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HOUSE ARMED SERVICES COMMITTEE

EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

WRITTEN STATEMENT OF

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BEFORE THE

EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

OF THE

HOUSE ARMED SERVICES COMMITTEE

ON

DEPARTMENT OF DEFENSE LABORATORIES: INNOVATION THROUGH SCIENCE AND ENGINEERING IN SUPPORT OF MILITARY OPERATIONS

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INTRODUCTION

My name is Dr. Edward Franchi. With Dr. John Montgomery's retirement in August after 14 years of service as Director of Research at the U.S. Naval Research Laboratory (NRL), I serve as the Laboratory's Acting Director. I have been NRL's Associate Director of Research for Ocean and Atmospheric Science and Technology since 2008.

I want to thank you for the opportunity to talk about NRL's work, how it performs its science and technology mission, and some of the challenges it faces to the successful execution of that mission. I also want to express my appreciation to this subcommittee for the many important ways it has over the years supported the vital work of the Defense Department's laboratories.

NRL'S IMPACT

NRL was born from an idea conceived in 1915 by the great inventor Thomas Alva Edison. Concerned that America would be eventually pulled into World War I, Edison urged the government to:

> "Maintain a great research laboratory, jointly under military and civilian control. In this could be developed . . . all the technique of military and naval progression, without any vast expense. . . . At this great laboratory we should keep abreast with every advanced thought."

Edison, Assistant Secretary of the Navy Franklin D. Roosevelt and the Naval Consulting Board were together instrumental in ensuring that this idea became a reality on July 2, 1923. The principal speaker at the new facility's opening was Theodore Roosevelt, Jr., who had followed his father, Theodore, and cousin, Franklin, into the job of assistant secretary of the Navy. As the Naval Consulting Board recommended, NRL was placed administratively in the secretary's office, under the assistant secretary. This was done to allow it to become a research establishment *for the whole Navy*, in other words, a corporate laboratory.

At its most elemental, Edison's idea was that NRL, working in league with industry, and knowledgeable of naval needs, would help build American sea power through long-term, mission-related research and development, all with the purpose of defending the republic. For more than 90 years now, NRL has fulfilled the inventor's vision. This was recognized in 2005 when the Navy League's New York Council bestowed the Laboratory with the Roosevelts Gold Medal for Science. The Council noted that NRL had "helped make the U.S. Fleet the most formidable naval fighting force in the world," and called it "the Government's premier defense research laboratory."

Some examples of NRL's numerous achievements over the years include:

EARLY YEARS TO WORLD WAR II

- Discovery of the "skip-distance effect," which laid the foundation for modern HF wave-propagation theory and led to the acceptance of HF radio frequencies in naval communication
- Invention of the first U.S. radar, the XAF, which transformed naval, ground, and air warfare. It was fielded in time for duty in the great Pacific naval battles of World War II, contributing to crucial victories at Coral Sea, Midway, and Guadalcanal
- Development of first operational U.S. sonar, which transformed surface and undersea warfare

COLD WAR

- Pioneering the fields of space-based astronomy and x-ray astronomy, which led to the award of the National Medal of Science to NRL's Dr. Herbert Friedman
- Invention of America's first operational intelligence satellite (GRAB I), launched only 52 days after a U-2 aircraft was lost on a reconnaissance mission over the Soviet Union
- Development of Aqueous Film-Forming Foam, a firefighting agent used aboard U.S. aircraft carriers, by all branches of the U.S. armed forces, as well as by fire departments around the world
- Development of the original concept and prototype satellites (NTS-1 and NTS-2) for the NAVSTAR Global Positioning System, which led to the award of the prestigious Collier Trophy to NRL and the National Medal of Technology to NRL's Roger Easton
- Pioneering direct methods of molecular structure analysis, which led to the award of the Nobel Prize to NRL's Dr. Jerome Karle and the National Medal of Science to Dr. Isabella Karle

