleet support.

Mobile Detection Assessment Response System (MDARS). MDARS is a joint services effort to provide an automated intrusion detection and inventory assessment capability for DoD warehouses and storage sites using multiple coordinated internal and external robots. SSC San Diego provides technical support for the MDARS program, acting as the Technical Director, System Integrator, and Software Developer. SSC San Diego has developed the Multiple Resource Host Architecture (MHRA) to allow the control of multiple robots, sensors, and other devices simultaneously. MRHA software was developed in Ada and employs the Windows NT operating system.

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Independent Research
New and innovative ideas proposed by SSC San Diego scientists and engineers are supported with discretionary funding provided by Independent Research programs. These programs support initial research in many areas of interest to the Navy. See the Accomplishments section for more information.

SSC-SD currently has several Cooperative Research and Development Agreements in place as follows:

Develop methodology to re-engineer very large software systems by integrating JAVA language into Navy mission critical systems.

Demonstrate appropriateness of using SSP Kaimalino SWATH ship to conduct commercial sea-going projects and operations.

Develop military and commercial applications for environmental subsurface geophysical investigations utilizing a cone penetrometer mounted video microscope system.

Determine and demonstrate the feasibility of implementing a JAVA based system via a network-centric architecture to reduce costs and improve functionality in a large IT enterprise.

Develop and demonstrate the feasibility of JAVA based scalable application receivers in a Network-Centric Architecture to implement Navy mission critical software applications.

EQUIPMENT/FACILITIES

SSC San Diego has superb capabilities-physical and virtual facilities and laboratories, distributed test beds, high-performance computers and networks, worldwide communications connectivity-for conducting RDT&E and providing life-cycle support in C4ISR. SSC San Diego's unique capabilities allow our scientists and engineers to replicate an operational environment unachievable in the commercial world. Specific SSC San Diego capabilities are described on the following pages, grouped by major areas of effort.

In San Diego, our facilities occupy more than 580 acres. Facilities are concentrated in four major areas: Topside, Bayside, Seaside, and Old Town. Topside facilities, located on the ridge of Point Loma, include the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance. Our Bayside facilities face San Diego Bay, which provides waterfront access and berthing capabilities vital to SSC San Diego activities in ocean surveillance, ocean engineering, navigation, and marine sciences. Seaside facilities are located on the west slope of Point Loma, which offers a protected, electromagnetically shielded site essential to RDT&E in C3I and ocean surveillance. The Old Town Campus houses work areas for the fabrication of electronic hardware supporting SSC San Diego's C4ISR programs. The Old Town Campus also became the headquarters of Space and Naval Warfare Systems Command on 1 October 1997.

Our Hawaii Activity and its two western facilities in Guam and Japan provide electronic systems engineering support to Navy and Marine Corps and joint service component forces in the Western Pacific and Indian Oceans.

Our communications connectivity allows most of the Navy's C4ISR systems to be interconnected to support developmental testing as well as to participate in live operations with U.S. Fleet units. SSC San Diego's total capability allows us to provide and manage rapid reconfiguration of our C4ISR capabilities and to provide national and international connectivity using commercial and military capabilities in support of primary mission areas.

EQUIPMENT/FACILITIES

C4ISR Systems Integration Environment
The C4ISR Systems Integration Environment (C4ISR SIE) is the Navy's premier C4ISR integration and test facility. The C4ISR SIE exploits current technology to realize cost-effective and timely integrated systems development and implementation. A distributed environment consisting of existing laboratory facilities, systems, and core personnel, the C4ISR SIE supports life-cycle acquisition, supports system integration and test, and assures cost-effective implementation of integrated, joint, and interoperable naval C4ISR systems. The C4ISR SIE pursues four main objectives:

Support C4ISR from initial concept to end of life.
Provide a collaborative engineering environment supporting technology insertion, concept development, architecture development, system-of-systems integration and test, systems interoperability, program manager's systems integration and test and experimentation/demonstration. Provide a reconfigurable and scalable C4ISR test capability by interconnecting existing SPAWAR facilities and labs and by interfacing with external facilities and labs.

Serve as SPAWAR's technical interface to the Navy's Maritime Battle Center.
Supporting these objectives is an extensive database of C4ISR capabilities and dedicated personnel to coordinate tests. The Scheduling and Engineering Tool (SET) is a current database of laboratories, systems, schedules, equipment, programs, and connectivity. The database is used to mitigate scheduling conflicts, to coordinate events, and to provide the collaborative engineering environment needed to produce fully integrated systems before they are deployed. SET currently provides data for over 283 labs and facilities. While the database is available to the general C4ISR community, the C4ISR SIE's experienced Lead Systems Engineers offer expert assistance in organizing and executing tests, enabling the best possible use of C4ISR test capabilities. The importance of the C4ISR SIE to the maritime C4ISR community lies in its integration capabilities-by facilitating integration across product lines, the C4ISR SIE contributes to the maritime system-of-systems capability, in turn enhancing battlespace capabilities for the warfighter.

C4ISR

Advanced Virtual Intelligence, Surveillance, and Reconnaissance Laboratory
The Advanced Virtual Intelligence, Surveillance, and Reconnaissance (ADVISR) laboratory, in development at SSC San Diego, is a distributed interactive simulation and future high-level-architecture compatible, physics-based simulator capable of modeling sensors, communications, and command and control systems. ISR system life-cycle costs can be minimized by evaluating system concepts and architectures in simulation and by testing complex systems in virtual environments prior to prototype development.

Reconfigurable Land-Based Test Site
The Reconfigurable Land-Based Test Site, a versatile integration interoperability test center, takes advantage of the variety of systems available at SSC San Diego and provides connectivity to operational tactical networks as well as development laboratories to configure interoperability tests that accurately reflect real-world operations in a controlled environment.

Advanced Combat Direction System Laboratory
The Advanced Combat Direction System (ACDS) Laboratory provides the primary development and testing facilities for the ACDS Block 0 and Block 1 programs and the Command and Control Processor (C2P). This laboratory complex provides a partial suite of legacy military computers and peripherals in a readily reconfigurable environment that can simulate many platform configurations for test of new programs or for troubleshooting of previously delivered Combat Direction System or C2P programs.

ACDS Staging Facility
The ACDS Staging Facility is a joint Program Executive Office Theater Air Defense-SSC San Diego project in support of the LHA-1 (general-purpose amphibious assault ship) class ACDS upgrade effort. It was developed as a reconfigurable system integration and grooming site. The Staging Facility provides ACDS engineering and installation teams an environment to work together in support of ensuring that a mature system is installed on board warfighting ships. The staging and integration

EQUIPMENT/FACILITIES

process continues to allow for actual ship's components to be installed and integrated into a working system prior to their transfer to the shipyard for actual shipboard installation.

Command and Control Advanced Research Network
The Command and Control Advanced Research Network (CCARnet) is a backbone network service for classified and unclassified, high-bandwidth, high-speed, multimedia (voice, audio, digital data) internetworking between SSC San Diego Command and Control Department spaces located throughout the Point Loma campus. CCARnet also provides connectivity to other SSC San Diego or tenant activity laboratories and wide-area connectivity to other networks.

CDES Site
The Combat Direction System (CDS) Development and Evaluation Site (CDES) is a multiconfigurable development center and provides the facilities, equipment, and system engineering capability for the development of new or upgraded ship combat direction systems.

Distributed Command and Control Laboratory
The Distributed Command and Control Laboratory provides hardware, software, and communications connectivity to support the development and application of distributed processing technology to command and control systems.

DSI Advanced Simulation Laboratory
The Distributed Simulation Internet (DSI) Advanced Simulation Laboratory (DASL) provides secure DSI integration hardware, software, simulations, and gateways to other simulations. The mission of the DASL is to support the use of advanced distributed simulation to create virtual environments to support command and control, training, system acquisition, and test and evaluation missions. Research is oriented toward simulation internetting of heterogeneous live and synthetic simulation and simulators. Work involves supporting the evolution of standard distributed interactive simulation protocols both in concept and through software prototype implementations.

GCCS-M Ashore Integration and Test Facility
The Global Command and Control System-Maritime (GCCS-M) Ashore Integration and Test Facility provides hardware, software, and communications for application development, integration, and compliance, functional, and interoperability testing in support of ashore command systems.

GCCS-M Afloat Test Bed and Integration Facility
The GCCS-M Afloat Test Bed and Integration Facility provides mockups of the installations on aircraft carriers, command ships, and unit-level platforms to support application development, integration, and compliance, functional, and interoperablilty testing.

Systems Integration Facility
The Systems Integration Facility is used for testing and integrating Joint Tactical Information Distribution System terminals with aircraft data systems and shipboard combat direction systems, and for testing the interoperability of Link-16 systems.

JMCOMS Simulation Facility
The Joint Maritime Communications Strategy (JMCOMS) Simulation Facility provides an environment for evaluating software components being developed for communication control systems; analysis includes fleet protocol definition, operator interfaces, and system engineering.

High-Data-Rate Mobile Internet
High-Data-Rate Mobile Internet (MONET) is a test bed for high-data-rate tactical communication technologies. MONET will incorporate new applications using commercial standards such as asynchronous transfer mode and the Synchronous Optical Network high-data-rate military radios, and Department of Defense and commercial satellite communication links.

EQUIPMENT/FACILITIES

Modeling and Simulation Operations Support Cell
The Modeling and Simulation (M&S) Operations Support Cell (MOSC) provides a single point of contact for information requests, analyses, and decision support for planners using C4I systems. MOSC is the first of several operations support cells that will be embedded in the M&S Operational Support Activity.

SHF SATCOM
The SHF SATCOM Test Facility contains a complete super high frequency (SHF) satellite communications terminal and test equipment to support follow-on SHF equipment development. The mission of the SHF SATCOM Test Facility includes providing earth terminal support for RDT&E missions using the Defense Satellite Communication System (DSCS), extending these data communication services to users via either leased landlines or the Timeplex campus network, and coordinating satellite access with the DSCS Network Manager at the Defense Information Systems Agency, Washington, DC. The facility consists of two earth terminals. The East earth terminal provides access to one of three DSCS satellites: the West Atlantic, East Pacific prime (EPAC), and East Pacific spare (EPAC spare) satellites. The West earth terminal provides access to one of four DSCS satellites: the EPAC, EPAC spare, West Pacific prime, and West Pacific spare satellites.

Ship Antenna Model Range
The Ship Antenna Model Range allows simulation and modeling of ship communications, consisting of ground planes, model ships, track, towers, control systems, test equipment, data collection systems, data-reduction computers, and analysis software and components.

Ship Antenna Simulation Facility
The Ship Antenna Simulation Facility operates with the Ship Antenna Model Range to provide software modeling and simulation of systems, confirmation of models, and extensions beyond the test capability of the model range.

Acoustic Systems and Technology Analysis and Research Laboratory
The Acoustic Systems and Technology Analysis and Research Laboratory provides both in-house and at-sea multistatic active acoustic signal-processing capabilities via a network of workstations and associated programs. Capabilities include the standard functions of demodulator, matched filter, beamformer, threshold, signal displays, and multistatic geographic situational displays, plus interface advanced algorithms such as adaptive beamforming, coherent inter-ping reverberation suppression, and adaptive Doppler processing. For in-house use, the laboratory is interfaced to our Paragon high- performance computer for evaluation of advanced algorithm parameters. A multi-static active sonar modeling capability using the range-dependent acoustic model and the acoustic warfare simulator is included.

Cryptologic Systems Land-Based Test Facility
The Cryptologic Systems Land-Based Test Facility supports prototyping, integration, validation, and testing of tactical cryptologic and information warfare exploitation systems.

Intelligence System Advanced Development Laboratory
The Intelligence System Advanced Development Laboratory offers radio frequency interference-shielded, vault-level security and capability to receive and process data from various sources through online communications.

Microwave and Millimeter-Wave Antenna Range Complex
The Microwave and Millimeter-Wave Antenna Range Complex supports development of surveillance antennas for numerous operational applications.

Processing and Data Exploitation Center
The Processing and Data Exploitation Center is an in-house laboratory facility to conduct data fusion and information processing research for the exploitation of national systems' products for national, unified, and specified command, and joint service and tactical applications.

EQUIPMENT/FACILITIES

Real-Time Embedded High-Performance Computing Facility
The Real-Time Embedded High-Performance Computing Facility (RTEHPCF) provides high-performance, parallel computing and visualization resources in a secure environment, with connectivity to other secure locations throughout SSC San Diego and to external locations by use of end-to-end encryption. The primary computational component, a 336-node Intel Paragon, provides up to 33-GFLOPS processing capability with 13.8-GBytes memory, 128-GBytes storage, and 2.3 TBytes of robotically controlled, high-speed tape storage. The RTEHPCF supports state-of-the art applications of parallel computing and visualization to naval and Department of Defense problems and systems, with an emphasis on sensor processing (e.g., sonar, infrared, and synthetic aperture radar).

High-Performance Computing and Networking

-SOLVING GRAND-CHALLENGE PROBLEMS
-ENHANCING GLOBAL CONNECTIVITY

SSC San Diego is a leader in Department of Defense (DoD) high-performance computing and networking (HPCN). The most recent addition to this capability is an upgrade to our high-bandwidth asynchronous transfer mode (ATM) campus network system linking SSC San Diego and other DoD scientists and engineers with our Intel Paragon and Hewlett-Packard/Convex Exemplar scalable, parallel computing systems. These two systems and ATM links provide DoD employees with both classified and unclassified HPCN environments, enabling the solution of grand-challenge problems in SSC San Diego and other DoD mission areas. Fiber-optic links supporting fiber-optic distributed data interface/ATM/Synchronous Optical Network connections between command-wide facilities are provided to enhance and enable global connectivity for state-of-the-art advances in HPCN and information integration.

Surveillance Test and Integration Center
The Surveillance Test and Integration Center (STIC) is a radio frequency interference-shielded vault that can receive and process data from various sources through online communications. STIC supports the Integrated Undersea Surveillance System; Relocatable Over-the-Horizon Radar; Fixed Distributed System; Surveillance Direction System Battle Group Passive Horizon Extension System; intelligence, surveillance, and reconnaissance (an overarching collection of sensor, processing, fusion, display, and dissemination systems); and other tactical or communication efforts that support joint warfare efforts and the C4ISR warfighter. STIC provides a test bed for the support of software development, integration, developmental verification and validation testing, life-cycle support, data acquisition, and real-time signal processing and display.

Surveillance Radar Development Facility
The Surveillance Radar Development Facility provides a test bed for development of radar waveforms, techniques, and equipment to support inverse synthetic aperture radar, radar cross section measurements, and higher resolution radar developments.

Signals Warfare Integration Facilities and Test Bed
The Signals Warfare Integration Facilities and Test Bed is a secure electromagnetic interference/electromagnetic frequency interference facility that supports the full spectrum of analysis, system development, test and evaluation, simulation, and integration in a multisystem environment supporting signals intelligence, counter communications, signal security, information warfare, and related cryptologic systems.

Transducer Analysis Computer Laboratory
The Transducer Analysis Computer Laboratory is a facility for evaluation and analysis of transducers, transducer arrays, and acoustic array system performance.

Transducer Evaluation Center
The Transducer Evaluation Center (TRANSDEC) is a controlled-environment, low-ambient-noise, conveniently accessible transducer calibration and underwater acoustic test facility. Operational since June 1964, the facility performs research and development tests, preproduction and production

EQUIPMENT/FACILITIES

evaluation, and acceptance testing of underwater electro-acoustic transducers for the government, Department of Defense contractors, private industry, and allied nations.

TRANSDEC can perform a wide variety of measurements for a complete transducer evaluation, including but not limited to:

- transmitting voltage, current, and power response
- receiving sensitivity
- directivity patterns
- complex impedance and admittance
- noise measurements and harmonic distortion
- target-strength measurements
- phase measurements between two hydrophones or array elements
- insertion loss of sonar windows

The low ambient noise level in the TRANSDEC pool is ideal for investigating the radiated noise of mechanical devices such as underwater motors, pumps, and low-thrust propulsion systems. Although not filtered, the water clarity in the pool is excellent for photographic work and optical experiments.

Tactical Surveillance Laboratory
The Tactical Surveillance Laboratory (TSL) offers a centralized facility for multiservice and national organizations to display and analyze tactical data systems.

The TSL is a multi-user development and demonstration laboratory capable of processing classified information. The TSL operates with multiple tactical receivers and an array of fielded and developmental end-user processor systems. With its broad reception, broadcast, relay, and processing capabilities, the TSL has the flexibility to provide a wide variety of services and functions to the tactical intelligence community.

Dive Locker
SSC San Diego's Dive Locker is responsible for all diving and diving-related operations in support of SSC San Diego projects. There are currently 36 U.S. Navy qualified civilian scuba divers and 10 enlisted military divers. Facilities are located at SSC San Diego and San Clemente Island. Examples of dive support include planning and conducting at-sea testing, organizing logistics for deployments or remote site testing, remotely operated vehicle operations, underwater facility inspection and repair, Arctic/Ice Camp planning and operations, outboard engine repair and operations, and shipboard interface and operations.

Distributed Test Beds

-SUPPORTING INTEGRATED TESTING

C4ISR systems must link U.S. ships, aircraft, submarines, and land sites, and theater, joint, allied, and coalition forces into an information network that supports warfighters in the execution of their assigned mission. The overarching nature of these systems requires test beds that support the integrated testing of multiple configurations involving components on a global scale. Connectivity for these distributed test beds is provided by integrated virtual networks using both military and commercial communications systems.

San Clemente Island
Located 80 miles off the coast from San Diego, San Clemente Island provides a physically remote multi-faceted ground, air, and sea test site suitable for a variety of projects. SSC San Diego is one of several tenant commands that operate test facilities at San Clemente Island, and has coordinated the conduct of a variety of test programs over the last 30 years, including Tomahawk, Joint Stand-off Weapon, and Navy Tactical Missile System missiles, SeaLab, Deep Submergence Rescue Vehicle, Deep Ocean Recovery Systems, and most recently the UAV/SSN Interoperability Demonstration.

EQUIPMENT/FACILITIES

USS Dolphin
The USS Dolphin is the Navy's only operational diesel-electric, deep-diving research and development submarine. Dolphin provides a cost-effective platform for both scientific research and test and evaluation programs. Working with Naval Sea Systems Command PMS 395 and Submarine Development Squadron 5, SSC San Diego provides homeport to the submarine, which can be modified internally or externally to allow installation of specialized equipment. Dolphin can also function as a threat diesel-electric or target vehicle for the evaluation of emerging surveillance or antisubmarine warfare technologies.

Visualization Image Processing Virtual Environment
The Visualization Image Processing Virtual Environment (VIPER) Laboratory is a facility for research and development studies in scientific visualization, interactive image processing, and advanced virtual environments. VIPER's most prominent feature is the FlexCAVE, a surround-screen, rear-projection, 10- by 10-foot immersive virtual environment that can be operated in either a 3- to 5-person room (U-shaped) configuration or in an up to 25-person, partial immersion theater configuration. The FlexCAVE is driven by a state-of-the-art graphics computer. Immersion is accomplished via stereographic imagery with 6-degree-of-freedom tracking for up to 12 people. The lab can operate at a wide range of information classification levels via swappable 64-GB disk systems. Video input/output up to digital Betacam quality can be texture-mapped directly on 3-D objects for high-fidelity virtual environments.

Navigation

GPS Central Engineering Activity
The Global Positioning System (GPS) Central Engineering Activity (CEA) was relocated to SSC San Diego in June 1997. The GPS User Equipment CEA has been the Navy's lead laboratory for developing GPS receivers. The CEA was established in 1980 in Warminster, PA. Base Closure and Realignment Commission action in 1995 (BRAC '95) directed relocation of the Warminster Detachment to San Diego. The new laboratory is a unique state-of-the-art facility, providing GPS User Equipment with a development, integration, test, and evaluation environment. Through real-time simulation of both GPS satellite signals and host-vehicle communications, the facility exercises GPS User Equipment hardware and software dynamically under precise laboratory conditions. Environments can be exactly replicated as many times as needed.

Navigation Sensor System Interface Development Laboratory
The Navigation Sensor System Interface (NAVSSI) Development Laboratory provides a facility, replete with navigation sensors identical to those found on U.S. Navy ships, for the development and test of NAVSSI software before introduction to the Fleet. It also serves to provide hands-on training and documentation validation. In addition, previous hardware and software versions of the NAVSSI system are maintained in order to aid in the troubleshooting of any problems identified in the Fleet.

NAVSSI Hardware Development Laboratory
The NAVSSI Hardware Development Laboratory provides an area in which new concepts for NAVSSI hardware can be tested and engineering development models can be built. The laboratory provides engineering support, including configuration management, logistics, and technical support.

OSPSS System Integration Laboratory
The Ocean Survey Program Survey System (OSPSS) System Integration Laboratory (SIL) contains an integrated navigation system, sonar sensor and processing systems, equipment prototypes, and simulators that replicate existing shipboard systems. The SIL supports the development and test of hardware, software, and signal processing algorithms to meet Ocean Survey Program requirements. The SIL also provides the in-house capability to SSC San Diego engineers and scientists to reproduce shipboard problems and provide rapid response and solutions to these problems.

EQUIPMENT/FACILITIES

Fleet Support and In-Service Engineering

AN/FRT ISEA Laboratory
The AN/FRT In-Service Engineering Agent (ISEA) Laboratory supports AN/FRT Series communications transmitters and provides capabilities for development of engineering change proposals, investigation of transmitter design problems, and simulation of fleet transmitter problems. It also supports life-cycle engineering for Navy high-frequency transmitters.

CARIBROC Processing and Display System Laboratory
The Caribbean Regional Operations Center (CARIBROC) Processing and Display System Laboratory provides testing, evaluation, life-cycle support capability, and integrated logistics support functions.

The Communications/TEMPEST Laboratory
The Communications/TEMPEST (Transient Electromagnetic Pulse Emanations Standard) Laboratory provides a capability for instrumented and visual equipment survey, emanations analysis, and testing, evaluation, and pre-installation of communications equipment wiring.

The Cryptographic Repair Facility
The U.S. Navy's primary Cryptographic Repair Facility provides maintenance, repair, and modification of cryptographic and communications security equipment, and interfaces with Navy, Army, and Air Force in matters relating to cryptographic automatic test equipment.

In-Service Engineering Agent/Pre-Installation Test and Check-Out
The In-Service Engineering Agent and Pre-Installation Test and Check-Out facilities provide engineering and technical services for integration and installation of 2-kHz to 45-GHz radio frequency communications systems, including system design, material control, system integration/installation, and system modifications. Other services are provided in support of high-frequency, very high-frequency, and ultra high-frequency line-of sight; ultra high-frequency, super high-frequency, and extremely high-frequency satellite communications; and commercial satellite communications systems. Services are provided to U.S. Navy and Coast Guard ships, submarines, aircraft, and shore activities, as well as foreign military sales customers.

Joint Integrated Voice Communications Facility
The Joint Integrated Communications Facility serves as an integration and test facility for legacy and emergent C4I in-service engineering agent maintained systems. Included are full-spectrum radio frequency assets spanning very low-frequency to extremely high-frequency, along with emergent systems and communications infrastructure upgrade programs such as the Automated Digital Network System and Defense Message System. The facility also is used for the pre-installation, test, and check-out of selected equipment, especially those complex items requiring total integration assets to effect initial set-up parameters such as asynchronous transfer mode routers and Windows NT workstations.

Integrated Voice Communications System
The Integrated Voice Communications System Life-Cycle Support Facility, initially installed in 1974 on board USS Tarawa (LHA 1), has since been expanded to cover a variety of shipboard integrated communications systems and equipment. Currently, the facility includes labs supporting the AN/STC-1 and AN/STC-2(V) systems, and the AN/WTC-3(V) Dimension 2000, Definity 75, and Mitel SX2000 dial telephone systems. The lab suite supports training, hardware/software maintenance and configuration control, and continued system application engineering. Also included is the Radio Frequency Screen Room, which supports calibration and repair of hand-held radios used in wireless communications systems.

LINK-16 ISEA Laboratory
The Link-16 In-Service Engineering Agent (ISEA) Laboratory has a fully operational Link-16 system and extensive test equipment, providing total life-cycle support to the Link-16 program. Current capabilities include fleet technical support, software development/testing, training, production engineering, and system installation support.

EQUIPMENT/FACILITIES

Engineering Software Development Laboratory
The Engineering Software Development Laboratory provides capabilities for Test Program Set development and maintenance to support organic depot repair capabilities for SPAWAR, Naval Inventory Control Point, and Naval Sea Systems Command, and includes state-of-the-art Consolidated Auto-mated Support System, VAX, and LASAR systems.

Intelligent Management Application System Laboratory
The Intelligent Management Application System (IMAS) is an architecture that combines leading commercial software and innovative programming to perform any desired business application through the World Wide Web. The IMAS laboratory provides capabilities for tailoring commercial off-the-shelf software to individual unique missions, automating individual business rules and processes, bringing all business users into the same working environment, and transitioning the business processes to a "truly" paperless environment.

RADIAC Calibration Laboratory
The RADIAC (Radioactivity Detection, Indication, and Computation) Calibration Laboratory provides capabilities for testing, calibration, and repair of distributed radiation detection equipment for the U.S. Navy. Test Engineering and Restoration Depot The Depot offers a wide range of capabilities to support shipboard and land-based communication systems test, repair, and restoration, including:

- AUTOCAD
- ESM (Electronic Surveillance Measures) Laboratory
- Teletype Laboratory
- UHF/VHF Laboratory
- NAVMACS (Naval Modular Automated Communications System) Laboratory
- Manufacturing Laboratory
- MATCALS (Marine Air Traffic Control and Landing System) Laboratory
- HF Laboratory
- EHF Laboratory
- AN/URN-25 Laboratory
- IFF (Identification Friend or Foe) Laboratory
- Calibration Laboratory
- Module Repair Laboratory
- Antenna Laboratory

Engineering Services Laboratory
The Engineering Services Laboratory provides facilities to perform environmental testing under shipboard shock, vibration, and climatic conditions, and capabilities to perform structural materials testing, analysis, and corrosion engineering. The Engineering Drawing Management Office provides the database and software tools for the Center's corporate engineering drawing, tracking, and management requirements in a Continuous Acquisition and Life-Cycle Support (CALS)-compliant integrated data environment.

Meteorological and Oceanographic System Laboratory
The Meteorological and Oceanographic (METOC) System Laboratory is a state-of-the-art systems integration laboratory for Navy and Marine Corps METOC equipment, including line data sources.

SURTASS Support
SPAWAR Systems Activity Pacific provides technical and logistical support for the Surveillance Towed Array Sensor System (SURTASS) ships and facilities. SURTASS is a mobile, passive undersea surveillance system; the system acquires data with an acoustic sensor array towed by a dedicated Auxiliary General Ocean Surveillance Ship (T-AGOS). The Integrated Undersea Surveillance System Operations Support Detachment at SPAWAR Systems Activity Pacific in Hawaii provides intermediate maintenance, dockside technical assistance, configuration management, fleet engineering, supply support, and fleet training. Two other commands involved in the SURTASS operations are tenants in Bldg. 992 in Hawaii: Naval Ocean Processing Facility Whidbey Island and Military Sealift Command.

EQUIPMENT/FACILITIES

Tactical Systems Support Complex
The Tactical Systems Support Complex supports engineering and technical services, configuration management, software maintenance, and repair of electronic surveillance measures systems. The facility meets rigid information classification requirements.

Ocean Sciences

Ocean Sciences Laboratory
The Ocean Sciences Laboratory provides special facilities for work in marine biology and toxicology, environmental chemistry research, analytical instrumentation development, marine environmental quality assessment and monitoring, environmental biotechnology, radiation sensor development, stochastic resonance, biomedical research, lasers, and microelectronics.

Marine Mammals

Bioscience Facility
The Bioscience Facility provides facilities for acoustical and physiological research, training, and handling of marine animals to perform naval tasks in the open ocean.

Microelectronics

Integrated Circuit and Fabrication Facility
SSC San Diego operates a state-of-the-art integrated circuit facility, generally regarded as a world leader in development of thin-film silicon-on-insulator technology (for radiation hardening).

Space and Naval Warfare Systems Center, San Diego
San Diego, CA 92152-5101 Commanding. Officer: CAPT Ernest L. Valdes, USN
(619)553-3000 Executive Director. Dr. Robert C. Kolb

FY1999 FUNDING DATA (MILLIONS $)*				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	2.564	N/A	0.000	2.564
6.1 Other	2.109	N/A	3.655	5.764
6.2	34.318	N/A	133.094	167.412
6.3	26.496	N/A	74.891	101.387
Subtotal (S&T)	**65.487**	**N/A**	**211.640**	**277.127**
6.4	34.491	N/A	83.293	117.784
6.5	31.907	N/A	50.718	82.625
6.6	4.768	N/A	3.928	8.696
6.7	30.393	N/A	55.531	85.924
Non-DOD	0.000	N/A	0.000	0.000
TOTAL RDT&E	**167.046**	**N/A**	**405.110**	**572.156**
Procurement	125.575	N/A	242.546	368.121
Operations & Maintenance	109.374	N/A	130.533	239.907
Other	35.105	N/A	18.118	53.223
TOTAL FUNDING	**437.100**	**N/A**	**796.307**	**1233.407**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	.920

PERSONNEL DATA (END OF FISCAL YEAR 1999)*				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	0	0	78	**78**
CIVILIAN	185	1645	1632	**3462**
TOTAL	**185**	**1645**	**1710**	**3540**

SPACE AND PROPERTY*			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1045.000	**REAL PROPERTY**	130.703
ADMIN	848.000	* NEW CAPITAL EQUIPMENT	0.621
OTHER	1210.000	**EQUIPMENT**	179.076
TOTAL	**3103.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.621
ACRES	**553**	* Subset of previous category.	

**As a result of applying the In-House RDT&E Activity criteria at the center level (see NOTE on page 3-1), SSC, Charleston and SSC, Chesapeake data is not included in the FY1999 report.*

DEPARTMENT OF THE AIR FORCE

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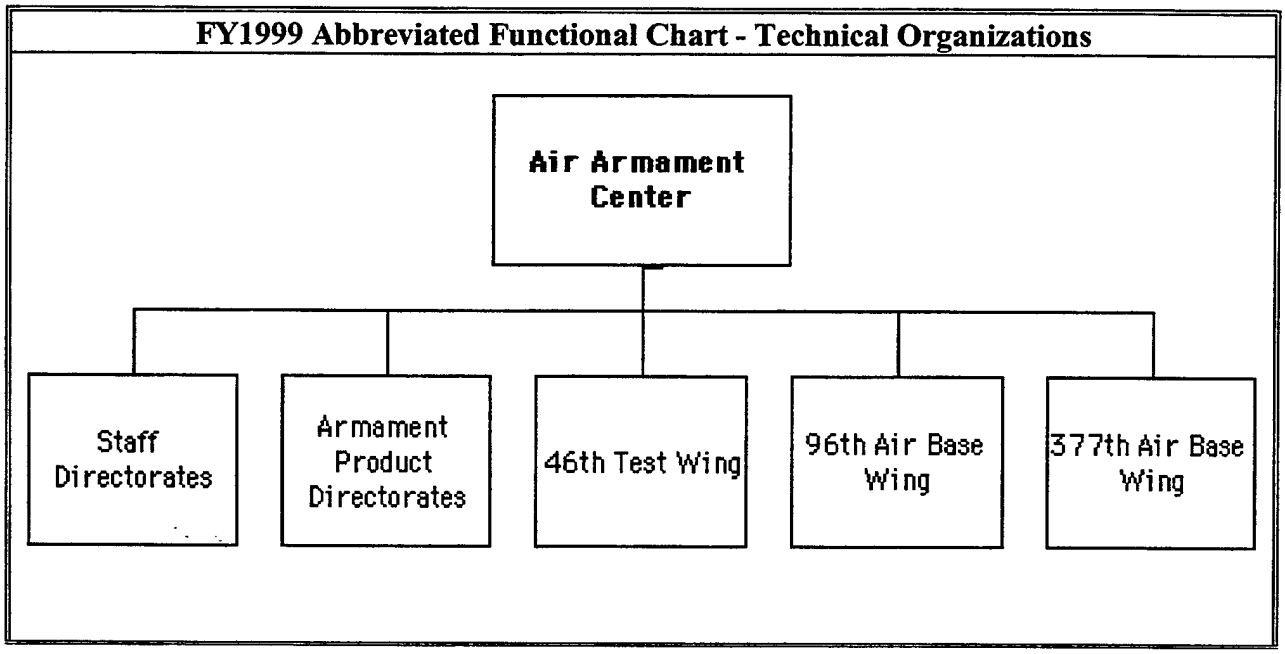
DEPARTMENT OF THE AIR FORCE

The Air Force's fourteen (14) In-House RDT&E Activities are:

Air Armament Center 4-2
Arnold Engineering Development Center 4-10
Flight Test Center 4-16
Headquarters Air Force Research Laboratory (AFRL) 4-22
Air Force Office of Scientific Research (AFOSR) 4-26
Air Vehicles Directorate (VA) 4-32
Directed Energy Directorate (DE) 4-36
Human Effectiveness Directorate (HE) 4-40
Information Directorate (IF) 4-44
Materials and Manufacturing Directorate (ML) 4-48
Munitions Directorate (MN) 4-54
Propulsion Directorate (PR) 4-58
Sensors Directorate (SN) 4-64
Space Vehicles Directorate (VS) 4-74

Air Armament Center



Air Armament Center
Eglin AFB, FL 32542-5498
(850)882-3931

Commander: MG Michael C. Kostelnik
Executive Director: Dr. Mario J. Caluda

MISSION

The Air Armament Center (AAC) is responsible for development, acquisition, testing, deployment, and sustainment of all air-delivered weapons. The AAC applies advanced technology, engineering, and programming efficiencies across the entire product life cycle to provide superior combat capability. The Center plans, directs, and conducts test and evaluation of US and allied air armament, navigation/guidance systems, and Command and Control (C2) systems. It operates two Air Force installations, providing host support to Eglin and Kirtland AFBs, and supports the largest single base mobility commitment in the Air Force. AAC accomplishes its mission through four components: The Armament Product Directorate (Eglin), 46th Test Wing (Eglin), 96th Air Base Wing (Eglin), and 377th Air Base Wing (Kirtland).

