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NCTRF

## MISSION STATEMENT

CONDUCT RESEARCH, DEVELOPMENT, TEST AND EVALUATION,  
AND ENGINEERING SUPPORT FOR DRESS UNIFORMS AS WELL  
AS ENVIRONMENTAL AND PROTECTIVE CLOTHING FOR THE  
UNITED STATES NAVY

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Distribution Unlimited

30 SEPTEMBER 1981

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## NCTRF

### INTRODUCTION

The Navy Clothing and Textile Research Facility (NCTRF), Natick, Massachusetts, designs and develops all protective clothing, dress uniforms and utility garments worn by most Navy personnel. Consequently, it conducts research on fabrics and materials which it develops into clothing items that it tests and evaluates before introduction to the Fleet.

Fire-preventive clothing, cold-weather garments, women's wear, deep-sea swimsuit materials, boots and shoes, insignia, buoyant-ballistic vests, decompression-chamber clothing, handwear, and dress and work uniforms are only some of the clothing products developed by NCTRF.

Located 20 miles west of Boston, NCTRF consists of five divisions, each of which performs a vital role in creating more attractive, functional, and durable garments for the Navy man and woman. The Materials Research Division analyzes the base fabric for a proposed item, the Clothing Development Division makes and field tests the prototype, the Environmental Sciences Division performs engineering and physiological test and evaluation of the item, and the Standardization and Specifications Division issues the requirements for future manufacture of the prototype. Finally, the Technical Support Division, located at the Defense Personnel Support Center (DPSC) in Philadelphia, works with DPSC and other agencies to supply the new product to the Fleet.

The NCTRF laboratory complex, located about 3 miles from NCTRF headquarters, houses extensive engineering, physiological, and materials test

facilities. Among the laboratories are the Environmental Test Chamber Laboratory that reproduces temperature and relative humidity extremes ranging from -40° to 200°F at 5 to 100% RH, and the Hydro-Environment Simulator Laboratory that reproduces air-sea surface temperature conditions existing anywhere on earth.

As of 30 September 1981, NCTRF employed 55 civilians and 1 military officer. Its total funding for FY 1981 was over \$3.3 million. Most of this funding was received from the Naval Supply Systems Command, NCTRF's major sponsor. Other funding sources were: the Naval Sea Systems Command, the Naval Coastal Systems Command, the Naval Military Personnel Command, the U. S. Coast Guard, the U. S. Army, and the Saudi Arabian Navy.

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30 SEPTEMBER 1981

## **NCTRF**

### **HISTORY**

NCTRF traces its origins to the Clothing Manufacturing Department of the Naval Clothing Depot, Brooklyn, which began operations in 1879. At that time, the forerunner of NCTRF was named the Inspection Division. The division's personnel inspected materials in bale, yarn, fabric, and garment form, developed inspection techniques, and worked with industry to introduce new materials.

In 1943 a Textile and Clothing R&D Department was formed, which included many personnel from the old Inspection Division. This new department, which consisted of a Clothing and Textile Research Division and a Specifications and Standards Clothing Research Division, eventually became the research arm of the Clothing Supply Office (CSO), which was established in 1947. Shortly thereafter, when industry focused its interest on the highly profitable civilian clothing market, military procurement problems arose. In response, the Textile and Clothing R&D Department helped to establish a Technical Division under CSO which became the first point of reference for all procurement problems concerned with clothing research and development.

In 1952 the R&D Department became a division of the CSO, and the Technical Division was later merged into the R&D Division. When the CSO was reorganized in 1958, the Clothing and Textile Research and Development Division remained in Brooklyn, but became a division of the Naval Supply Research and Development Facility (NAVSUPRANDFAC), Bayonne, New Jersey. It moved to Bayonne in 1962. In 1967, when NAVSUPRANDFAC closed its doors, the Clothing and Textile R&D Division was renamed the

Navy Clothing and Textile Research Unit and was relocated in Natick, Massachusetts. Finally, in March, 1976, the unit received its current title, the Navy Clothing and Textile Research Facility.

