Apr 1st, 8:00 AM

Technology Transfer and the Coast Guard R&D Center

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This paper is intended to present an overview of the Coast Guard Research and Development Center's active participation in the transfer of science and technology to local governments, foreign governments, industry, colleges and universities, and other federal agencies.

The R&DC became a member of the Federal Laboratory Consortium in 1976. Association with this august body was strongly supported by then Secretary of Transportation Coleman as evidenced by a statement of National Policy made by him on 17 September 1975 "...effective dissemination of information about new technology, community demonstration projects, and financial incentives to utilize cost effective, energy-efficient technology are essential elements of a complete R&D program...", we still feel that this association is a prime vehicle to insure that we get our science and technology in the hands of interested users. The description or definition of the consortium essentially paralleled the Secretary's policy - "...as the process by which capabilities developed under Federal R&D funding are transferred to fulfill actual or potential public or private needs...". We have reached out - we have extended ourselves by becoming active in Federal Laboratory Consortium activities, becoming a member of the New England Innovation Group, and discussing technical transfer as a philosophy wherever and whenever the occasion arises. The message early in this paper is that the CG R&DC is with it - we have top management support and the technical momentum is quite strong.

Before we go any further, a brief description of the U.S. Coast Guard and the evolution of the Research and Development Center might be in order.

Since its founding in 1790, the United States Coast Guard; the nation's oldest, continuous maritime service, has met all technical and scientific challenges as they occurred, often having to conduct research and evaluation as an adjunct to its regular work. However, in today's changing world, with its increasing scientific and technological demands, it was recognized that research and development, as well as test and evaluation, could be most effectively handled by an integral Coast Guard organization devoted exclusively to such tasks. Accordingly in 1968, the Office of Research and Development was established at Coast Guard Headquarters in Washington, D.C., to fill this need. In the next few years this office increased its staff to approximately 140 personnel, yet it became increasingly clear that additional in-house support was required. With this in mind, the Commandant, with concurrence of the Secretary of Transportation, disestablished the Coast Guard Field Testing and Development Center, Curtis Bay, Maryland, and combined personnel and equipment from there and the Applied Science Division, Office of Research and Development, and established the R&D Center, at Avery Point, Groton, Connecticut, in August of 1972. In 1977, technical direction of the Coast Guard Fire and Safety Test Facility, located in Mobile, Alabama, was assigned to Commanding Officer, Coast Guard Research and Development Center, and became a detachment thereof.

Our mission is to conduct applied research and develop, test, and evaluate operational techniques, concepts, systems, equipment, and materials in support of the operational and regulatory programs of the Coast Guard with the following objectives:

- Increasing the capacity of the national marine transportation systems.
- Improving maritime law enforcement.
- Protecting and enhancing the marine environment.
- Protecting public safety at sea and in territorial waters.
- Reducing cost and manpower requirements.

The organizational structure of the R&D Center features three divisions; two technical and one administrative, reporting to the Commanding Officer via the Technical Director. The Physical Science and Technology Division includes the Chemistry, Electronics, and Physics Branches while the Marine Safety, Oceanography, and Ocean Systems Branches are components of the Ocean Science and Technology Division. The Administration and Services Division provides all support services which are divided between the Administration, and Finance and Supply Branches.

Just as a vertical control structure is necessary in a logical chain of command, even greater emphasis is required to maintain horizontal relationships through common interest in project activities.

This lateral interface is accomplished in two ways: first by developing an organizational approach based upon a need for branches to interact; and, secondly, by acquiring a wide range of specialists assigned to six professional areas.

Consequently, interactive science and engineering can be applied to problems requiring a multi-discipline approach. For example, in many instances, such as search and rescue or oil pollution identification, the primary responsibility will be assigned to one branch but several branches may be associated in the project effort.

Overall, what has been achieved is an improved response, at less cost, from a relatively small but highly effective organization.

In summary then, there is really only one project team - that of the entire R&D Center Staff.

What technology is transferred and how does this transfer take place. I would like to share with you a few examples of the methods used by the CG R&DC in making our technology and personnel available to anyone in need of the resources developed at the CG R&DC.

Perhaps the most immediate example of technology transfer in action is the preparation, presentation and documentation of the discussion points included in this paper. For presentation purposes the following paragraphs will discuss, (1) the areas of expertise and, (2) how that technology is transferred.