CURRENT IMPORTANT PROGRAMS

Advanced Medium Range Air-to-Air Missile* - T&E includes flight test and hardware-in-the-loop testing at the Guided Weapons Evaluation Facility (GWEF) for an improved autopilot repackaged electronics, new warhead, new fuze, extended rocket motor, shortened control actuator, and improved electronic counter-counter measures (ECCM). Munitions lethality testing is conducted at Eglin, including Congressionally mandated LIVE FIRE T&E vs. modern threat aircraft.

Hellfire – Production lot and pre-planned product improvement (P3I) testing of Hellfire and Longbow Apache Hellfire Modular Missile Systems.

CHICKEN LITTLE** - A joint Army-Air Force smart weapons test and evaluation organization hosted at Eglin. This organization conducts seeker/sensor and lethal mechanism T&E and system effectiveness evaluations.

Joint Surveillance & Target Attack Radar System (JSTARS) - Tests are conducted on Eglin ranges to evaluate Joint Stars capability to detect and track multiple targets in various environments.

Theater Battle Management Core System (TBMCS)*** - T&E included inplant and field developmental testing. Test locations for simultaneous distributed testing include Eglin AFB, Hurlburt AFB, contractor facilities, various Navy facilities and operational ships on either coast, operational units to include 12 AF in Davis Monthan AFB and Langley AFB. Also supported operational T&E prior to fielding decisions. TBMCS is AC2ISRC/CC's number one priority program. It will integrate legacy battle management systems into one multi-service application that is standard for all Air Operation Centers (AOC) and unit level Wing and Squadron Operation Centers.

Tactical Datalink Link-16 *** - T&E to support Air Force Fighter Data Link tactical datalink terminal and software development for F-15E aircraft and Block Cycle Changes for fielded Class 2 terminals in ABCCC, Rivet Joint, JSTARS, AWACS, and MCE platforms. Also supports Navy Aegis test and Army Patriot tests. Link-16 has been chosen by the Air Force as the tactical datalink of choice and will soon be developed, tested and fielded for nearly all operational platforms in USAF inventory.

Base Installation Security Systems (BISS) *** - Conduct DT&E and OT&E in dedicated DoD test facilities and ranges for evaluating exterior and perimeter security subsystems and systems. Systems include base perimeter to protect priority resources such as parked aircraft, weapons storage, and command posts.

CURRENT IMPORTANT PROGRAMS

SEEK EAGLE - Air Force stores compatibility program hosted at Eglin AFB. Flight tests to verify weapon separation simulations as well as instrumented flight testing (flutter, loads, stability, and control) to define safe carriage and employment limits are conducted on Eglin ranges.

F-15E Tactical Electronic Warfare Systems (TEWS) – Electronic counter measures performance testing.

Sensor Fuzed Weapon - Production lot flight and P3I ground testing (including DT&E, IOT&E, and LIVE FIRE (LF) T&E) are currently being conducted at Eglin. P3I testing will begin 3Q FY99 and continue through 1Q FY00.

Joint Direct Attack Munition * - JDAM is a joint Air Force-Navy program. Development, Test and Evaluation planning and flight testing are conducted. Lot Acceptance Testing is being conducted for JDAM Production Lot 1 munitions. Ultimately, a total of twenty-two weapons will be randomly selected from 900 Production Lot 1 munitions. This test includes six GBU-31(V)1/B(2000 lb.) Guided Test Vehicle missions in support of JDAM LAT Testing. Two or four JDAMs are released from a F-16 Block 50 aircraft during each mission.

Joint Stand Off Weapon * - JSOW is a joint Air Force-Navy program. Development, Test and Evaluation planning and flight testing and LFT&E are conducted. Jettison mission planned for Dec 99 to demonstrate safe separation from an F-16 for a production representative JSOW with a worst case center of gravity. This change in c.g. allows the weapon to accommodate the low cost guidance electronics unit. Further live JSOW testing scheduled for Jan 00.

AIM-9X (Air launch, Intercept Mission) - This program is a joint Air Force-Navy program led by the Navy. The 46th Test Wing is principal Air Force test office. Captive flight testing, separation testing, and live launches will be conducted during the next three years.

Advanced Short Range Air-to-Air Missile (British) and Various Allied Weapons - A component of allied munitions testing. The ASRAAM TRIALS (essentially Development, Test and Evaluation) are being conducted by a British Aerospace establishment team at Eglin. ASRAAM Service Evaluation Trial begins testing of launch profiles this year in preparation for launches next calendar year.

Wind Corrected Munition Dispenser - Modification package with low-cost tail kit and two movable fins converts CBU-87/89/97 into CBU-103/104/105. INS and GPS information is transferred from the aircraft to the munition. The munition then guides to dispense point - WCMD allows standard cluster bombs to become smart weapons. Development, Test and Evaluation planning and flight testing are being conducted.

Joint Air-to-Surface Standoff Missile * - JASSM is a joint Navy and Air Force program to acquire a next generation air launch, long range, precision guided standoff missile weapon system. Free flight testing is being conducted as the final PDRR Phase test events. Initial planning and testing for EMD Phase are ongoing. Captive flight testing, separation testing, and live launches will be conducted during next four years. The Weapons Test Flight has conducted ground testing to demonstrate hard target penetration capability and determine the hazard classification designation for the JASSM fuze. Also, analysis and testing were conducted to develop a multi-hit model to be used to predict the use of multiple precision strikes against hardened structures.

Conventional Air-Launched Cruise Missile (CALCM) - The Munitions Test Division supported sled testing to evaluate two competing designs to upgrade the CALCM with a hard target defeat capability. The Multiple Warhead System (MWS) and the Advanced Unitary Penetrator 3 (AUP-3) warheads were installed into CALCM airframes and sled tested against composite soil and concrete targets at Eglin Test Area C-74.

CURRENT IMPORTANT PROGRAMS

Gun and Ammunition Sustainment Testing - A wide range of testing was conducted to evaluate performance of the USAF's inventory of 20mm, 25mm, 30mm, 40mm, and 105mm ammunition and their related gun systems.

Enhanced GBU-15 - During Operation Allied Force, a quick reaction development, test, and production program was initiated to produce an all-weather GBU-15 for the warfighters. In support of this effort, the 46TW activated AFDTC Plan 70, compressing the normal test planning process from two months to three days, and conducted 7 ground missions, 3 captive flight missions, and 6 free flight missions in 44 days. A limited number of these enhanced weapons have been deployed to forward operating locations. A follow-on development/test/production effort will extend these capabilities to the remainder of the GBU-15 fleet.

PATRIOT- The Alabama Air National Guard (ANG) and Patriot Program Office participated in the first-ever launch of the PATRIOT missile system from Eglin's ranges. Three missiles were launched by the Alabama ANG, the first guard unit to ever employ live PATRIOT missiles. Testing was conducted over the water ranges and will likely become an annual event.

Hammerhead - The Air Force Research Laboratory is the customer in the Hammerhead research and development flight test program. The intent of this program is to couple Global Positioning System (GPS) mid-course guidance with synthetic aperture radar (SAR) terminal guidance on a GBU-15 to provide all-weather precision attack capability. Ground testing was conducted 1Q99 and flight testing 2-3Q99. Additional flight testing is on hold pending data review and analysis.

Bomb Damage Assessment - The result of a Strategic Roundtable Initiative, this program is designed to demonstrate the feasibility of a bomb damage assessment (BDA) sensor. The program intends to show the usefulness of a deployable video system to expedite BDA, thereby enhancing the warfighter's operational effectiveness. The most recent flight test (May 99) revealed several design deficiencies, all of which are currently being addressed by the contractor and will be resolved prior to future flight testing. Target date to resume testing is Mar 00. Plans include at least 1 more live GBU-10 drop with BDA camera installed.

AGM-130 Midcourse Guidance (MCG) - The MCG test program was conducted in response to an Air Combat Command (ACC) requirement for the improvement of the existing AGM-130A weapon system. The test program was conducted in two phases. Phase one added an inertial navigation system (INS) that is position and velocity aided by the Global Positioning System (GPS). The purpose of the INS/GPS is to reduce the Weapon System Officer workload by navigating the weapon to the target. Phase two added the Horizontal Target attack requirement to deliver the BLU-109 warhead against hardened horizontal targets. All testing of this test program has been completed and the weapon system was used during Operation Allied Force.

US Navy Aerial Targets - The F-16 has been selected as a launch platform for the AQM-37 and BQM-74 aerial targets. Flight testing planning and execution are being conducted to provide a limited flight clearance for the F-16 to launch the drones during US Navy operations.

A-10 Testing - Three major programs have been conducted to enhance the capability of the aircraft. The Low Altitude, Safety, and Targeting Enhancement (LASTE) program introduced new software capabilities. The Embedded Global Positioning System and Inertial Navigation System (EGI) Program increased the navigation accuracy of the aircraft. The 600-Gallon Fuel Tank program resolved stability and control questions necessary to increase loiter time by using external fuel tanks. We are currently testing Block Cycle Change BCC-01 and will begin planning efforts for BCC-02 in Jan 99.

Low Cost Autonomous Attack System - Testing of the unpowered LOCAAS is being conducted over Eglin land ranges to evaluate the systems ability to acquire, classify, and attack ground targets.

Anti-Jam GPS Technology Flight Test - The AGTFT, which is similar to a JDAM, is designed to resist GPS jamming and is currently being evaluated by the 46th Test Wing.

CURRENT IMPORTANT PROGRAMS

Air Force Mission Support System (AFMSS) - Testing of the core software and many of the 50 plus aircraft/weapon/electronic system software modules for mission planning.

Mission Systems – Combined testing of the Air Force Mission Support System (AFMSS) software including the Mission Planning System (MPS) and the Portable Flight Planning (PFPS) was conducted on Eglin. Planning for the upcoming Joint Mission Planning System (JMPS) was also accomplished.

TRIDENT - An instrumented pod developed to evaluate missile guidance software updates. The pod is flown on the F-15E aircraft.

BOL Chaff and Flare Dispenser - This foreign comparative test evaluated the operations of this new dispenser on the F-15E.

The following are Technology Transfer Programs providing unique T&E facilities/capabilities for commercial use. Capabilities are followed by actual commercial test efforts (if applicable).

Advanced Transportation and Automotive - Accomplish vehicle and automated highway systems tests in varying climatic conditions; test sensors under controlled electromagnetic environment; collision avoidance sensor tests.

Law Enforcement and Security - Intrusion, surveillance, access control, and weapons and ammunition testing.

Medical Equipment - Characterize electromagnetic emissions of equipment; test compatibility with helicopters, aircraft, or ambulances; test systems under controlled climatic conditions.

Communications Aviation - Test aircraft in climatic chamber; evaluate electromagnetic compatibility in large anechoic chamber; test on open air ranges.

Interstate Electronics - advanced GPS navigation equipment.

Environmental - Use infrared and other technologies to test forest fire detection, and pollution detection. Apply expertise in environmental monitoring, restoration and field data collection.

Accu-Weather - software evaluation for weather assessment.

Software/Modeling and Simulation - Access CRAY Supercomputer; use AAC developed software products.

At Holloman AFB are the:

NASA X-34 (Spaceplane) – The 586 TS provides ground and flight support for the test of NASA's X-34 reusable launch vehicle and technology demonstrator.

Navigation Warfare (NAVWAR) - The Navigation Warfare (NAVWAR) Program will mitigate threats by improving the performance of US and allied military class GPS PPS receivers in the operational threat environment. The 746 is testing assets includes Airborne Jammers, HMMWV mounted ground jamming assets, and small man portable jammers.

GPS Y2K Testing – The 746 TS provides Y2K compliance testing for all USAF aircraft Global Positioning Satellite (GPS)/Navigational Systems.

PAC-3 Blast and Impact Lethality Testing - The Patriot Advanced Capability 3 (PAC-3) Live Fire Test & Evaluation (LFT&E) program tests full-length and reduced-length full scale interceptors against targets at defined engagement conditions.

CURRENT IMPORTANT PROGRAMS

SM-2 Warhead LFT&E – The 846 TS is testing the Block IV-A upgrade to the US Navy's current anti-missile defense system, the SM-2 missile. This LFT&E program will provide lethality data on the shrapnel-producing warhead mode of this upgrade.

Egress and Recovery Systems – The 846 TS operates sled test programs including ejection seat testing of the Joint Helmet-Mounted Cueing System (JHMCS); performance testing of the F-22A's ejection seat, escape system, and life support system; and ejection seat testing of various egress systems in support of joint USAF/USN efforts to increase the reliability and maintainability of aircraft escape systems.

*Navy and Air Force Joint Programs
**Army and Air Force Joint Programs
*** Multi-service programs, Army, Navy, and Air Force

EQUIPMENT/FACILITIES

Capabilities and facilities include those for armament and C4I (Command, Control, Communication, Computer System, Intelligence) testing. The only DOD location with contiguous major land (724 sq. mi.) and water test ranges (125,000 sq. mi.), and the largest climatic test facility in the free world. Equipment and facilities include: a DoD High Performance Computing Center (real time and post mission support); airborne and ground based multispectral signature measurement; kinetic energy munitions test facility (sled track); static warhead arenas; gun test facilities; combined hardware and simulations testing (Guided Weapons Evaluation Facility - GWEF) and Preflight Integration of Munitions and Electronic Systems (PRIMES) facility; time-space-position information; telemetry systems facilities including airborne relay; airborne and surface targets; ground threat systems; base installation and security systems (BISS) test facility; photographic laboratory; Wing Operations Center and Squadron Operations Center test facility; Link-16 Support Facility; and aircraft maintenance (test associated) facilities.

Also, at Holloman AFB are the:

1. High Speed Test Track (HSTT): The world's longest sled track (50,788 ft), the Project Reliance lead for all DoD test tracks, and the Center of Excellence for ejection seat testing. The HSTT supports sled speeds exceeding Mach 8 and accelerations up to 200G for aerodynamic tests, impact tests, and missile simulations in various controlled environments of rain, particle, and blast/shock wave;
2. Central Inertial Guidance Test Facility (CIGTF): America's most seismically stable (0.01 micro G isolated background level) test bed for truth reference validation of navigation systems. CIGTF has the largest collection of precision rate tables (10), multi-axis tables (12), and precision centrifuges (3) in DoD;
3. National Radar Cross Section (RCS) Test Facility (NRTF) for full-scale and sub-scale systems--up to 100,000 lbs. The NRTF has computer resources to support Radar Cross Section (RCS) target predictions, detection profiles, model validation, and real-time diagnostic imaging; and
4. 586th Flight Test Squadron: Aircraft support for testing of air-to-air missiles, air-to-ground ordnance, photo/safety chase, inertial navigational systems, and Global Positioning Systems. The squadron operates two T-38's and a C-12, and uses F-15 and F-16 aircraft from Eglin AFB.

Air Armament Center
Eglin AFB, FL 32542-5498
(850)882-3931

Commander: MG Michael C. Kostelnik
Executive Director: Dr. Mario J. Caluda

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	0.000	0.000
6.1 Other	2.766	0.047	6.154	8.967
6.2	3.365	0.058	7.486	10.909
6.3	2.296	0.039	5.108	7.443
Subtotal (S&T)	**8.427**	**0.144**	**18.748**	**27.319**
6.4	2.175	0.037	4.839	7.051
6.5	17.621	0.302	39.198	57.121
6.6	188.202	1.560	114.631	304.393
6.7	21.796	0.373	48.488	70.657
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**238.221**	**2.416**	**225.904**	**466.541**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	84.649	N/A	86.536	171.185
Other	26.276	N/A	14.244	40.520
TOTAL FUNDING	**349.146**	**2.416**	**326.684**	**678.246**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	28.350

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	90	4076	**4166**
CIVILIAN	14	644	2198	**2856**
TOTAL	**14**	**734**	**6274**	**7022**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	2267.770	**REAL PROPERTY**	947.390
ADMIN	1048.589	* NEW CAPITAL EQUIPMENT	0.190
OTHER	9191.576	**EQUIPMENT**	839.343
TOTAL	**12507.935**	* NEW SCIENTIFIC & ENG. EQUIP.	7.502
ACRES	**463546**	* Subset of previous category.	

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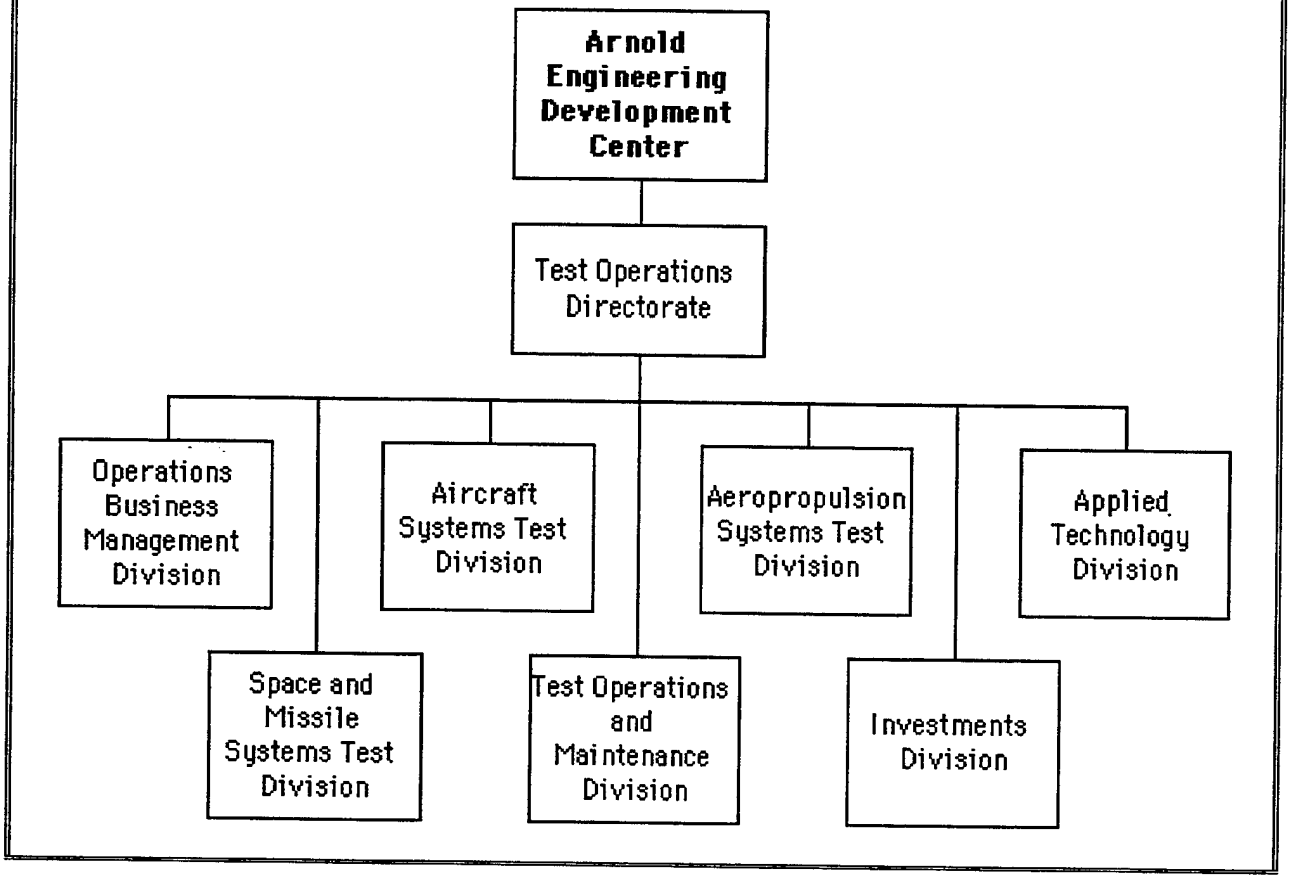
Arnold Engineering Development Center

FY1999 Abbreviated Functional Chart - Technical Organizations



Arnold Engineering Development Center
Arnold AFB, TN 37389-1303
(615)454-5201

Commander: Michael L. Heil, Col, USAF
Executive Director: Mr Alan B. Goldstayn

MISSION

The overall mission of Arnold Engineering Development Center (AEDC) is to support the development of aerospace systems by testing hardware in facilities that simulate flight conditions. AEDC is the Department of Defense's premier aerospace ground test and evaluation/simulation center specifically by performing tests, engineering analyses, and technical evaluations for research, system development, and operational programs of the Air Force and Department of Defense, other government agencies, and industry.

CURRENT IMPORTANT PROGRAMS

The following list contains some of the more important test programs at the Arnold Engineering Development Center:

F-22 Fighter: Wind tunnel testing and analysis accomplished supporting the engineering/manufacturing/development phase; majority focused on store separation testing.

F119 Engine for F-22: Significant testing completed on altitude development and ram Accelerated Mission Test qualification supporting the initial service release milestone and flight clearance of flight test engines 8 and 9. Continued flight envelope expansion for the flight test program.

F-18 Fighter: Store separation and loads testing conducted on the E/F versions of the aircraft; ASRAAM integration on the C/D version.

Joint Strike Fighter (JSF): Testing accomplished for both competing contractors.

B-2 Bomber: Store separation testing conducted to integrate JASSM.

F119 Engine for JSF: Completed the necessary background testing for the CTOL versions of the aircraft for both competing Weapon System Contractors (WSCs). This effectively allows for the flight testing to continue with no apparent restrictions for the Concept Development Phase of the JSF program. FY00 will continue with testing focused on completing requirements for the STOVL mission for the two WSCs.

JDAM: Testing in support of time critical weapon modifications.

Space Shuttle: Material testing conducted on external tank foam insulation.

AE3007 Engine for Global Hawk Aircraft: Completed high altitude performance and operability testing of the AE3007H engine for Global Hawk Aircraft and a high altitude reconnaissance unmanned air vehicle.

F110 Engine for F-16: Completed Component Improvement Program (CIP) testing on the F110-GE-129 engine. An improved exhaust duct liner, turbine frame fairing, and Digital Engine Control (DEC) were certified.

F404/RM12 Engine for Gripen Aircraft: Completed altitude performance and operability testing of the Volvo RM12 engine with a revised A/B flameholder and control system design.

CURRENT IMPORTANT PROGRAMS

Evolved Expendable Launch Vehicle: Provided simulated altitude test services for the RL-10B-2 upperstage engine to be used on the Boeing Delta III and Delta IV launch vehicles.

Peacekeeper Intercontinental Ballistic Missile (ICBM): Provided simulated altitude test services for both aging and surveillance of one stage three solid rocket motor.

Minuteman III ICBM: Provided simulated altitude test services for aging surveillance of a third stage solid rocket motor.

Minuteman III Propulsion Replacement Program: Provided simulated altitude test services for the development of the replacement second and third stage solid rocket motors.

Ground Base Interceptor: Calibrated and tested the sensor using target simulation packages traceable to national standards. Evaluated in a vacuum, cryogenic environment that closely simulated actual operation conditions.

Patriot Advanced Capability-3 (PAC-3) Program: Completed sub-scale hypervelocity lethality testing in support of Live Fire Test and Evaluation (LFT&E) during low rate initial production.

Navy Theater Wide: Completed sub-scale hypervelocity impact testing to evaluate the lethality of the Navy Standard Missile-3 (SM-3) Interceptor against ballistic missile threat targets.

National Missile Defense (NMD): Performed sub-scale hypervelocity impact testing to evaluate the lethality of the NMD Exoatmospheric Kill Vehicle (EKV) against nuclear threat targets and conducted sub-scale testing to evaluate operation of the Photonic Hit Indicator (PHI) system prior to flight test.

National Missile Defense (NMD): Static stability and aerothermal testing was completed on the NMD missile and full booster configuration through the hypersonic regime prior to the first system flight test.

Naval Trident SLBM RV Testing: Completed evaluation of the thermal protection systems of the Trident SLBM reentry vehicles. Flight hardware materials and nosetips were successfully tested at high-pressure, high-enthalpy reentry simulations.

USAF Peacekeeper RV Testing: Completed multi-run test entries characterizing the performance of several candidate heatshield variants for the Peacekeeper reentry vehicles. The testing was sponsored by the USAF RVAP Program.

EQUIPMENT/FACILITIES

AEDC represents a $6 billion investment in the most advanced and largest complex of flight simulation facilities in the world with test units having capabilities unmatched elsewhere. AEDC encompasses three main business areas: Aeropropulsion, Aerodynamics, and Space and Missiles.

The **Aeropropulsion Business Area** includes 15 turbine engine test cells supporting aircraft and missile system research and development simulating flight tests over a wide range of Mach numbers and altitudes to determine operational characteristics of air breathing propulsion systems. Test capabilities include engine performance and operability, engine/inlet integration, and environmental/climatic testing. Unique military requirements supported include afterburner use, high altitude flight, high speed low altitude flight, maneuverability, fighter/bomber engine/inlet integration, and environmental testing.

The **Aerodynamics Business Area** includes 7 wind tunnels (conventional, continuous-flow, and intermittent blowdown) supporting flight simulation, store separation simulations, computational fluid dynamics, and engineering approximations of relatively large-scale models of high speed aircraft, missiles, and spacecraft. Unique military requirements supported include high performance fighter flight simulations, full scale engine/inlet/exhaust testing, and store separation simulations.

The **Space and Missile Business Area** includes altitude rocket facilities, propulsion research test cells, aerospace chambers, hypervelocity wind tunnel, continuous flow arc-heated facilities, and free-flight ranges providing test capabilities for rockets, spacecraft, and hypersonic interceptors and re-entry systems. Unique military requirements supported include large solid and liquid rocket altitude tests, aero/thermal testing, high speed impact/counter fire, high speed large model launches, soft model recovery, digitally controlled scene generation, and multi-functional focal plane array.

Arnold Engineering Development Center
Arnold AFB, TN 37389-1303
(615)454-5201

Commander: Michael L. Heil, Col, USAF
Executive Director: Mr Alan B. Goldstayn

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	1.135	N/A	N/A	1.135
6.1 Other	0.000	0.000	0.000	0.000
6.2	1.712	0.003	0.069	1.784
6.3	0.109	0.000	0.004	0.113
Subtotal (S&T)	**2.956**	**0.003**	**0.073**	**3.032**
6.4	33.409	0.067	1.339	34.815
6.5	28.560	0.057	1.145	29.762
6.6	138.264	0.770	15.407	154.441
6.7	18.127	0.036	0.727	18.890
Non-DOD	21.379	0.043	0.857	22.279
TOTAL RDT&E	**242.695**	**0.976**	**19.548**	**263.219**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	35.277	N/A	8.242	43.519
Other	1.974	N/A	1.294	3.268
TOTAL FUNDING	**279.946**	**0.976**	**29.084**	**310.006**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	11.400

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	12	95	**107**
CIVILIAN	3	71	128	**202**
TOTAL	**3**	**83**	**223**	**309**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	230.549	**REAL PROPERTY**	1403.502
ADMIN	505.851	* NEW CAPITAL EQUIPMENT	0.000
OTHER	2097.570	**EQUIPMENT**	243.244
TOTAL	**2833.970**	* NEW SCIENTIFIC & ENG. EQUIP.	0.820
ACRES	**39081**	* Subset of previous category.	

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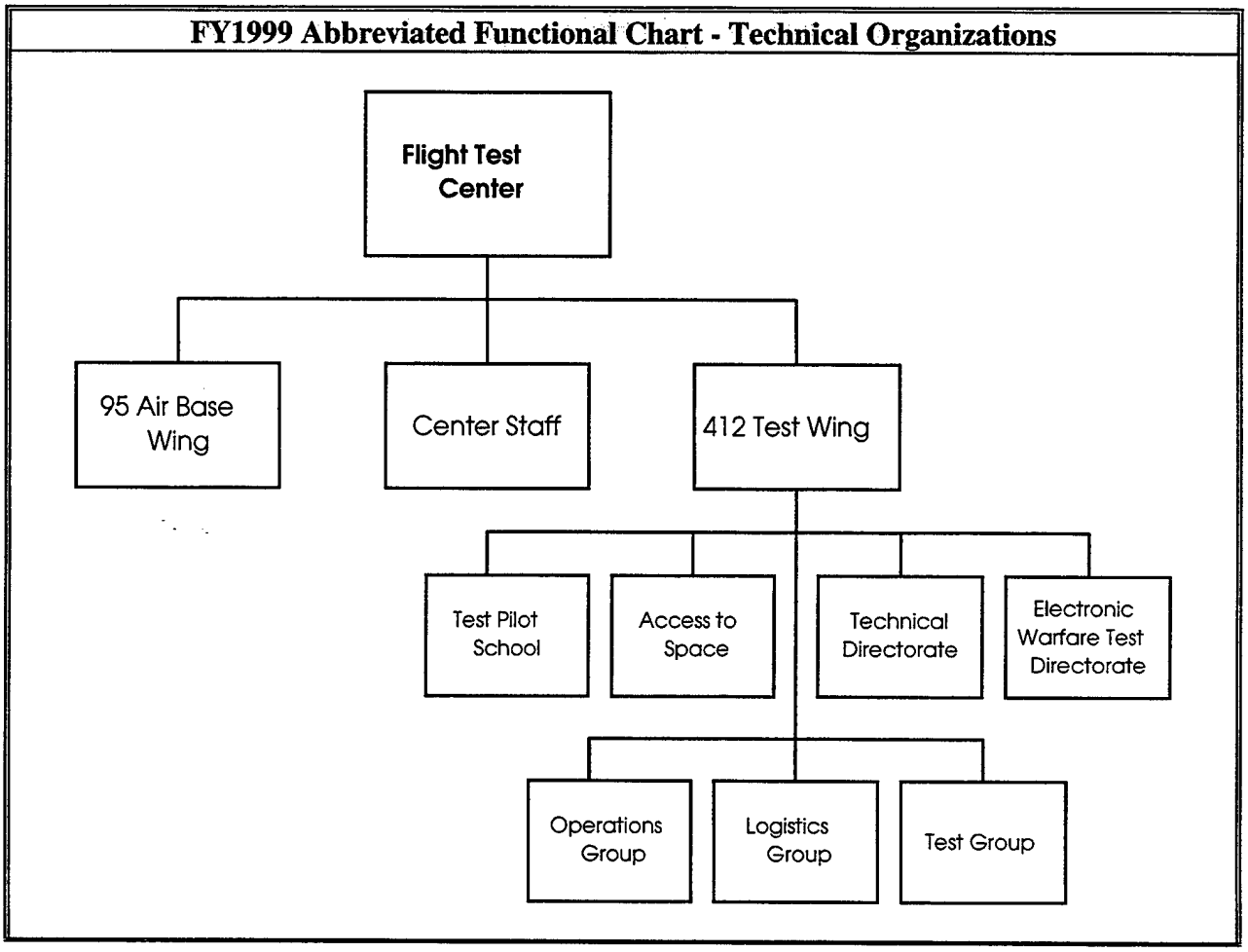
Flight Test Center



Flight Test Center
Edwards AFB, CA 93524-1033
(805)277-2704

Commander: Maj Gen Richard Reynolds
Executive Director: James A. Papa

MISSION

Air Force Flight Test Center's (AFFTC) job is to support the warfighter through test and evaluation. The Air Force Flight Test Center provides the premier aerospace research, development, test and evaluation and support for the United States and our allies. The Air Force Flight Test Center also supports non-military government agencies, commercial and allied nations test and evaluation needs. The capabilities of most of the Air Force's weapons systems were first proven at Edwards, giving the Air Force Flight Test Center a direct, tangible link to the Air Force's core competencies (air and space superiority, global attack, rapid global mobility, precision engagement, information superiority, agile combat support, and command and control). The long-term end state of the AFFTC is a multi-mission military/industrial base with operational runways, assigned flying mission activities, major air, land and/or sea ranges, and unique national military capabilities. The future is expected to lead to more unmanned aerospace systems, support for commercial test activities, air and space operations, tenant and base community support activities. Support services will be extensively augmented by contract assistance and alliances with other government and commercial entities.