Through the years, NCTRF research scientists have developed the thermal, waffle-weave, cold-weather underwear, and the vapor barrier "Mickey Mouse" boot. They are currently advancing the state-of-the-art in firefighters' protective clothing, divers' underwater garments, cold-weather and shipboard protective wear, and life-support systems and equipment.

Meanwhile, NCTRF clothing designers and technologists have refashioned the old 13-button, bell-bottom uniform for today's sailor, and, of course, continue to design all uniforms and work clothing for the Navy and the Coast Guard.

**30 SEPTEMBER 1981**

## NCTRF

### FACILITIES

The Hydro-Environment Simulator Laboratory can reproduce air-sea interface temperature conditions existing anywhere on earth. The air chamber and marine tank combination permits simulation of temperature variations from the Arctic Ocean (air, -40°F; sea, 28°F) to the Red Sea (air, 120°F; sea, 110°F). Physiological tests conducted in this laboratory were instrumental in the development of the submarine-deck exposure suit and the buoyant ballistic armored vest. The laboratory also tested the recently authorized Ship's Survival Suits used by the Coast Guard in the Great Lakes regions.

The Environmental Test Chamber Laboratory reproduces extremes of environmental conditions with temperature and relative humidity controlled from -40°F to 200°F at 5 to 100 percent RH. Different types of human work activities at different levels of work loads are simulated by use of a treadmill with variable speeds and inclinations, step tests, and other work tasks as needed. A heat lamp bank simulates radiant solar heat load. During testing, the physiological responses of test subjects are monitored through thermocouples applied to various parts of the body. The laboratory has been used in developing extreme and intermediate cold-weather clothing, firefighters' ensembles, and the recently invented portable, dry-ice, liquid-pulse-pump cooling system that can be used by a ship's engine- and boiler-room personnel to combat heat stress.

NCTRF engineers have created a unique thermal manikin that will permit NCTRF to evaluate the thermal protection of clothing and diving suits in water as well as cold air. The manikin, which simulates metabolic heat, has 10 independently heated and controlled sections made from aluminum castings. A pressure equalization system permits immersion of the manikin in water environments equivalent to submersion in 300 meters of sea water.

The Thermal Flammability Laboratory comprises: (1) the unique fire simulator apparatus that provides controlled thermal energy in the forms of infrared radiant and convective heat on fabrics and fabric insulation assemblies for firefighters' clothing; (2) the infrared radiant heat test apparatus for firefighters' fabrics; (3) standard test equipment for direct flame tests. With this equipment, the laboratory can evaluate the effects of thermal energy on fabrics in the form of flame and of conductive, convective, and radiant heat. It can determine and evaluate the relationship of heat conduction in fabric assemblies (i.e., clothing) to the probable effects on the wearer's skin and his subsequent comfort. By evaluating the effects of direct flame impingement, the laboratory can determine ignition time, rate of burn, after-flame, afterglow, and char length of standard and experimental fabrics. As the lead laboratory in the Department of Defense for firefighters' clothing, NCTRF employs this laboratory in developing fire-preventive clothing. This laboratory is now engaged in the development of a flame-retardant battle dress garment to be worn aboard ship.

30 SEPTEMBER 1981

**NCTRF**

**FACILITIES (CONTINUED)**

The Chemical Test Laboratory performs research, development, test and evaluation on fibers, yarns, fabrics, coatings, films, laminates, dyes, and finishes used in all types of general- and special-purpose protective clothing and textiles. It conducts investigations on dye formulations and chemical finishes for fibers, fabrics, leather and elastomeric products. This laboratory was used in the development of the torpedo handler's disposable garment for use as protection against the toxic fuel used in the Mark 48 torpedo. The laboratory presently is conducting slip-resistance tests on shipboard work shoes.

The Physical Test Laboratory conducts research, development, test and evaluation on the physical properties of fibers, yarns, fabrics, and fabric blends to determine their probable end-item performance in clothing and textiles. Colorfastness, breaking strength, tear resistance, abrasion resistance, aging, weather resistance, water repellency, air permeability, adhesion, stiffness and crease resistance are many of the physical properties tested in this laboratory. In general, the laboratory: (1) investigates the effect of fiber characteristics and fabric geometry on the appearance, comfort, durability, and protective capabilities of materials; (2) originates physical test requirements for standard and experimental samples; and (3) recommends physical tests to be performed on textiles and finishes for specification or procurement purposes.