Developments in the Area of Fire Safety

Fire at sea has always been one of the calamities most dreaded by seamen. The most successful approach in trying to eliminate this enemy has been through the use of information gathered from fire tests conducted onboard actual vessels. It is difficult, if not impossible, to relate small scale tests to what will occur in an actual shipboard fire. For this reason, the Fire and Safety Test Detachment, located in Mobile, Alabama was established. The Detachment comes under the direction of the Coast Guard's Research and Development Center.

The primary function of the Detachment is to evaluate full scale, possible improvements for the safety of the maritime community. Active testing at the Detachment began in July, 1969. Areas investigated or slated for investigation include:

- Evaluation of new firefighting systems (high expansion foam, Halon 1301, etc.)
- Evaluation of special purpose systems (dry chemical for liquified natural gas)
- Evaluation of structural materials (aluminum superstructures in tankers, fiberglass hatch covers, etc.)
- Evaluation of protective or lifesaving equipment.
- Evaluation of new materials for critical systems such as cargo lines, overboard discharges, etc.
- Fire performance evaluation of containerized cargo systems

Transfer of Fire Research Technology

Reports on fire tests conducted at the CG R&DC Mobile, Alabama Detachment are available through the National Technological Information Service, Springfield, Virginia. The following representative reports are considered significant in the industry:

- Machinery Space Fire Detecting Tests.
- Fire Testing of Independent Fiberglass Fuel Tanks With and Without Protective Coating of Fire Retardant Paint.
- An Investigation into the Effectiveness of Halon 1301 (Bromotrifluoromethane (CBrF3) as an Extinguishing Agent for Shipboard Machinery Space Fires.
- Report of Deck Foam Fire Extinguishing Test Aboard M/V RHODE ISLAND.
- Report on Foam - Dry Chemical Compatability Testing Aboard M/V RHODE ISLAND.
- The Effectiveness of "Fire Gas Recirculation" Extinguishing Systems on Shipboard Machinery Space Fires.
- Report on Fire Extinguishing Effectivness of a Synthetic Surfactant Foam.
- Fire Exposure of Life Rafts.
- Fire Tests of Resiliently Seated Butterfly Valves.
- Obstructed Fire Tests on Hand-held Fire Extinguishers for Recreational Boats.
- High Expansion Foam Extinguishment of Machinery Space Fires.
- Development of Explosion Suppression System Requirements for Shipboard Pumprooms.
- Estinguishment of Engine Compartment Fires in Recreational Boats.
- Full Scale Ship's Hull Exposure Fire Tests.
- Fire Exposure Tests of Polyethylene and Fifty-Five Gallon Steel Drums Loaded with Flammable Liquids.
- Evaluation of Nozzles to be used with AFFF and the Coast Guard Inline Proportioner.
- Automated Deck Foam Fire Extinguishing Systems.

Examples of direct transfer of the technology evolving from above studies are:

- 30 or more visitors from government, industry and other countries to our Fire and Safety Test Detachment in Mobile, Alabama.
- Over 200 business', consultants, colleges and universities, and government agencies notified of all fire tests through a series of notices.

Action through consortium members - The technology transfer coordinator for the State of Oregon, Gerry Miller; who incidentally is on an IPA assignment,

referred an unusual fire extinguishing problem to the technology transfer coordinator at the CG R&DC. He had read somewhere that the Coast Guard had on the drawing board, a droppable pump that could be used for extinguishing fires on small boats. He sought information on this pump or any similar equipment that, potentially, could solve a problem having to do with a dirigible hanger in the event fire occurred at the very top - 360 feet high. He was referred to our fire expert who, after listening to the problem, referred him to a Coast Guard Headquarters R&D Staff member who was working on a transportable pump that conceivably could reach significant heights.

Dr. Charles Bates, Scientific Administrator to the Commandant often times refers people from the public or private sector to the R&DC for transfer of technology. He recently referred the Dean of Mechanical Engineering, Texas A&M, who is interested in observing and learning how to conduct fire tests aboard vessels, to our Fire Research Project Manager. It seems that the Dean desires to develop similar testing facilities as part of his academic program. Dr. Bates frequently is asked for information regarding a variety of scientific problems. For example, he received a phone call from the New York Port Authority asking - "how to determine the amount of grease to be kept on railroad wheels to cut down the screeching and wear on curves without accumulating excessive grease on top of the rail proper, which causes uneven traction". By using the consortium directory, he was able to refer him to the Army Mobility Laboratory at Fort Belvoir.