CURRENT IMPORTANT PROGRAMS

B-1 BOMBER AVIONICS AND CONVENTIONAL WEAPONS UPGRADES

The B-1B is a flexible bomber with a large payload capability and long range that makes it an ideal aircraft to support our deterrent posture across the full spectrum of conflict. The B-1B has been designated to form the core of future conventional bomber capability. The challenge of a conventional role requires the development of an extensive offensive and defensive capability without compromising current capability. The conventional mission upgrade program is planned to accomplish the changes required for the B-1B aircraft to become an effective conventional bomber.

B-2 BOMBER FOLLOW-ON PROGRAM

The B-2 Follow-on Flight Test Program is a Development Test and Evaluation program. The program is a continuance of testing critical technical characteristics. The evaluation includes signature, composite structure, flight control system, air data system, and software integration. Testing will support activity in the following priority: safety of flight, initial system capability, and full capability. It must verify specification compliance for operational assessment.

B-52 BOMBER UPGRADES

The B-52H is an all-weather Interdiction Bomber capable of launching conventional weapons (CALCM, Mk-82, Mk-62, Mk-84, CBU-87, CBU-89, CBU-97, M-117, AGM-142, JDAM, GBU-10, GBU-12, Sea Mines, WCMD) and nuclear weapons (B-61, B-83, ACM, ALCM). Upgrades are planned in the following areas: advanced weapons integration, advanced avionics integration, situation awareness and survivability. Advanced weapons integration will include the: Joint Stand-Off Weapons (JSOW), Joint Air-to-Surface Stand-Off Missile (JASSM) and 500 lb. Joint Direct Attack Munitions (JDAM). Advanced avionics integration consists of the Avionics Midlife Program (AMI). AMI replaces the Inertial Navigation System (INS), Avionics Computer Unit (ACU), and Data Transfer System (DTS) to avert loss of combat capability beginning in FY 06. Situation awareness and survivability upgrades consists of Electronic Counter Measures Improvement (ECMI) and Situational Awareness Defensive Improvement (SADI). ECMI installs a new Control Display Unit (CDU) and 1553 data bus to provide weapon hand-off capability. ECMI will provide the ability to respond to changes to the threat and

CURRENT IMPORTANT PROGRAMS

maintain situation awareness (SA). SADI replaces unsupportable defensive avionics. SADI will keep current system from becoming unsupportable and will prevent the lost of primary means of SA. SADI will restore early warning and combat SA.

C-17 TRANSPORT FOLLOW-ON PROGRAM

The C-17 Follow-On Flight Test Program is a Development Test and Evaluation program. This program will support the fielded system which results from the C-17 Weapon System Production, Field Support or Flexible Sustainment contract and support enhancements to C-17 capabilities by supporting the authorized Producibility Enhancement/Performance Improvement Program. The program encompasses, but is not limited to, testing needed for engineering studies, preplanned product improvements, performance improvements, system upgrades, modifications of production equipment, field problem evaluations, production cut-ins, and mission changes. The program will provide data for use in design studies, system development, field problem resolution specification compliance and performance characteristic evaluations.

C-130J TRANSPORT

The C-130J Test and Evaluation program is currently flight testing at Edwards AFB on a USAF-owned aircraft. The tests support the recommendation to move to operational testing of the basic Lockheed C-130J aircraft and unique USAF C-130J systems. The tests have included the following: software regression testing, avionics, airdrop, personnel airdrop (paradrop), wake vortex, defensive systems and the recommendation for OT&E. Another facet of C-130J testing was the WC-130J "Hurricane Hunter" test accomplished out of Keesler AFB, MS to qualify the WC-130J for hurricane-penetration weather reconnaissance missions. The WC-130J was flown by AFFTC crews using test plans prepared by AFFTC engineers into hurricanes (including Hurricane Lenny - a CAT V storm with sustained winds over 150 mph) in order to evaluate the new aircraft for the hurricane hunter mission.

F-15 FIGHTER

The F-15 Development Test and Evaluation (DT&E) program provides general avionics laboratory and overhead support for the F-15 System Program Office DT&E program requirements. Specific program objectives, descriptions and requirements are in support of radar, avionics, and operational flight program (OFP) updates for the F-15A-E. The F-15 test aircraft at Edwards support a variety of non F-15 SPO programs such as Joint Helmet-Mounted Cueing System (JHMCS), AIM-9X, B-1B Avionics Testing and Engine Testing.

F-16 FIGHTER

The F-16 Follow-on DT&E program is a continuing effort to add enhanced tactical capabilities and correct previously identified deficiencies. Testing centers on the development and integration of new avionics and sensors and associated weapons to production blocks 30B, 40, 50. Testing will be conducted by a large test force and will involve virtually every technical discipline within the AFFTC mission.

F-117 FIGHTER

The F-117 test program provides for the continuous test of all systems as they are made available to the test team. As the aircraft systems mature, testing to include maintainability, reliability, survivability and effectiveness are evaluated. The goals of the test program are to ensure the F-117A stealth fighter can be deployed anywhere in the world at a moments notice and carry out it's intended mission: to employ stealth technology and precision weapon delivery on time and on target.

CURRENT IMPORTANT PROGRAMS

F-22 ADVANCED TACTICAL FIGHTER

The F-22 Advanced Tactical Fighter (ATF) will provide air dominance, with improved capability over current United States Air Force (USAF) aircraft. In addition, the F-22 will possess an inherent air-to-ground weapons employment capability. Beyond the turn of the century, the F-22 will be required to defeat the quantitative advantage, and emerging qualitative equivalency, of aircraft employed by air forces worldwide. Using existing and emerging technologies, the F-22 will complement current USAF fighter performance for a clear advantage over future generation fighters. The overall development goal for the F-22 is to achieve a balance between performance, survivability, reliability and maintainability, and affordability. The Engineering and Manufacturing Development (EMD) phase of testing is currently ongoing at Edwards AFB; future EMD testing will include avionics testing, climatic tests, and Dedicated Initial Operational Test and Evaluation (IOT&E) testing.

JOINT STRIKE FIGHTER

The Joint Strike Fighter (JSF) Test and Evaluation (T&E) Support Office is responsible for all AFMC T&E support conducted in executing the JSF Concept Demonstration Phase (CDP) and planning for the Engineering and Manufacturing Development E&MD Phase. The JSF T&E Support Office provides a single point of contact for the member services, Office of the Secretary of Defense, AFMC and the Weapon Systems Contractors for AF T&E related matters. Specifically, the JSF T&E Support Office: coordinates AFMC test facilities and T&E resources; provides input to the Test and Evaluation Master Plan and the Flight Certification Plan; helps coordinate the combined DT and OT activities; serves as liaison between the Weapon Systems Contractors and government ground and flight test teams; helps coordinate the systems' safety requirements and helps develop and execute the Concept of Operations for the Concept Demonstration Aircraft. Personnel spread across the 412th Test Wing are currently accomplishing these actions. This proposed change would bring these people together and provide a single AFMC T&E team to support the customer needs.

LANTIRN

The test effort supports the continued development and refinement of the LANTIRN navigation and targeting pod. Efforts include continuing software development and area tracker testing.

BIG CROW

The mission of the Big Crow Program is to create electronic warfare environments for weapon system vulnerability assessments in both test and training situations. The systems have the capability to create the environment and to capture data required to do vulnerability assessments for DoD weapon systems and joint exercises. The capability is used extensively by all services, with the aircraft deploying all over the globe to execute their mission.

ADVANCED RANGE INSTRUMENTATION AIRCRAFT (ARIA)

ARIA supports a variety of DoD, National, NASA and commercial spacelaunch customers. The ARIA mission is to gather telemetry from booster and/or space launch payloads in locations of the globe that are inaccessible by other telemetry gathering assets. The captured data is used to verify correct orbital insertion and/or payload operation. If a problem occurs, ARIA data is often the only information from which programs can do failure analysis. ARIA's mission is world-wide, with aircraft deploying from locations such as Ascension Island, Easter Island, Australia, Tahiti, and a long list of other remote sites.

UNMANNED AERIAL VEHICLE (UAV)

The High Altitude Endurance (HAE) UAV Program is an advanced concept technology demonstration aimed at developing and demonstrating long dwell, high altitude tactical reconnaissance. Two HAE airborne components and a common ground segment are being developed under this program; a low observable HAE "Darkstar" and conventional design HAE "Global Hawk".

CURRENT IMPORTANT PROGRAMS

ACCESS TO SPACE PROGRAMS

AFFTC/RL will manage and act as the AFFTC focal point for the NASA X-32, X-33, X34, X-35, X-37, X-38, X40, X44 and subsequent Reusable Launch Vehicle (RLV) programs. The AFFTC will provide a cadre of personnel with experience in the development and testing of these types of vehicles and other transatmospheric/orbital spacelift programs. Numerous commercial access to space, reusable launch vehicle, and spaceplane ventures are currently in various stages of development and desire unique AFFTC engineering expertise or facility/extended range use.

AIRBORNE LASER (ABL)

The ABL will be a cost-effective, flexible weapon system that will provide a credible deterrent and a lethal defense against an increasingly proliferating theater ballistic missile threat (TBM). The ABL can be deployed with hours to any potential conflict, arriving in theater ready to provide an initial US deterrent and defensive capability for deploying US and/or allied forces. The ABL will be fully interoperable with other weapon systems in the joint theater missile defense architecture. The ABL weapon system orbits at high altitude. Through in-flight refueling and rotation of aircraft on combat air patrol, ABLs will provide near continuous 24-hour coverage of potential TBM launch sites. ABL's on board surveillance sensors can autonomously detect, acquire, and track multiple TBM launches, although cueing data from off-board sensors will be used when available within the short engagement timeline.

EQUIPMENT/FACILITIES

Major unique facilities and equipment include: Rogers Dry Lake, a natural landing field; ground-test capabilities: Integrated Facility for AvionicsSystem Test (IFAST), Benefield Anechoic Facility (BAF), and Test & Evaluation Mission Simulator (TEMS) as part of the Electronic Combat Integrated Test (ECIT) complex; Edwards Flight Test Range (EFTR) which includes the real time mission control facilities, Precision Impact Range Area (PIRA) used for bombing/gunnery/infrared systems integration, personnel and cargo parachute drop zones, photo resolution range, and instrumented low level terrain following course; hydrant refueling system for heavy aircraft; aircraft weight and balance facility complex; photo/video lab for airborne and ground testing; intermediate aircraft maintenance support capability; Pacer Comet jet engine test facility; horizontal aircraft thrust stand; and aircraft gun system harmonization range (GUNBUTT); Aircraft Dynamic Research, Engineering, Maintenance, Manufacturing, and Modification facility; Corrosion Control facility; Ridley Mission Control Center; and Test Pilot School (TPS).

Flight Test Center
Edwards AFB, CA 93524-1033
(805)277-2704

Commander: Maj Gen Richard Reynolds
Executive Director: James A. Papa

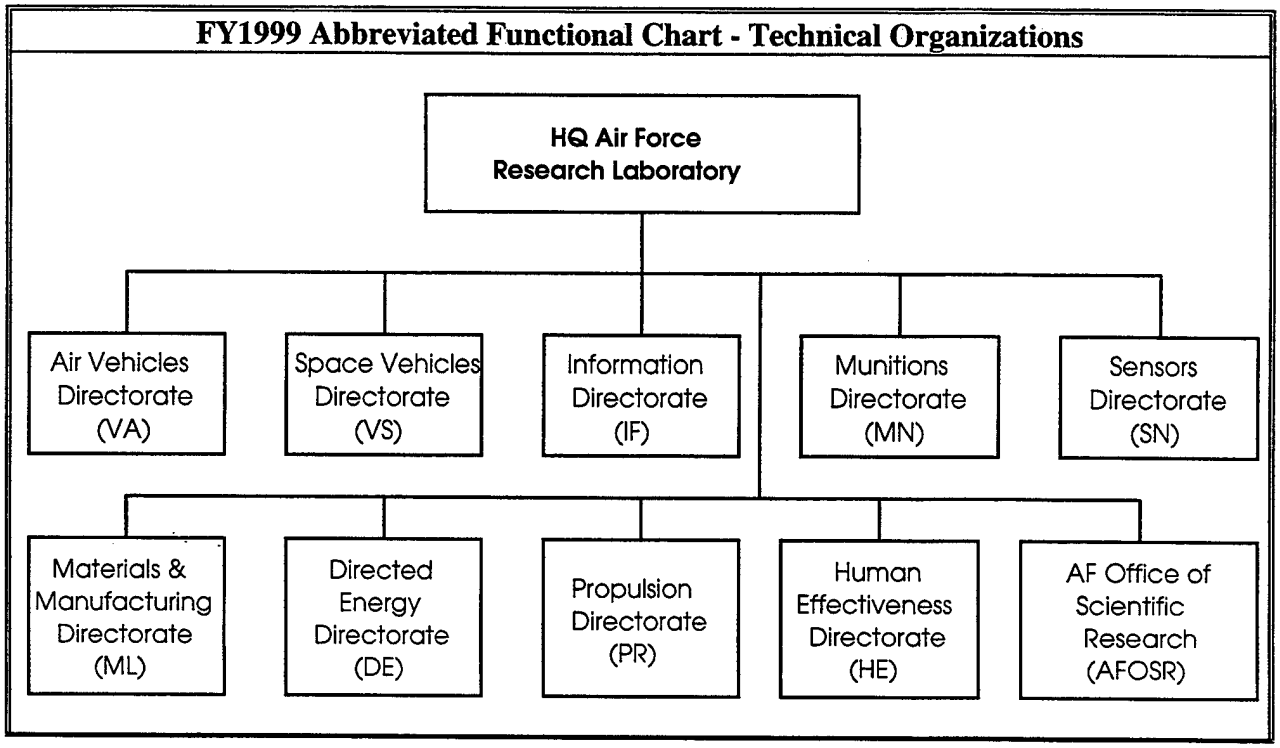
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	17.671	0.000	1.416	19.087
6.2	0.651	0.000	0.539	1.190
6.3	0.775	0.000	0.641	1.416
Subtotal (S&T)	**19.097**	**0.000**	**2.596**	**21.693**
6.4	2.723	0.000	2.252	4.975
6.5	42.273	0.000	34.962	77.235
6.6	228.210	0.206	33.210	261.626
6.7	25.102	0.000	20.761	45.863
Non-DOD	15.101	0.000	12.490	27.591
TOTAL RDT&E	**332.506**	**0.206**	**106.271**	**438.983**
Procurement	8.152	N/A	0.653	8.805
Operations & Maintenance	162.430	N/A	32.610	195.040
Other	78.530	N/A	0.513	79.043
TOTAL FUNDING	**581.618**	**0.206**	**140.047**	**721.871**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	8.694

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	5	119	3526	**3650**
CIVILIAN	5	559	2398	**2962**
TOTAL	**10**	**678**	**5924**	**6612**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	332.522	**REAL PROPERTY**	910.727
ADMIN	261.645	* NEW CAPITAL EQUIPMENT	0.000
OTHER	8953.882	**EQUIPMENT**	273.673
TOTAL	**9548.049**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**297732**	* Subset of previous category.	

HQ Air Force Research Laboratory



HQ Air Force Research Laboratory

Wright-Patterson AFB, OH 433-7131
(937)904-9000

Commander: Major General Richard R. Paul
Acting Executive Director: Mr. Timothy L. Dues

MISSION

To lead the discovery, development, and timely transition of affordable, integrated technologies that keep our Air Force the best in the world.

CURRENT IMPORTANT PROGRAMS

The Air Force Research Laboratory has taken a bold new step to respond to the needs of the Air Force and DoD by integrating its major technology programs across directorates, in the form of Integrated Technology Thrusts (ITTs). The ITTs are groupings of related high visibility programs that provide a top-level means of characterizing the Air Force's portfolio of customer focused programs.

The goal of the Aircraft Sustainment ITT is to provide technologies that will reduce aircraft sustainment costs, while increasing force readiness. Achieving this goal should free monies for badly needed force modernization. The Aircraft Protection ITT is to provide technologies that enhance the warfighter's abilities to detect, and defend themselves from the latest forms of directed energy weapons and advanced targeting systems. The Information Dominance ITT will develop technologies to collect, control, exploit, and defend information while denying an adversary the ability to do the same. The Precision Strike ITT will develop and demonstrate the enabling technologies required to swiftly locate, strike, and destroy targets throughout the globe. Each of the Precision Strike ITT programs contribute dramatic improvements to warfighting platforms in the following areas: information exploitation, survivability, precision targeting, and lethality. The Space Superiority ITT will generate AFRL technologies to support fielded, and future system operations in or through the space environment. The ITT develops, advocates, documents and maintains a "Space systems technology portfolio" and investment strategy that is orchestrated across all AFRL technology directorates. The Agile Combat Support ITT will provide improved capability to prepare and rapidly deploy responsive and tailored forces in support of multiple flexible deterrent options. The Expeditionary Air Force, (EAF) concept mandates a force that is "light, lean and lethal" (CSAF). Being lean means using Agile Combat Support to operate out of austere locations with minimal resupply. Technology Transfer: Located in the Air Force Research Laboratory, Wright-Patterson AFB, Ohio, the Air Force Technology Transfer Program was created to assure all Air Force science and engineering activities promote the transfer or exchange of technology with state and local government and the private sector. These activities enhance the economic competitiveness of industry and promote the productivity of state and local governments while leveraging the Department of Defense (DoD) research and development investment. The end result is a strong industrial base the Air Force and DoD can utilize to supply their needs.

EQUIPMENT/FACILITIES

Not Applicable

HQ Air Force Research Laboratory

Wright-Patterson AFB, OH 433-7131
(937)904-9000

Commander: Major General Richard R. Paul
Acting Executive Director: Mr. Timothy L. Dues

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	4.713	0.000	4.713
6.2	0.000	14.969	0.000	14.969
6.3	0.000	8.549	0.000	8.549
Subtotal (S&T)	**0.000**	**28.231**	**0.000**	**28.231**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**0.000**	**28.231**	**0.000**	**28.231**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.000	N/A	0.000	0.000
TOTAL FUNDING	**0.000**	**28.231**	**0.000**	**28.231**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	2	19	52	**73**
CIVILIAN	6	46	103	**155**
TOTAL	**8**	**65**	**155**	**228**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	0.000	**REAL PROPERTY**	1.914
ADMIN	49.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	0.000	**EQUIPMENT**	1.402
TOTAL	**49.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**1**	* Subset of previous category.	

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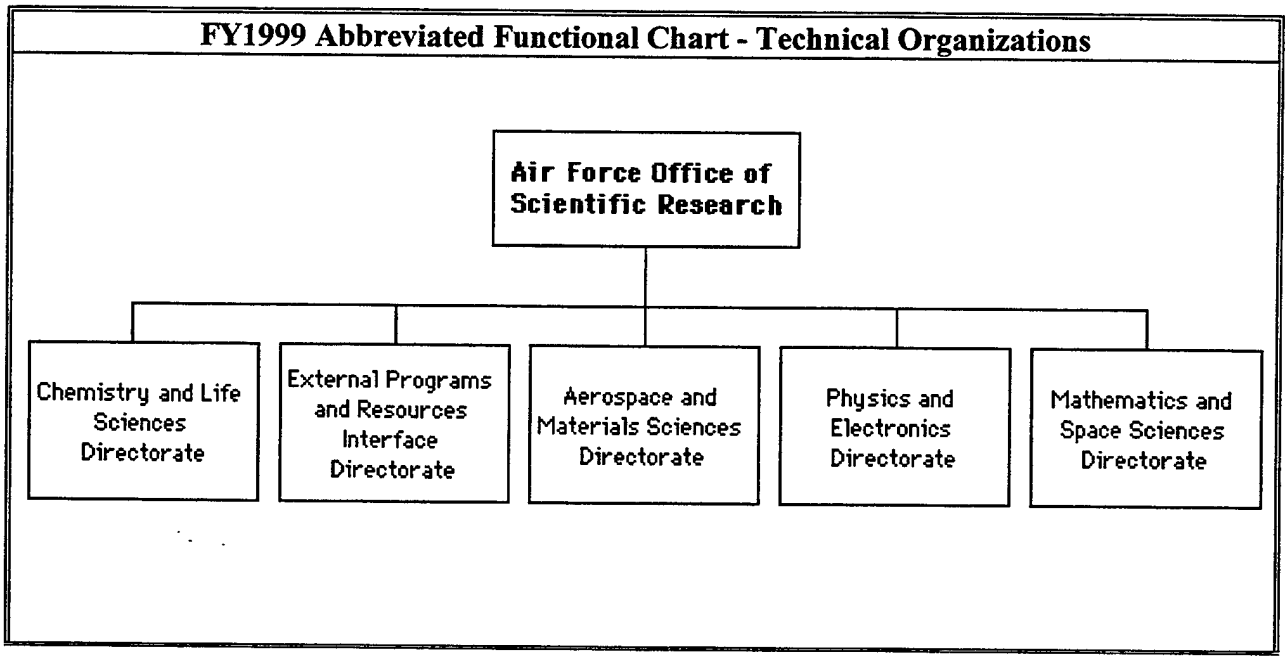
Air Force Office of Scientific Research



Air Force Office of Scientific Research
Arlington, VA 22203-1977
(703)696-7796

Director: Dr. Joseph F. Janni
Commander: Col Steven Reznick

MISSION

AFOSR manages the entire basic research investment of the US Air Force. Plans, coordinates, and executes the Air Force Research Laboratory's (AFRL) basic research program in response to technical guidance from AFRL and requirements of Air Force. Fosters, supports, and conducts research within Air Force, university, and industry laboratories. Ensures transition of research results to support USAF needs.

CURRENT IMPORTANT PROGRAMS

The AFOSR research program is responsible for funding broad-based scientific and engineering basic research in technologies critical to the Air Force mission. These technologies include aerospace structures, aerodynamics, materials, propulsion, power, electronics, computer science, directed energy, conventional weapons, life sciences, and atmospheric and space sciences. All projects are coordinated through the Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds. All technology areas are subject to long-range research planning and technical review by tri-Service scientific planning groups that interface and support the Defense Technology Area Planning process. The AFOSR basic research program is divided into the following twelve scientific projects and one educational project:

PROJECT	TITLE
2301	Physics
2302	Solid Mechanics and Structures
2303	Chemistry
2304	Mathematical and Computer Sciences
2305	Electronics
2306	Structural Materials
2307	Fluid Mechanics
2308	Propulsion
2310	Atmospheric Sciences
2311	Space Sciences
2312	Biological Sciences
2313	Human Performance
4113	Science and Engineering Education Program

2301 Physics: This project provides the fundamental knowledge required to conceptualize and develop new Air Force weapons and also establishes the basis for many technologies critical to the Air Force. Research in physics has an impact on electromagnetic countermeasures, nuclear weapons effects, communications, and non-destructive and non-intrusive testing and analysis, as well as new materials development. Other technologies affected include avionics, laser technology, and propulsion research. The primary areas of research supported by this project are Photonic Physics, Optics, Plasma Physics, and Atomic and Molecular Physics.

2302 Solid Mechanics and Structures: This project seeks to develop a fundamental understanding of the behavior of aerospace materials, structures, and supporting facilities, leading to cost-effective development and safe and reliable operation of superior weapons and defensive systems. Research includes such diverse topics as the micromechanical design of advanced materials, modeling and

CURRENT IMPORTANT PROGRAMS

simulation of the dynamic behavior of aircraft, missiles, and large space structures, and technology integration for the performance and survivability enhancement of these systems. This research will result in expanding the fundamental knowledge base to better understand the mechanics of deformation and damage of aerospace materials and structures. Also, this research will lead to an improved understanding of the aeroelastic and acoustic behavior of airframe and engine structures, and the dynamic behavior of launch vehicles and space structures.

2303 Chemistry: In the chemistry research program, knowledge and understanding are sought in chemical synthesis and reactivity, polymer chemistry, surface science, and molecular dynamics. The focus is on building the knowledge base required to develop new materials and to improve the synthesis of existing materials. Specific research focus areas include functional and structural materials, electronic and photonic materials, biomimetic materials, electromagnetic and conventional weaponry, propellants, and environmentally safer materials. This program conducts novel synthesis and characterization of higher performance and lower cost nonmetallic and biomimetic materials for application as infrared sensors, and safer, more efficient fire suppressants and deicer/anti-ice materials, and mechanistic studies of biological corrosion and semiconductor nanolithography. The chemistry program also investigates effects of chemical and morphological structures on functional and mechanical properties of polymeric materials. The program also explores atomic and molecular surface interactions that can limit performance of electronic devices, compact power sources, and lubricant materials, and investigates molecular energy release mechanisms and energy storage in metastable molecular systems to foster advances in laser weapons development and new chemical propellants.

2304 Mathematical and Computer Sciences: This research focuses on mathematical modeling, simulation, and control of complex systems and provides analytical and computational methods. Topics include: effective utilization of high-performance computers; control of aerospace systems; models and computational tools for the design of aircraft, missiles, or other weapons; efficient production of large-scale, well documented computer programs and software; communication and information theory; signal processing; artificial intelligence in surveillance systems or independent weapons; reliability and maintainability; and the allocation of resources in logistics or operational activities using ideas from optimization and linear programming theories.

2305 Electronics: Research in this project emphasizes electronic devices and systems that enable new Air Force capabilities such as battle information management systems, countermeasures, sensors, and the more electric aircraft concept. The goals are to increase the data and information processing speed of electronic systems, to firmly control their complexity and reliability, and to improve the security and reliability of information and data transmission. Research is conducted in electronic processes which will enable the engineer to model and predict performance of electronic materials, devices, and systems for high-speed digital and analog signal processing, microwave and millimeter wave signal and power generation, superconducting, optical signal processing, and radiation effects.

2306 Structural Materials: Research focuses on metallic, polymeric, ceramic, and nonmetallic structural materials. Materials research provides the knowledge for improving the performance, cost, and reliability of structural materials. Structural materials research studies a broad range of material properties such as strength, toughness, fatigue resistance, and corrosion resistance of airframe, turbine engine, and spacecraft materials. Emphasis is on refractory alloys, intermetallics, polymer composites, metal and ceramic matrix composites, and advanced ceramics, such as alumina, silicon carbide, silicon nitride, and carbon/carbon. Research in new processing methods complements research on materials properties. Direct goals of this program are to increase the operating temperature of engine materials which will further increase thrust-to-weight ratio of engines, develop improved aerospace vehicle structural materials, and control or eliminate advance material reliability issues related to high temperature strength, toughness, fatigue, and environmental conditions.

CURRENT IMPORTANT PROGRAMS

2307 Fluid Mechanics: Research involves turbulence prediction and control, unsteady and separated flows, hypersonics, and internal fluid dynamics. This research provides fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of aerospace vehicles. Research provides an understanding of key fluid flow phenomena, improves theoretical models for aerodynamic prediction and design, and originates flow control concepts and predictive methods to expand current flight performance boundaries. Research includes the development of computational methods for complex flows, prediction of real gas effects in high-speed flight, control and prediction of turbulence in flight vehicles, propulsion systems, aero-optic applications, the dynamics of unsteady and separated flows, thrust vectoring and high lift concepts associated with enhanced performance and maneuverability, heat transfer and compressor instabilities in gas turbine engines, flow-structure interactions in both external and internal flows, and transport phenomena in structural materials processing.

2308 Propulsion: Efforts include space power and propulsion, airbreathing propulsion, and propulsion diagnostics. Research is focused on the efficient utilization of energy in airbreathing engines and chemical and non-chemical rockets. Research is organized into the areas of chemically reacting flow, non-chemical energetics. Chemically reacting flows involve complex coupling between energy release through chemical reaction and the flow processes which transport chemical reactants, products, and energy. Non-chemical energetic systems include plasma and beamed energy propulsion for orbit raising space missions and efficient ultra-high energy techniques for space-based energy utilization. Thermal management of space-based power and propulsion systems will be addressed.

2310 Atmospheric Sciences: Areas of emphasis include ionospheric research and meteorology. This research includes the physics, dynamics, and chemistry of processes that determine the structure and variability of the earth's atmosphere. Atmospheric properties such as wind, density, clouds and precipitation, ionization, and optical/infrared (IR) transmission/emissivity all affect the performance of Air Force systems. Research includes new measurement techniques and the development of models for specifying and predicting weather and other atmospheric conditions. Emphasis is placed on understanding fundamental atmospheric processes and their impacts on optical and IR weapon systems, and on understanding the dynamics and structure of the ionosphere that affect communications and surveillance systems. Major research efforts focus on ionospheric dynamics, mesoscale meteorology, triggered and natural lightning, cloud prediction, and models which define the optical structure of the atmosphere.

2311 Space Sciences: The objective of this project is to provide basic knowledge of the space environment and solar activity for the design and calibration of advanced Air Force systems relevant to operations in and through near-Earth space. The project also supports the Air Weather Service (AWS) by improving observing and forecasting techniques that support operational military systems in space environments. Theoretical and empirical descriptions and models of the physics of the sun and the earth's magnetosphere, which are critical elements of future AWS prediction models and radiation belt codes, are being investigated.

2312 Biological Sciences: This project consists of two research areas: biodegradation and the toxicology of biohazards; and chronobiology and neural adaptation. Understanding how microbes degrade Air Force chemicals will enable the development of efficient and cost-effective strategies for cleaning up Air Force bases and preventing exposure to hazards due to Air Force operations. Likewise, knowledge of the mechanisms by which Air Force chemical and physical (lasers and microwaves) agents produce toxic effects will enable the development of safety assessment strategies and technologies to ensure the hazard-free development and use of future aerospace materials and systems. Basic research in neuroscience and chronobiology will result in new strategies to prevent G-induced loss of consciousness in pilots, impaired performance due to jet-lag and shift-work, night operations, and the loss of life and aircraft due to stress, inattention, or lack of vigilance.

CURRENT IMPORTANT PROGRAMS

2313 Human Performance: This project provides fundamental knowledge of information processing in humans and other complex organisms needed to advance technologies for autonomous systems, command and control, human systems integration, and personnel selection and training. Research on sensory systems impacts technologies of computer image and speech processing, human interface, sensors, and sensor fusion. Research on cognitive and perceptual processes impacts technologies of selection, education and training, command and control, and adaptive autonomous systems. Supported areas of research include sensory systems, with emphasis on vision and hearing; Cognition, Perception, and Intelligent Tutors; and Team Situational Awareness.

4113 External Research Programs Interface: This project stimulates scientific and engineering education and increases the interaction between the broader research community (including the international research community) and the Air Force laboratories. Emphasis is placed on increasing the number of U.S. citizens, especially women and minorities, with advanced degrees in science and engineering. These programs include: the Summer Faculty Research Program under which selected university faculty members conduct research at Air Force labs; the Graduate Student Research Program where graduate students in areas of interest to the Air Force perform research at Air Force labs; the University Resident Research Program where faculty members spend one year at an Air Force lab contributing to Air Force research needs and operations; the U.S. Air Force National Research Council (NRC) Resident Research Associateship Program which provides outstanding post-doctoral and senior scientists and engineers opportunities to research problems of their own choice that are compatible with the research interests of selected Air Force labs; the Laboratory Graduate Fellowship Program which is designed to stimulate doctoral candidate interest in Air Force labs and the research programs of those labs; and the National Defense Science and Engineering Graduate Fellowship Program which is jointly sponsored by the Army, Navy, Air Force, and the Defense Advanced Research Projects Agency for the purpose of increasing the number of U.S. citizens trained in science and engineering, and various international programs such as Windows on Science which provides insight and experience in international research.

EQUIPMENT/FACILITIES

Primary operating location is Arlington, VA. Overseas Detachments are maintained in London, UK, and Tokyo, Japan.