The Laundry Laboratory performs research, development, test and evaluation of the laundry effects on fabrics and clothing to determine dimensional stability, colorfastness, appearance, and durability of fabrics and fabric finishes with such properties as water repellency, soil release, flame retardance, anti-stats, and softeners. The laboratory also determines suitable laundry procedures for general and protective clothing that are subjected to shipboard and special-care laundering.

The Clothing Design and Development Laboratory designs clothing, develops patterns, and prepares prototypes of all male and female conventional uniforms and accessories, utility clothing and environmental and protective clothing for the Navy and other services. The laboratory also fabricates containers to protect electronic and other equipment against the rigors of environmental hazards.

Land Owned/Leased.....1 acre

**Buildings:**

Laboratory.....10,000 square feet  
Administrative.....7,000 square feet  
Other.....3,000 square feet

**Acquisition Costs:**

Real Property  
(Classes I & II).....\$440,000  
Equipment  
(Classes III & IV).....\$975,000

**30 SEPTEMBER 1981**

## **NCTRF**

### **PROGRAM WORK**

As the principal Navy activity for conducting RDT&E of military clothing and clothing accessories, NCTRF provides technological development and support in several major program areas. The following headings represent broad fields of NCTRF research. The various sub-headings describe more specific areas of investigation.

#### **MATERIALS RESEARCH**

- Clothing and Textiles
- Leather
- Elastomers
- Coatings and Dyes
- Footwear
- Laundering Processes

#### **FIRE RETARDANCE AND HEAT RESISTANCE**

- Firefighters' Crash-Rescue Clothing
- White Phosphorous Protective Clothing
- Fire-Retardant Materials

#### **WATER IMMERSION AND BUOYANCY**

- Cold-Water Exposure
- Swimsuit Materials
- Buoyant-Ballistic Materials

#### **CLOTHING DESIGN AND DEVELOPMENT**

- Dress Uniforms and Accessories
- Utility Clothing
- Environmental and Protective Clothing
- Insignia
- Anthropometry
- Protective Containers

#### **HEAT AND COLD STRESS**

- Cold-Weather Clothing
- Cooling Systems
- Life-Support Equipment

#### **DEPTH SIMULATION**

- Divers' Clothing
- Decompression-Chamber Materials

**30 SEPTEMBER 1981**

## **NCTRF**

### **MAJOR ACCOMPLISHMENTS**

NCTRF has been integrally involved with the Navy's new battle dress program to upgrade both the occupational clothing and the damage control gear used aboard ship. During FY 81, the Chief of Naval Operations adopted the fire-retardant engineering coveralls developed by NCTRF for use in engine rooms, boilers rooms, and other hot spaces aboard ship. NCTRF also began a program to develop a fire-retardant utility uniform for all shipboard personnel. Two designs--a one-piece model and a shirt and trousers ensemble--made of various fire-retardant fabrics are being tested aboard ship. Together with the Naval Surface Weapons Center, Navy Natick evaluated various chemical warfare suits for shipboard personnel. The development of an improved chemical warfare suit is planned for FY 82. Finally, as part of the battle dress program, NCTRF has developed a quick-don submarine firefighting outfit--consisting of a hooded, high-length cape--for use at the outset of a submarine fire.

During FY 80 & 81, Navy Natick has been in the vanguard of the Navy's effort to place women on sea duty. Using the size schedule of specific body measurements contained in its published anthropometric study of Navy women, NCTRF developed and field-tested jackets, trousers, and caps for intermediate cold weather (-7°C to 5°C); cold-weather, cotton, waffle-knit underwear; and wet-weather parkas and trousers. All of these items have since been adopted for use by Navy women. During FY 81, NCTRF began developing firefighters' clothing for women.