Other Methods Used to Transfer Fire Research Technology

Results of fire research have been disseminated through technical papers at:

- National Fire Protection Association
- Society of the Plastics Industries
- Offshore Technology Conference
- American Society for Testing and Materials
- American Society of Naval Engineers
- Intra-Governmental Maritime Consultative Org.
- International Association of Fire Chiefs

Results often end up as authoritative sources in technical reports prepared by others. "Explosion Protection Evaluation for the Brent B Offshore Installation", prepared for Shell UK Exploration and Production Company, Limited, Shell Centre, London, SE1 6NA, October 1977, is a representative example.

Oily/Water Separator Equipment

In 1975 the Coast Guard Research and Development Center was requested by Coast Guard Headquarters Office of Research and Development to install an oily/water separator testing laboratory and to conduct tests of oily/water separators to validate the then proposed IMCO (Inter-Governmental Maritime Consultative Organization) specification for such equipment.

The R&D Center satisfied this request by installing an oily/water separator test loop in the No. 4 hold of its test ship, SS MAYO LYKES; a Victory type cargo vessel, located at Little Sand Island, Mobile, Alabama. The test loop was designed to utilize the ship's deep, double bottom and potable water tanks for influent test water, effluent discharge and oil slop storage.

Test oil storage was provided by four 1000-gallon capabity tanks.

Provision was made to inject known amounts of particulate matter or detergents into the influent to determine their effects on separator operation. A motion (shaker) table was installed to simulate shipboard motions at sea and to evaluate their effects on separator operation.

The laboratory installation was completed and placed in service in the spring of 1976. Since then, tests have been conducted on several types of oily/water separators including those of the multi-stage coalescent filter types and combination plate separator and coalescent filter types.

Transfer of Oily Water Technology

- Technical report No. CG-D-33-77 Task No. 774305.2, "The U.S. Coast Guard Oily/Water Separator Testing Laboratory" has been individually distributed to those U.S. industrial firms who expressed interest in participating in or becoming a certification testing laboratory in accordance with the proposed U.S. rules.

- Industry, through "Proposed Rules for Oil Pollution Prevention", published in the Federal Register, June 27, 1977.

Oil Identification

The objective of oil spill identification work is to develop a forensic system which can be used in enforcing the Federal Water Pollution Control Act. The operational Coast Guard has a functioning Central Oil Identification Laboratory for this purpose with a number of satellite laboratories at COTP offices throughout the country. These laboratories have already demonstrated some deterrent effect on accidental oil spills or illegal discharges.

Transfer of Oil Identification Technology

The Chemistry Branch has worked primarily in the field of oil identification since the inception of the CG R&DC in 1972. Technology transfer of the methodologies developed by the Chemistry Branch, or its contractors, is accomplished by various means such as: formal reports, publication of papers, participation in symposia, seminars, workshops and committees.

There are at present 19 formal reports published which include oil spill identification, sampling systems, dissolved hydrocarbons and tar ball studies. The reports are written by Chemistry Branch personnel or their contractors in academia or industry and are available through NTIS.

Presentation of papers have included two at the American Chemical Society Meetings, and 35 at five annual Pittsburgh Conferences. One presentation was made

at the 1977 Annual Meeting of the American Bar Association. Several have been made at nearby universities and local organization meetings.

Several Chemistry Branch members are active participants in the American Society for Testing and Materials in their development of consensus standard methods. Two methods were generated under subcommittee chairmanship of Chemistry Branch members, were balloted and are due for publication in March 1978.

Eight papers have been published in international journals such as Analytical Chemistry and Environmental Science and Technology. More are pending.