REGIONAL CONFLICT AND GLOBAL TERRORISM

- Development of the ALE-50 decoy, which is credited with saving several aircraft in the Kosovo campaign alone and earned the name "Little Buddy" from U.S. pilots
- Development of the InfraLynx system, which provided for assured communication capabilities during emergencies. It was deployed for events such as the Winter Olympics, Super Bowl, WMD training drills, and natural disasters such as Hurricane Katrina
- Development of *Dragon Eye*, a hand-launched 5.5-pound surveillance plane with the radar signature of a bird. Carried by U.S. Marines in a backpack, it was deployed in the battle for Fallujah. A model is on exhibit at the National Air and Space Museum.
- Development of CT-Analyst, a tool to provide first-responders with accurate, instantaneous, three-dimensional predictions of chemical, biological, and radiological agent transport in urban settings. It was deployed for both the 2009 and 2013 Presidential inaugurations.

FOCUS ON FUTURE WARFIGHTING CAPABILITIES

In the Naval S&T Strategic Plan, there are nine Naval S&T Focus Areas, within which there are defined specific Objectives and associated S&T Research Areas. NRL's S&T programs are mapped to the Focus Areas, Objectives, and Research Areas shown in the following tables.

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Expeditionary and Irregular Warfare	• Battlespace Awareness • Irregular Warfare Operations • Expeditionary and Distributed Operations • Irregular Threat Countermeasures	• Data Visualization and Training • Efficient Processing • Tactical Networking • Over the Horizon Communications • Small Unit Communications Technologies • Cross-Domain Network Operations • Human Social, Cultural, and Behavioral Sciences • Pattern Recognition • Spectrum Protocol Content Awareness and Influence • Precision Target Identification and Location • Small Unit Air Defense • Networked Fires • Small Unit Water Purification • Small Unit Power • Fuel Efficiency • Vehicle Power Generation • Autonomous platforms and payloads • Psychometrics • Instructional Design and Technology • Machine Learning • Immersive Sciences • Explosive Hazard Defeat • Counter RPGs and ATGMs • Counter Tactical Surveillance and Targeting • Biometrics • Forensics • Personal Survivability • Vehicle and Personnel Signature Management • Vehicle Survivability
Platform Design and Survivability	• Mobility • Susceptibility/survivability • Optimized Payload Capabilities • At-Sea Sustainment • Affordable Fleet/Force Modernization	• Platform Design focused on efficiency, agility, and affordability • Autonomous and Unmanned Vehicle Mobility • Vehicle Structures and Materials • Platform Performance Models • Low Observable (LO) and Counter LO Technologies • Softkill Techniques • Automated Response and Recovery Technologies • Modeling and Simulation Tools • Modular/Affordable Platforms • Structural, Mechanical, and Electrical Support Infrastructure • Payload and Weapons Movement • Underway Replenishment • Interfaces and Standards • Sea Platforms • Air Propulsion • Air/Ground Vehicles • Functional Materials • Structural Materials • Manufacturing Science

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Assure Access to Maritime Battlespace	• Achieve and Maintain Undersea Dominance • Improve Mobile Autonomous Environmental Sensing • Match Environmental Predictive Capabilities to Tactical Planning Requirements • Maximize Systems Performance via Adaptation to the Environment	• Anti-Submarine Warfare Surveillance • ASW Performance Assessment • Bio-sensors, Bio-processes, and Bio-inspired Systems • Electronic Warfare Attack • Functional Materials • Intelligent and Autonomous Systems • ISRT-ESM • Large Vessel Stopping • Littoral Geosciences, Optics and Biology • Marine Mammals • Marine Meteorology • Mine Neutralization • Nanometer Scale Electronic Devices and Sensors • Navigation & Precision-Timekeeping • Networked Sensors • Non-Lethal Weapons • Ocean Acoustics • Physical Oceanography • Solid State Electronics • Space Environmental Effects • Spacecraft Technology • Unmanned Air Vehicles • Unmanned Sea Vehicle Technologies • Naval Power Systems • Sea Platforms • Affordability/Reduced Platform Lifecycle Cost • Air/Ground Vehicles • Information Assurance and Anti-tamper • Intelligent and Autonomous Systems
Autonomy and Unmanned Systems	• Human/Unmanned Systems Collaboration • Perception and Intelligent Decision Making • Scalable and Robust Distributed Collaboration • Intelligence Enablers and Architectures • Novel Platforms and Integration	• Intelligent and Autonomous Systems • Unmanned Air Vehicles • Unmanned Sea Vehicle Technology • Unmanned Ground Vehicles • Human Robotic Interaction/Human Factors • Machine Reasoning, Learning, and Intelligence • Scene/Image Understanding • Biorobotics, Cognitive Science, and Neuroscience
Information Dominance - Cyber	• Communications and Networks • Computational and Information Construct • Full Spectrum Cyber Operations • Decision Making Superiority	• ASW Surveillance • Computational Decision Making • Bio-sensors, Bio-processes, and Bio-inspired Systems • Communications and Networks • Applied & Computational Analysis • Human Factors Organizational Design and Decision • Complex Software Systems & Information Assurance • Cyber Security & Information Operations S&T • Intelligent & Autonomous Systems • Spacecraft Technology • Optimization • Data Science • Command & Control and Combat Systems • Quantum Information Sciences