Air Force Office of Scientific Research
Arlington, VA 22203-1977
(703)696-7796

Director: Dr. Joseph F. Janni
Commander: Col Steven Reznick

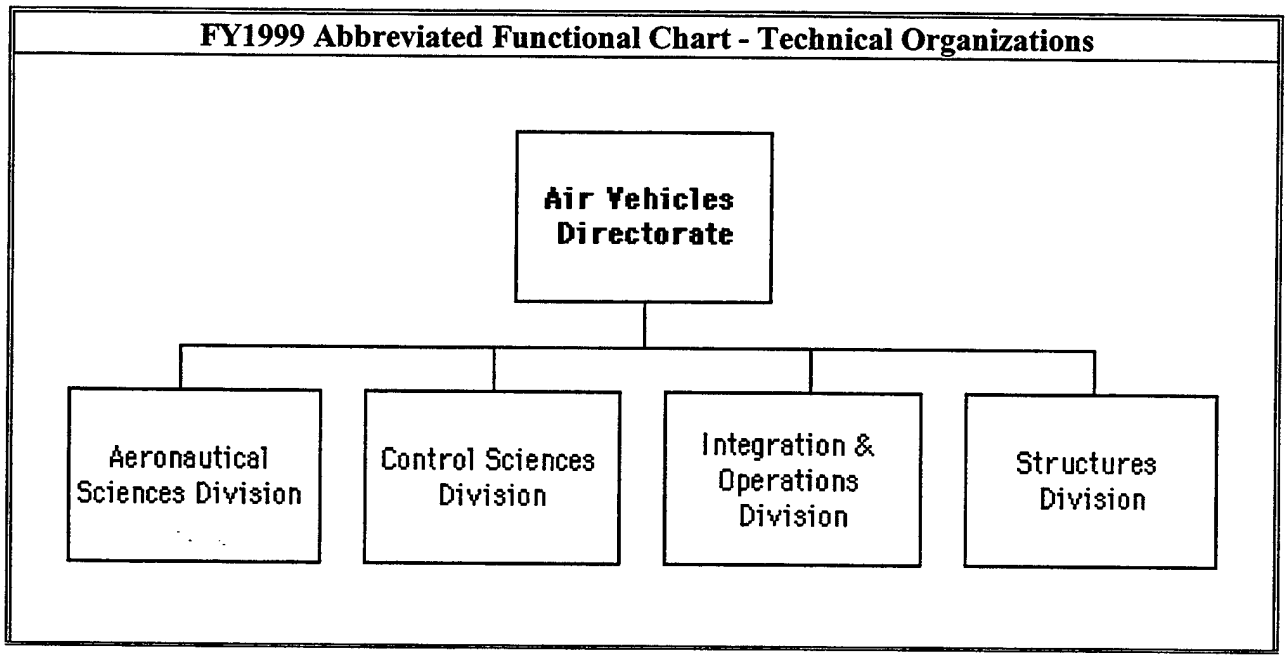
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	53.949	155.446	209.395
6.2	0.000	0.000	0.000	0.000
6.3	0.000	0.000	0.000	0.000
Subtotal (S&T)	**0.000**	**53.949**	**155.446**	**209.395**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	4.000	4.000
TOTAL RDT&E	**0.000**	**53.949**	**159.446**	**213.395**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.000	N/A	120.100	120.100
TOTAL FUNDING	**0.000**	**53.949**	**279.546**	**333.495**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	12	7	8	**27**
CIVILIAN	35	7	57	**99**
TOTAL	**47**	**14**	**65**	**126**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	0.000	**REAL PROPERTY**	0.000
ADMIN	25.250	* NEW CAPITAL EQUIPMENT	0.000
OTHER	0.000	**EQUIPMENT**	0.000
TOTAL	**25.250**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**0**	* Subset of previous category.	

Air Vehicles Directorate



Air Vehicles Directorate
Wright-Patterson AFB, OH 45433-7542
(937)255-4012

Director: Colonel David E. Walker
Associate Director: Dr. William U. Borger

MISSION

As the Department of Defense leader in the development and integration of fixed wing air vehicle technologies, the Air Vehicles Directorate understands the operational environment of warfighters and focuses resources to:

(a) Demonstrate affordable and supportable options to improve capabilities in current Fixed Wing Air Vehicles
(b) Deliver revolutionary Fixed Wing Air Vehicle Technologies for a new warfighting capability

AERONAUTICAL SCIENCES DIVISION
The mission of the Aeronautical Sciences Division is to advance the state-of-the-art for air vehicle technology from subsonic through hypersonic flight by developing and demonstrating new innovative aeromechanic technologies for original and derivative military aircraft.

CONTROL SCIENCES DIVISION
The mission of the Control Sciences Division is to develop and demonstrate advanced flight control concepts, and to advance technology for flight vehicle equipment and subsystems, which contribute to an affordable combat advantage for 21st century operational Air Force air vehicles.

STRUCTURES DIVISION
The mission of the Structures Division is to plan, manage, and conduct research and development programs to solve critical structural problems on fixed-wing aerospace vehicles.

INTEGRATION & OPERATIONS DIVISION
The mission of the Integration Division is to integrate multi-discipline functional areas, such as aeromechanics, structures, flight control, crew systems, subsystems, propulsion, avionics, and weapons to maximize the payoff of the technologies on overall system performance and affordability.

SUPPORT DIVISIONS
This includes the Contracting Division (AFRL/VAK), the Financial Management Division (AFRL/VAF), the Corporate Information Office (AFRL/VAI), and the Corporate Development Office (AFRL/VAN).

CURRENT IMPORTANT PROGRAMS

NF-16D Variable Stability In-Flight Simulator Test Aircraft (VISTA), Inhabited Air Vehicle Technology (IAV), Unihabited Air Vehicle (UAV) Technology, DARPA/USAF Strike Unmanned Combat Air Vehicle (UCAV) Program, Auto Ground Collision Avoidance System (GCAS), Advanced Fighter Technology Integration (AFTI) NF-16.

3-D Design Optimization, Aerostructural CFD, Fludic Injection Nozzle Technology, Advanced Compact Inlets, Inlet Aerostructural Integration LO External Carriage, Weapons Bay Active Flow Control, High L/D Technology, Continuous Moldline Technology.

Aircraft Battle Damage Repair, Thermal Energy Management, Next Generation Transparency, Ballistic Impact Damage Prediction.

Flight Control Integrity, Control Automation Task Allocation, Reconfigurable Control for Tailless Fighters, Advanced Vehicle Management Technology, Control Concepts for Global Range, Innovative Control Effectors, Optical Air Data System, Electrically Powered Actuation Demonstration.

CURRENT IMPORTANT PROGRAMS

Bonded Composite Repairs, Widespread Fatigue Damage, Affordable Exhaust-Washed Structures, Conformal Load Bearing Antenna, Composite Affordability Initiative (CAI), Weapon Bay Acoustic Suppression, Multidisciplinary Design and Analysis Methods.

EQUIPMENT/FACILITIES

F-16 Variable Stability In-Flight Simulator Test Aircraft (VISTA) and the Total In-Flight Simulator (TIFS) Test Aircraft.

LAMARS - Large Amplitude Multimode Aerospace Simulator, a one-of-a-kind 20' diameter motion base simulator dome providing large amplitude, high fidelity, five degree-of-freedom motion simulation.

Flight Control Actuation Systems Facility - Only US facility with test rig that can evaluate linear actuators under static and dynamic (high - bandwidth - up to 100 Hz) loads up to 100,000 pounds.

Unmanned Research Vehicle Facility - Two unmanned research air vehicles (14' and 18' wingspan) with flexible control laws for flight control validation.

Landing Gear Development Facility - Advanced aircraft tire testing capability including realistic tread wear test, dynamic stability testing of integrated nose and main dear assemblies at representative takeoff and landing load/speed conditions.

Hydrogen Test Facility - Specifically designed to experimentally simulate the thermal environment of airframe and engine hydrogen actively cooled structures or small cryogenic tankage. Fluids available include both hydrogen and helium. Heat source provided by a plasma arc heater, which provides an impinged heat flux up to 2000 BTU/FT2/Sec.

Fatigue and Fracture Extreme Environment Facility - Provides combined thermal/mechanical fatigue testing under controlled temperatures from -200 to 2200F. Altitudes may be simulated from sea level to 150,000 ft with flexibility to simultaneously mix up to four separate gases. Specimens up to 4 inches wide including complex structural joints may be tested.

Combined Environment Acoustic Chamber - conducts high temperature acoustic response and fatigue testing of structural components. The facility can produce a heat flux of 50 BTU/Ft2/Sec in 170 dB overall sound pressure level creating temperatures as high as 2500F. Test specimen up to 4 x 10 feet may be accomplished.

Large Acoustic Test Facility - Used to conduct fatigue testing of aerospace structures and components. The test chamber is 20 x 56 ft and could be configured to test full-scale aerospace vehicles and components in a reverberate of anechoic mode.

Vertical Wind Tunnel (VWT) - features the capability, unique to US, of simultaneous acquisition of both rotary balance and forced oscillation wind tunnel data using the same model. This capability enables researchers to efficiently acquire both sets of dynamic data, crucial to the study of aircraft control under extreme maneuvering conditions, with one test entry. Current research is exploring the potential of combining the two motions to simulate more flight representative motions of highly agile aircraft.

Subsonic Aerodynamic Research Laboratory (SARL) - unique in the US for its (1) extremely low (<0.1%) test section turbulence levels achieved by a large, 36:1 contraction ratio coupled with a honey comb and six fine mesh screens, its (2) max viewing area (55% of test section walls are transparent) to enable unique non-intrusive advanced diagnostic flow visualization, its (3) high model attitude (-5/+45 degree angle of attack, -10/+10 degree angle of yaw, -185/+185 degree angle of roll) coupled with (4) high aerodynamic load capability (8000,2200 and 1000 pound normal, axial and side force respectively).

Air Vehicles Directorate
Wright-Patterson AFB, OH 45433-7542
(937)255-4012

Director: Colonel David E. Walker
Associate Director: Dr. William U. Borger

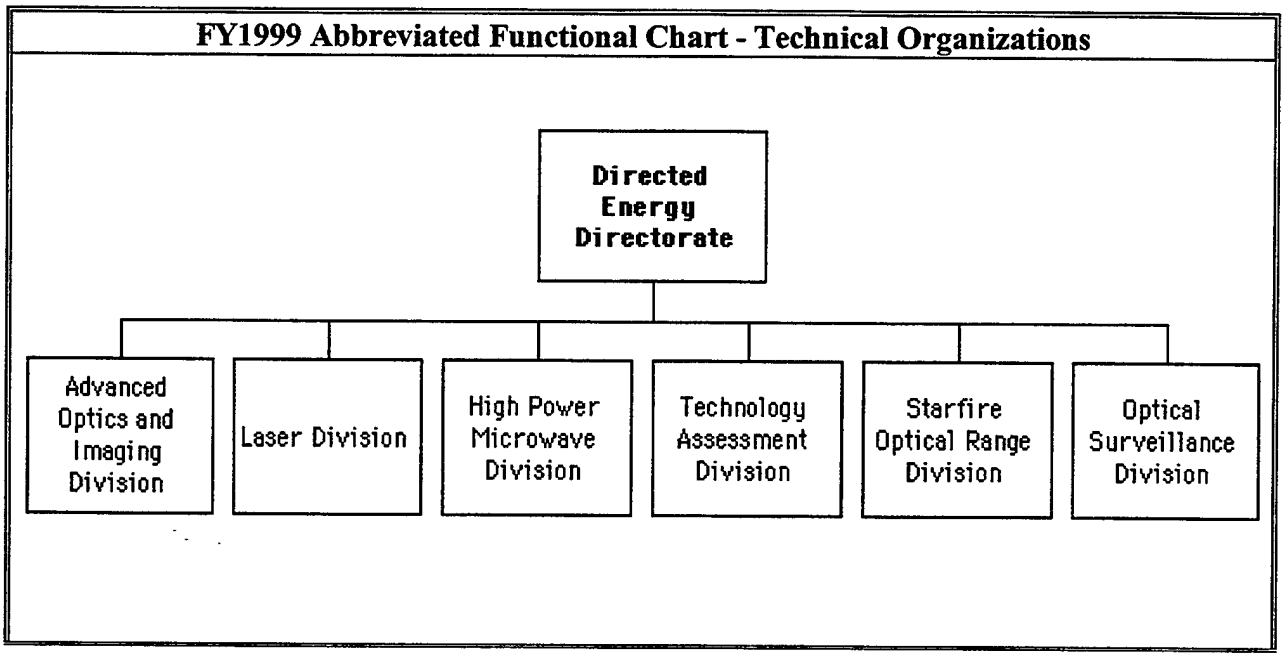
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	2.357	0.306	0.906	3.569
6.2	32.440	2.128	20.485	55.053
6.3	2.467	0.240	20.190	22.897
Subtotal (S&T)	**37.264**	**2.674**	**41.581**	**81.519**
6.4	0.024	0.003	3.473	3.500
6.5	0.000	0.000	8.858	8.858
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**37.288**	**2.677**	**53.912**	**93.877**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	5.020	N/A	0.000	5.020
Other	20.059	N/A	0.000	20.059
TOTAL FUNDING	**62.367**	**2.677**	**53.912**	**118.956**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	3	29	5	**37**
CIVILIAN	48	206	93	**347**
TOTAL	**51**	**235**	**98**	**384**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	438.050	**REAL PROPERTY**	210.000
ADMIN	139.716	* NEW CAPITAL EQUIPMENT	0.000
OTHER	115.961	**EQUIPMENT**	1001.000
TOTAL	**693.727**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**44**	* Subset of previous category.	

Directed Energy Directorate



Directed Energy Directorate
Kirtland AFB, NM 87117-5776
505-846-0241

Director: Dr R. Earl Good
Deputy Director: Col Douglas Beason

MISSION

The mission of the Directed Energy Directorate is to develop, integrate, and transition science and technology for Directed Energy to include high power microwaves, lasers, adaptive optics, imaging and effects to assure the preeminence of U.S. in air and space.

CURRENT IMPORTANT PROGRAMS

Laser Technology verifies the feasibility and payoff of lasers in advanced weapon, communication, illumination, and optical counter-measure applications. Development efforts continue to address the concerns of scaling to high power, good beam quality, and high efficiency. Increased emphasis on laser suitability for specific classes of applications and operational environments with wavelength tunable sources, packaging for minimum weight and volume, and affordability and reliability in real weapon systems has significantly influenced the development effort. Chemical lasers have demonstrated many of these capabilities, particularly scalability, and will be the device of choice in the near term. However, on-going research in solid state lasers offers a promising class of systems to meet the increasingly rigorous demands of small size, low price and multifunction capability in a future Aerospace Expeditionary Force role.

Beam Control Technology involves the development and transition of advanced optical systems for laser propagation and high resolution imaging applications. This includes technologies for adaptive optics, highly accurate target acquisition and tracking, precision beam pointing for aimpoint control, and high quality optical components.

Advanced Optics and Imaging Technology involves the development and transition of multi-spectral sensing and image processing technologies for high resolution imaging applications. Advanced optics and imaging technology also involves the development of large optics and their optical compensation for large mirror-based applications. This technology takes advantage of adaptive optics and target acquisition/tracking technologies developed under the Beam Control technology to produce a compensated, stabilized image which can then be further improved with advanced imaging sensors and post-processing of the image. Advanced concepts, which can reconstruct images from interferometric or speckle data, are also being pursued.

HPM RF Technology develops and demonstrates high-powered microwave (HPM) technology to disrupt, degrade, and destroy electronics in communication and information systems to support command and control information warfare missions. Adversaries will be denied use of electronic information processing and communications systems by using high-peak (damage) and high-average (disruption) power wideband sources packaged for an air-deliverable bomb, submunition, man-portable device or unmanned aerial vehicle (UAV). Nonlethal or lethal technology will initially concentrate on man-portable (short-range) or heavy transportable weapons and SEAD applications, followed by airborne weapons on UAVs or as submunitions, as prioritized by user needs and technical maturity.

EQUIPMENT/FACILITIES

The primary operating location for the Directed Energy Directorate is at Kirtland AFB, NM. Unique facilities include the High Energy Research and Technology Facility, High Energy Microwave Laboratory, High Energy Plasma Laboratory, Starfire Optical Range, Chemical Laser Facility (COIL), and underground tunnels in the Manzano Weapons Storage Area. The Directed Energy Directorate also has two unique sites at remote locations: at the White Sands Missile Range, where there are DE Laser and Optics laboratories sited on cliff edges to permit propagation of laser energy over vast desert valleys; and the Atmospheric Electro-Optical System (AEOS), on top of Mount Haleakala in Maui, HI, to permit accurate viewing and tracking of space objects.

Directed Energy Directorate
Kirtland AFB, NM 87117-5776
505-846-0241

Director: Dr R. Earl Good
Deputy Director: Col Douglas Beason

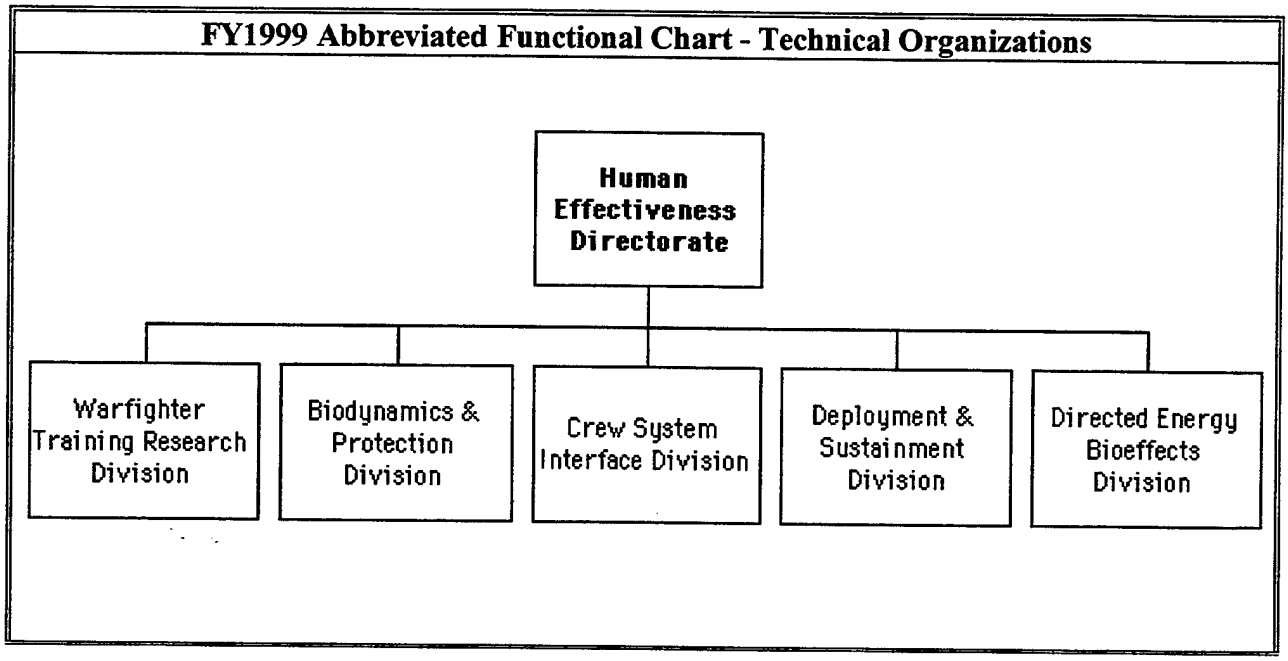
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	2.060	0.119	2.309	4.488
6.2	3.933	8.314	17.237	29.484
6.3	3.620	1.614	43.678	48.912
Subtotal (S&T)	**9.613**	**10.047**	**63.224**	**82.884**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.041	12.547	12.588
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.288	0.115	3.102	3.505
TOTAL RDT&E	**9.901**	**10.203**	**78.873**	**98.977**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	3.621	N/A	0.000	3.621
Other	6.127	N/A	78.266	84.393
TOTAL FUNDING	**19.649**	**10.203**	**157.139**	**186.991**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	28	64	111	**203**
CIVILIAN	92	103	224	**419**
TOTAL	**120**	**167**	**335**	**622**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	373.000	**REAL PROPERTY**	84.828
ADMIN	86.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	154.000	**EQUIPMENT**	39.600
TOTAL	**613.000**	* NEW SCIENTIFIC & ENG. EQUIP.	11.800
ACRES	**4325**	* Subset of previous category.	

Human Effectiveness Directorate



Human Effectiveness Directorate
Wright-Patterson AFB, OH 45433-7901
(937)255-2683

Director: James W. Brinkley
Deputy Director: Col. Robin R. Taylor

MISSION

Develop, integrate, and transition science and technology products for training personnel, protecting and sustaining the crew member, and improving human interfaces with weapon systems, to assure the preeminence of US air and space forces.

CURRENT IMPORTANT PROGRAMS

HUMAN EFFECTIVENESS TECHNOLOGY AREA - The Human Effectiveness Technology Area consists of four thrusts:

CREW SYSTEM INTERFACE THRUST: The Crew System Interface Thrust conceives, develops, integrates, and transitions science and technology that revolutionizes the human interfaces with weapon systems, to assure the preeminence of US Air and Space forces. This thrust applies the science and technology of biologically based signal processing, cognitive interface design, aural interfaces, noise mitigation, meta interface assessment, human-system interface measurement, bio-centered control and applied multi-sensory interfaces, and visual display interfaces to develop crew system interfaces matched to the warfighter's capabilities. This thrust is presently investigating information analysis and exploitation technology, aural displays and bioacoustic technology, crew system development technology, human interface technology, and visual display system technology.

WARFIGHTER TRAINING THRUST: The Warfighter Training Thrust researches, develops, demonstrates, evaluates, and transitions technologies and methods to enable the warfighter to "train the way we intend to fight" and enable an expeditionary Air Force. Utilizing the theory and science of learning and instruction, methods for development and evaluation of training, and tools, and technologies for training, this thrust advances the state of the art in training technologies and methods. This thrust is presently investigating knowledge representation technologies, distributed mission training technologies, night vision device training technologies, and operation center training methods to create on demand, affordable, realistic training environments.

BIOEFFECTS AND PROTECTION THRUST: The Bioeffects and Protection Thrust researches, develops, demonstrates, evaluates and transitions technology to predict and mitigate the biological effects of aerospace stressors, and directed energy on Department of Defense personnel and mission performance. This thrust defines the human responses to impact, sustained acceleration, vibration, and altitude, and provides human system criteria for emergency escape and crash protection. This thrust also researches the bioeffects of directed energy and the interaction with tissues, organisms, and mammalian function, providing operational guidelines to the warfighter. The thrust is presently investigating impact protection and safe escape technologies, aircrew protection technologies, laser bioeffects, radio frequency bioeffects, non-lethal technologies, and biomechanisms and modeling methods.

DEPLOYMENT AND SUSTAINMENT: The Deployment and Sustainment Thrust researches, develops, demonstrates, evaluates, and transitions technology to maximize warfighter effectiveness by improving logistics capabilities and assuring survivability in toxic environment. Using logistics systems modeling, enhancement and simulation, advanced information displays, and human performance process models, this thrust enhances the warfighter's capability to deploy and sustain operations. This thrust currently has programs in readiness and sustainment logistics, predictive toxicology, and chemical and biological defense.

EQUIPMENT/FACILITIES

The Air Force Research Laboratory Human Effectiveness Directorate conducts Science and Technology Research at Wright-Patterson AFB OH, Brooks AFB TX, and Mesa AZ. Equipment and facilities include: Two human centrifuges, a high onset rate centrifuge located at Brooks AFB and a multi-axis centrifuge located at Wright-Patterson AFB; hypobaric chambers with capability to simulate high altitude subzero conditions; anechoic chambers for study of human and noise interactions; "virtual worlds" for systems training research; inhalation toxicology chambers; directed energy laboratory to research bioeffects of lasers and Radio Frequency radiation; human isolation facility for controlled study of group dynamics in simulated air operations; a TEMPEST secure facility with simulators for Electronic Warfare research and training; and a facility for testing subjects (mostly new recruits) in Science and Technology Research on computer automated training and force management tools.

Human Effectiveness Directorate
Wright-Patterson AFB, OH 45433-7901
(937)255-2683

Director: James W. Brinkley
Deputy Director: Col. Robin R. Taylor

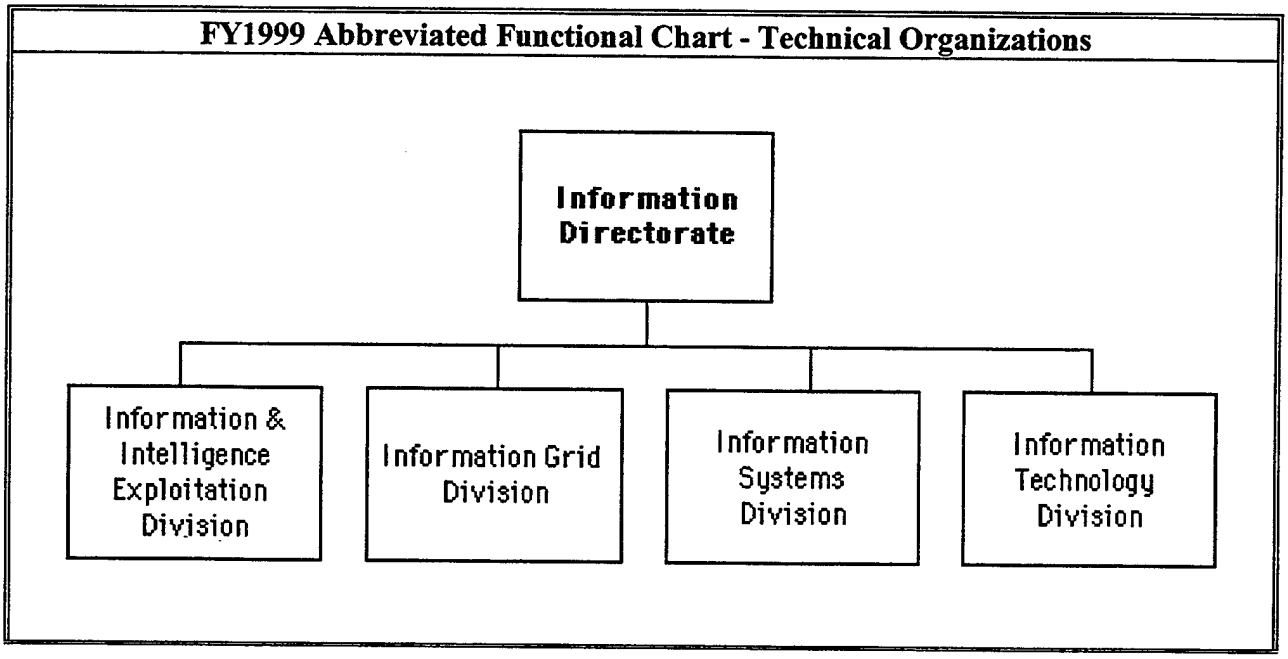
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.100	N/A	N/A	0.100
6.1 Other	1.700	0.156	4.900	6.756
6.2	28.492	4.913	29.063	62.468
6.3	4.777	2.981	35.435	43.193
Subtotal (S&T)	**35.069**	**8.050**	**69.398**	**112.517**
6.4	0.000	0.000	0.273	0.273
6.5	0.011	0.000	18.413	18.424
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.004	0.798	0.802
TOTAL RDT&E	**35.080**	**8.054**	**88.882**	**132.016**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.050	N/A	29.157	29.207
TOTAL FUNDING	**35.130**	**8.054**	**118.039**	**161.223**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	19	69	144	**232**
CIVILIAN	83	100	160	**343**
TOTAL	**102**	**169**	**304**	**575**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	307.241	**REAL PROPERTY**	499.922
ADMIN	195.587	* NEW CAPITAL EQUIPMENT	2.097
OTHER	136.268	**EQUIPMENT**	45.403
TOTAL	**639.096**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**125**	* Subset of previous category.	

Information Directorate



Information Directorate
Rome, NY 13441-4514
(315)330-7701

Director: Mr. Raymond Urtz
Deputy Director: Col. John Bedford

MISSION

The advancement and application of information systems science and technology for aerospace command and control and its transition to air, space, and ground systems to meet customer needs in the areas of Global Awareness, Dynamic Planning and Execution, and Global Information Exchange is the focus of this AFRL organization. The Directorate's areas of investigation include a broad spectrum of information and fusion, communication, collaborative environment and modeling and simulation, defensive information warfare, and intelligent information systems technologies.

CURRENT IMPORTANT PROGRAMS

The following are some of the important programs on which the laboratory is working: Consistent Battlespace Picture; Dynamic Command and Control; Global Grid; Configurable Aerospace Command Center; Defensive Information Warfare; Offboard Augmented Theater Surveillance and High Performance Computing for Joint STARS; Intelligence Data Handling; Information For The Warrior; Secure Survivable Communications; Reachback from Airborne Platforms; Imagery Product Archive; Joint Battlespace Infosphere; Effect Based Operations; Integrated Sensor System; Information Fusion; Information Extraction; Knowledge Bases; Intelligent Agents; Collaboration and Simulation; Aerospace Connectivity; Signal and Image processing; High Performance Computing; Networking; Signal Exploitation; Timeline Analysis System; Artificial Intelligence; Speech Processing; Storage & Retrieval; Concept Based Indexing & Retrieval; Imagery Exploitation; Situation Assessment & Target Analysis.

The Technology Transfer Program includes: Utilizing Education Partnerships with 46 Universities for collaborative research under the Information Institute Program and the donation of over 200 computers to 17 school districts under the Computers for Schools Program; CRADAs between the laboratory and New York State Technology Enterprise Corporation (NYSTEC) continued in the areas of Advanced Communications for the NY State Police and a statewide advanced telecommunications system design for all NY State Agencies and local governments; A CRDA with NYSTEC was initiated to explore methods to be implemented to ensure computer security within the New York State network computer system; Under the Dual-Use Progran, the Directorate has initiated a Technology Investment Agreement with Kodak Corporation titled Robust Image Authentication and Discovery and has six on-going Dual-Use Agreements in place. The Laboratory's Patents database was increased to include new patents issued this year; Participated in the joint training exercise Global Patriot 99 using advanced communications technology to enhance the capabilities of the warfighter in the field.

EQUIPMENT/FACILITIES

Primary operating locations are: Griffiss Business &Technology Park, Rome NY and Wright Patterson Air Force Base, Dayton OH.

Equipment and facilities include.

Equipment:
SKY, high performance computer - Fastest computer in the Air Force with 384 processors capable of 256 GFLOPS computer performance

EQUIPMENT/FACILITIES

Facilities:
Defensive Information Warfare R&D Facility - Only systems level facility addressing the complete Information Assurance and Operations issues; Fusion Facility - multi-sensor information fusion; Signal Processing R&D Facility; Network Management R&D Facility - measurement of UHF and VHF radio transmitter and receiver performance parameters; Audio/Speech Facility - capability to analyze and evaluate tactical audio databases and processing algorithms; Micro Electro Mechanical Machine Systems Center; Network Design Facility; High Performance Computing Facility - SKY and Paragon high performance computers; Command & Control Visulation Data Wall Facility; Distributed Systems Evaluation Environment Testbed; Imagery Exploitation 2000 / Elint Facility - capable of coupling new R&D technology and commercial hardware and software with operational systems; Artificial Intelligence Facility; Command & Control Technology Center - consists of controlled access computing environment with state-of-the-art processing and display equipment; Embedded Systems Laboratory - performs state-of-the-art embedded software assurance for Fighter aircraft; Joint Integrated Test Facility; Highbay Anechoic Measurement Facility - measurement and analysis of multibeam antennas and jammer nulling characteristics; Newport and Stockbridge Antenna Evaluation Facilities, two hilltops 1.5 miles apart with six fully instrumented far-field reflectivity ranges; Concealed Weapons Detection Facility - specialized analysis and demonstration of concealed weapons detection through-the-wall technologies;

Information Directorate
Rome, NY 13441-4514
(315)330-7701

Director: Mr. Raymond Urtz
Deputy Director: Col. John Bedford

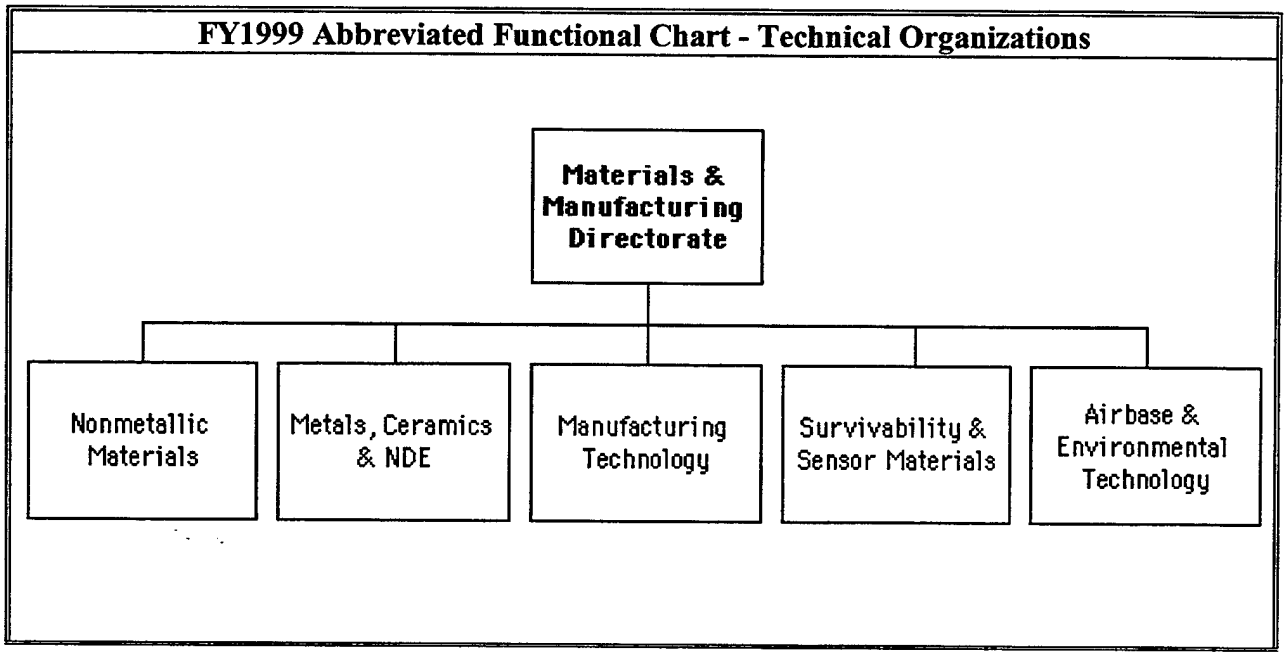
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.142	0.151	4.453	4.746
6.2	37.872	2.944	153.993	194.809
6.3	3.012	3.740	162.627	169.379
Subtotal (S&T)	**41.026**	**6.835**	**321.073**	**368.934**
6.4	1.283	1.277	25.939	28.499
6.5	0.383	0.511	23.297	24.191
6.6	0.018	0.026	1.121	1.165
6.7	0.231	0.096	17.198	17.525
Non-DOD	0.050	0.066	4.497	4.613
TOTAL RDT&E	**42.991**	**8.811**	**393.125**	**444.927**
Procurement	0.900	N/A	3.567	4.467
Operations & Maintenance	3.684	N/A	94.073	97.757
Other	6.289	N/A	0.000	6.289
TOTAL FUNDING	**53.864**	**8.811**	**490.765**	**553.440**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	5	41	46	**92**
CIVILIAN	31	321	359	**711**
TOTAL	**36**	**362**	**405**	**803**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1065.400	**REAL PROPERTY**	54.500
ADMIN	89.200	* NEW CAPITAL EQUIPMENT	0.000
OTHER	220.300	**EQUIPMENT**	83.500
TOTAL	**1374.900**	* NEW SCIENTIFIC & ENG. EQUIP.	5.800
ACRES	**84**	* Subset of previous category.	