As the lead laboratory in the Department of Defense for proximity firefighter's clothing and materials, NCTRF continued its development of improved firefighters' coats, trousers, hoods, and handwear. During FY 81, a new fabric--aluminized, woven Kevlar--was selected to replace the aluminized asbestos in all firefighters' clothing. This new fabric is lighter, less expensive, and more comfortable than its predecessor. The Navy adopted NCTRF's new design of the firefighter's glove, which features a single-component, four-finger glove to replace the cumbersome two-piece (knit insert and aluminized outer shell) standard glove. Navy Natick also began development of a new firefighter's hood with a lift-up visor to replace the standard hood, which has an uncomfortable, stationary visor.

During the past 2 fiscal years, NCTRF maintained its excellent cost reduction record. In FY 80, Navy Natick submitted cost saving proposals concerning footwear that will save the government \$5.1 million annually, based upon FY 80 dollar figures. NCTRF proposed that rubber be used instead of leather in men's dress shoes and that the Department of Defense use an all-welt construction for all men's and women's dress and work shoes. This \$5.1 million figure was nearly twice the amount of Navy Natick's entire budget for FY 80. In FY 81, NCTRF achieved a one-year saving of \$2 million by proposing several improvements in the materials and construction of military footwear. Some of these improvements can be used by all Services.

**30 SEPTEMBER 1981**

## **NCTRF**

### **MAJOR ACCOMPLISHMENTS (CONTINUED)**

To increase the protection for the sailor against fire aboard carrier decks, NCTRF designed a new flight- and hangar-deck jersey and trouser ensemble. The jersey is made of fire-retardant knit and woven materials, while the trousers contain fire-retardant cotton. A field-evaluation of these items is planned for FY 82.

To restore uniformity of appearance to the white shirts worn by male officers and chiefs, NCTRF designed two new styles of white dress shirts--one with shoulder straps and one without shoulder straps. These shirts, which have a uniform collar length and styling, are worn with the service dress blue uniform. The shirt without shoulder straps is worn with soft shoulder boards. NCTRF also developed the summer khaki, summer white, and service dress white uniforms for officers and chiefs. For the improved appearance of these items, NCTRF used the concept of vertical matching, in which the tops and bottoms of the uniforms have the same color, material, and weave.

NCTRF has developed an amphibious assault suit for the Marine Corps. The suit, a dielectrically heat-sealed garment that fits over cold-weather clothing, is a disposable outfit intended to be worn only once. The suit protects the marine from becoming wet if, in an emergency, he must enter the water during an amphibious assault. When he arrives on shore, the marine merely tears off the garment and discards it. During FY 81, NCTRF created two prototype garments--one constructed with urethane film, the other with vinyl film. In FY 82, NCTRF will evaluate these garments.

During FY 81, NCTRF developed a new yarn blend of 70-percent modacrylic and 30-percent wool, which it hopes to use as a replacement for the 100-percent wool in the standard-issue, Navy-blue, pullover sweater and in the green organizational sweater used by all Services. This new blend, which is fire-retardant, can be machine-laundered. Wool, on the other hand, must be either hand-laundered or dry-cleaned--both processes being more expensive than machine laundering. NCTRF conducted laboratory tests on both types of sweater containing the modacrylic-wool blend and received satisfactory results. Field tests of the sweater will be performed in FY 82.

During FY 81, NCTRF originated a new layering concept for cold-weather clothing which eliminates the need for two separate cold-weather ensembles in the supply system. Using this layering concept, Navy Natick designed a combination intermediate-cold-weather (-7°C to 5°C) and extreme-cold-weather (-7°C to -18°C and below) jacket. This garment contains a self-sizing liner that allows a perfect fit whether both layers are worn together or each is worn separately. NCTRF also developed a new cold-weather facemask to replace the standard item. The standard contains material that allows moisture to build inside the facemask, which could eventually lead to frostbite. The new facemask contains an outer layer of nylon and an inner layer of gortex polyurethane foam sandwiched between the nylon and cotton on the inside. This material combination results in a water-proof and breathable facemask. Moreover, an improved nose-piece design channels breathing downward to preclude moisture buildup and