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Electromag-netic Maneuver Warfare	• Spectrum Dominance • Advanced Electronics, sensing and response techniques	• Electronics Materials and Devices • Electronic Warfare • Multifunction Systems • Nano Electronics • Precision Time and Navigation • Quantum Measurement Architecture Devices • Radar & Electro-optical/IR Sensing • Surface/Aerospace Surveillance
Power and Energy	• Energy Security • Efficient Power and Energy Systems • High Energy and Pulsed Power	• Advanced Naval Power Systems • Air Platform Power • Bio-derived Materials and Systems • Functional Materials • Personal Power • Power Electronics • Power for Future Electric Weapons and Radars • Materials, Computation, and Prediction • Manufacturing Science
Power Projection and Integrated Defense	• Future Naval Fires • Integrated Layered Defense Across the Entire Detect-to-Engage Continuum • Extended Threat Neutralization Capabilities • Time-Critical Precision Strike	• Advanced Energetics • Air Platform Survivability • Directed Energy • Electromagnetic Guns • EW Attack • Expeditionary Firepower Torpedo Defense • Expeditionary Force Protection • Functional Materials • High Speed Weapons Technologies • ISRT-ESM • Mining • Non-Lethal Weapons • Precision Strike • Sea Platform Survivability • Solid-State Electronics • Affordability/Reduced Platform Life-Cycle Cost • Air/Ground Vehicles • Intelligent and Autonomous Systems • Manufacturing Science • Structural Materials • Materials, Computation and Prediction • Platform Affordability • Undersea Weaponry
Warfighter Performance	• Manpower, Personnel, Training and Education • Human-system Design and Decision Support • Bio-engineered Systems • Warfighter Health and Survivability	• Human factors, Organizational Design and Decision Research • Manpower and Personnel • Training, Education and Human Performance • Undersea Medicine • Bio-sensors, Bio-processes and Bio-inspired Systems • Casualty Care and management • Casualty Prevention

NRL is also focusing on the key technologies that encompass what defense leaders are calling a "Third Offset" strategy: cyber and space capabilities, unmanned systems, directed energy, undersea warfare, hypersonics, and robotics, among others. For example, the Laboratory is making important contributions to what may become the most revolutionary advances in naval power projection in decades — laser weapons and railguns. NRL scientists were the first to propose and simulate the use of incoherently combined, high-power fiber lasers as the architecture for the Navy's new Laser Weapon System (LaWS). In 2014, LaWS was deployed in the Persian Gulf aboard the USS *Ponce*. At less than one dollar per shot, in testing it has downed an unmanned aerial vehicle and destroyed moving targets at sea. NRL's railgun program began in 2003 and has since become a critical element in the efforts to develop hypervelocity electric weapons for long-range fire support and ship defense. When the Navy deploys its first hypervelocity electric launcher, its overall success will be due in part to NRL's key contributions.

Rapid prototyping and experimentation is an important mechanism in transitioning S&T to demonstrations of operational capabilities. NRL contributes to the Navy's new rapid prototyping process where fleet needs are identified through the OPNAV and Secretariat organizations to energize the Naval Research and Development Enterprise (NRL and the Naval Warfare Centers) to develop best-of-breed solutions for demonstration and evaluation.