Materials and Manufacturing Directorate



Materials and Manufacturing Directorate
Wright-Patterson AFB, OH 45433-7739
(937)255-4726

Director: Dr. Charles E. Browning
Deputy Director: Col. Robert L. Tipton, Jr.

MISSION

Plan and execute the USAF program for materials and processes, manufacturing, and environmental technologies in the areas of basic research, exploratory development, advanced development and industrial preparedness. Provide systems support to Air Force product centers, logistics centers, and operating commands to solve system related problems and to transfer expertise.

CURRENT IMPORTANT PROGRAMS

Metallic Materials Computational Methods and Tools encompasses research and development leading to effective modeling and simulation for advanced metals development, processing, and behavior and life prediction. This modeling and simulation technology is critical to accelerating the development and implementation of new metals technologies and to dramatically reducing development costs.

The Metals Affordability Initiative is a unique consortium of domestic metal suppliers focused on impacting affordable metals technologies and associated business case development and transition plans to lower acquisition costs of metallic components and assemblies by 50%.

Dimensional Control of Large Composite Structures is investigating process modeling and material variability effects on final dimensions of composite structures. This will eliminate cost intensive processing steps and improve the ability to predict behavior and tolerance variability for composite parts, reducing cost and improving performance of composite structures.

Thermal Management Materials program is developing alternative highly conductive material systems to replace aluminum and inconel environmental control system heat exchangers with lightweight, high thermal conductivity, corrosion resistant composite materials. Replacement with composites improves sustainability, reduces weight and increases range of air platforms.

Composite Affordability Initiative develops the tools and technologies necessary to enable integrated product teams to confidently design, manufacture and integrate with aircraft subsystems and "all-composites" airframe utilizing revolutionary design techniques, innovative manufacturing concepts, materials, processes and advanced business practices, to enable breakthrough reductions in cost, schedule and weight.

Developing innovative Non-destructive Evaluation technologies including eddy current methdos and laser based ultrasound techniques to detect hidden corrosion on aging aircraft. These techniques play a significant role in the effective management of the safety and cost of the aging AF fleet.

The Point Inspection LO Tool program is developing RF imaging tools and IR reflectometer tools to allow perform inspection of low observable systems during deployed operations. This technology greatly enhances the affordability and maintainability of the LO fleet and supports survivability, readiness, and Air Expeditionary Force operations as well.

The Non-destructive Evaluation for Turbine Engines effort investigates the integration of several NDE techniques to conduct residual stress gradient measurements to better predict remaining life of engine components, allowing retirement for cause and extended life of engine components. Enables significant cost avoidance for management of aging AF fleet.

Gap Treatments for Low Observable Aircraft develops electronically conductive gap sealants for stealth aircraft. This technology dramatically reduces the maintenance man-hours per flight hour while preserving integrity of low observable system and enhancing survivability and operability of the low observable fleet.

CURRENT IMPORTANT PROGRAMS

The Infrared Reduction Coatings program is scaling up and transitioning infrared signature reduction coatings for advanced aircraft to enhance their survivability in infrared threat environments.

Detector Materials and Materials Processes investigates and develops materials and processes to improve the yield of low rate production detector materials to reduce cost or focal plane arrays for space based infrared sensor applications. This program also develops multi and hyperspectral detector materials to enable multiple sensors on a single focal plane, dramatically reducing the weight and cost of sensor systems.

The Non-linear Optical Materials effort develops non-linear optical materials and processes to enable laser line frequency conversion of low cost, lightweight, solid state laser sources. This technology is key to enabling affordable infrared countermeasure systems for large aircraft protection against anti-aircraft missiles.

Laser Hardened Concepts program will invent and investigate advanced laser protection concepts and materials for high-speed, broadband response. The technology developed on this program will provide the basis for fabricating novel tunable filters and optical limiters for wavelength-independent protection of personnel and electro-optical sensor systems.

Force Protection Research program is developing and demonstrating elastomeric coatings and retrofit techniques to harden and protect deployed soft assets against terrorist and other unfriendly threats. This technology enhances the safety of deployed troops and equipment in forward deployed operations and locations and supports the implementation of the expeditionary air force concept.

Mixed Based Hydrogen Peroxide research and development program is developing an industrial based process to make mixed base hydrogen peroxide for use as the laser energy source on the Airborne Laser system. This technology is a critical enabling technology for the baseline ABL.

Electronics Parts Obsolescence program is a major initiative to address the problem of managing the Air Force fleet with many parts out of or going out of production. This is an issue for aging, fielded, and soon to be fielded systems. Successful implementation of process and management methods is critical to managing the safety and cost of sustaining the AF fleet.

The Management of Affordable Space Systems program focuses on implementation of new technologies and lean principles to manage the cost of AF space systems. The program is focused on satellite systems to complement the AF investment in launch cost reduction.

Supplier Focused Initiatives aim to fuse new technologies and lean principles and implement these ideas into small/medium based suppliers, casting suppliers, and forging suppliers. Successful transfer of these concepts will result in significant cost reductions for deploying future AF systems and sustaining the deployed and aging fleet.

EQUIPMENT/FACILITIES

Behavior and Life Prediction Laboratory - Extensive and unique capability for evaluation of properties of metals, alloys, and composites under a wide range of environmental conditions, including high cycle fatigue.

Laser Hardened Materials Evaluation Laboratory - Unique capability to evaluate laser/materials interactions and effects of lasers on advanced materials for aerospace applications. Includes a 15 KW, continuous wave, carbon dioxide laser with a well characterized flat-top beam and 1 to 11 cm spot sizes Special capabilities include three vacuum environment test chambers (1x10-6 Torr); 50 ksi tensile test machine; subsonic blow-down wind tunnel (Mach 0.1 to 0.9); supersonic blow-down wind tunnel (Mach 2); 7ft by 9 ft chamber (to lx10-6 Torr); cryogenic sample holders.

EQUIPMENT/FACILITIES

Electronic Properties of Semiconductors Laboratory - In this unique facility, one can measure the Hall Effect at ambient and elevated temperatures, the temperature-dependent Hall Effect, and the Shubnikov Effect. In addition, there is the capability for doing deep level transient spectroscopy and optical admittance spectroscopy.

Processing Laboratory - This is a unique facility for the process of a wide range of metals and alloys. It includes both commercial and one-of-a-kind apparatus for producing special samples by extrusion, forging, rolling, swaging, and heat-treating.

SCEPTRE Laboratory - The Space Coatings Environmental Test and Research Laboratory is a unique facility for testing thermal radiation and protective coatings under conditions of high vacuum, high electron or proton flux, and high intensity electromagnetic radiation

Computational Materials Science/Molecular Modeling Laboratory - A variety of workstations and software, plus a virtual reality facility with a force-feedback arm.

Chemical Analysis Laboratory - Includes capability for the wet chemical and instrumental analyses of a wide range of materials

NDE Laboratory - Facilities for the non-destructive evaluation of metallic and non-metallic materials

Failure Analysis Laboratory - Capability for the analysis of metal, electronic, and other samples for purposes of determining the causes of failure.

Corrosion Test Laboratory - Facilities comprise a variety of equipment for testing, and instruments for evaluating, corrosion.

Rain Erosion Facility - This unique facility permits the evaluation of rain erosion of a variety of materials under realistic use conditions.

Ultrasonic laboratory - Ultrahigh frequency laser-generated ultrasound system, acoustic microscopes and large and small precision ultrasonic imaging systems.

Computed Tomography (CT) Laboratory - Includes a laminography/dual energy CT system and a tomoscope CT system.

Polymer Physics Experimental Laboratory - Includes instrumentation necessary to measure thickness and the conductivity of polymer films.

Polymer Characterization Laboratory - This laboratory includes the capability for obtaining spectroscopic data, plus measuring the mechanical and thermal properties of polymers.

Fiber/Film Fabrication Laboratory - This laboratory provides the capability for producing fibers and films in controlled environments.

Polymer Synthesis Laboratory - A well-equipped facility for the synthesis and chromatographic characterization of polymers

Morphology Laboratory - An X-ray diffraction laboratory with multiple generators and cameras, plus optical and electron microscopes.

Analytical Spectroscopy Laboratory - This laboratory includes FTIR, Solid State NMR, and GC-MS, with all supporting equipment

Optical Microscopy Laboratory - In this laboratory there are a variety of light microscopes and an electron microscope.

EQUIPMENT/FACILITIES

Thermal Analysis Laboratory - This well-equipped laboratory is equipped to do DSC, PDSC, DTA, TGA and Dilatometry measurements.

Rheological Characterization Laboratory - This laboratory is centered around a Dynamic Mechanical Analyzer.

Mechanical Characterization Laboratory - This well-equipped laboratory features tensile and other mechanical tests for laboratory to extremely large scale samples.

Materials Processing Laboratory - In this facility, it is possible to go from the starting materials to finished product for a number of composite materials.

Optical Properties of Semiconductors Laboratory - A wide variety of measurements are possible in this laboratory, including infrared, photoluminescence, light scattering, reflectance, and magneto-optical semiconductor behavior.

Nonlinear Optical Materials Laboratory - In this laboratory, one can measure a variety of NLO properties on bulk and film samples.

Superconductor Materials Characterization Laboratory - This laboratory has the capability to measure transport properties and critical current densities along with AC magnetic susceptibility

Pulsed Laser Deposition Laboratory - The capability exists to prepare thin films for hard or lubricious coatings or for application in sensors

Molecular Beam Epitaxy Laboratory - This is a major facility for the preparation and characterization of a wide range of semiconductor materials and devices.

AC Hydraulic Pump Test Laboratory - This is a specialized facility for testing both components of aircraft hydraulic systems and hydraulic fluids.

Lubricant Traction Lab - This laboratory is a specialized facility for measuring the traction coefficients of liquid lubricants under controlled (high) temperature conditions.

Optical lab - Included in this laboratory is a variety of optical instrumentation including scatterometers, emissometers, imaging IR radiometers, UV-Vis-NIR and IR spectrophotometers, and optical microscopes.

Liquid Lubricants Lab - This laboratory includes a wide range of testing equipment such as viscosity baths and measuring devices and instruments such as gas chromatographs, a gas chromatograph-mass spectrometer, and an infrared spectrophotometer.

X-ray Photoelectron Spectroscopy Laboratory - In this laboratory there are two XPS instruments, one devoted to solid lubricants and a second with an in-situ tribometer for use with solid or liquid lubricants

Raman Analysis Laboratory - There are two Raman spectrometers in this lab, primarily used for the evaluation of solid lubricant coatings.

Mechanical Test Laboratory - This laboratory comprises a variety of instruments for determining friction and wear properties of lubricant, hard coatings, and other systems.

Ceramic Composites Research Laboratory - This laboratory has a wide variety of specialized equipment for fiber growth and coating, ceramic powder characterization and composite processing and testing.

Materials and Manufacturing Directorate
Wright-Patterson AFB, OH 45433-7739
(937)255-4726

Director: Dr. Charles E. Browning
Deputy Director: Col. Robert L. Tipton, Jr.

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	13.406	0.000	0.000	13.406
6.2	19.888	28.774	21.741	70.403
6.3	0.000	9.947	24.720	34.667
Subtotal (S&T)	**33.294**	**38.721**	**46.461**	**118.476**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	21.254	21.254
6.6	0.000	0.000	0.000	0.000
6.7	0.000	11.328	36.234	47.562
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**33.294**	**50.049**	**103.949**	**187.292**
Procurement	0.000	N/A	2.431	2.431
Operations & Maintenance	0.000	N/A	6.429	6.429
Other	14.289	N/A	37.586	51.875
TOTAL FUNDING	**47.583**	**50.049**	**150.395**	**248.027**

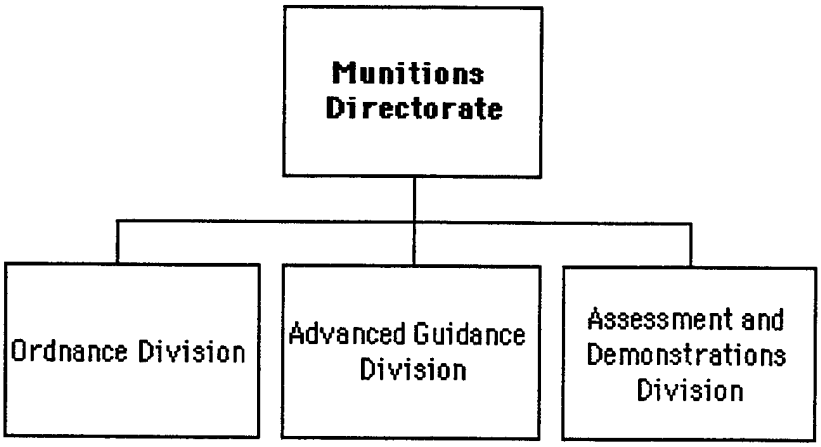
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	5	34	15	**54**
CIVILIAN	92	243	123	**458**
TOTAL	**97**	**277**	**138**	**512**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	294.500	**REAL PROPERTY**	103.800
ADMIN	189.300	* NEW CAPITAL EQUIPMENT	0.080
OTHER	83.400	**EQUIPMENT**	43.800
TOTAL	**567.200**	* NEW SCIENTIFIC & ENG. EQUIP.	0.100
ACRES	**135**	* Subset of previous category.	

Munitions Directorate

FY1999 Abbreviated Functional Chart - Technical Organizations



Munitions Directorate
Eglin AFB, FL 32542-6810
(850)882-3003

Director: Col. H. V. Dutchyshyn
Deputy Director: Mr. S. C. Korn

MISSION

Develop, integrate, and transition science and technology for air-launched munitions for defeating ground fixed, mobile/re-locatable, air, and space targets to assure the preeminence of U.S. air and space forces.

CURRENT IMPORTANT PROGRAMS

MN's research and development planning process is structured around Integrating Concepts. The Integrating Concepts can be thought of as planning modules consisting of suites of technologies integrated into munition systems, time phased over a 25 year period into near, mid and far term concepts. Each of the Integrating Concepts has been built around satisfying particular warfighters' needs associated with engaging air and ground targets. The Integrating Concepts are implemented via Integrated Product Teams drawn from the Directorate's Core Competencies and from external organizations to develop the necessary technology roadmaps and concepts. An annual process is conducted to ensure the Integrating Concepts remain fully aligned with the users' operational needs and to capture new technology opportunities. The Directorate currently has four identified Integrating Concepts:

The Small Smart Bomb (SSB) Integrating Concept (ICIPT) is developing the set of synergistic technologies to allow miniature munitions to defeat 85 % of the MK-83/BLU-109 target set. This target set consists of fixed soft to moderately hardened targets as well as relocatable targets. There are many benefits to smaller munitions, the greatest of which is an increased loadout capability for fighter and bomber aircraft. Miniature munitions also permit usable payloads to be carried in small delivery platforms such as Uninhabited Combat Air Vehicle (UCAV) and the planned Common Air Vehicle (CAV).

The Anti-Materiel Munition (AMM) Integrating Concept Integrated Product Team (ICIPT) pulling together four new techniques that will revolutionize air-to-surface warfare against ground mobile targets. Our targets are the enemy vehicles that bring the war to us and include SCUDs, surface to air missiles (SAM), and tanks. The new technologies include a 3-dimensional imaging laser radar (LADAR) Seeker and a multi-mode warhead (capable of shooting tank targets with explosively formed slugs and softer SCUD and SAM missile launchers with a shotgun spray of lethal fragments).

The Hard Target Smart Munition (HTSM) Integrating Concept (ICIPT) follows the vision of providing the warfighter with the means to hold all of an enemy's hardened and/or deeply buried structures at risk using conventional, air-delivered munitions. Its task is to advocate, initiate, develop, and transition the munition related technologies necessary to accomplish this vision.

The Air Superiority Missile (ASM) Integrating Concept (ICIPT) is focused on the technical challenges of defeating broad classes of airborne targets as well as a limited set of ground based enemy air defense targets. The Air Superiority technology planning process consists of four distinct sub-processes designed to provide technology solutions for both current and future postulated air combat operational needs.

The Munitions Directorate (MN) of the Air Force Research Laboratory has instituted a full spectrum technology transfer program consisting of outreach, education, patents and intellectual property management, marketing, and cooperative research efforts. At the present time, the Munitions Directorate has five active Cooperative Research and Development Agreements (CRADAs) and two in coordination. These CRADAs encompass research in Global Positioning System (GPS) communication, miniature munition separation, millimeter wave/radar imaging, explosives, weapons fuzing, and infrared imaging polarimeter technologies. (One example of this cooperative research is a CRADA with Control Systems

CURRENT IMPORTANT PROGRAMS

Research to provide the communication interface between a commercial simulator and miniature airborne GPS receivers.) Royalties from licenses of MN technologies brings in approximately $50K per year.

Four University professors worked in AFRL/MN in FY 99 under Intergovernmental Personnel Agreements (IPA).

EQUIPMENT/FACILITIES

Primary Operating location is Eglin AFB Fl. Equipment and Facilities include:

- Munitions research complex which includes the following labs:
  - Kinetic Kill Hardware in the Loop Simulation (KHILS): Provides an independent, government owned, national resource for nondestructive testing and technology integration of precision guided weapon systems.
  - Inertial Navigation Lab: Develops and conducts experiments on tactical grade weapons navigation and control technology.
  - Optical Correlation Research lab: Designs, develops and evaluates optical processors for munition applications, combines lenses, mirrors and laser diodes to process data at the speed of light.
  - Environmental Sciences lab: Supports conventional munitions technology programs and environmental assessment requirements through chemical, radiochemical and microanalysis research.
  - Prototype munitions Fabrication Lab: Provides a wide range of rapid fabrication support for experimental hardware for testing in exploratory and advanced development programs.
  - Technical Library: Provides technical library support for the Munitions Directorate and the Air Armament Center
  - Radio Frequency/Millimeter Wave Lab; develops and evaluates sensors and seekers using radar guidance technology employing frequencies up to millimeter wave.
  - Advanced Guidance Research Lab: Provides image and signal processing computer lab for developing and evaluating weapon guidance algorithms.
- High Explosive Research & Development Facility: provides high explosive formulation, processing, x-ray, quality control and loading support for Air Force non-nuclear weapons development programs.
- Advanced Warhead Experimentation facility: Provides state of the art capability to conduct research and development of advanced warhead technologies; including heavy metals, projectiles, penetrators, shaped charge liners, agent defeat payloads, electromagnetic payloads, and various initiation components and explosives.
- Fuze Research and development Facility: Provides capability to develop and evaluate technologies for fuzes, target detection devices, and initiation components of conventional air launched fuzes. Simulates shock and G loading needed to develop penetration fuzing.
- LADAR Development and Evaluation Research Facility: Develops and evaluates active imaging direct detection laser radar seekers.
- Aeroballistic Research facility: Advances basic aerodynamic knowledge and defines aerodynamic performance, stability and control parameters for advanced ammunition and high fineness ration penetrators. Only range suited for medium caliber free flight experimentation and testing to acquire dynamic stability derivatives for spin stabilized ammunition.

Munitions Directorate
Eglin AFB, FL 32542-6810
(850)882-3003

Director: Col. H. V. Dutchyshyn
Deputy Director: Mr. S. C. Korn

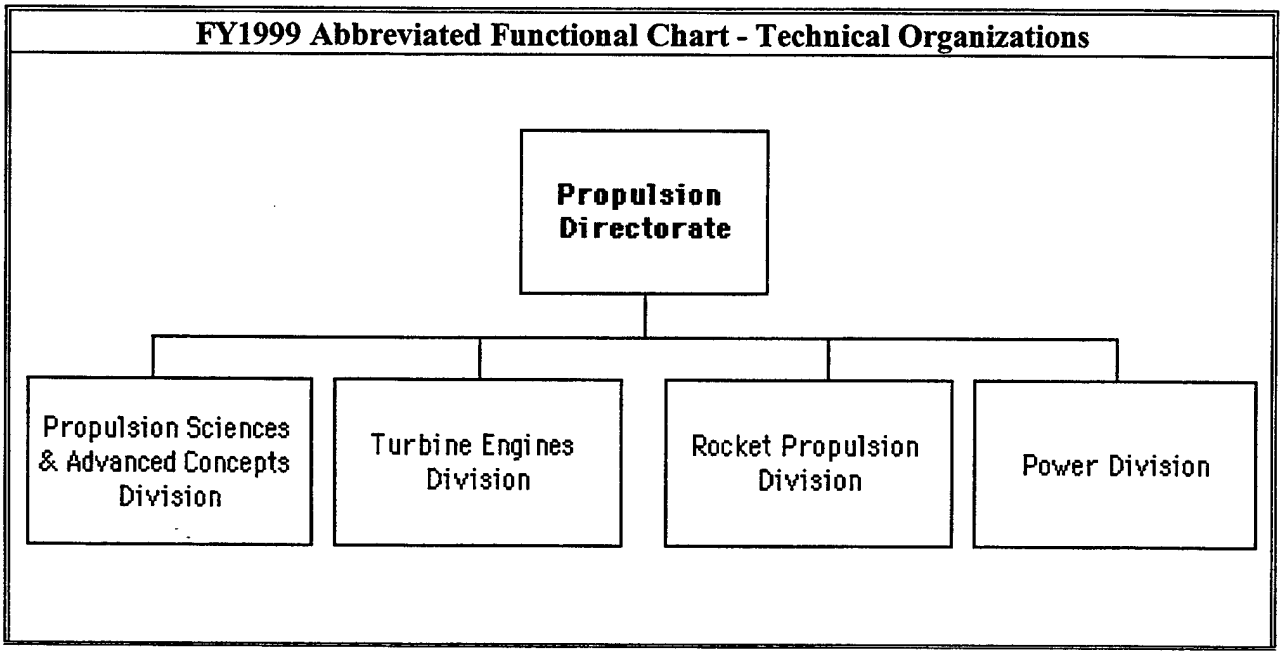
FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.100	N/A	N/A	0.100
6.1 Other	0.936	0.000	0.000	0.936
6.2	17.534	7.520	12.396	37.450
6.3	0.000	4.561	16.138	20.699
Subtotal (S&T)	**18.570**	**12.081**	**28.534**	**59.185**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.018	15.363	15.381
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**18.570**	**12.099**	**43.897**	**74.566**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.000	N/A	0.000	0.000
TOTAL FUNDING	**18.570**	**12.099**	**43.897**	**74.566**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	6	35	20	**61**
CIVILIAN	34	146	80	**260**
TOTAL	**40**	**181**	**100**	**321**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	207.484	**REAL PROPERTY**	23.700
ADMIN	19.628	* NEW CAPITAL EQUIPMENT	0.000
OTHER	42.888	**EQUIPMENT**	34.780
TOTAL	**270.000**	* NEW SCIENTIFIC & ENG. EQUIP.	1.356
ACRES	**1159**	* Subset of previous category.	

Propulsion Directorate



Propulsion Directorate
Wright-Patterson AFB, OH 45433-7251
(937)255-2520

Director: Richard E. Quigley, Jr.
Deputy Director: Col. Alan Janiszwski

MISSION

AFRL/PR creates and transition propulsion and power technology for the military dominance of air and space

CURRENT IMPORTANT PROGRAMS

The FY99 Integrated High Performance Turbine Technology (IHPTET): Joint DoD/NASA/Industry time-phased program to demonstrate technologies to enable doubling turbine engine capability by 2003. IHPET includes three classes of engines: large turbofan/turbojet for fighters, bombers, and transports; smaller turboprop/turboshaft for rotorcraft, patrol, and trainers; and limited life for missiles and UAVs.

Integrated High Payoff Rocket Propulsion Technology (IHPRPT): Joint DoD/NASA/Industry program to demonstrate rocket propulsion technologies to improve performance of solid and liquid rockets. IHPRPT includes all classes of rockets including tactical, space launch, and orbit transfer.

More Electric Aircraft (MEA) Initiative: Joint program to demonstrate electric power technologies to improve reliability and maintainability of aircraft. MEA addresses power generation, distribution, and storage components and systems.

Hypersonic Technology for Missiles (HyTech): HyTech develops and demonstrates hypersonic technologies for advanced airbreathing propulsion systems. The current emphasis is on a Mach 4-8 hydrocarbon-fueled scramjet for unmanned (missile) application. Long term applications include hypersonic strike/reconnaissance vehicle and affordable demand space transportation system.

JP-8+225 Fuel Development Program: This program seeks to develop a second generation high heat sink fuel thermally stable to 550 °F, JP-8+225. JP-8+225 will build on the additive technology of JP-8+100 and will require a more aggressive additive package that eliminates autoxidation deposits and enables the continuous use of the fuel as a cooling media in high performance aircraft.

TECHNOLOGY TRANSFER

The Propulsion Directorate has CRADAs to conduct impact and containment testing of GE90 (which is a commercial engine) turbine blade; to investigate carbon lithium-ion battery anodes; and to investigate the use of drag-reducing agents in pipelines to increase throughput; to develop commercial applications of Polyhedral Oligomeric Silsesquioxane (POSS); to develop improved scientific understanding of the dissociative ionization process in molecules that are important to plasma devices; to investigate alternate fuels for space launch vehicles; to provide for experimental validation of High Cycle Fatigue detection measurement and control techniques in a high speed environment; to conduct vacuum research test for Pulse Detonation Rocket Engine.

EQUIPMENT/FACILITIES

Compressor Aero Research Lab - The CARL is used to perform independent Air Force basic and applied research in compressor aero performance through investigations into high risk/high payoff turbine engine axial compressor aeromechanical performance.

Compressor Research Facility - The CRF conducts and supports exploratory and advanced development efforts in compressor technology, independently evaluating full-scale, multi-stage, single-spool dual-flow fans and compressors under operating conditions similar to an actual flight profile.

Turbine Engine Fatigue Facility - Used to perform structural and vibrational evaluations on turbine engine components, demonstrate durability of advanced turbine engine components, and perform life predictions and analytical assessments.

Turbine Aero Thermal Basic Research Facility - Used to determine boundary conditions for computations, including turbulence intensity levels and scales along with heat transfer measurements, to evaluate turbulence models, design methods and heat transfer mechanisms for turbine engines.

Turbine Research Facility - Used for exploratory development of advanced, full-scale turbines, studies include aerodynamic, aerothermal and aeroelastic research. The facility simulates all important engine conditions through the use of aero and thermodynamic similarity in a short-duration (transient) research procedure.

Component Calibration Facility - Used to support all the above turbine engine research facilities. This facility is used for the development of advanced, experimental instrumentation, such as, laser transit anemometry and laser Doppler anemometry systems that are used to measure intra-blade flow fields.

Scramjet Research Facility - Used to perform research on high risk/high payoff scramjet engine combustion devices in the Mach 3-8 range. Operating parameters can simulate conditions from 0 to 100,000-ft altitude and Mach 2 to 6. These conditions can be sustained indefinitely making use of the 30 lbm/s continuous flow capacity of the Directorate's Air Facility.

Ramjet Combustion Research Facility - Used to conduct fundamental and applied research for subsonic combustion ramjet component research and development in the Mach 2-5 range. It consists of a small-scale, direct-connect thrust stand (component size up to 12-inch diameter, 60-inch length) with vitiated air heater and 02 replenishment system.

Supersonic Research Facility - A continuous flow supersonic combustion tunnel which is specifically designed for optical diagnostics of supersonic fuel and air mixing combustion. The facility is housed in a climatically controlled explosion proof laboratory to allow research with hydrocarbon and hydrogen fuels. The principle program in this facility is the measurement of turbulent mixing of fuel and air stream in supersonic flow regimes.

Fuel Development Research Facilities - State-of-the-art, nationally unique facilities using a wide variety of instrumentation and equipment to develop, analyze, characterize, and process aviation and missile fuels and fuel additives for all current, next generation and future AF air breathing weapon systems. Fuel storage facilities are also available for evaluation of long-term storage effects at controlled conditions.

Turbine Engine Lubricants Research Facilities - Used to perform RDT&E to develop optimum lubricants and provide timely and effective lubricant-related operational support to satisfy current and future Air Force and DoD gas turbine engine needs. Part of the effort in this facility includes running full-scale engine operations to qualify oils for the field and to maintain and upgrade military specifications for use in procuring oils.

EQUIPMENT/FACILITIES

Bearings Research Facilities - Used to study the basic mechanisms involved in lubrication of bearing surface, and to establish a technical data base for design of conventional and alternative lubrication concepts for advanced turbine engines.

Diagnostic Development and Combustion Research Facilities - Used to conduct basic research in combustion sciences, conduct exploratory development of combustor concepts, and to develop combustion models and diagnostic techniques.

Component Research Air Facility - The Air Facility is used to provide simulated flight conditions for R&D programs in the turbine engine advanced propulsion and fuel technology areas. It supports the six component research cells in Bldg 18C and 18E, as well as the Compressor Research Facility.

Propeller Test Facilities - Three electrically driven whirl test stands are used to determine propeller (or other rotating device) performance at various rotational speeds. These test stands are capable of performance and endurance testing of propellers to 10,000 horsepower and 10,800 rpm.

Helicopter Rotor Facility - This electrically driven whirl test stand is used to determine rotor performance at various rotational speeds. This facility is capable of performance and endurance testing of up to 90-ft diameter rotors to 6,000 horsepower and 625 rpm. Horsepower and lift can be determined for various speeds. (This facility has been mothballed.)

High Power Laboratory - This laboratory supports the development of materials, components and systems for application in the presence of very high electric fields or currents in electrical systems for various Air Force and DoD missions.

Battery Laboratories - This facility is equipped to conduct research and development in the area of electrochemical power generation, evaluate advanced battery and fuel cell designs, and conduct experiments and analyses to support electrochemical power sources.

Power Devices, Components & Power Systems Facilities - Used to evaluate the electrical performance characteristics of experimental power semiconductor devices, evaluate experimental optically controlled power devices, and to conduct supporting power semiconductor materials research for air and space vehicles and directed energy weapon systems.

Heat Transfer R&D Facilities - Utilized to conduct basic and applied heat transfer research applicable to power system thermal management in existing and advanced aircraft, as well as some spacecraft applications. Overall, the laboratory supports research in heat pipe performance and life cycle, thermal energy storage, and advanced experiments related to pulse power.

Superconductivity Laboratory - This laboratory provides a complete facility for the development, production, and measurement of high temperature superconductors for high power applications.

Plasma Physics Research Facilities - The Plasma Physics Laboratory pursues basic experimental and theoretical research on plasmas having applications to laser, high power switches, plasma diagnostics, power generation, combustion diagnostics, high energy density fuel storage, and plasma processing of thin films.

Propulsion Directorate
Wright-Patterson AFB, OH 45433-7251
(937)255-2520

Director: Richard E. Quigley, Jr.
Deputy Director: Col. Alan Janiszwski

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.242	N/A	N/A	0.242
6.1 Other	1.268	0.756	7.464	9.488
6.2	28.000	22.297	63.996	114.293
6.3	9.323	5.501	63.333	78.157
Subtotal (S&T)	**38.833**	**28.554**	**134.793**	**202.180**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	17.690	17.690
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	16.775	2.655	34.208	53.638
TOTAL RDT&E	**55.608**	**31.209**	**186.691**	**273.508**
Procurement	0.000	N/A	0.575	0.575
Operations & Maintenance	0.000	N/A	0.167	0.167
Other	0.000	N/A	0.000	0.000
TOTAL FUNDING	**55.608**	**31.209**	**187.433**	**274.250**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	**END STRENGTH**
TYPE	**DOCTORATES**	**OTHER**		
MILITARY	10	30	40	**80**
CIVILIAN	81	230	175	**486**
TOTAL	**91**	**260**	**215**	**566**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	1413.000	**REAL PROPERTY**	151.000
ADMIN	16.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	130.000	**EQUIPMENT**	2.500
TOTAL	**1559.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.200
ACRES	**41642**	* Subset of previous category.	