Chemistry Branch members have chaired, or been major participants in numerous symposia and workshops, among which are:

- Oil Spill Identification Symposia, organized and chaired for the last five years at the Pittsburgh Conference.
- The Bi-Annual Oil Spill Conferences, co-sponsored by EPA, API and USCG.
- An Infrared Pattern Recognition Conference, sponsored by the R&DC, held in Groton in 1975.
- A Workshop on Pattern Recognition Applied to Oil Identification contracted for by the R&DC and chaired by R&DC personnel, held in Coronado, California in 1976.
- Participation in the National Bureau of Standards Workshops on Standard Reference Materials for Offshore Drilling.
- Participation in the symposium entitled "In the Wake of the ARGO MERCHANT" at URI, 1978

The foregoing activities have brought the work of the Chemistry Branch to the attention of all parts of the globe, as evidenced by reprint requests and notable visitors, such as a Government Laboratory Director from Adelaide, S. Australia, and a well known researcher from the Venezuelan Institute of Scientific Investigations. We have had government visitors from, for example, the Connecticut State Health Department, and the U.S. Environmental Protection Agency (including the Director of the Gulfbreeze, Florida laboratories). We have had professors from numerous universities (University of Maryland, University of Rhode Island, University of Connecticut, etc.), and a graduate student from Penn State visit to learn our techniques or obtain data.

We have a request from the Chief of the Fire Investigation Section, National Institute of Police Science in Tokyo, Japan, to work in our laboratories for 2-3 months during 1978. This will involve direct technology transfer.

In the same vein of direct technology transfer, we have established a good working relationship with the University of Connecticut. Currently, a professor is engaged in a Coast Guard project, working at the CG facility in a cooperative study. A student is doing a directed study project on the effect of oil clean-up dispersants on the capability to fingerprint the oil to determine its source. A graduate student is contemplating doing a thesis under CG auspices with a Chemistry Branch member designated as an adjunct professor.

The following list of reports prepared or monitored by the Chemistry Branch are available through NTIS:

- A portable Gas Chromatographic Technique to Measure Dissolved Hydrocarbons in Sea Waters
- A Quantative and Qualitative Survey of Oils and Tars Stranded on Galveston Islands' Beaches
- Field Infrared Method to Discriminate Natural Seeps from Non-Seeps (Santa Barbara, California Area)
- Monitoring Dissolved Hydrocarbons as a Function of the Tidal Cycle (New York Harbor)
- Studies on the Composition and Aging of Marine Tars
- Oil Spill Identification System
- Use of Pattern Recognition Techniques for Typing and Identification of Oil Spills
- Methods of Identifying Source of Petroleum found in Marine Environment, Report II
- Identification of Oil Slicks by Infrared Spectroscopy
- Classification of Oils by the Application of Pattern Recognition Techniques to Infrared Spectra
- Oil Spill Identification Bibliography
- An Oil Slick Sampling System
- Identification of Weathered Oil found in the Marine Environment
- Discrimination of Waste Oils by Micro Emission Spectra Chemical Analysis
- Tar Ball Distribution in the Western North Atlantic Ocean
- Methods of Identifying and Determining Source and Age of Petroleum Found in the Marine Environment
- Tar Pollution Survey at Golden Beach, California
- Weathering of Oil at Sea
- Galveston Harbor: Factors Affecting Pollution and Pollution Monitoring

Transfer of Oil Identification Technology - (The Hard Way)

The ultimate test of the system is its success in the courtroom. Two cases have been tried in Federal Court, one using EPA data with expert backup testimony from the R&D Center; the other using R&D Center

analyses. Both were won by the Government. This is the hardest test of technology transfer, because it involves the transfer of technical information to lay persons.

On 17 January 1978 two health officers of the Connecticut State Department of Health visited the R&D Center for orientation and familiarization of the Chemistry Branch's activities in oil identification and particularly to learn details of the Coast Guard's gas chromatography methodology in this area. The Health Department's gas chromatographic work is applied for classification of oils such as gasolines which leak from old storage tanks and find their way into underground telephone or electrical conduits and dissolve plastic insulation. The two visitors were given detailed demonstrations and instructions on how to utilize, accurately, the Coast Guard's chemical analytical technique of dual detection gas chromatography for the Health Department's specific application. Thus, the R&D Center was able to provide a technology transfer for a related, yet different endeavor from the Coast Guard's oil spill identification activity.

Solar Powered NAVAIDS

The Physics Branch has made substantial progress in its research projects for solar-powered NAVAIDS and improved techniques for A/N positioning. The project to use solar energy on buoys is achieving interesting and tangible results. We have progressed from the simple life testing of 53 complete power systems on the rooftop of an R&D Center Laboratory to the start of a full-scale operational evaluation of 50 power systems in Miami, Florida. Results of both these efforts will be meshed into the computer simulation model. Together with the accelerated life testing procedures developed at the R&D Center, test results will provide the operational Coast Guard with procurement specifications for reliable solar power units.