FACTORS FOR NRL'S SUCCESS

As the corporate laboratory of the Department of the Navy, NRL conducts basic research, translates the results of this research into technologies, and assists in the transfer of these technologies to other Navy Department, the Defense Department, federal, and industrial organizations for incorporation into effective operational military systems. The successful transition of these technologies supports NRL's corporate philosophy that a sustained and well-managed investment in multidisciplinary research and development leads to continual improvements to the nation's defense, helps prevent technological surprise by potential adversaries, and can lead to revolutionary and world-changing capabilities, such as sonar, radar, satellites, GPS, and, maybe soon, laser weapons and railguns.

The reasons for NRL's success include the fundamental imperatives — a high-quality workforce and satisfactory facilities. But there are eight other factors of vital importance that helped build and then maintain NRL's reputation as a world-class research laboratory.

- <u>Broadly Based Multidisciplinary Program</u>

  NRL's program includes more than 15 scientific disciplines and applied technology areas, including optics, chemistry, plasma physics, materials science, oceanography, acoustics, electronic warfare, radar, remote sensing, and space science and technology. This broadly based multidisciplinary approach allows for a better understanding of a problem and taps the creative synergy of diverse disciplines. Moreover, technical problems are becoming increasingly complex in nature. For this reason NRL established its Nano-science Institute, which conducts research at the intersections of materials, electronics, and biology. NRL created its Laboratory for Autonomous Systems Research to support research in intelligent autonomy, sensor systems, power and energy systems, human-system interaction, and more.

Recently, using a methodology reminiscent of Project Hindsight (October 1969), the Office of the Secretary of Defense led a survey that quantitatively confirmed the benefits of a broadly based multidisciplinary program: NRL made 181 R&D contributions to 43 of the 83 current Major Defense Acquisition Programs (or MDAPs). The survey, however, likely undercounted contributions from early basic and applied research that found their way into these programs outside the knowledge of the survey respondents, which only replicated Project Hindsight's chief weakness.

Another quantitative metric showing the value of this approach to the warfighter is that NRL made 240 product transitions over a five-year period to various DoD agencies, which included 19 to Joint Agencies and 78 to other DoD agencies.

- <u>Organizational Position</u>

Public Law 79-588 created the Office of Naval Research (ONR) and placed it, along with NRL, within the Office of the Secretary of the Navy in 1946. Since then NRL has reported directly to the Chief of Naval Research (CNR). This preserved the original guidance from Edison and the Naval Consulting Board that NRL be placed where it could focus on the long-term needs of the Navy, rather than on short-term operational requirements.

- <u>Strategic Guidance and Funding</u>

NRL's programs address the capability gaps identified in the CNR's Naval S&T Strategic Plan. Department of Defense and Department of the Navy strategic documents provide the foundation for this plan. It is a broad strategy that articulates a general direction for the future, while retaining sufficient flexibility and freedom of action to meet emerging challenges. For its base program, NRL receives broad guidance from the CNR that also establishes level of effort. Using a rigorous internal review process, NRL then develops an annual comprehensive base program plan that is proposed to the CNR. The base program, funded directly by the CNR, is a vital key to NRL's success. Indeed, the importance of a supportive CNR to an innovative NRL program cannot be overstated.

- <u>Navy Working Capital Fund (NWCF)</u>

Reimbursable funding provided by Navy, Defense, and non-Defense customers through the NWCF helps to produce world-class research results at the lowest possible cost. In FY15, NRL executed more than $1.2 billion for more than 230 customers. This "executed" funding includes funds contracted to external performers, both public and private sector. Approximately 40% of NRL's funding comes from ONR.

The system works as follows: All costs of doing business are distributed proportionately as overhead charges added to the cost of a research work year and are paid by the customers of each project. Customers have the choice of funding or not funding individual projects on the basis of cost, scientific quality, and responsiveness to their needs, so it follows that NRL's researchers must compete by satisfying those needs. In 2015, NRL received funding from 184 DoD and non-DoD agencies, as well as from 53 industrial customers.