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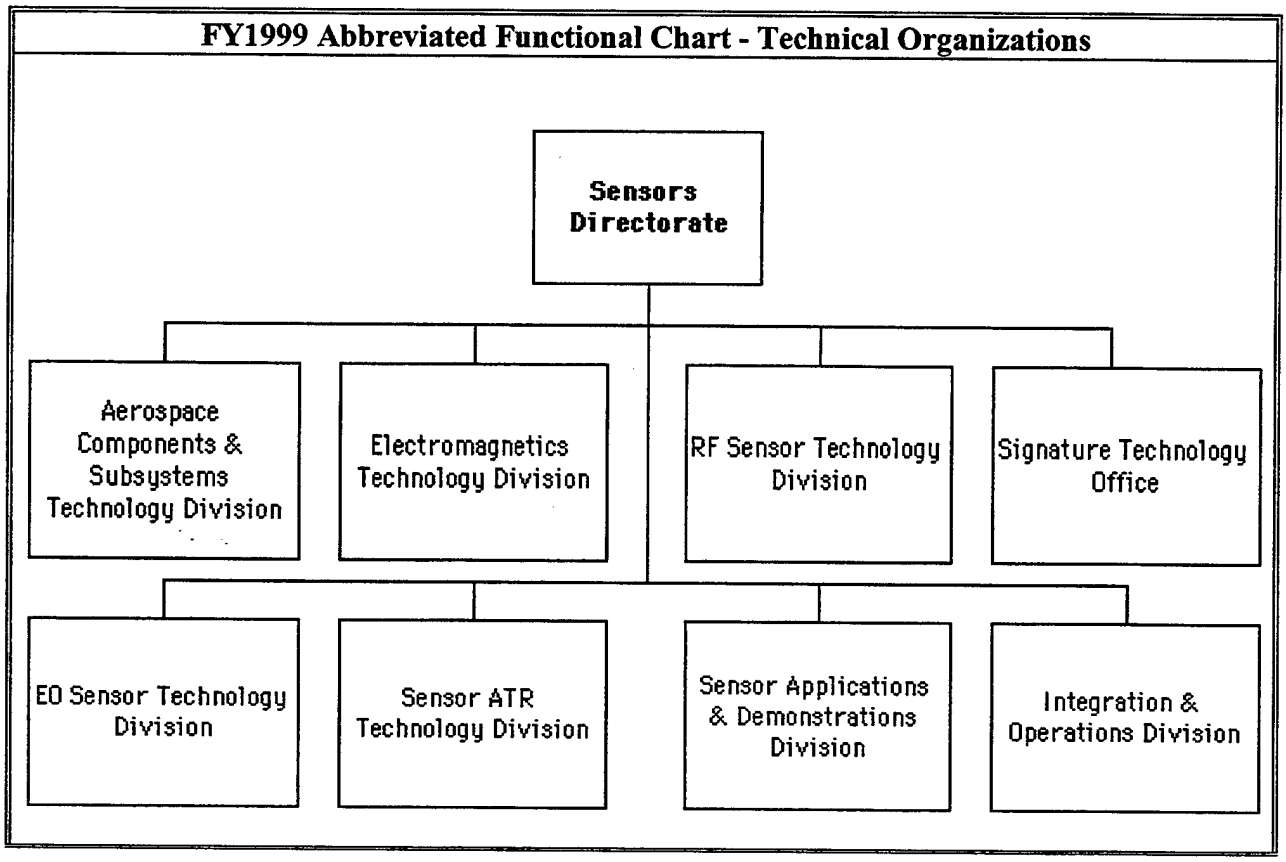
Sensors Directorate



Sensors Directorate
Wright-Patterson AFB, OH 45433-7320
(937)255-2620

Acting Director: Dr. Donald Hanson
Deputy Director: Col. Larry Strawser

MISSION

Ensures unequaled reconnaissance, surveillance, precision engagement and electronic warfare capabilities for America's air and space forces by conceiving, demonstrating and transitioning advanced sensors and sensor technologies in partnership with industry, universities and other DoD agencies, and providing knowledgeable support to the acquisition community and warfighters.

CURRENT IMPORTANT PROGRAMS

The following are just some of the current important programs/thrusts on which the Sensors Laboratory is working:

Large Aircraft Infrared Countermeasures (63270F): Threat-adaptable, laser based techniques to defend large signature aircraft from the growing infrared surface-to-air missile threat.

Advanced Tactical Targeting for Supression of Enemy Air Defenses (SEAD) (63270F): Affordable, passive SEAD techniques to allow multiple, non-dedicated platforms to cooperate in quickly deriving the precise location of a ground threat radar, even if it shuts down after emitting only briefly.

Command & Control Warfare (63270F): Advanced techniques to supress and counter adversary command and control networks.

Enhanced Recognition & Sensing Ladar (63203F): Laser radar (ladar) technologies for positive air-to-ground target identification (ID) at longer, safer standoff ranges.

Integrated Real-Time Information into the Cockpit (63203F): On-board mission management technologies to allow strike aircraft to use the latest intelligence information from off-board sources to improve re-routing capability, effectiveness, and survivability.

Space Based Radar (63203F): Radio frequency sensor components and techniques to enable advanced orbital radar systems.

Automatic Target Recognition (63203F): Technologies and techniques to help warfighters quickly pick out potential targets from an increasing flood of information and reliably identify those potential targets as friend or foe, even at long ranges.

Tanks Under Trees (TUT) Initiative (63203F): Eliminate any sanctuary that ground mobile targets may gain using foliage masking, camouflage, communications silence, and/or decoys.

Foliage Penetration Synthetic Aperture Radar (63253F): Develop, fabricate and test a radar system for installation on a Global Hawk (Tier II+) Unmanned Aerial Vehicle (UAV) which can provide near real-time, automatic target detection and cueing of time critical targets hidden under foliage and/or camouflage.

Spectral Infrared Remote Imaging Transition Testbed (SPIRITT) (63203F): The objective of this ATD is to develop a day/night, high altitude, hyperspectral reconnaissance sensor testbed, demonstrate the technology for transition to the U-2 and Global Hawk UAV.

EQUIPMENT/FACILITIES

WRIGHT-PATTERSON A.F.B. OHIO

Name of Facility: ELECTRONIC WARFARE ANECHOIC CHAMBER (EWAC)
Facility Type: Electronic Warfare.
Purpose: Develop and evaluate RF Electronic countermeasures techniques, devices and subsystems.
Primary Capabilities: 39Lx26Wx26H, electromagnetically shielded room lined with radio frequency (RF) energy absorbing material. Used for RF measurements, such as antenna polarization patterns, from 250MHz to 100MHz. Ability to test/evaluate most types of ECM hardware/techniques against hardware-in-the-loop simulations of seeker/target interactions.
Special/Unique Capabilities: Instrumentation systems for measuring and printing 3D plots of angle error voltage developed by a monopulse tracking radar in response to polarization jamming.
Instrumentation: Wide range of microwave instrumentation.

Name of Facility: RF RECEIVER/PROCESSOR LABORATORY
Facility Type: RF Receiver and Processor
Purpose: Evaluation and development of new RF receiver, processor, and software concepts.
Primary Capabilities: Evaluation, test, evaluate, and develop new RF receiver systems in frequency range 2 to 18GHz. Research, evaluate, develop new threat sorting and identification software techniques.
Special/Unique Capabilities: Classified facility and screen room, capability of both laboratory and field research, and capability to collect and analyze special signals of interest.
Instrumentation: Prototype receivers-superhet, instantaneous frequency measurement, microscan, channelized, optical various RF transmission and modulation technique available. Sorting and identification software prototype available.

Name of Facility: OPTO-ELECTRONIC RESEARCH FACILITY
Facility Type: Coherent and Non-Coherent Optical Device Research
Purpose: Exploratory development of lasers, optical processing and control devices, opto-electronic integrated circuits, detectors and detector arrays.
Primary Capabilities: Characterization and evaluation of laser and non-linear materials. Optical device evaluation, including surface metrology, optical waveguide elements, optical logic and active optical processing evaluation. Infrared and ultraviolet optical detector characterization, evaluation and optimization, including optical Fourier transform measurement facility.
Special/Unique Capabilities: Optical excitation spectroscopy, time-resolved, for laser materials from 4 degreesKelvin through elevated temperatures. Absorption, fluorescence and transmission spectroscopy from UV through long wave infrared. interferometric and scatterometric surface analysis together with topographical surface microscopy for both insulating and onducting/semiconducting samples.
Instrumentation: Multiple spectrometers and spectrophotometers; laser sources from visible through long wave infrared (10.6 micrometers). Bi-directional, reflectance distribution function measurement instrumentation for 4 inch surfaces at 3 visible wavelengths; Zygo surface interferometer.

Name of Facility: OPTICAL RESEARCH LABORATORY
Facility Type: Optical and Digital Seeker Processing
Purpose: Design, develop, and evaluate optical and digital processing technology; develop a standard math morphology for image processing; develop seeker algorithms.
Primary Capabilities: Main Lab:(1232sq ft) Vibration isolated benches and computer workstations, Laser Polarimeter. Make measurements of the Kerr and Farady constants of infrared materials.
Special/Unique Capabilities: Only known achromatic infrared laser Polarimeter; computer driven spatial light modular for evaluation binary-phase-only-spatial filters. Optical/digital integration for image processing capability.
Instrumentation: Photometers, laser beam cross section analyzer, high speed oscilloscopes, Co2, Co and solid state lasers, long and mid wavelength IR detectors. Spatial light modulators integrated wit high speed Sun workstation.

EQUIPMENT/FACILITIES

Name of Facility: MICROWAVE/MILLIMETER WAVE LABORATORY
Facility Type: Microwave/Millimeter Wave
Purpose: Design, simulate, fabricate and/or test microwave and millimeter wave electronic components and integrated circuits.
Primary Capabilities: Design, model and simulate solid state devices, integrated circuits and multi-chip assemblies operating in the 0.1 to 100GHz frequency range. MMIC and multi-chip assembly performance and fabrication parameter correlation and data analysis. Design, fabrication and testing of GaAs MIMMICs; testing of a wide range of microwave/millimeter wave components.
Special/Unique Capabilities: Radio Frequency (RF) on-wafer testing of MIMMICs using a Cascade automatic prober and a Hewlett-Packard (HP) vector network analyzer. Load pull testing of high power devices using semi-automatic system employing automatic tuners operating in the 0.1 to 26GHz frequency range. Overstress testing of microwave devices and MIMMICs.
Instrumentation: PMI scalar network analyzer (1-40GHz); HP8510 vector network analyzers (0.1 to 65GHz), On-wafer RF prober, Wiltron/HP load-pull measurement system; Ees of and Compact microwave computer-aided design software and workstations; and general purpose microwave/millimeter wave test equipment.

Name of Facility: MICROELECTRONICS COMPUTER AIDED DESIGN (CAD) & TEST FACILITY
Facility Type: Microelectronic
Purpose: Design and test microelectronic devices and integrated circuits. Maintain a state-of-the-art CAD facility.
Primary Capabilities: Very Large Scale Integrated Circuit (VHSIC) and analog circuit design.
Development of FaAs-based heterojunction field effect transistors, heterojunction bipolar transistors and resonant tunneling devices. High speed testing of devices, circuits, and analog-to-digital (A/D) converters.
Special/Unique Capabilities: Silicon compilation of integrated circuits. Automated wafer parametric testing; automate A/D converter testing. Research and development prototype design tools.
Instrumentation: Electroglass automatic prober, Tektronics login analyzer, Hewlett Packard: parameter analyzer, impedance analyzer, switching matrix, sweep oscillator, data generator, rate generator, oscilloscope, synthesized sign generator, LeCroy pulse generator, Fluke synthesized radio frequency signal generator, Stanford Research System amplifies, and general purpose test equipment.

Name of Facility: LASER RADAR RESEARCH LAB (LADAR)
Facility Type: Laser radar systems
Purpose: Research, test and develop high performance solid state laser radar and component technology.
Primary Capabilities: Development of new system integration technologies of laser radar systems. Can perform heterodyne detection and fiber optic mixing.
Special/Unique Capabilities: Uses non-mechanical beam agility device. Combines beam agility devices in the receiver portion of the laser radar system.
Instrumentation: Solid State 1.06um ND:YAG laser, consto-optic modulator, In GaAs detector, Faraday isolator, fiber couplers, digital oscilloscope. Two beam agility devices using liquid crystal phase grating concept using acoustic-optic defector modules.

Name of Facility: LASER COMMUNICATION LABORATORY
Facility Type: Laser Communications
Purpose: Research, development and research of ground, airborne, and space based laser communications systems.
Primary Capabilities: Atmospheric Turbulence, laser Characteristics, spectral Characterization of Transparent Materials and Systems Reliability research.
Special/Unique Capabilities: Real-time measurement of atmospheric conditions to include temperature, pressure, humidity, and diffraction-limited aperture of the atmosphere. Eight inch telescope interfaced with optical detection equipment and Micro VAX for use a generic optical antenna/receiver in lasercom link analysis system. Optical wavefront/coherence analysis system interfaced with Micro VAX for laser beam wavefront characterization.
Instrumentation: EGG-55 Spectral radiometer capable of wavelength measurements (UV through IR), Phtodyne Radiometer, Optical wavefront/coherence analysis system. Eight inch telescope, Micro VAX workstation interfaced wit IEEE-488 Data Bus for use as data acquisition equipment. Software for

EQUIPMENT/FACILITIES

design/analysis of optical systems; Evaluation laser hazards, evaluations/simulation of atmospheric equipment modeling.

Name of Facility: INTEGRATED DEFENSIVE AVIONICS LABORATORY (IDAL)
Facility Type: Hybrid/real-time digital simulation Laboratory
Purpose: To conduct integrated EW system/concept evaluate in support of Air Force Exploratory and Advanced Development programs.
Primary Capabilities: Real-time interactive, multispectral EW simulation to drive hardware system to digital emulation's.
Special/Unique Capabilities: Real-time interactive implementation of SUPPRESSOR command and control model, digital IR/EO scene generator, real-time digital RWR emulation. Interaction with DEES/CEE SIM RF environment generators, interaction with Integrated Test Bed Cockpit/Avionics simulator. Interaction with Electronic Defense Evaluator threat radar simulator.
Instrumentation: VAX 11/750, VAXstation 3, Sun 4, CCC3240, CCC3260 MPS.

Name of Facility: INTEGRATED AVIONICS LAB (IAL)
Facility Type: Avionics Research
Purpose: Conduct classified/unclassified, real-time/non-real-time, multispectral, multidisciplinary experiments, studies, research, simulations and analyses in the areas of integrated avionics, core processing architecture, information processing, communications, navigation, identification, software, life cycle support and machine intelligence.
Primary Capabilities: Real-time simulation of aircraft performing an operational mission allows evaluation of capabilities across entire spectrum of performance requirements. Provides a direct (non-extrapolated) view of real world problems and considerations. Validation of contract research products in a Systems context.
Special/Unique Capabilities: Real-time simulation/stimulation of avionics interface signals. Generalized Avionics and Simulation/Integration Systems (GENASIS) software configurable simulated aircraft workstations. Real-time interface to defensive and communication avionics test facilities.
Instrumentation: Avionics flight processors with Ada operational flight programs and the avionics multiplex and fiber data buses. Models set include multiple aircraft, sensors, weapons and external environment modules; VAX 11/785/non-real-time development environment. GENASIS modular cockpit with six-nine inch diagonal color displays couple with F-15 type stick and throttle, moving map display, fiber optics communications.

Name of Facility: ELECTRONIC COMBAT RESEARCH SIMULATION LAB (ESCRL)
Facility Type: Electronic Combat Simulation
Purpose: Develop requirements for electronic combat equipment; evaluate electronic combat equipment.
Primary Capabilities: Three levels of digital simulation; one-on-one, one of many, and, campaign level (many-on-many).
Special/Unique Capabilities: Classified TEMPEST Facility.
Instrumentation: Electronic and data processing hardware.

Name of Facility: ELECTRO-OPTICAL RECEIVER LABORATORY
Facility Type: E-O Devices
Purpose: Research and evaluate IR and laser warning receivers.
Primary Capabilities: Calibrate, test, and evaluate infrared laser sensors and warning receivers in Bands I, II and III.
Special/Unique Capabilities: Classified facility with additional capabilities for foreign equipment exploitation. Capability for both laboratory and field research. field research utilize outdoor WL turntable facility located on WPAFB, OH, Area C, flight line for rotation for full scale aircraft.
Instrumentation: Large array of optical, electrical, and data processing hardware in a facility comprising greater than 5,000 sq ft. Equipment account exceeds a value of $2m. Large optical collimator.

EQUIPMENT/FACILITIES

Name of Facility: DYNAMIC INFRARED MISSILE EVALUATOR (DIME)
Facility Type: Infrared Target Simulator and Multispectral Signature Generation.
Purpose: Research and develop infrared countermeasures (IRCM) techniques and assessment of multispectral signature control techniques for EOCM.
Primary Capabilities: Provides semi-physical simulation of the homing interception of a target by and IR guided missile. Optiscan instrumentiation for evaluating IRCM effects upon infrared missiles. Interactive image processing system that allows aircraft signature modifications to be designed, modified, and evaluated by use of and image array processor.
Special/Unique Capabilities: Use actual IR missile optics and guidance electronics along with computer simulated, aerodynamic characteristics and servo controlled sources. Can manipulate imagery representing both the aircraft signature and camouflage treatment of interest. Multi-spectral tool to be used for signature analysis into the year 2000 and beyond.
Instrumentation: Operational IR missile guidance and control units. Digital aerodynamic computational capability. Servo-controlled IR sources/optics. SPIRITS; generic sensor model.

Name of Facility: 100 INCH COLLIMATOR FACILITY
Facility Type: Electo-Optical Sensors
Purpose: Research, test and analysis of tactical and strategic electro-optical and laser radar systems under simulated environmental conditions.
Primary Capabilities: Profiling atmosphere to in excess of 100km. Sub-centimeter space debris experiment.
Special/Unique Capabilities: 100inch diameter optical collimating mirror housed in vacuum chamber which can be evacuated to simulate a 270,000 ft altitude.
Instrumentation: Seismometers, 32 channel data logger, 8 channel digital recorder. PC based computer system.

Name of Facility: DEVICE RESEARCH LABORATORY
Facility Type: Device and Semiconductor Research.
Purpose: Research on compound semiconductors and semiconductor structures, advanced microwave, high speed digital and novel electro-optic devices.
Primary Capabilities: Theoretical and experimental research on III-V semiconductor structures and devices; development of advanced electronic and electro-optical devices. Extensive theoretical and experimental growth and characterization of electronic and optical properties of III-V materials and devices.
Special/Unique Capabilities: Molecular beam epitaxy of components of gallium; indium, aluminum, arsenic, and antimony; ion implantation; metal and dielectric deposition. Reactive ion etching; nanometer lithograph; modeling of device physics. Conventional and rapid thermal annealing; scanning electron microcopy and electrical testing.
Instrumentation: JEOL 5 DIIU-A e-beam; Varian 360 and GEN II MBE; full complement of conventional semiconductor process equipment. Time resolved high resolution photoluminescence; photoreflectance; hall measurement apparatus; Fourier transform infrared spectroscopy.

HANSCOM A.F.B. MASS

FACILITY: Hyperspectral Imaging (HSI) Infrared imaging processing facility. Facility type: A real time high speed imaging processing network.
PURPOSE: To process consecutive frames of infrared data at 12 bits dynamic range up to 400 frames per second.
DESCRIPTION: A high speed 100 megabit network connecting 30 computers to process field collected data.
UNIQUE FEATURES: Id of difficult targets using hyperspectral techniques.
INSTRUMENTATION: High speed midwave infrared cameras capable of processing up to 64 monochomatic images in near real time.

EQUIPMENT/FACILITIES

FACILITY: Bulk III-V Growth Facility
PURPOSE: To perform research and development on the crystal growth and preparation of III-V compounds with emphasis on producing bulk indium phosphide crystal substrates of high quality necessary for the next generation of photonic and electronic devices.
DESCRIPTION: The facility consists of a high pressure growth furnace of unique design and associated equipment for determining the quality of bulk material and substrate wafers. The furnace itself is inside a sixteen foot standing hood; disassembly is facilitated by a one ton crane on a monorail. In InP growth, the furnace maintains temperatures up to 1070 degrees Celsius at pressures exceeding 600 psi. An axial magnetic field can be applied during crystal growth. Associated equipment includes crystal cutting and wafer preparation stations. Hall effect measurements systems, and a photoluminescence system.
CAPABILITIES: III-V single crystals can be grown by a variety of high pressure techniques. These techniques include the liquid encapsulation Czochralski method of pulling from the melt, and the liquid encapsulation Kyropoulous technique of topseeded growth into a crucible, pioneered in this facility of InP growth. A strong magnetic field may be applied during growth to suppress turbulent convection in the melt. Indium phosphide may be synthesized in situ prior to growth using a unique phosphorus injection method. The hot zone of the furnace is large enough to accommodate growth of crystals up to eight inches in diameter.
UNIQUE FEATURES: The crystal growth system was designed by Rome Laboratory personnel. It supports the capability for in situ synthesis of indium phosphide prior to growth. Magnetic fields up to four kilogauss may be applied during growth. Crystals of commercial dimensions may be grown to facilitate technology transfer.
INSTRUMENTATION: Fifty kilowatt radio frequency power supply and thirty kilowatt DC resistance heating supply for crystal growth. Computer controlled motors for rotation and positioning of crystals and crucibles. Crystal cutting saws and polishing equipment. Photoluminescence and Hall effect equipment for characterization. Characterization advanced electromagnetic techniques. Preparation and characterization support such as clean rooms and deep level transient spectroscopy are available in other Rome Laboratory facilities.
LOCATION: Hanscom AFB MA, Bldg 1142

FACILITY: Superconductor Thin Film Fabrication/Characterization Facility
PURPOSE: To perform research and development on the fabrication of high temperature superconductor (HTS) films and structures for electromagnetic, devices, including microwave and millimeter wave devices.
DESCRIPTION: This facility supports research and development of the fabrication and patterning of large are HTS films, and of multilayer structures for circuit elements and superconductive tunneling devices.
CAPABILITIES: Film fabrication facilities included RF diode sputtering apparatus that has been modified for HTS deposition and a fully automated CVC SC-4000 three gun magnetron sputtering system. The CVC system, which was originally specified by Rome Lab, incorporates such features as a heated substrate holder and a fast oxygen source that are specially adapter to HTS film fabrication. A system for laser evaporative deposition is under construction. Equipment for sol-gel preparation of HTS films, e.g., high quality glove boxes and photo resist spinners, is available. The facility also includes an array of supporting fabrication and characterization equipment such as a SQUID magnetometer, furnaces, equipment for fabricating sputter targets, equipment for photolithography and patterning, a differential scanning calorimeter, and a differential thermal analyzer.
UNIQUE FEATURES: The tow sputtering systems have been modified to meet the unique and fast-changing demands of HTS research and development. The laser evaporative deposition system has been designed in-house by Rome lab, and it will include, in addition to the deposition chamber, a chamber for Auger analysis of the deposited films.
INSTRUMENTATION: The sputtering and laser deposition units described above; a mask aligned and other equipment for patterning films; automated systems for measuring resistance and critical current as a function of temperature; a SQUID magnetometer for measuring dc magnetic susceptibility and apparatus for measuring the ac magnetic susceptibility. Scanning electron microscopy (including elemental analysis via EDS and WDS) and a variety of x-ray diffraction analysis techniques are provided through the Microcharacterization Facility. The Microwave characterization is provided by the Monolithic Microwave Integrated Circuit Facility.
LOCATION: Hanscom AFB MA Bldg 1141

EQUIPMENT/FACILITIES

FACILITY: PHOTONIC CRYSTAL/PHOTONIC GLASS FACILITY
PURPOSE: To perform research and development on linear and nonlinear optical (including photorefractive crystalline and glass materials for future Air Force applications that employ free-space signal, image processing and optical computing.
DESCRIPTION: The facility includes a variety of crystal growth and material processing systems. The Research Hydrothermal Growth System consists of 11 high temperature, high pressure autoclaves capable of growth from solution at temperatures up to 550 C and pressures up to 20,000psi. This system is completely computer controlled. Melt growth capabilities include a twenty atmosphere system and a variety of systems for growth in controlled atmospheres. A top seeded solution growth system designed in-house operates at temperatures above 1400 C. Glass forming and annealing furnaces are available for processing in air or controlled atmospheres. Optical characterization is also available in this facility.
CAPABILITIES: Crystals of photorefractive and other non linear optical materials may be grown by several techniques, to assist in determining basic physical mechanisms and to optimize properties. When possible the same crystals are grown by several methods. Complete glass synthesis capacity, including both glass melting and sol-gel preparation techniques, permits investigation of novel nonlinear optical glass compositions.
UNIQUE FEATURES: The Research Hydrothermal Growth System is completely computer controlled and supports the simultaneous operation of ten crystal growth autoclaves for growth runs in excess of 90 days. Multiple safety alarms and interlocks protect personnel. This the most extensive and comprehensive research Hydrothermal facility in the United States.
INSTRUMENTATION: Research Hydrothermal Growth System with local controls and computer. MP furnace capable of growth at 20atm. Controlled atmosphere growth system. High temperature to seeded solution growth (TSSG) furnaces. Spectrometers and apparatus for photoconductivity, optical absorption, and photoluminescence measurements. Fourier Transform Infrared Spectrometer, Additional x-ray characterization and analysis is available in the Microcharacterization Facility. Other sample evaluation techniques, e.g., differential scanning calorimetry and differential thermal analysis, are also available in Rome Laboratory facilities.
LOCATION: Hanscom AFB MA Bldgs 1142/1141

FACILITY: ELECTROMAGNETIC TECHNOLOGY RESEARCH FACILITY
PURPOSE: To investigate methods for design, construction, and testing of millimeterwave integrated circuit (MMIC) components; to research superconducting materials and their application to practical components; to conduct measurements of the radar cross-section of selected model targets; and to measure the properties of phased array antennas.
DESCRIPTION: 15,000 sq ft facility with a clean room; laboratories for MMIC magnetic and photonic research; ant tow anechoic chambers.
CAPABILITIES: See Purpose/Description
UNIQUE FEATURES: The facility is planned to have a near-field measurement range to characterize large phased array antennas in a controlled environment.
INSTRUMENTATION: No information available at this time.
LOCATION: Hanscom AFB MA, Bldg 1123

FACILITY: MONOLITHIC MICROWAVE AND MILLIMETERWAVE INTEGRATED CIRCUIT FACILITY
PURPOSE: To design, fabricate, and test monolithic microwave and millimeterwave integrated circuit
DESCRIPTION: A highly sophisticated mask layout program, a class 100 clean room, an ohmic contact annealing furnace, a vacuum station for electron beam metalization, a photo resist spinner, and ultraviolet exposure system, and several wire bonders all work together to give MMIC fabrication capability. Additionally, network analyzers are available to test MMIC components and upload experimental data in a format directly compatible with design software.
CAPABILITIES: In addition to the design and test of MMIC components, the facility permits the integration of superconducting electronics and photonic circuits with MMIC components to offer better performance and the opportunity for less expensive electronics through wafer scale integration.
UNIQUE FEATURES: All critical design and test functions are consolidated on a single computer to allow rapid turnaround of experimental components.
INSTRUMENTATION: See Description
LOCATION: Hanscom AFB MA, Bldg 11105B, 1123

EQUIPMENT/FACILITIES

FACILITY: MICROCHARACTERIZATION FACILITY
PURPOSE: To perform chemical, crystallographic, and microstructural characterization of electromagnetic and photonic materials in response to requirements of photonic/electromagnetic materials and device development programs.
DESCRIPTION: This facility consists of equipment that utilizes x-ray and electron beam technologies to measure, analyze, and characterize microstructural properties of materials. X-ray diffraction techniques are used to perform phase identification, measure lattice parameters, orient single crystals, evaluate crystal perfection, and determine lattice match of epitaxial layers. Electron microscopy techniques re used to evaluate surface microstructure; to perform qualitative and quantitative chemical analyses of major and impurity constituents of materials; and to measure crystallographic properties of selected portions of samples.
CAPABILITIES: Microstructural features can be imaged from 10X 300,000X with a resolution of 4nm (secondary image) and 10nm (backscattered image) on the scanning electron microscope (SEM). On the scanning transmission electron microscope (STEM), magnification ranges from 30X ñ 800,000X, with a resolution of 0.2 nm. Chemical analyses of elements having atomic numbers of 5 or greater can be performed routinely. X-ray techniques can measure lattice parameters with a precision of 0.00001 nm, and lattice match differences of epitaxial layers to 10ppm.
UNIQUE FEATURES: The SEM is equipped with a cold stage for examination of high temperature superconducting materials at temperatures as low as 80 degrees Kelvin.
INSTRUMENTATION: Scanning electron microscope equipped with both energy and wavelength dispersive spectrometers; scanning transmission electron microscope equipped with energy dispersive x-ray spectrometer and high resolution electron diffraction capability; automated x-ray power diffraction system; automated double crystal x-ray diffractometer; Lang topographic camera; Lauc and Debye-Scherrer cameras; x-ray generators; optical microscopes; micohardness tester, (Knoop and Vickers); and support equipment such as ion mill and evaporative coater.

Sensors Directorate
Wright-Patterson AFB, OH 45433-7320
(937)255-2620

Acting Director: Dr. Donald Hanson
Deputy Director: Col. Larry Strawser

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.748	N/A	N/A	0.748
6.1 Other	0.000	4.744	5.239	9.983
6.2	6.576	22.933	112.211	141.720
6.3	6.098	19.146	111.581	136.825
Subtotal (S&T)	**13.422**	**46.823**	**229.031**	**289.276**
6.4	0.000	0.000	0.000	0.000
6.5	0.426	1.487	7.276	9.189
6.6	0.195	0.681	3.330	4.206
6.7	0.896	3.126	15.296	19.318
Non-DOD	0.203	0.708	3.464	4.375
TOTAL RDT&E	**15.142**	**52.825**	**258.397**	**326.364**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.000	N/A	0.000	0.000
TOTAL FUNDING	**15.142**	**52.825**	**258.397**	**326.364**

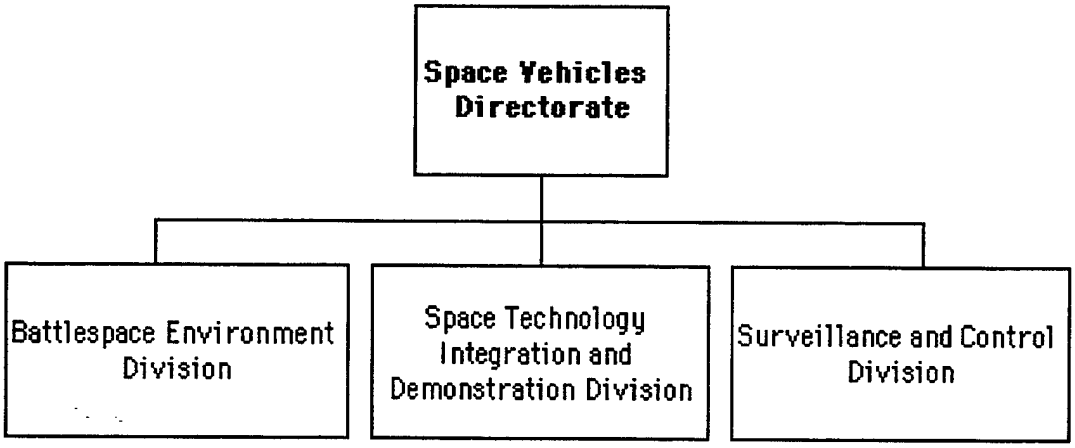
MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	17	41	11	**69**
CIVILIAN	74	356	137	**567**
TOTAL	**91**	**397**	**148**	**636**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	292.790	**REAL PROPERTY**	182.164
ADMIN	127.276	* NEW CAPITAL EQUIPMENT	0.150
OTHER	64.650	**EQUIPMENT**	43.500
TOTAL	**484.716**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**100**	* Subset of previous category.	

Space Vehicles Directorate

FY1999 Abbreviated Functional Chart - Technical Organizations



Space Vehicles Directorate
Kirtland AFB, NM 87117-5776
(505)846-6243

Director: Christine M. Anderson
Deputy Director: Col. Richard A. Kniseley

MISSION

Innovate, develop, integrate and transition science and technology for, effective and affordable space vehicles, launch vehicles, and space concepts supporting America's Aerospace Force.