Transfer of Solar Power Technology

During the early period of study, the Jet Propulsion Laboratory (JPL), California Tech was requested by ERDA to do a literature search and an industry search for any activity in photovoltaic technology. JPL found that the CG R&DC had the only significant body of information on test data available anywhere. The CG R&DC was recognized as the technological leader since we had done a great deal of photovoltaic applied research. JPL called upon our scientists and technical people for procurement specifications, design and data philosophy.

Naval Underwater Systems Center (NUSC) scientists used some of our technology integrating it with studies they were doing in Solar Thermal design.

A contract effort conducted by the Navy (CRANE) in which the various lead acid and NiCad type batteries were compared, resulted in the recommendation that lead acid be used because of its low cost and general availability. Farwest Corrosion Company and other battery manufacturers visited our laboratories to learn more about storage of photovoltaic source and battery life cycle under natural environment conditions.

Side Scan SONAR

During 1976, an underwater search team was deployed at the request of CG Headquarters on three urgent quick-response operations. These involved searching for a Cessna-150 aircraft lost in Long Island Sound, a charter fishing vessel lost off the mouth of the Columbia River in Oregon, and a Piper Navaho aircraft lost off Newport News, Virginia. The searchers used the R&D Center's side-scan SONAR and micro-wave precision positioning system and comprehensively searched the designated search areas but did not locate any of the lost objects. During the operation off Newport News, Virginia, the search team relocated a sunken barge which had migrated along the bottom and represented a potential threat to navigation. The Cessna-150 was subsequently located by a fishing dragger more than one mile from the designated search area.

Technology Transferred to the Coast Guard R&D Center

The side scan SONAR which had been developed primarily for use in the geophysical industry for sea-floor surveys in connection with pipeline installation,etc. has been used by the CG R&DC for underwater searches. For example, the side scan SONAR was used by the R&DC in the successful search and location in 1975 of the wreck of the EDMUND FITZGERALD in 525 feet of water in Lake Superior. The use and adaptation of this equipment by the USCG is an example of technology transfer sought by the Coast Guard.

Search and Rescue and Boating Safety

The CG R&DC has developed many new concepts and equipment designs in the area of search and rescue (SAR) and recreational boating safety. An overview of a few examples are:

Search Planning - The Coast Guard has sophisticated electronic and computer facilities available for planning and executing search and rescue missions at sea. An expendable device for measuring surface currents from aircraft or boats has been designed to determine more accurate values for the leeway of search objects. These contributions enhance the Coast Guard's ability to protect public safety at sea with improved search and rescue systems.

Vacuum Grip Towing System - A towing system consisting two 10-inch diameter vacuum grips, a 5/8-inch double braided nylon bridle with snap shackles and a traveling block, all stored in a floatable lightweight waterproof storage container was developed to reduce damage to the assisted craft's deck fittings and appendages during towing and refloating operations. Adaptable to boats from 17 feet to 45 feet in length, the vacuum grip towing system is a definite asset in Coast Guard towing operations.

Motor Rescue Boat - Two years of technical and operational evaluations coupled with modifications and model testing resulted in transforming the experimental 26-foot motor rescue boat to a prototype for a production motor rescue boat. MRBX not only survived the rigors of actual operations but also

performed most capably without the benefit of specially trained operators or technicians. The MRB type design fulfills the need for a high speed personnel rescue boat which can operate in 8 to 10 feet of plunging surf, as well as in shallow bays and rivers. This boat could satisfy many of the operational missions now performed by 44-foot motor lifeboats at considerably less cost in purchase and operating expense.

Underwater Search - The Coast Guard's mission responsibilities extend below the sea surface. The U.S. Congress has explicitly affirmed this within recent years by modifying the Coast Guard's statutory authority by adding the phrase "and under" to phrases that previously read "on the high seas...". The R&D Center has an undersea search capability that is completely portable and can be operated by one person. Our expertise and equipment can be deployed from available CG field boats/vessels as required to perform undersea search missions. The R&D Center has conducted several undersea searches including those for the Civil War ironclad MONITOR, the sunken tug COURAGEOUS in the waters off Port Jefferson Harbor, New York, and the location of the ore carrier EDMUND FITZGERALD in 525 feet of water in Lake Superior.