It should also be noted that the working capital fund also fosters decentralized decision making by placing the responsibility for program success on the technical abilities of each division superintendent and branch head. This is proper because technical decisions are best made at a level of authority closest to the expertise of the researchers.

- Dual-Executive Management Model

For several decades one of the basic tenets upon which the excellence of the Laboratory has rested is the concept of the dual executive, whereby the Commanding Officer (CO) and the Director of Research (DOR) share management responsibilities. The success of this arrangement is most evident in the Laboratory's recognition among the best of the world's applied research laboratories. That stature, and the scientific, technical and support staff that enables it, represents the primary value of NRL to the Navy. One co-executive, a senior civilian scientist of recognized stature, selected by the Secretary of the Navy, ensures that the Laboratory is managed like its peer civilian research laboratories worldwide when viewed by industry, academia, and these other peer laboratories. At the same time, with a senior military officer as co-executive, NRL stands clearly to serve the U.S. Navy as a military organization that supports its long term needs for advanced science and technology. The dual executive arrangement, for all its complexities, has evolved over the years as the best solution for running NRL because there is no part of the laboratory structure that does not affect the quality of the research. *With this model, the paramount issue is always the importance of, and the well-being of, NRL, an issue that trumps the interests of both the CO and the DOR.*

- Continuity of Civilian Technical Leadership

A landmark White House study, chaired by David Packard [Report of the White House Science Council, May 1983], stressed that, "The quality of management is crucial to a laboratory's performance. Federal agencies must insist on highly competent laboratory directors." Indeed, the job of NRL's senior management is to choose areas in which to work, divest work that has become appropriate for other performers, serve as the final arbiter of scientific merit, and foster the basic conditions necessary for innovation. The latter includes a high-quality staff, challenging programs, productive partnerships, effective support services, satisfactory facilities, state-of-the-art equipment, and a reasonable degree of autonomy. History has shown that the stable continuity of NRL's senior civilian management is key to ensuring those conditions — just six civilian directors have guided the program since 1949. Such stability is vital for nurturing long-term basic research programs.

- A Collaborative Naval Research Enterprise

In a three-year period (2012-14), there were 507 "interactions" between NRL and other Navy laboratories. The interactions included, but were not limited to, panel and committee participation, shared research, and funded collaborations. There also were 266 interactions with Army laboratories and 188 with Air Force laboratories. Over a similar three-year period (2010-12) NRL researchers had 1,019 collaborations with 232 U.S. universities and research institutions in 48 states, and 193 with foreign universities and research institutions in 34 countries. NRL's relationship with the private sector is characterized by productive collaboration and mutual respect. In fact, Charles Townes, Nobel Laureate and former vice president of the Institute for Defense Analyses, commented on that relationship when he said, "NRL is important to all of us — to defense industry and to science."

NRL also participates in Cooperative Research and Development Agreements (CRADAs), with five companies supported by Small Business Innovation Research / Small Business Technology Transfer funding in FY 15 and three in FY 16. The sources of funding were the Department of Energy and DoD agencies. Technologies include development of new optical fibers, solar cells and photovoltaic cells. NRL also has thirty-four active licenses for products of importance both to DOD and the commercial sector. Of the eight new licenses in FY15, seven were to small businesses. Products under development include: a manufacturing method for wafer bonding of thinned electronic materials and circuits to high performance substrates; high-performance interband cascade lasers for gas sensing, food processing, infrared countermeasure; a software-based technique for analyzing ultraviolet photoluminescence images of SiC wafers for manufacturing quality control; and phthalonitrile-based polymers with high temperature thermosets that remain strong at temperatures up to 500ºC and are easily processed into shaped fiber reinforced composites for use in aircraft, ship, automotive, and wind blade structural components.