CURRENT IMPORTANT PROGRAMS

Ionosphere

Communication/Navigation Outage Forecasting System (C/NOFS): C/NOFS is a candidate Advanced Concept Technology Demonstration (ACTD) project, sponsored by AF Space Command (AFSPC), and a DoD Space Test Program (STP) initiative. It is the ionospheric scintillation forecast tool of the future. The system will alert US warfighters to impending UHF and L-band satellite communication (SATCOM) outages, GPS navigation degradations, and Space-Based Radar (SBR) tracking errors caused by equatorial ionospheric scintillation. C/NOFS consists of three segments: a space-based sensor suite, ground-based receivers, and forecasting software with tailored product displays for the warfighter. The goal of C/NOFS is to forecast scintillation 4 to 6 hours before its onset. Technology is also being developed to extend the forecast out to 24 hours.

Global Ionosphere and Neutral Atmosphere Specification and Forecast: Global models of the ionosphere and the neutral upper atmosphere are being developed to specify and forecast space environmental effects on combat systems. The models are physics-based and designed to assimilate environmental measurements in near real time to provide the best possible specifications and forecasts. The models exploit the coupled physics of the Earth's ionosphere and upper atmosphere. Applications for the models include selection of optimum C3I-system operating frequencies and modulation schemes, reduced space surveillance tracking and range errors, increased GPS navigation accuracy, reduced geolocation errors, improved forecasts of scintillation, and improved predictions of satellite drag effects including collision avoidance requirements and reentry locations and forecasts.

High-Frequency Active Auroral Research Program (HAARP): A key objective of this Congressional add program is the identification and characterization of the physical processes that can be initiated in the atmosphere, ionosphere and space via interactions with high power radio waves. Research objectives are to investigate plasma instabilities and turbulence; electron acceleration, including the production of optical and infrared (IR) emissions; the generation, maintenance, and/or suppression of ionization structures aligned along the earth's magnetic field; the modulation of currents in the ionosphere, thereby producing virtual antennas in space to generate ULF/ELF/VLF radio waves; and the production of stimulated electromagnetic emissions (SEE). The efficiencies that can be obtained in the initiation, maintenance, and control of such processes and techniques to excite selected (individual) processes, or to suppress unwanted ones, are also research areas of increasing interest. Other program objectives include experimental research to assess the potential for exploiting this emerging ionospheric technology.

Operational Space Environment Network Display (OpSEND): This product provides the theater warfighter with real-time maps of space weather impacts on UHF satellite communications and HF systems. It monitors disturbances in the ionosphere that routinely degrade the performance of space-based communications, navigation, and RF surveillance systems. It also provides real-time estimates of the accuracy of single-frequency GPS systems, and estimates of the performance of HF propagation systems.

CURRENT IMPORTANT PROGRAMS

Scintillation Network Decision Aid (SCINDA): SCINDA is a system of ground-based sensors and software designed to detect and predict the occurrence of ionospheric scintillation and to specify and predict its effects on C3I systems. Ionospheric disturbances cause rapid phase and amplitude fluctuations of satellite signals observed at or near the earth's surface. SCINDA is used to specify and predict the degradation of satellite communication and navigation signals due to ionospheric scintillation in the equatorial region.

Vehicle-Generated Charged Particle Effects: Program develops technologies to predict and mitigate reentry blackout effects on GPS navigation, communications, and sensors, and to predict and mitigate signatures associated with reentry and hypersonic flight. Reentry blackout and signature effects are predicted for advanced systems under development such as Common Aero Vehicle (CAV), Military Spaceplane (MSP), Conventional ICBM, Ballistic Missile Replacement, and other advanced systems. Recent developments include design optimization for minimizing reentry blackout of GPS navigation for a missile technology demonstration flight test. The basic research component of the program investigates the underlying chemistry and physics that lead to effects on systems and investigates potential breakthrough technologies for hypersonics.

Space Environment

AF-GEOSpace: AF-GEOSpace is a software package designed to provide a user-friendly graphical interface to a variety of near-Earth space environment models and applications with an emphasis on three-dimensional visualization. AF-GEOSpace includes models of the radiation belts based on measurements by the Combined Release and Radiation Effects Satellite (CRRES), which was flown from 25 July 1990 to 12 October 1991 during solar maximum. AF-GEOSpace also includes the Parameterized Ionospheric Model and models of ionospheric scintillation, ionospheric three-dimensional ray-tracing, energetic particles and conductivities in the auroral regions, and magnetic fields. These empirical, statistical, and physics-based models provide environmental information required for spacecraft design, mission planning, satellite operations, and C3I system design and operations. AF-GEOSpace is also an effective tool for magnetospheric and ionospheric research and education.

Charge Control System (CCS): CCS is an autonomous monitoring and control device designed to prevent damaging levels of charge buildup on geosynchronous spacecraft. CCS was launched 31 July 1995 on Defense Satellite Communication System (DSCS) satellite B-7. It provides the first autonomous system that detects dangerously high voltage levels of spacecraft charging and initiates a plasma source to bathe the spacecraft in a protective environment until the hazard disappears.

Compact Environmental Anomalies Sensor Experiment (CEASE): CEASE system is designed to measure and predict on-orbit spacecraft anomalies resulting from interaction with the earth's radiation environments. CEASE consists of a series of charged particle radiation detectors located within shields representative of spacecraft electronics boxes and components that is flown in the earth's radiation belts that monitors intensity variations with time. It provides real-time space hazard warnings (anomaly avoidance), detailed space environment data (anomaly analysis). Total radiation dose, radiation dose rate, deep dielectric charging, surface dielectric charging, single event upsets. Upcoming CEASE flights on TSX-5, STRV-1c and DSP are planned. CEASE is an integral component of the Spacecraft Survivability and Protection Program and is planned to be included as part of the Satellite Threat Warning System on future US Military Spacecraft.

Digital Ion Drift Meter (DIDM): DIDM is a highly advanced ion drift, ion temperature, and ion density sensor utilizing miniaturized state-of-the-art detector components and on-board digital signal processing. The follow-on US meteorological satellite program (NPOESS), which will replace DMSP early in the next century, requires higher resolution, sensitivity, accuracy, and dynamic range for its plasma measurement devices. The goal is for a next generation DIDM instrument to be the standard drift meter aboard the NPOESS spacecraft. CHAMP Satellite Status: The first DIDM unit was launched on the Space Test Program's STEP-4 spacecraft in October 1997. A second, more advanced prototype is being developed for launch aboard the German CHAMP experimental satellite in mid 1999.

CURRENT IMPORTANT PROGRAMS

Magnetospheric Plasmas and Field Effects: The objective of the program is to conduct computer modeling and analysis of data collected from ground-based and space-based instruments that can detect important characteristics of the Earth's magnetosphere. Research applications include specifications and predictions of magnetospheric particle populations that address such problems as spacecraft charging, radiation dosage, and single event upsets.

Magnetosphere/Ionosphere Coupling: The objective of the program is to conduct computer modeling and analysis of data collected from ground-based and space-based instruments to study coupling processes between the Earth's magnetosphere and ionosphere, with special emphasis on ionospheric impacts. Research applications predict magnetic field variability, the onset of equatorial irregularities, magnetic storms, and substorm electrodynamics.

Relativistic Electron and Energetic Proton Experiment (REEPER): REEPER provides improved space radiation models and forecasting capabilities, better support to space environmental coverage and modeling requirements. Program includes research to differentiate high-energy inner-zone protons and electrons, measure outer zone electrons over wide dynamic range, and create database with adequate energy and angular resolution.

Solar/Interplanetary Monitoring, Modeling, and Disturbance Forecasting: The objective of this program is to observe, model, and predict the solar disturbances that impact the aerospace environment and AF systems that operate therein. These disturbances include (1) solar flare electromagnetic emissions that can cause natural jamming of radio receivers and blackouts of high-frequency communications; (2) solar energetic particles that pose a radiation threat to spacecraft as well as to personnel in space; and (3) solar plasma clouds that cause geomagnetic storms and heat the neutral atmosphere, resulting in increased atmospheric drag on satellites and shortened mission lifetimes.

Turbulence in Space Plasmas: Mathematical and computational methods for studying turbulence in space plasmas are being developed. Plasma turbulence occurs at both low latitudes and high latitude and can affect the operation of systems such as GPS (Global Positioning System), AFSATCOM and DSCS satellites.

Optical and Infrared Technology

Atmospheric Radiance and Transmission Models: Models of atmospheric transmission and radiance and related databases are in continuous development to expand their spectral domains and to include new or improved representations of atmospheric constituents. The High-resolution Transmission Molecular Absorption Database (HITRAN) is a compilation of spectroscopic parameters that is used by a variety of computer simulation codes to predict the transmission and emission of light in the atmosphere. The Moderate-resolution Transmittance (MODTRAN) Code calculates atmospheric transmittance and radiance for wavelengths from ultraviolet through infrared at moderate spectral resolution. An extension of MODTRAN for hyperspectral imaging applications is the Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (FLAASH). The Synthetic High-Altitude Radiance Code (SHARC) is the DoD standard for simulating high-altitude (50-300 km) backgrounds at wavelengths from ultraviolet through long-wavelength infrared. An advanced version of SHARC, designated SHARC4, adds atmospheric structure to the radiance description and, in conjunction with the SHARC Image Generator (SIG) code, provides scene generation capability. The Fast Atmospheric Signature Code (FASCODE), a first-principles, line-by-line atmospheric radiance and transmittance code, is the standard benchmark for atmospheric background codes based on band-model approaches to radiation transport. FASCODE is applicable from the visible to long-wavelength infrared and is generally used to calculate atmospheric radiance and path transmission at low altitudes; it can be used for non-equilibrium high-altitude calculations if supplied with the appropriate vibrational-level temperatures. The Moderate Spectral Atmospheric Radiance and Transmittance Code (MOSART) is a unified and seamless code for calculating atmospheric transmission and radiance in the ultraviolet through microwave spectral region at low altitudes for line-of-sight paths within the atmosphere and for paths which intersect the earth's surface. SHARC and MODTRAN Merged (SAMM) is a recently developed code that provides seamless coverage of radiance and transmittance over the entire altitude range from the earth's surface to 300 km.

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Background Clutter Mitigation: Models to specify and predict background clutter are being developed from data acquired by airborne and space based sensors. The data span the short-, medium-, and long-wavelength infrared and include a wide variety of background scenes and global clutter statistics. Models are developed using these data together with laboratory measurements and theory. The data and models support the design of the Space-Based Infrared System (SBIRS) by SMC and the design of theater missile defense and national missile defense systems by BMDO.

Flying Infrared Signatures Technology Aircraft (FISTA): FISTA carries a suite of instrumentation to measure infrared signatures of aircraft, missiles, and backgrounds. The data are used to evaluate specification compliance, support analyses of vulnerability and survivability and the development of IR countermeasures, and develop models for aircraft simulation and threat scenario analysis.

Midcourse Space Experiment (MSX): The MSX program was established by the Ballistic Missile Defense Organization as a functional demonstration of target detection and as a background measurements program. The MSX Earth Limb and Terrestrial Backgrounds Team in the Space Vehicles Directorate generated a series of well-documented reference scenes of infrared backgrounds of unprecedented quality to the SBIRS community to assist in the design of the next-generation infrared (IR) surveillance systems. The MSX measurements include the first infrared observations of several atmospheric phenomena that present newly identified sources of background clutter. These include atmospheric gravity waves, stratospheric warming, and polar mesospheric clouds. The MSX data provide the first definitive measurements of infrared backgrounds at the spatial scales, sensitivity and wavelengths needed to support both current and future requirements for theater and national missile defense.

SBIRS Phenomenology Data Archive Center (PDAC): The SBIRS PDAC is a repository of background scenes and statistical descriptions of short-wavelength and medium-wavelength infrared background clutter. The data are used to support clutter model development and to guide the development of surveillance systems.

See Through Clouds (STC): The STC program seeks ways to mitigate the effect of intervening cloud cover on the interpretation of data from surveillance satellites. A combination of airborne measurements and modeling is used to evaluate sensor design and algorithms that will permit identification of ground-based targets under all weather conditions.

Spectral and In-Band Radiometric Imaging of Targets and Scenes (SPIRITS): SPIRITS is a software package of infrared signature models of aircraft and missiles. Its functional sections include aircraft engine characteristics, mixing of engine exhaust with ambient air, rocket plume radiance, and reflectance and emission from targets and backgrounds. Models for the ALCM, B-1B, B-52, C-17, C-130H, F-15, F-16, KC-10, and KC-135R have been developed from measurements by FISTA.

Atmospheric Technology

Atmospheric Turbulence Measurement and Modeling: A series of field measurement campaigns is being conducted to develop a worldwide data base of atmospheric turbulence affecting optical systems such as the Airborne Laser (ABL) system. A new generation of turbulence sensors was developed and is being used with high-resolution GPS-based radiosondes to measure vertical profiles of turbulence. These measurements are coordinated with airborne measurements of refractive index and velocity turbulence, and the data are analyzed to yield better understanding of the relationships between turbulence regions and large-scale atmospheric dynamics. The results have contributed to the development of the ABL and will yield operational decision aids of value to the ABL and other optical systems.

Cloud Scene Simulation: A capability is being developed for high-fidelity simulation of clouds and related atmospheric phenomena including rain, fog, and wind. Objectives include the development of new parallel-processing algorithms for generating synthetic cloud environments and radiometric cloud scenes and the development of new methods for diagnosing cloud parameters, e.g., type, height, and amount, from available data such as satellite imagery or numerical weather prediction model output.

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Development of an advanced atmospheric scene simulation model will meet rapidly growing demands for realistic system simulation capabilities. The advanced model will include efficient algorithms for scene visualization and will use data structures and procedures consistent with distributed interactive simulation requirements.

Contrail Analysis and Forecasting: A statistical contrail prediction algorithm based on radiosonde data was developed to determine the likelihood that an aircraft flying in a certain environment will produce contrails. This algorithm provides a dramatic improvement in contrail forecasts when compared to the operational contrail prediction algorithm now used by Air Force Weather Agency. Work has begun to incorporate numerical weather prediction output and satellite sounding and imagery data to improve the algorithm.

Master Environmental Library (MEL) Site Development: MEL allows users to search for browse, and retrieve environmental data (e.g., meteorological satellite data) from distributed sources from a regional site. The Defense Modeling and Simulation Office (DMSO) is currently sponsoring the MEL program.

Weather Impact Decision Aids (WIDA): WIDA is a multi-faceted program to develop decision aids for electro-optical weapon sensing systems to support warfighter mission planning and decision-making activities. Night Vision Goggle Operations Weather Software (NOWS) is designed to give mission operations planners information on how nighttime environmental conditions will affect the mission; Version 5.2 was transitioned to users in September 1999. Infrared Target Scene Simulation Software (IRTSS) provides realistic target area scene visualizations for combat aircrews. IRTSS integrates physical models that calculate target/background contrast. In addition, atmospheric transmission, weapon sensor performance, weather data, geographical background data, and target parameters can be modeled. Target Acquisition Weather Software (TAWS) predicts detection and lock-on ranges for electro-optical weapon and target acquisition systems and replaces the Electro-Optical Tactical Decision Aids (EOTDA), which have been in operational use by combat air forces since the early 1980's. TAWS Version 1 was transitioned to operational users in December 1999. Weather Automated Mission Planning Software (WAMPS) will be incorporated into the Air Force Mission Support System (AFMSS) to enable aircrews to visualize target areas in a particular sensor waveband under forecast weather conditions. This allows the determination of best mission time, tactics, and weapons.

AFRL/VSD Space Technology Integration Demonstration Division Programs:

XSS-10: The XSS-10 program is a USAF satellite that is developing and demonstrating micro-satellite (10-100kg) technologies to support operational deficiencies such as surveillance, communications, navigation, and logistics. It explores technologies necessary for satellite proximity maneuvering, observing, and manipulation, and for the rapid deployment of satellites for emergency surveillance, satellite inspection, and servicing requirements. One micro-satellite will be launched on a Delta II in September 2000, with a spare available for launch in spring 2001.

Military Spaceplane System: The Military Spaceplane System (MSP) is a reusable space architecture capable of providing aircraft-like operability, flexibility, and responsiveness, and supporting AF Space Command mission areas. The MSP System includes the Space Operations Vehicle (SOV), a reusable first stage and booster; the Space Maneuver Vehicle (SMV), a reusable upper stage and satellite bus; the Modular Insertion Stage (MIS), a low cost expendable upper stage; and the Common Aero Vehicle (CAV), a maneuvering reentry vehicle for bringing payloads down through the atmosphere. The MSP System heavily leverages work being done by NASA, and NASA's X-33 is a technology leader for SOV, X-37 leads SMV, and Upper Stage Flight Experiment leads MIS. X-37, in particular uses a very similar outermold line to Boeing's SMV concept, and lessons learned from X-37 will transfer directly to a planned SMV demonstration program. Once fielded, the MSP System will offer revolutionary capabilities in on-demand launch, high sortie rates and rapid turn times.

Near-Space Access Program: The Near-Space Access Program is operated by the High-Altitude Balloon and Tethered Aerostat Group in the Air Force Research Laboratory Space Vehicles Directorate,

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Space Integration and Demonstration Division. High-altitude balloons and aerostats are ideal vehicles for space environment qualification; meteorological measurements; optical, infrared, ultraviolet, and radar surveillance; radio and laser communications; and target simulation.

MightySat I: The MightySat I program is an USAF satellite that is demonstrated new technologies in space. It was the first in a series of low-cost Air Force Research Laboratory small satellites to quickly and inexpensively explore, demonstrate, and transition space technologies from the research phase to operational use. The 140-pound satellite was launched from the Space Shuttle Endeavor in December 1998 and has performed robustly in orbit, with no spacecraft anomalies during its mission. MightySat I's mission ended when it re-entered the atmosphere at 1711 Zulu on 21 November 99. Operators from the Space and Missile Systems Center Test and Evaluation Directorate (SMC/TE) monitored on-orbit performance from their center at Kirtland Air Force Base, New Mexico. The MightySat II program is a follow-on series of spacecraft that will provide AFRL with a "lab bench" for responsively testing emerging technologies to ensure their readiness for operational Air Force missions, such as Picosatellite technologies and Hyperspectral Imaging.

MightySat II.1: MightySat II.1, the first satellite in the second series of MightySat spacecraft is a robust, 3 axis stabilized platform that continues the "space work-bench" concept of the MightySat program. MSII.1 will fly 9 payloads comprised of both stand-alone experiments and experimental bus components and is slated for launch in April 2000 aboard the Air Force's new Minotaur launch vehicle. MightySat II.1 features its primary payload, the Fourier Transform Hyperspectral Imager expected to demonstrate the benefits of an alternative method of hyperspectral imaging using a monolithic glass interferometer and on-board image data processing. A pair of tethered, autonomous Picosats will be ejected late in the MSII.1 mission helping to demonstrate dynamics of ejecting small bodies from the main spacecraft and as a pathfinder use of small satellites in "constellations." The 275 lb. MightySat II.1 also features a solar array concentrator, a shaped memory alloy experiment and a new generation of miniature SGLS S-band transponder including encryption capability. The multi-functional composite structure of the MightySat II.1 bus provides insight into developing spacecraft structures combining both thermal and structural properties aimed at optimizing mass, cost and construction simplicity. MightySat II.1 operations will occur via the AFSCN through the RDT&E Support Center (RSC) of SMC/TE at Kirtland AFB. MightySat II.1 launches from California's new commercial spaceport at Vandenberg AFB to a sun-synchronous orbit and will operate for a minimum of 1 year in orbit.

Warfighter 1: Warfighter-1 (WF-1), the first project in the series, is an Advanced Technology Demonstration (ATD) that involves the development and launch of a hyperspectral imaging satellite. The program is addressing, through the use of new technologies; selected surveillance related deficiencies and needs of AFSPC and the Space Warfare Center. Once the satellite is in orbit, hyperspectral technologies will be evaluated and validated. Development of a mobile ground station with related data processing algorithms and software for tactical operations would also be evaluated. Warfighter-1 also leverages off commercial industry, whereby the Air Force will pay for the development and integration of a hyperspectral imaging capability on a commercial remote sensing satellite.

ISTD-2/XSS-11: The Integrated Space Technology Demonstration-2 (ISTD) is the second in a series of demonstrations intended to address near-term AFSPC deficiencies as outlined in the Mission Area Plans (MAP). The ISTD-2 objectives are to demonstrate proximity operations, situational awareness and assessment, and surveillance of space. Two micro-satellites will perform stand off inspection, rendezvous, docking, and transfer procedures. Small lightweight hardware will detect, characterize, and geo-locate RF and laser threat illumination. Additionally, these satellites will have sensors to validate ground based tracking techniques of satellites at low elevation angles.

Techsat 21: The Techsat 21 program is a new way to perform missions from space by using clusters of micro-satellites that operate cooperatively to perform the function of a larger, single satellite. Each smaller satellite communicates with the others and shares the processing, communications, and payload or mission functions. Thus, the cluster of satellites forms a "virtual satellite," an idea characterized by the Air Force Scientific Advisory Board Space Technology Panel as the technology that will lead to new exploitation of capabilities in space. This concept promises many benefits, including greater utility and flexibility by permitting the cluster to reconfigure and optimize its geometry for a given mission,

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enhanced survivability, and increased reliability. It is expected that clusters will reduce life cycle cost by using mass-produced satellites and minimizing the launch cost by optimizing the launch vehicle's cargo capacity. The cluster concept also eases performance upgrades by allowing upgraded satellites to join a cluster, increasing the overall performance of the virtual satellite rather than replacing a single, large satellite or the entire cluster.

Scorpius: The Scorpius program is designed to quickly provide low cost surrogate target vehicles for BMDO and to provide expendable launch vehicles to the Air Force at a cost of 10% to 20% of that of current vehicles. The surrogate target vehicle, SR-M, is designed to simulate a SCUD B. The first orbital vehicle, Sprite, will carry a small payload to low earth orbit. The first Scorpius vehicle, SR-Sa, was successfully launched from White Sands Missile Range on 27 Jan 99. The SR-M precursor, SR-XM-1, is scheduled for launch in Mar 00. The Scorpius program has produced the state of the art in ablative liquid rocket engine technology; having successfully fired numerous 5,000 lb. thrust engines for their design life of 200 sec. In production mode, these engines are predicted to cost on the order of $2/lb of thrust. A 20,000 lb. thrust engine has also been designed, fabricated, and successfully initially tested.

Excalibur: Excalibur is a reusable, two stage to orbit low cost launch vehicle program which is designed to lower cost of space access by 5-10X. It employs innovative low cost propulsion and vehicle technologies such as a balanced thrust gimbal, pepperbox valve, flexible ablative nozzle extension, lightweight heat exchanger, composite tanks, and low cost pressure fed propulsion. These innovative technologies are currently being developed and tested under a Phase II SBIR contract. Excalibur technologies will be demonstrated and flight tested in a subscale version developed as a target application for BMDO/DET under Phase III.

Solar Orbit Transfer Vehicle: The Solar Orbit Transfer Vehicle program is developing new space capabilities around the concept of a highly mobile spacecraft. A very large velocity change capability will lead to derivative vehicles capable of asset repositioning, satellite rescuing, graveyarding, high altitude refueling, servicing, inspection, taskable earth observation and numerous space control activities. The unique concept uses highly efficient propulsion and power system that can deliver about three times the mobility of current technology. The technology uses a direct thermal transfer of solar energy into the propellant and electrical power converters. The program oriented toward development of multiple derivative concepts, advancement of component level technologies, and the integrated space experiment and demonstration of the capabilities. Several directorates of AFRL jointly support the effort; two NASA centers, and augmented by the IRAD of several industry corporations. Precision Controls Group: The Precision Controls Group at AFRL/VS develops and transition's technologies supporting space surveillance and force application missions. The Precision Controls Program includes actuators for high-precision, high-bandwidth real time control, advanced control systems theory and algorithms, and innovative deployment and release mechanisms, spacecraft attitude dynamics and control, and vibration management techniques for large, flexible precision structures.

Integrated Structural Systems Group: The Integrated Structural Systems Group is developing technologies to improve the structures in existing spacecraft and launch vehicles as well researching highly innovative structural concepts that will enable new spacecraft systems. Current research efforts include technologies to add secondary functionality to primary structure, large space structure concepts, ultra lightweight mirror structures, and advanced vehicle structures.

Advanced Power Systems Group: The Advanced Power Systems Group is focused on development and demonstration of next-generation space power technologies for advanced space platforms that require increased payload mass and power budgets, along with increased power levels. Technologies under development include ultra-high efficiency crystalline solar cells (25-35%, AM0), ultra-lightweight flexible-thin-film Photovoltaics (FTFPV) blankets and solar arrays, and advanced mechanical flywheel and Li-Ion batteries for energy storage.

Space Vehicles Interaction Group: The Space Vehicles Interactions Group investigates and applies technologies that protect valuable payloads during spacecraft launch from vibration and acoustic loading. This protection result's in both reduced first day failures and reduced spacecraft mass.

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Ballistic Missile Technology: The Ballistic Missile Technology (BMT) program within the Air Force Research Laboratory Space Vehicles Directorate is responsibility for Science and Technology programs related to USAF ballistic missiles. BMT develops and demonstrates advanced technologies necessary for current Minuteman life extension programs. BMT also develops ballistic missile enhancements to respond to emerging threats; to reduce cost of development, production, operations, and maintenance costs; and to apply technologies common to the directed D-5 missile life extension and the replacement of the Minuteman III missile. BMT supports Air Force Space Command Force Applications requirements for Ballistic Missile Replacement (BMR) technology to develop the next generation guidance/navigation/control (GNC), and advanced reentry systems for replacement of the Minuteman Missile III system. BMT's approach is to utilize a series of Missile Technology Demonstration (MTD) flights to provide data for both range safety instrumentation and terminal guidance. These experimental flights will furnish flight data for evaluating a number of technologies needed for the next generation ballistic missile. Those technologies include advanced GPS/INS navigation systems capable of GPS reacquisition after reentry plasma blackout, specialized GPS antennas and antenna windows, jamming-resistant miniaturized GPS receivers, advanced reentry vehicle designs capable of meeting mid and far-term GNC requirements, and high temperature materials capable of withstanding demanding reentry conditions.

AFRL/VSS Surveillance and Control Division Programs:

RAD-HARD 32 BIT processor: The objective of the RAD-HARD 32 BIT processor program is to study and upgrade the current multiple-chip/bulk radiation hardened 32 bit (RH32) data processing architecture and technology to single-chip/silicon-on-insulator. Next generation strategic ballistic missiles and space systems require strategically hardened technology with increased performance. Technology will result in increased performance, throughput, and decreased prompt dose transient upset. AFRL/VSSE is collaborating with Honeywell Space Systems Division and TRW Space and Electronics Group to study this upgrade.

Advanced Solid State Recorder (QC40): The experiment investigates the space radiation susceptibility of critical new forms of microelectronics through the advanced, high-speed digital signal processor and memory assembly. QC40 will also perform on board processing of the FTHSI raw data; providing thumbnails, image compression, target recognition, etc. The scope has been to be expanded to serve as a QC40 experiment on Mightysat II.1. The original SBIR Phase II program was to develop large, fast memory system for space.

Single-chip Within A Missile (SWAM): Single-chip Within A Missile (SWAM) assess the interoperability of the Single-chip Generic Very High Speed Integrated Circuit Spaceborne Computer (GVSC) as a replacement for the present five chip multichip module version for use on the Minuteman III Guidance Replacement Program (GRP). The ultimate goal of this effort is to qualify the Single-chip GVSC for the GRP program. The SWAM effort takes advantage of the parallel GRP design translation of all the digital application specific integrated circuits and discrete parts from the 1.2 micron silicon on insulator three (SOI-3) technology to 0.8 micron SOI four (SOI-4). When complete, the SWAM effort combined with the design translation will put all GRP digital parts on SOI-4 having the advantage of lower overall program costs through production efficiency improvements, lower support costs, and decreased schedule risk for the GRP production program.

Polarimetry Program: The purpose of the program is to develop polarimetry techniques that have the promise of detecting and identifying man-made and natural objects from long standoff ranges with little or no thermal contrast. Technology developed under this program will provide autonomous detection and identification of military targets for reconnaissance and surveillance missions which allows for more area to be covered by these sensors than conventional imagery systems. In addition, technology developed under this effort allows for the detection and identification of targets that were previously undetectable by conventional imaging systems. Examples include camouflaged targets, underground and concealed targets, and terrain features for trafficability analysis. Successful field experiments were done in FY99 evaluating a LWIR instrument for measuring polarimetric signatures. These experiments showed excellent contrast between man-made and natural objects.

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Micro-electromechanical systems (MEMS): Develop Micro-electromechanical systems (MEMS), associated architectures, and their application to achieve dramatic miniaturization, very low-power electronics, and high-performance architectures. These efforts additionally leverage several space electronics technologies. Specific programs / project collections worked in this focused technology area follow: Highly Integrated Packaging and Processing (HIPP) Program; low-cost 2-D and heterogeneous 3-D packaging; Space Experiments Program; Microsystems and Packaging of Low-power Electronics (MAPLE).

Ultra-High Density Interconnect (UHDI): The long term objective is to develop and qualify electronic packaging improvements in Multi Chip Module (MCM) building blocks, to quadruple density of Space Microsystems packaging. UHDI will demonstrate feasibility of die-optimization, integration of passive components, and improve mixture of signal domains within a single MCM. In addition, UHDI will develop and demonstrate aerospace forms of chip-scale packaging to improve efficiency of board designs in terms of size and weight. Combined packaging and chip-thinning have made it possible to make electronics as thin as a business card. These modules can be stacked so that four modules are now thinner than a single unthinned module. Existing hermetic packages, boards, etc. can be used with a 4X increase in capability over current electronic performance. UHDI can be leveraged into 6.3 programs, especially Space Microsystems Packaging and the Integrated Space Computer Program (ISCP).

Improved Space Computer Program (ISCP): The Improved Space Computer Program (ISCP) objective is reducing the development time and cost of future high-performance DoD space missions by optimizing how signals and data are handled on-board satellites. This is accomplished by developing a computer architecture that is based on an open systems approach (standards based) having the qualities of flexibility and scalability. Flexibility is defined as the ability of the architecture to satisfy the processing requirements of a wide-range of satellites with little to no modification. Flexibility also refers to the degree to which the architecture can support various technologies. Scalability refers to the degree to which the architecture can support a variety of processing requirements. The ISCP architecture will provide the ability to incorporate minor modifications easily. The computer architecture will provide improved throughput performance to meet demanding processing needs for the next century. Architectural modules will address a full range of space/radiation hardened microelectronics needs, as well as, the needs for system software and software tool, low power components, and high-density packaging. The digital signal processor module will be developed for high-end, stand-alone, space applications targeting over one (1) Billion Floating Point Operations Per Second (GFLOPS). The data processor module will target applications requiring 100+ Million Instructions Per Second (MIPS) per node. ISCP enables the support of next generation space operations by providing users with a capability for autonomous mission operation, going beyond spacecraft control to increasingly independent information gathering, on-board hyperspectral data analysis, and data dissemination. ISCP modules will greatly increase the "intelligence" of spacecraft while reducing the size, weight, and power cost drivers.

Counterspace Protection Technologies-Active Techniques: The long-term objective of Counterspace Protection Technologies-Active Techniques is the identification, development and demonstration of active survivability enhancement options that will provide, in conjunction with on-board threat warning/attack reporting capabilities, the capability for spacecraft to avoid hostile threat environments. Balanced survivability, particularly for long-term, advanced threats to spacecraft, will necessitate the inclusion of active survivability enhancement options to reduce or eliminate the intensity of threat environments by threat avoidance. Work includes: assessment of satellite vulnerabilities against advanced threats; survivability enhancement options trade studies; and the identification of technology requirements for chosen active countermeasure. The active protection program includes robust satellite survivability against advanced threats and advanced satellite protection against nuclear effects.

Counterspace Protection Technologies-PassiveTechniques: The objective of Counterspace Protection Technologies-Passive Techniques is the development and demonstration of passive protection techniques (hardening) to protect US space related capabilities from attack and interference. Multi-threat (including laser, RF/HPM, enhanced radiation, and other advanced weapons concepts) mitigation techniques and performance-compatible survivability enhancement options will be identified, developed and demonstrated consistent with minimum impact on weight/power/cost constraints for high performance

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mission-critical subsystems. The program includes: 1)development of high fidelity assessment tools for multi-threat environment; 2)assessment of satellite vulnerabilities against current and projected threats; 3)identification of potential passive countermeasures; and 4)development of mitigation techniques. Payoff: endurable mission capability; minimal performance penalty; affordable protection; options supported end states; satellite protection.

Counterspace Protection Technologies-Threat Warning/Attack Reporting: The Counterspace Protection Technologies-Threat Warning/Attack Reporting is the developing and demonstrating the essential key technologies for single platform, on-board, satellite threat warning and attack reporting (STW/AR) capabilities. Principal threat environments of concern are those potentially created by radio frequency and laser ground based sources. A secondary objective is to exercise key CONOPS elements for STW/AR. The STW/AR hardware will detect any radio frequency or laser source tracking or interfering with the operation of the spacecraft. It will geo-locate and characterize the source and report this information to the host spacecraft and subsequently down linked to the ground and sent to the Cheyenne Mountain Complex.