Transfer of SAR and Boating Safety Technology. A graphical presentation of the USCG R&D Center's efforts in technology transfer in this field are as follows:

How \ To	1	2	3	4	*
SAR (Search and Rescue)					
Coast Guard SAR Seminars	X	X			
International Forums					
International Lifeboat Conference		X			
NTIS	X	X	X	X	
Professional Societies	X	X	X	X	
Boating Safety					
Boating Safety Advisory Council (BSAC)	X	X	X	X	
NTIS	X	X	X	X	
American Boat Yacht Council Committee Membership			X		
Professional Societies			X	X	
CG Auxiliary Meetings				X	

Other Examples of Technology Transfer Involvement:

- Port Authority Allegheny County, Pittsburgh, Pennsylvania Librarian wanted a listing of our R&D publications.
- Other countries which have requested listings of our activities, reports, etc., include Kuwait, Iran, Canada, etc.
- Connecticut Conference of Municipalities.

Bob McDonald on an IPA assignment to CCM referred an oil problem from the State of New Hampshire to the CG R&DC. The problem had to do with the possible effects of petroleum and or wax being present in the concrete which would prohibit the bonding of "TAC Coat" for use on a tennis court.

- George Lindstedt, Chairman of this panel referred a problem of "Navigation Aids re: Bridge". Apparently, somewhere in Puget Sound a ship's captain wanted to know if there was technology to determine the height of bridges spanning rivers. Our Coast Guard expert was given the problem and responded negatively.

The above are examples of those actions channelled through consortium members.

Another method used by the CG R&DC for transfer of technology is an extensive mailing list compiled from the 1977 Technology Transfer Directory of People. This directory lists people who are interested in the process of technology transfer. It was prepared by the California State University at Sacramento, California and the Naval Post-Graduate School at Monterey, California, for the National Science Foundation, RANN and Program Division of Intragovernmental Science and Public Technology. Mailing contents consist of CG R&DC brochures, annual reports, significant accomplishments and other information tailored for the particular area of interest/expertise of addressees.

An important element of the Consortium activities is the networking of the member laboratories. In order to operate as an effective national resource, the member laboratories must, and do, communicate and coordinate with each other. Each laboratory is familiar with the capabilities and activities of the other laboratories. Technology transfer opportunities, activities, and experiences are shared to make the best use of these resources. An example of the CG R&DC sharing is the Connecticut Coastal Awareness Day - an annual event open to the public on marine activities along the Connecticut coastline.

In a recent NATO technology transfer conference in Portugal on 6-11 November 1977, Dr. Bates, William Mokin and David Hairly presented a paper entitled "Technology Transfer Mechanisms for a Multi-Purpose Sea Going Force"; inasmuch as the U.S. Coast Guard already maintains a Loran-C network in Europe for NATO, expanding on some of the civil developments and uses of this type of navigation.

Other Techniques in Transfer of Technology Used by the CG R&DC:

Foreign Exchange Program - Mr. Hiroshi Abe of the National Institute of Police Science, Tokyo, Japan, will be working in our laboratory for 2-3 months to

study oil identification techniques.

Federal Laboratory personnel exchange program; University Professorial assignments, plus a host of other exchange programs available through the Civil Service Commission.

Attendance at the Tech X'78 "World Fair Technology Exchange". Here we add to our network of contacts and provide others with the R&DC central point of contact.

Use of Unique Equipment - NUSC/Newport Technician and an individual from DuPont Fibers Group use of specialized tensile testing machine to test sample batches of rubber and various types of synthetic lines, cable, etc.

The Commanding Officer and Technical Director have assigned me the responsibility of administering the Technology Transfer Program. As illustrated in the foregoing text, this program essentially deals with the spin off of technologies derived from mission oriented research developments to other non-agency use. Our program is designed to work within the broad policies of the Federal Laboratory Consortium which is to increase the use of Federal Laboratories' unique expertise and R&D products toward the solution of problems facing our Government agencies and private industries.

In order to sustain and enhance this program, we have generated continuing in-house interest among our scientists and technical personnel to be responsive by dealing directly (person-to-person) with those in need.

The Coast Guard R&D Center at Groton, Connecticut, is an active link in the Federal Laboratory Consortium.

* 1 = U.S. and State Governments
2 = International
3 = Industry
4 = Public