**30 SEPTEMBER 1981**

## **NCTRF**

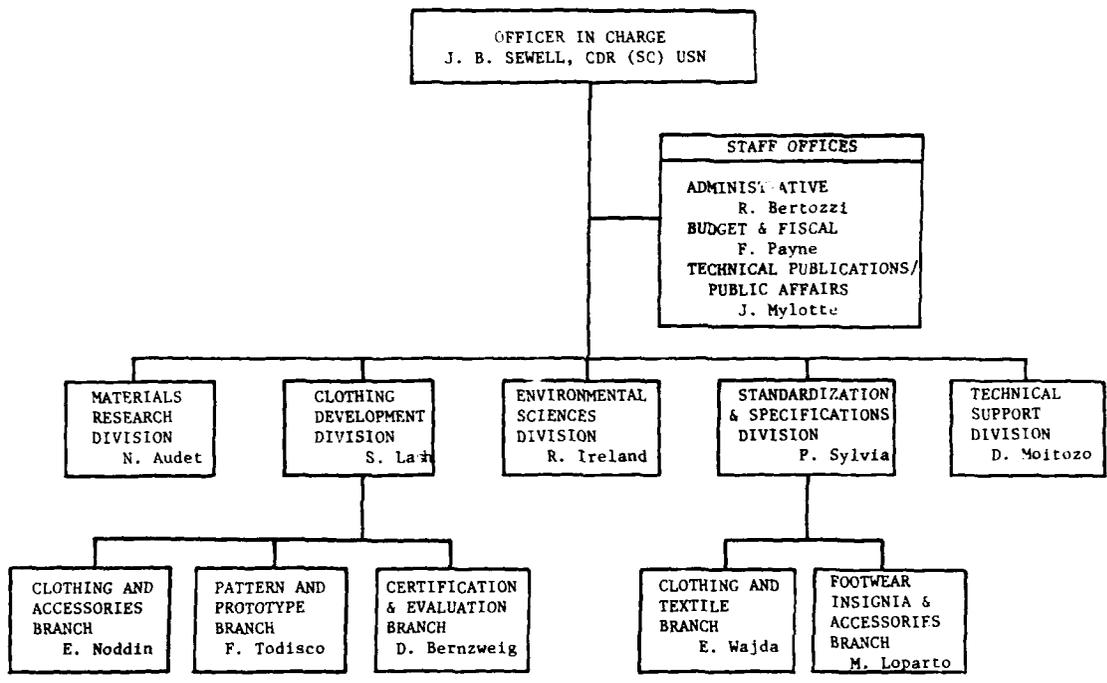
### **MAJOR ACCOMPLISHMENTS [CONTINUED]**

the fogging of eyeglasses. The facemask has been successfully tested in dry-cold environments and, in FY 82, will be tested aboard ship to evaluate its protection against the cold and heavy seaspray encountered during watchstanding activities.

During FY 81, NCTRF continued to design and develop all clothing for the U. S. Coast Guard. Included in its efforts for this program were the adoption of a new fabric for service dress uniforms and the development of a new raincoat for men and women. At NCTRF's recommendation, the Coast Guard adopted the 55-percent-polyester, 45-percent-wool, Coast Guard blue serge for the service dress uniforms of male officers and enlisted men. This fabric replaces the 65-percent-polyester, 35-percent-wool gabardine fabric of the standard. The serge, which is used by most of the Services, has better quality, appearance, durability, and is more available than the standard fabric. To replace the Coast Guard's all-weather raincoat concept, NCTRF created a strictly foul-weather coat, which fits better, costs less, and is easier to manufacture.