- Facilities Management Authority

In 2003 the Chief of Naval Operations (CNO) consolidated his organization from eight claimancies (facility-owning commands) down to one: the Commander, Navy Installations (CNI). The CNO's action applied to his organization alone, so the property and base operating support (BOS) functions of the four naval warfare centers were placed under CNI ownership [CNO message 271955Z, March 2003]. The CNO's directive did not apply to the Marine Corps and NRL, both of which have separate and independent reporting chains. The Laboratory reports to the CNR, and ultimately to the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN(RD&A)) and the Secretary of the Navy. In fact, Navy Secretariat policy mandates that NRL manage its own real property and BOS functions because it is "a Secretary of the Navy corporate activity that has been assigned unique Navy-wide and national responsibilities." In order to "protect the unique corporate status of the NRL", this policy stipulates that, "Real property and BOS functions imbedded inseparably with the research and industrial functions at NRL will remain with the Commanding Officer" [ASN (RDA) letter to Deputy Chief of Naval Operations (Logistics), October 2, 1997]. BOS functions not deemed "imbedded inseparably" (i.e., the guard force, some facility support functions, and Morale, Welfare, and Recreation facilities and functions) were transferred by NRL to NDW.

The Base Realignment and Closure Commission understood the risks of applying inappropriate management methods to R&D. In 2005, it rejected a proposal to absorb NRL's facilities and BOS functions into a joint-base operated by CNI's Naval District Washington region. The commissioners ruled 8-0 that "NRL's continued control of laboratory buildings, structures, and other physical assets is essential to NRL's research mission", and they endorsed the ASN (RDA)'s 1997 policy by codifying it in law [Defense Base Realignment and Closure Commission, Final Deliberations, August 25, 2005, 57; and "A Bill to Make Recommendations to the President Under the Defense Base Closure and Realignment Act of 1990," Q-70.].

In short, the above eight factors are vital and must be preserved. Two additional factors — a high-quality workforce and satisfactory facilities — are, of course, fundamental factors for NRL's record of excellence, but they differ from the other eight in that constant attention and persistent effort is required to ensure that they do not become a cause for scientific stagnation and decline.

CHALLENGES TO MISSION ACCOMPLISHMENT

THE WORKFORCE CHALLENGE

NRL has a world-class workforce of 1,567 scientists and engineers (S&Es) that has in recent years included 11 members of the National Academies of Sciences and Engineering (7 retired and 4 onboard), more than 870 PhDs, 163 fellows of prestigious professional societies, two recipients of the National Medal of Technology (in 2005 and 2012), and more than 170 postdoctoral fellows. From FY11 to FY15, NRL's S&Es generated 4,193 refereed journal articles (with a cumulative 40,857 citations), 546 patents issued, and 513 invention disclosures. *This high quality workforce is the biggest reason for NRL's sustained success*. However, this workforce must be constantly renewed, especially as the rate of retirements grows. To be successful in sustaining this renewal, NRL must preserve a creative environment despite the challenges. *This is critical to its long-term health because a creative environment attracts the new talent*.

Managing, motivating, and renewing a creative scientific and engineering workforce within the federal government is not easy. A government laboratory never has been able to match the scale of compensation offered by industry or the degree of autonomy offered by universities. Historically the government has offered sufficient compensation and superior "psychic" income, such as important and challenging work, reasonable autonomy, organization reputation, state-of-the-art equipment, high quality colleagues, etc. Over time, however, it has become more difficult to compensate high quality talent sufficiently and the "psychic" income has degraded due to aging facilities, a low regard for public service, and less responsive personnel management systems. Two demographic factors also contribute to the difficulties in recruitment: the aging of the baby boomer generation, and a shrinking number of U.S. citizens obtaining scientific and technical degrees.

Therefore, other approaches have become critical to the continued viability of the DoD's laboratories. To help stem the decline in brainpower and maintain a high quality standard (average S&E GPA = 3.60), NRL uses three primary vehicles provided by the U.S. Congress: the Naval Innovative Science and Engineering (NISE) program (Section 219), Laboratory Demonstration Program, and Direct Hire Authority, along with other recruiting tools.

- <u>NISE Program (Karles Fellowships and Karles Invitational Conference)</u>

Since March 2010, NRL's primary use of NISE is workforce development through the Karles Fellowship program. Named after two of NRL's most distinguished and world-recognized scientists, Drs. Jerome and Isabella Karle, the program provides funding for highly accomplished scientists and engineers at any degree level within a year of graduation and a minimum GPA of 3.5. The fellowships provide funding for two years to conduct a specific program of research appropriate with the candidate's background and the NRL division. NISE funding to NRL typically allows for approximately 25-30 fellows each year. The two-year duration provides time for the fellows to establish their credentials at NRL, develop their own research programs to adapt to NRL's NWCF operating model, and integrate themselves into NRL research community.