Transmit Receive Antenna Module (TRAM): TRAM is a lightweight, modular, phased array, sub-array antenna concept that is being developed for use in satellite antenna systems, specifically in support of space surveillance and navigation programs. All the antenna RF components are mounted directly on the exposed antenna face. The antenna area density goal, including the supporting antenna structure, for the TRAM antenna is 6kg/m^2 which represents a 75% reduction over current state-of-the-art antennas. TRAM is one of several experiments aboard the STRV-1d. As such, TRAM operation will be tested in the harsh radiation environment of a GEO transfer orbit.

Modeling and Simulation for Surveillance: Space Surveillance and distributed satellite constellations have a potential role in the future US force structure, based on their capability for all-weather, 24 hour coverage and surveillance of denied areas. Currently, there are no space surveillance models that will simulate the sensor performance from a space environment against a variety of targets within diverse clutter backgrounds. AFRL/VS is currently guiding development of a varying fidelity simulation model within the Spacecraft Simulation Toolkit (SST) environment. This model will ultimately predict multi-mode antenna performance from space across a variety of proposed concept designs for use in military reconnaissance and imaging. For each concept, a preferred method of CONOPS (Concept of Operations) must be developed to answer basic resource allocation requirements. This includes issues such as the command and control options, communication requirements, and data distribution methods for various numbers of satellites within the global constellation. The long term integrated ability to model a mixed force structure, including other phenomenology's (e.g., Space-Based Infrared (SBIR)) and non-space applications of radar (AWACS, JSTARS) along with Fourier Transform Hyperspectral Imaging (FTHSI) is required. Many distinct and necessary pieces for such an integrated analysis exist, but they do not presently work together within a unified simulation environment. AFRL's goal is to help develop modeling and simulation tools to meet all of these needs.

Electronic Test Bed (ETB) for STRV-1d: The STRV-1d (Space Technology Research Vehicle) is a US/UK satellite sponsored by the Defense Research Agency (DERA) and the Ballistic Missile Defense Organization (BMDO). It will be the secondary payload on an Ariane V launch during 1999. The STRV-1d ETB Data Handling System (DHS) is a general purpose interface between multiple space flight experiments, including TRAM mentioned above, and the spacecraft. The DHS will enable TRAM to ride on any spacecraft of opportunity. The DHS design simplifies some of the complexities to be faced by sub-experimenters, and it provides a simplified interface for operating the space experiment, recording the results, and communicating the results to the spacecraft. It also reduces the risk to the spacecraft mission by providing a degree of separation between the spacecraft and less-proven new technologies, and it provides a similar degree of separation between experiments. The sub-experiments may be mounted on any surface of the STRV-1d spacecraft and will be connected, controlled, and commanded by the DHS.

35/60K Protoflight Cryocooler: This BMDO and Space Based Infrared System (SBIRS) Low co-sponsored program is designed to produce a prototype multi-load Stirling, Brayton, and pulse tube cycle cryocoolers capable of providing simultaneous cooling of MWIR and LWIR sensors at 35 and 60 K.

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This technology is considered a technology option for the SBIRS Low EMD system. Two programs are being funded to address the SBIRS Low program objectives. A joint program through NASA/GSFC leverages previous development efforts with Ball Aerospace Corporation in developing a Stirling cycle cryocooler for operation at 30K. Utilizing the compressor design of the 30K program, Ball developed a unique three-stage cryocooler providing two simultaneous cooling loads (0.4W at 35K and 0.6W at 60K).

Advanced Distributed Computer Architecture for Space (ADCAS): Program defines and demonstrates an open, distributed and scalable computer architecture for follow-on to Improved Space Computer Program. Program provides a standard electronics subsystem with flexible and robust data and signal processing for a wide variety of demanding, higher-performance applications. An efficient architecture (targeting Teraflop performance) minimizes weight and power consumption of the electronics subsystem, while capitalizing on distributed processing and optical interconnect technologies for improved performance. Investigate, develop, and implement methods to adapt and transfer state-of-the-art processors, memories, support components, and architectures to future space processing needs. Invest in projects to support enabling and supporting technologies for revolutionary improvements to space architectures.

Development of Advanced Very Long Wavelength Infrared Detectors (DAVID): Development of FPA technology and fabrication methodology required to produce cost effective and high performance FPA meeting space based LWIR missile tracking requirements for Nuclear Missile Defense. The Development of Advanced Very Long Wavelength Infrared Detectors (DAVID) program, is working to advance strategic long wavelength infrared (LWIR) focal plane array (FPA) sensitivity, operability, uniformity, dynamic range, cut-off wavelength, and radiation hardness. DAVID is improving FPA radiation hardness extending the cut-off wavelength from 11.5 um to 14 um, while keeping the same 40K operating temperature and a comparable sensitivity specification. This extended cut-off wavelength is required to detect and track post-boost inter-continental ballistic missiles during their trajectory outside the earth's atmosphere. This program is designed to support the SBIRS Low by providing them the technology required for both National and Theater Ballistic Missile Defense.

EQUIPMENT/FACILITIES

Primary operating locations are: Kirtland AFB NM, and Hanscom AFB MA. Secondary locations are at Edwards AFB CA, Holloman AFB NM, Sunspot NM and Gakona AK. Unique facilities at Kirtland AFB NM include: the Space Structures/Composites Laboratory, the Aerospace Engineering Facility (AEF), the Space Assembly and Integration Facility (SAITF), Power and Thermal laboratory, Dynamitron facility, Cobalt 60 facility, and Nuclear Engineering evaluation facility. Unique facilities at Hanscom AFB MA include: the High Resolution Spectroscopy facility, Cold Chemiexcited Infrared Simulation Experiment (COCHISE), Laboratory Cryogenic Electron Dependent Emissions (LABCEDE), Selected Ion Flow Drift Tube (SIFDT), Air Force Interactive Meterological System (AIMS), Electron/Ion and Thermal Calibration Facility (MUMBO and JUMBO), Mass Spectrometer Calibration System, and High Altitude Light Detection and Ranging (LIDAR) Sounder. At Edwards AFB CA: the National Hover Test Facility (NHTF). At Gakona AK: the High Frequency Active Auroral Research Program (HAARP) facility. At Sunspot NM: shared use of the National Solar Observatory (owned by NSF). At Holloman NM: the high altitude balloon launch facility.

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FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	4.870	0.282	5.458	10.610
6.2	7.607	16.081	33.337	57.025
6.3	5.695	2.540	68.721	76.956
Subtotal (S&T)	**18.172**	**18.903**	**107.516**	**144.591**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	24.204	24.204
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD.	1.140	0.508	18.572	20.220
TOTAL RDT&E	**19.312**	**19.411**	**150.292**	**189.015**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	0.000	N/A	71.474	71.474
TOTAL FUNDING	**19.312**	**19.411**	**221.766**	**260.489**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	9	80	50	**139**
CIVILIAN	92	134	234	**460**
TOTAL	**101**	**214**	**284**	**599**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	237.000	**REAL PROPERTY**	153.000
ADMIN	67.000	* NEW CAPITAL EQUIPMENT	0.000
OTHER	450.000	**EQUIPMENT**	364.000
TOTAL	**754.000**	* NEW SCIENTIFIC & ENG. EQUIP.	0.000
ACRES	**5787**	* Subset of previous category.	

UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES

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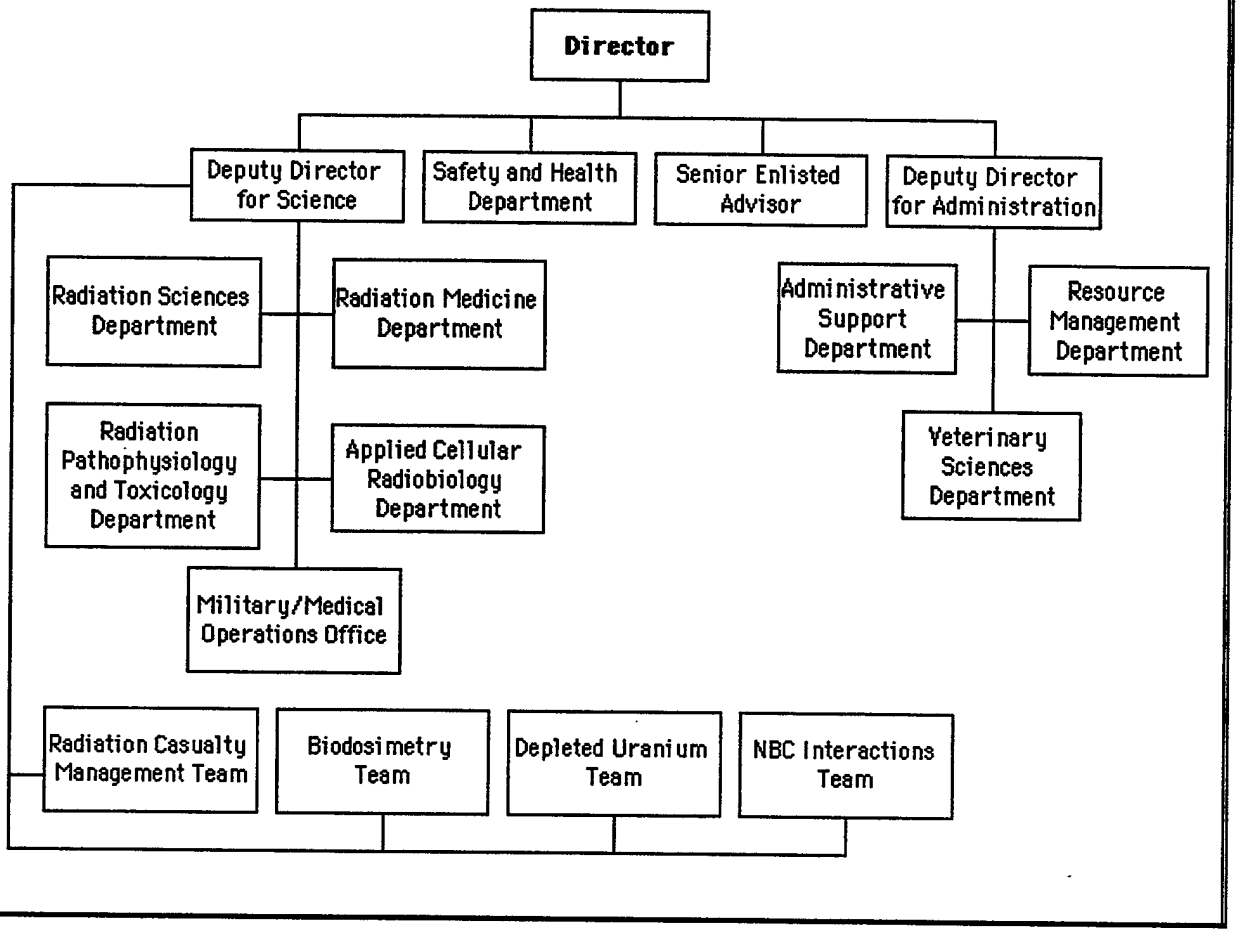
UNIFORMED SERVICES UNIVERSITY of the HEALTH SCIENCES (USUHS)

The only In-House RDT&E Activity within USUHS is the Armed Forces Radiobiology Research Institute (AFRRI).

Armed Forces Radiobiology Research Institute

FY1999 Abbreviated Functional Chart - Technical Organizations



Armed Forces Radiobiology Research Institute
Bethesda, MD 20889-5603
(301) 295-1210

Director: COL Robert R. Eng, MS, USA
Deputy Director: LTCOL Ronald E. Palmer, USAF

MISSION

The mission of Armed Forces Radiobiology Research Institute shall be to conduct research in the field of radiobiology and related matters essential to the operational and medical support of the Department of Defense and military services.

CURRENT IMPORTANT PROGRAMS

Develop medical countermeasures to treat radiation injuries.

Optimize combinations of protective agents to promote survival and combat effectiveness following irradiation at high or low dose rates.

Development of reliable biodosimetry assays/techniques.

Evaluation of early and late effects of radiation exposures at low dose rates.

Neutralization of BW/CW weapons of mass destruction.

Impact of imbedded depleted uranium shrapnel on biological systems.

Continue to support studies of residents of the former Soviet Union who were exposed to chronic radiation through environmental contamination.

EQUIPMENT/FACILITIES

Functions: operate facilities for conducting radiobiology research and disseminating results, conduct advanced training, provide analysis consultation on bioeffects of radiation, and perform such other research functions as required. Major equipment includes: TRIGA Mark-F, moveable-core, pool-type reactor, to operate in pulse and steady state modes; 73,000 Curies cobalt-60 facility permitting either unilateral or bilateral exposures, 100 Curie cobalt-60 Panoramic irradiator with retractable source, 54 MeV linear accelerator, 320 kVp Industrial x-ray machine. Support services include: measurement of radiation fields, provision and care of laboratory animals, equipment design and fabrication assistance, real-time data acquisition system, television and film documentation of experiments, personnel and environmental monitoring, editorial assistance in report preparation, and a large technical library.

Armed Forces Radiobiology Research Institute

Bethesda, MD 20889-5603
(301) 295-1210

Director: COL Robert R. Eng, MS, USA
Deputy Director: LTCOL Ronald E. Palmer, USAF

FY1999 FUNDING DATA (MILLIONS $)				
APPROPRIATION	**IN-HOUSE**	**IN-HOUSE MANAGEMENT**	**OUT-OF-HOUSE**	**TOTAL**
RDT&E:				
6.1 ILIR	0.000	N/A	N/A	0.000
6.1 Other	0.000	0.000	0.000	0.000
6.2	9.119	0.000	0.000	9.119
6.3	2.109	0.000	0.000	2.109
Subtotal (S&T)	**11.228**	**0.000**	**0.000**	**11.228**
6.4	0.000	0.000	0.000	0.000
6.5	0.000	0.000	0.000	0.000
6.6	0.000	0.000	0.000	0.000
6.7	0.000	0.000	0.000	0.000
Non-DOD	0.000	0.000	0.000	0.000
TOTAL RDT&E	**11.228**	**0.000**	**0.000**	**11.228**
Procurement	0.000	N/A	0.000	0.000
Operations & Maintenance	0.000	N/A	0.000	0.000
Other	1.224	N/A	0.000	1.224
TOTAL FUNDING	**12.452**	**0.000**	**0.000**	**12.452**

MILITARY CONSTRUCTION (MILLIONS $)	
Military Construction (MILCON)	0.000

PERSONNEL DATA (END OF FISCAL YEAR 1999)				
	SCIENTISTS & ENGINEERS		**TECHNICAL SUPPORT & OTHER PERSONNEL**	
TYPE	**DOCTORATES**	**OTHER**		**END STRENGTH**
MILITARY	0	0	48	**48**
CIVILIAN	17	35	29	**81**
TOTAL	**17**	**35**	**77**	**129**

SPACE AND PROPERTY			
BUILDING SPACE (THOUSANDS OF SQ FT)		**PROPERTY ACQUISITION COST (MILLIONS $)**	
LAB	61.750	REAL PROPERTY	18.610
ADMIN	34.257	* NEW CAPITAL EQUIPMENT	0.000
OTHER	23.908	**EQUIPMENT**	11.972
TOTAL	**119.915**	* NEW SCIENTIFIC & ENG. EQUIP.	0.051
ACRES	**10**	* Subset of previous category.	

APPENDICES

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APPENDIX A
DISESTABLISHMENT, ESTABLISHMENT, OR CHANGE IN ORGANIZATION NAME

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APPENDIX A

DISESTABLISHMENT, ESTABLISHMENT, OR CHANGES IN ORGANIZATION NAME BETWEEN FY1998 AND FY1999

DEPARTMENT OF THE ARMY

Cold Regions Research and Engineering Laboratory, Construction Engineering Research Laboratories, Topographic Engineering Center, and **Waterways Experiment Station** data is now reported as part of the *Engineer Research and Development Center (ERDC).*

Edgewood Research, Development and Engineering Center and **Natick Research, Development and Engineering Center** data is now reported as part of the *Soldier and Biological Chemical Command RDEC.*

DEPARTMENT OF THE NAVY

Naval Aerospace Medical Research Laboratory and **Naval Submarine Medical Research Laboratory** data is now reported as part of the **Naval Health Research Center.**

The **Naval Medical Research Institute** is now the *Naval Medical Research Center.* **Naval Dental Research Institute, Naval Medical Research Unit #2,** and **Naval Medical Research Unit #3** data is now reported as part of the *Naval Medical Research Center.*

The four Naval warfare centers provide full spectrum research, development, test and evaluation, engineering, and fleet support services and perform a substantial amount of non-RDT&E work. Prior to FY1998, the Navy reported each warfare center in its entirety, even though a considerable amount of the reported end strengths, funding, and other resources were devoted to other than RDT&E programs. For purposes of more accurately reflecting RDT&E In-House resources in this report, the Navy has applied the established RDT&E In-House criteria (i.e., a minimum of 25% of total funds is RDT&E and a minimum of 25% of in-house effort is devoted to RDT&E) at the division or major site level rather than reporting all warfare center sites, regardless of their level of RDT&E work. As a result, some warfare center entities have been eliminated from this report because they are below the 25% RDT&E threshold for inclusion in this report:

The **Naval Air Warfare Center** does not include data from the Aircraft Division Lakehurst Activity and Training Systems Division..

The **Naval Surface Warfare Center** does not include data from the Crane and Port Hueneme Divisions and NWAS Corona.

The **Naval Undersea Warfare Center** does not include data from the Keyport Division.

The **Space and Naval Warfare Systems Centers** do not include data from SSC, Charleston and SSC, Chesapeake.

DEPARTMENT OF THE AIR FORCE

The **Development Test Center** is now the *Air Armament Center.*

Headquarters Air Force Research Laboratory (AFRL)/Research Sites is now referred to as *Headquarters Air Force Research Laboratory (AFRL).*

APPENDIX A

DISESTABLISHMENT, ESTABLISHMENT, OR CHANGES IN ORGANIZATION NAME BETWEEN FY1998 AND FY1999

DEPARTMENT OF DEFENSE AGENCIES

No changes.

Note: Activities in **bold typeface** were reported in the FY1998 edition of this report as separate Activities.

Italicized Activities are new for FY1999.

APPENDIX B
DEFINITIONS OF REPORT ELEMENTS

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APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

INTRODUCTORY PRECAUTIONARY NOTE

Data in this report should not be summarized or used for comparative analyses between Activities and/or across Services because labs/centers use different business systems to satisfy their special needs. Some organizations (e.g., Navy) operate on an industrial funding basis; that is, they charge their customers for all operating costs, including maintaining their physical plants and providing other necessary support services (e.g., human resources office, finance and accounting support). Other labs/centers (e.g., Air Force) are institutionally funded; that is, they receive most of their funding as direct appropriations from Congress and use these funds for operating support costs as well as for research. In addition, most institutionally funded labs/centers are tenants on larger military bases and receive their support services at reduced or no charge from their host. Even those that own their own facilities receive separate funding support services and do not charge their customers for these overhead costs. Efforts are underway to institute common business practices across the DOD RDT&E labs, but until that occurs comparisons may be misleading.

Abbreviated Functional Chart - Technical Organizations B-2
Narratives B-2
Funding B-3
Personnel B-8
Space and Property B-10

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

ABBREVIATED FUNCTIONAL CHART - TECHNICAL ORGANIZATIONS

This is a partial organization chart, provided by each Activity, to provide an overview of its technical operations. It does not depict the entire organizational structure and is abbreviated for purposes of this report.

NARRATIVES

Mission Statement
Stated is the mission of the laboratory or Activity.

Current Important Programs Narrative
Summarized are current important programs on which the laboratory or Activity is working. Any Technology Transition efforts like Cooperative Research and Development Agreements (CRADAs) are identified.

- **Technology Transfer**
  Data supplied are any major Technology Transfer efforts underway, including the number of scientists and engineers exchanged with industry or academia.

Equipment/Facilities Narrative
Summarized are the major equipment and facility capabilities of the laboratory or Activity including any unique equipment and facilities not available to the commercial or academic R&D community anywhere else.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

FUNDING

RDT&E Budget Activities (BAs)

BA	BA Title	Applicable Research Categories
1	Basic Research	6.1
2	Applied Research	6.2
3	Advanced Technology Development	6.3
4	Demonstration and Validation (Dem/Val)	6.4
5	Engineering & Manufacturing Development (EMD)	6.5
6	RDT&E Management Support	6.6
7	Operational Systems Development (OSD)	6.7

In-House RDT&E Activities
These Activities are organizational entities which perform at least 25% of their work in any or all of the categories of research, development, test and evaluation (RDT&E). In addition, at least 25% of an Activity's In-House manpower and/or 25% of the obligation authority used In-House is devoted to one or more of the categories of RDT&E.

Current Year Obligation Authority
Authority for the financial resources available for obligation in the specific year being reported. This excludes unobligated authority carried forward from the prior year. The appropriation category refers to the original funding source, even if it may reimburse a different funding category.

In-House
The total amount for the fiscal year reporting period for mission-oriented work directly performed, or to be performed, by government personnel of the reporting organization.

- **Included**: funding regardless of source (i.e., own Service, sister Service, ARPA, OSD, etc.); costs of supplies and equipment essentially of an off-the-shelf nature, which are procured for use in-house; direct labor, direct material, direct travel, direct equipment, direct computer support, other direct support; and all overhead costs.
- **Excluded**: expenses for planning and administering contracts and grants for out-of-house work and expenses for activities performed by contractors of the reporting organization.

In-House Managing Out-of-House
The total amount of funds incurred in planning and administering out-of-house programs by personnel of the reporting organization. **(This data element is not applicable for the Navy. The Navy includes these funds in the In-House category).**

- **Included**: travel and other supporting services.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

FUNDING (continued)

Out-of-House
The total amount for the fiscal year reporting period for direct mission-oriented work performed, or to be performed, by other than the government personnel *at* the reporting organization.

- **Included**: RDT&E work by other departmental or DoD organizations, industrial firms, educational institutions, not-for-profit institutions, and private individuals.
- **Excluded**: all overhead costs.

6.1 Basic Research

6.1 In-House Laboratory Independent Research (ILIR)
The total amount for research 6.1 In-House Laboratory Independent Research program elements.

6.1 Other In-House/Out-of-House
The total amount for Basic Research 6.1 program elements which are not ILIR but are conducted in-house/out-of-house.

6.1 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Basic Research 6.1 programs, by personnel of the organizational entity, which are conducted out-of-house.

6.2 Applied Research

6.2 In-House/Out-of-House
The total amount for Applied Research 6.2 program elements conducted in-house/out-of-house.

6.2 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Applied Research 6.2 programs, by personnel of the organizational entity, which are conducted out-of-house.

6.3 Advanced Technology Development

6.3 In-House/Out-of-House
The total amount for Advanced Technology Development 6.3 program elements conducted in-house/out-of-house.

6.3 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Advanced Development 6.3 programs, by personnel of the organizational entity, which are conducted out-of-house.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

FUNDING (continued)

6.4 Demonstration and Validation (Dem/Val)

6.4 In-House/Out-of-House
The total amount for Dem/Val 6.4 program elements conducted in-house/out-of-house.

6.4 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Dem/Val 6.4 programs, by personnel of the organizational entity, which are conducted out-of-house.

6.5 Engineering and Manufacturing Development (EMD)

6.5 In-House/Out-of-House
The total amount for EMD 6.5 program elements conducted in-house/out-of-house.

6.5 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Engineering and Manufacturing Development 6.5 programs, by personnel of the organizational entity, which are conducted out-of-house.

6.6 RDT&E Management Support

6.6 In-House/Out-of-House
The total amount for RDT&E Management Support 6.6 program elements conducted in-house/out-of-house.

6.6 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Management Support 6.6 programs, by personnel of the organizational entity, which are conducted out-of-house.

6.7 Operational Systems Development (OSD)

6.7 In-House/Out-of-House
The total amount for all OSD 6.7 with RDT&E funds conducted in-house/out-of-house. This item is interpreted in its broadest sense to include operational developments outside the systems areas, and not included in any of the above categories.

6.7 In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering Operational Systems Development (OSD) 6.7 programs, by personnel of the organizational entity, which are conducted out-of-house.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

FUNDING (continued)

Non-DoD

Non-DoD In-House/Out-of-House
The total amount for all In-House/Out-of-House RDT&E not included in 6.1-6.7 as defined above.

Non-DoD In-House Effort Managing Out-of-House Contracts (In-House-Management)
The total amount for expenses incurred in planning and administering RDT&E not included in 6.1-6.7 programs, by personnel of the organizational entity, which are conducted out-of-house

Procurement

Procurement In-House/Out-of-House
The total amount for procurement appropriations in-house/out-of-house regardless of source.

Operation and Maintenance (O&M)

O&M In-House/Out-of-House
The total amount for O&M appropriations in-house/out-of-house regardless of source.

Other

Other In-House/Out-of-House
The total amount for all other appropriations in-house/out-of-house regardless of source. Included are Military Pay and Allowances (MPA) if applicable.

Military Construction (MILCON)

MILCON
This is the total amount for Military Construction appropriations.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

FUNDING (continued)

Totals

Total RDT&E
The sum of the total amount, regardless of source, for both In-House, In-House Managing Out-of-House, and Out-of-House funding for the following categories:

ILIR	6.1
Basic Research	6.1
Applied Research	6.2
Advanced Technology Development	6.3
Demonstration and Validation (Dem/Val)	6.4
Engineering and Manufacturing Development (EMD)	6.5
RDT&E Management Support	6.6
Operational Systems Development	6.7
Non-DOD	

Total Funding
The sum of Total RDT&E, Procurement, Operations & Maintenance and Other.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

PERSONNEL

Military

Military End Strength
Military end strength is the September 30 strength of Active duty military

- **Included**: Transients, trainees, holdees and students.
- **Excluded**: Cadets.

Military Scientist and Engineering Doctorates
The total number of military scientists and engineers (officer and enlisted) whose most advanced degree is a doctorate. Degrees must be earned from an accredited college or university. Honorary degrees are excluded.

- **Included**: Full-time military scientific, engineering, mathematical, and medical personnel actively engaged in RDT&E activities.
- **Excluded**: Lawyers, accountants, chaplains, social workers and educators.

Other Military Scientists and Engineers
The total number of military scientists and engineers (officer and enlisted) who do not hold a doctor's degree, but who are considered professionals.

- **Included**: Full-time military scientific and engineering personnel actively engaged in RDT&E activities.
- **Excluded**: Lawyers, accountants, chaplains, social workers and educators.

Military Technical Support and Other Personnel
The total number of Military Technical Support and Other Personnel. This includes all military personnel not listed in the above two categories.

Civilian

Civilian End Strength
Civilian end strength is the September 30 strength of DoD civilian direct hires in a paid, active duty status who are paid from appropriated funds (RDT&E and other appropriations).

- **Included**: Part time and temporary personnel.
- **Excluded**: Defense Intelligence Agency and National Security Agency personnel.

Civilian Scientist and Engineering Doctorates
The total number of civilian scientists and engineers whose most advanced degree is a doctorate. Degrees must be earned from an accredited college or university. Honorary degrees are excluded.

- **Included**: Full-time government scientific, engineering, mathematical, and medical personnel actively engaged in RDT&E activities.
- **Excluded**: Lawyers, accountants, chaplains, social workers and educators.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

PERSONNEL (continued)

Other Civilian Scientists and Engineers
The total number of civilian scientists and engineers who do not hold a doctor's degree, but who are rated as professionals.

- **Included**: Full-time government scientific and engineering personnel actively engaged in RDT&E activities.
- **Excluded**: Lawyers, accountants, chaplains, social workers and educators.

Civilian Technical Support and Other Personnel
The total number of Civilian Technical Support and Other Personnel. This includes all civilian personnel not listed in the above two categories.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

SPACE AND PROPERTY

Acreage
The total number of acres owned, combined with the total number of acres occupied, rounded to the nearest acre. In cases involving tenants who are also RDT&E Activities, the tenants report only the acreage occupied solely by them. The owning Activity reports the remainder including any acreage occupied by non-R&D tenants.

- **Included**: land which is public domain.
- **Excluded**: all easements and permits.

Laboratory Space
The total number of square feet (in thousands)* of permanent and semi-permanent (e.g., fixed-site trailers) building space that is laboratory space.

- **Included**: only walled and roofed building space; facilities assigned to, leased by, or occupied by the reporting organization.
- **Excluded**: parking lots; open storage areas; lean-tos.

Administrative Space
The total number of square feet (in thousands)* of building space that is administrative space (usually that portion occupied by the headquarters and support services staff).

- **Included**: facilities assigned to, leased by, or occupied by the reporting organization.
- **Excluded**: scientists' or engineers' offices in a laboratory which is reported as Laboratory Space.

Other Space
The total number of square feet (in thousands)* of all remaining building space (e.g., hangars, warehouses, garages, etc.).

- **Included**: facilities assigned to, leased by, or occupied by the reporting organization.

**Square feet is expressed in thousands. For example, 15,200 square feet is entered as 15.2.*

Acquisition Cost of Real Property
The total acquisition cost (in millions $)** of all land, buildings, and capital equipment and their improvements. An RDT&E owner does not report this information for the facilities assigned to, or occupied by its RDT&E tenants, as they report this information separately.

- **Included**: the cost of installed physical plant equipment, such as HVAC; facilities assigned to, leased by, or occupied by the reporting organization.
- **Excluded**: The cost of acreage or buildings rented from private owners.

Each reporting activity is responsible for determining and reporting the cost of real property. This includes the cost of installed equipment. This figure represents the true total investment over the life of the activity for real property on hand as of the reporting date.

APPENDIX B

DEFINITIONS OF REPORT ELEMENTS

SPACE AND PROPERTY (continued)

New Capital Equipment
The total acquisition cost (in millions $)** for new capital equipment (i.e., installed physical plant equipment such as HVAC) acquired during the fiscal year reporting period. This amount is also included in the entry for Acquisition Cost of Real Property.

Acquisition Cost of Equipment
The total acquisition cost (in millions $)** of all "personal property" equipment. An RDT&E owner does not report this information for the facilities assigned to, or occupied by its RDT&E tenants, as they report this information separately.

- **Included**: The cost of installed equipment directly related to mission execution, such as lab test equipment; the cost of equipment in facilities assigned to, leased by, or occupied by the reporting organization.
- **Excluded**: The cost of physical plant equipment reported under Acquisition Cost of Real Property (explained previously).

Each reporting activity is responsible for determining and reporting the cost of personal property. This cost includes those costs incurred by the acquisition (including installation when applicable) of all property other than real property. It includes personal property such as machine tools, environmental test equipment, furniture, laboratory equipment, vehicles, etc. Items having a unit cost of less than $200 are excluded. The figure represents the cost of all personal property acquired throughout the life of the activity, to the reporting date, that is still on hand.

New Scientific & Engineering Equipment
The total acquisition cost (in millions $)** for new scientific & engineering equipment acquired during the fiscal year reporting period. This amount is also included in the entry for Acquisition Cost of Equipment.

- **Included**: The cost of installed equipment directly related to mission execution, such as lab test equipment.

*** Dollars are expressed in millions rounded to the nearest thousand. For example, $2,517,830 is entered as 2.518.*

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APPENDIX C
SELECTED STANDARD ABBREVIATIONS AND ACRONYMS

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APPENDIX C

SELECTED STANDARD ABBREVIATIONS AND ACRONYMS

ACTD - Advanced Concept and Technology Demonstration
ASW - Antisubmarine Warfare
ATD - Advanced Technology Demonstration
BRAC - Base Realignment and Closure
C2 - Command and Control
C4I - Command, Control, Communications, Computers, and Intelligence
CAD - Computer Aided Design
CAE - Computer Aided Engineering
CAM - Computer Aided Manufacturing
CB - Chemical Biological
CBR - Chemical, Biological, Radiological
CM - Countermeasures
CONUS - Continental United States
COTS - Commercial off-the Shelf
CRADA - Cooperative Research and Development Agreement
CW - Chemical Warfare
DOD - Department of Defense
ECM - Electronic Countermeasures
EMI - Electromagnetic Interference
EMP - Electromagnetic Propagation
EPA - Environmental Protection Agency
EW - Electronic Warfare
GPS - Global Positioning System
HF - High-Frequency
HVAC - Heating, Ventilation, and Air Conditioning
IFF - Identification, Friend or Foe
ILIR - In-House Laboratory Independent Research
IR - Infrared
KE - Kinetic Energy
LAN - Local Area Network
M&S - Modeling and Simulation
MOUT - Military Operations in Urban Terrain
MSRC - Major Shared Resource Center
NBC - Nuclear, Biological and Chemical
NVD - Night Vision Devices
OCONUS - Outside the Continental United States
PEO - Program Executive Officer
PM - Program Manager
R&D - Research and Development
RDT&E - Research, Development, Test and Evaluation
RF - Radio Frequency
SOF - Special Operations Forces
S&T - Science and Technology
SBIR - Small Business Innovation Research
STO - Science and Technology Objective
T&E - Test and Evaluation

APPENDIX C

SELECTED STANDARD ABBREVIATIONS AND ACRONYMS

UAV - Unmanned Aerial Vehicle
USW - Undersea Warfare
UUV - Unmanned Undersea Vehicle
UV - Ultraviolet