**30 SEPTEMBER 1981**

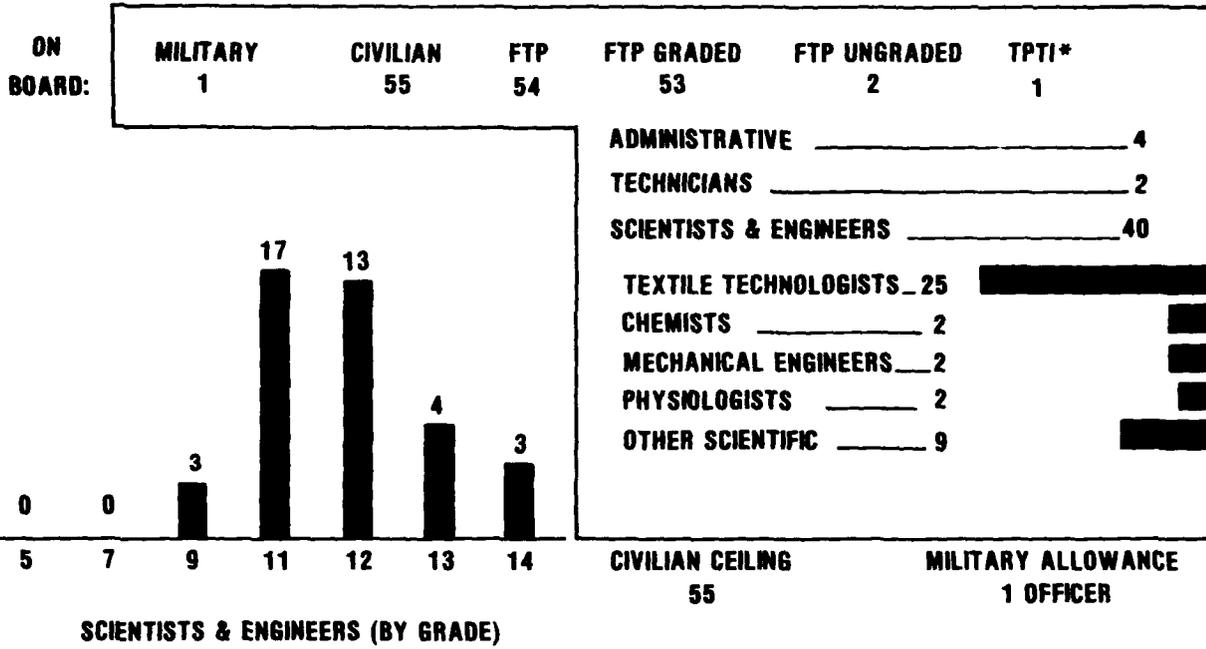
**NCTRF**



DATE: 30 SEP 1981	APPROVED: <i>J. B. Sewell</i> J. B. SEWELL Commander, (SC) USN Officer in Charge	Parent Organization: NAVY RESALE AND SERVICES SUPPORT OFFICE	Field Activity: NAVY CLOTHING AND TEXTILE RESEARCH FACILITY	Chart No. 1 (Rev.)
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**NCTRF**

**PERSONNEL**



\*Temporary, Part-time, Intermittent (Summer Employees Excluded)

30 SEPTEMBER 1981

**NCTRF**

**NOA**

**SOURCE OF FUNDS**

**(\$ IN THOUSANDS)**

SOURCE	FY 81 (ACTUAL)		FY 82 (EST)		FY 83 (EST)	
	DOLLARS	PERCENT	DOLLARS	PERCENT	DOLLARS	PERCENT
NAVSUP	2,086	63	1,984	57	2,288	62
NAVSEA	756	22	1,300	38	1,300	35
NMPC	226	7	—	—	—	—
USCG	120	4	130	4	130	3
USA	126	4	22	1	—	—
OTHER NAVY	14	—	5	—	—	—
<b>TOTAL</b>	<b>3,328</b>	<b>100</b>	<b>3,441</b>	<b>100</b>	<b>3,718</b>	<b>100</b>

**NAVSUP - NAVAL SUPPLY SYSTEMS COMMAND — NAVSEA - NAVAL SEA SYSTEMS COMMAND**

**NMPC - NAVAL MILITARY PERSONNEL COMMAND — USCG - U.S. COAST GUARD**

**30 SEPTEMBER 1981**

**USA - U.S. ARMY**

**NCTRF**

**NOA**

**FUNDS BY TYPE**

(\$ IN THOUSANDS)

TYPE	FY 81 (ACTUAL)		FY 82 (EST)		FY 83 (EST)	
	DOLLARS	PERCENT	DOLLARS	PERCENT	DOLLARS	PERCENT
6.1 RESEARCH	—	—	—	—	—	—
6.2 EXPLORATORY DEVELOPMENT	700	21	542	16	450	16
6.3 ADVANCED DEVELOPMENT	—	—	—	—	440	12
6.4 ENGINEERING DEVELOPMENT	—	—	—	—	—	—
6.5 MANAGEMENT & SUPPORT	470	14	482	14	390	11
6.6 OPERATIONAL SYSTEMS DEV.	—	—	—	—	—	—
O&MN	916	27	960	28	1,008	27
U.S. COAST GUARD	120	4	130	4	130	3
REIMBURSABLE	1,122	34	1,327	38	1,300	35
<b>TOTAL</b>	<b>3,328</b>	<b>100</b>	<b>3,441</b>	<b>100</b>	<b>3,718</b>	<b>100</b>