The Karles Fellows program continues to be successful. As a brief example, FY15 Karles Fellows had an average GPA of 3.76, published almost 75 peer-reviewed papers, and submitted 8 patent applications. In FY17, NRL expects to execute NISE by funding Karles Fellows in various fields including cybersecurity, quantum systems and electronics, cognition for autonomy, synthetic biology, neuroelectronics, electromagnetics, materials by design, and others. NRL expects to hire fellows as the opportunities present during the year.

NISE also provides funding for the annual Karles Invitational Conference, established in 2011. The conference brings together distinguished scientists and engineers working at the frontiers of research in a particular area with the goals of examining the most recent advances and stimulating new directions for research, and finding interdisciplinary collaborations. The 6th Karles Invitational Conference took place in August 2016 and was focused on 3D additive manufacturing.

- Laboratory Demonstration Project (Demo)

The U.S. Congress has, over the years, helped to reform the inherently ponderous Government personnel system by authorizing various special hiring and salary authorities, and exempting the DOD's R&D organizations from its most onerous and time-consuming processes and procedures. The most sweeping of these reforms was codified in Section 342 of the fiscal year 1995 National Defense Authorization Act (NDAA), which created a series of "Science and Technology Demonstration Labs" within the family of R&D labs operated by the Services.

NRL implemented Demo in September 1999. It has been highly successful in meeting the goals of: maintaining the quality of the NRL workforce in the scientific and engineering disciplines, as well as administrative specialist/professional and support positions; more timely processing of personnel actions; increased retention of high-level contributors and wider distribution of salaries; and increased satisfaction with human resources management processes by employees and managers. The most recent employee survey conducted in the fall of 2014, indicated 84.6% of respondents are in favor of the Demo.

NRL is a member of the OSD Laboratory Quality Enhancement Program (LQEP), Personnel Subcommittee which is working to implement authorities in the NDAA 2014, Section 1107(h), including:

- Exercise to the fullest extent, authorities provided under DoD STRL Personnel Demonstration Projects to include: authority to pay performance and other cash awards without regard to pay freezes or award restrictions; and authority to adopt, with reasonable adaptations, demonstration project authorities previously approved by any STRL through notification to appropriate DoD / component officials and the laboratory's workforce.
- Freedom from hiring restrictions provided appropriate funding is available.

- <u>Direct Hire Authorities</u>

Since Congress provided various direct hire authorities for portions of the S&E workforce starting in FY09, NRL hired or is in the process of hiring almost 500 people (427 advanced degree, 62 bachelor's degree, 7 veterans), representing 67% of the possible workforce size-based allocation (496 of a possible 744) in spite of the 2013 hiring freeze.

- <u>NRL Pipeline for Future Employees</u>

The Navy has a rich history of providing educational opportunities for students of all ages. These opportunities begin with naval-relevant outreach programs at the kindergarten through high school grade levels. They continue through internships and other programs in post-secondary schools, supporting student advancement into post-doctoral work and continue through all stages of professional development. In short, there is no more valuable investment we can make in Naval S&T than in the minds of our current and future workforce. A portion of that investment takes shape in our internship programs.

The Science and Engineering Apprenticeship Program (SEAP) program is an eight-week paid internship opportunity for high-school students. Throughout the apprenticeship interns gain real-world, hands-on experience and research skills under the guidance of a mentor. These internships introduce high-school students to the Naval Science and Technology environment. Recent SEAP student research areas included: corrosion preventive compound analysis, pathogen carriage by fleas in Kenya, manufacturing ball bearings using additive manufacturing, high altitude balloon design, wave energy testing; nanocomposite analysis, and collision avoidance for collaborative Unmanned Aerial Vehicles.

The Naval Research Enterprise Internship Program (NREIP), similar to SEAP, is a ten-week long paid research internship opportunity for the undergraduate and graduate. NREIP interns gain real-world, hands-on experience and research skills, under the guidance of a mentor. These internships introduce post-secondary students to the Naval Science and Technology environment. NREIP interns have proven to be an excellent source of future Naval Research Enterprise employees. Students conduct research in a wide range of areas including: cyber analytics, 3D printing applications, underwater archaeology, taxonomic analysis, digital forensic analysis, flight training devices, virtual reality technologies, and psychology of unmanned systems.

In addition to NREIP and SEAP, NRL executes an internship program for Historically Black Colleges and Universities/Minority Institutions undergraduates. These research interns are active participants and conduct hands-on laboratory research under the guidance of senior NRL staff. At the conclusion of the program, students prepare written reports and make brief presentations describing their summer's work. In addition to conducting scientific research, the interns attend scientific and skill-set seminars on laboratory safety, ethics in science and engineering, job search skills, and resume writing.

NRL provides postdoctoral scientists and engineers the opportunity to pursue research on problems, largely of their own choice, that are compatible with and contribute to the overall effort of NRL. For recent doctoral graduates, this is an opportunity for concentrated research in association with selected members of the permanent NRL staff, often as a climax to formal career preparation. This relationship enhances the quality of the Laboratory’s research activities, acquaints participants with Navy capabilities, and provides a potential path to full time employment.

NRL also participates in the Summer Faculty Program, which provides S&E academic faculty opportunities to participate in research of mutual interest for a period of 10 weeks. Participants may be appointed as a summer faculty fellow, as a senior summer faculty fellow, or as a distinguished summer faculty fellow. Weekly stipends are paid, travel expenses are reimbursed, and fellows may be allowed to bring an undergraduate or graduate student to the lab to assist with the summer research (and also receive a student stipend).

THE FACILITIES CHALLENGE

NRL's most serious challenge is the need to modernize an aging infrastructure so that the Laboratory can continue to meet the emerging needs of our future Naval forces. This is especially important as the pace of S&T advancement accelerates rapidly across the rest of the world and near peer competitors arise to challenge American naval superiority. Various facilities and laboratories are experiencing excessive leaks, heating and air conditioning problems, and other infrastructure failures. While this is to be expected given the average age of the buildings at the NRL main campus is 59 years old, it is further compounded by inadequate investment in new facilities and major repairs of existing facilities. For many reasons military construction funding for the DoD laboratories has declined steadily over the years. Similarly, funding shortages and other difficulties for executing facilities repairs and modernization efforts have not kept pace sufficiently addressing the facilities deterioration and essential modernizations. NRL continues to work within the DON and DoD to address these issues as it is critical that the facilities be improved so that we can attract and retain qualified personnel to work at NRL, and provide state of the art research and technology solutions in facilities adequately suited for current and future requirements. NRL fully supports the various initiatives to revitalize the DoD laboratories, including the use of "Section 219" authorities for minor construction, the proposed increase in the minor construction threshold from $4 million to $6 million (or higher), and any increases in major military construction funding for new facilities.

CONCLUSION

NRL is important because of what it does, but it is indispensable for what it is — a government laboratory. The federal government ultimately bears sole accountability for national missions and public expenditures, so decisions concerning the types of work to be undertaken, when, by whom, and at what cost should be made by government officials responsible to the president. The government therefore must be a smart buyer and be capable of overseeing its contracted work. For this the government uses its "yardstick." In technical matters, this measure is the collective competence of its scientists and engineers. Their advice must be technically authoritative, knowledgeable of the mission, and accountable to the public interest. William Perry, former secretary of defense, underscored that necessity when he stated that the government "requires internal technical capability of sufficient breadth, depth, and continuity to assure that the public interest is served." A detailed discussion on the many ways that NRL and its sister DoD laboratories fulfill, and go beyond, the Government's "yardstick" requirements can be found in "Breaking the Yardstick: The Dangers of Market-Based Governance," *Joint Force Quarterly*, (JFQ Issue 55,4th Quarter 2009), 126-135.

I invite each of you to visit the Naval Research Laboratory, located a short drive from the Capitol. Thank you for your time today, your interest in NRL's work, your concern for defense science and technology, and support of the DoD laboratories and their missions. I look forward to answering any questions you may have.