**30 SEPTEMBER 1981**

NCTRF

NOA

**RD&E FUNDS BY CATEGORY**

(\$ IN THOUSANDS)

CATEGORY	FY 81 (ACTUAL)		FY 82 (EST)		FY 83 (EST)	
	DOLLARS	PERCENT	DOLLARS	PERCENT	DOLLARS	PERCENT
6.1 RESEARCH	—	—	—	—	—	—
6.2 EXPLORATORY DEVELOPMENT	700	59.8	542	52.9	450	35.2
6.3 ADVANCED DEVELOPMENT	—	—	—	—	440	34.4
6.4 ENGINEERING DEVELOPMENT	—	—	—	—	—	—
6.5 MANAGEMENT & SUPPORT	470	40.2	482	47.1	390	30.4
6.6 OPERATIONAL SYSTEMS DEV.	—	—	—	—	—	—
<b>TOTAL</b>	<b>1,170</b>	<b>100</b>	<b>1,024</b>	<b>100</b>	<b>1,280</b>	<b>100</b>

30 SEPTEMBER 1981

**NCTRF**

**NOA**

**DISTRIBUTION OF FUNDS**

**(\$ IN THOUSANDS)**

CATEGORY	FY 81 (ACTUAL)		FY 82 (EST)		FY 83 (EST)	
	DOLLARS	PERCENT	DOLLARS	PERCENT	DOLLARS	PERCENT
LABOR	1,571	54	1,600	48	1,675	45
MATERIALS/SERVICES	1,018	35	1,443	41	1,618	44
INTERSERVICE SUPPORT AGREEMENT (NATICK R&D LAB)	165	6	248	7	270	7
TRAVEL	148	5	150	4	155	4
<b>TOTAL</b>	<b>2,902</b>	<b>100</b>	<b>3,441</b>	<b>100</b>	<b>3,718</b>	<b>100</b>

**30 SEPTEMBER 1981**

## **NCTRF**

### **FUNCTIONS AND RESPONSIBILITIES**

In the accomplishment of its mission, NCTRF must:

1. Perform research, development, test and evaluation in textile fibers, fabrics, colorants, functional finishes and coatings, clothing and related material, for the safety, protection, health and well being of Naval personnel in the marine climate and occupational environment of surface ships and submarines.
2. Design the articles of the Naval uniform including distinctive insignia, and provide advice to the Chief of the Navy Supply Corps in his function as technical member of the Navy Uniform Board.
3. Prepare Military and Federal specifications and standards for use in the procurement and production of clothing and textiles for the Navy.
4. Evaluate and render decisions on applications for waivers in or deviations from established standards and specifications for Navy clothing and textiles.
5. Provide technical advice to the Defense Personnel Support Center in the procurement, supply, and cataloging of Navy clothing and textiles.
6. Prepare instructions on the fitting, alteration, care and maintenance of Navy clothing.
7. Conduct a certification program for articles of the Naval uniform to provide warranties

by manufacturers; that such articles, offered for sale to Naval personnel outside the Navy Supply System--commercial outlets and Navy Exchanges--will meet or exceed prescribed standards.

8. Perform test and evaluation of laundry and dry cleaning supplies and procedures, and prepare instructions for the care and maintenance of clothing in the supply system.

9. Conduct continuing technical surveillance of and liaison with the scientific, academic and industrial communities and other Government agencies in the application of technology to advance the *state-of-the-art*, avoid unnecessary duplication of effort and achieve economies in methodology and end products.

10. Perform similar functions, as above, for the U. S. Coast Guard in time of war or when requested.

11. Initiate and maintain an exchange of technological information on clothing and textiles between the U. S. Navy and the navies of friendly foreign countries.

**30 SEPTEMBER 1981**