Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Navy												Date: May 2021
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602236N *I Warfighter Sustainment Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	93.481	116.051	70.547	-	70.547	-	-	-	-	-	-
0000: *Warfighter Sustainment Applied Res*	0.000	62.590	66.551	70.547	-	70.547	-	-	-	-	-	-
9999: *Congressional Adds*	0.000	30.891	49.500	0.000	-	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

U.S. Sailors and Marines underpin all missions. Advances in Artificial Intelligence (AI) enabled decision aides, autonomy, human-machine training, augmented performance, command and control and protective equipment will ensure their advantage in a complex, maritime environment. This Program Element (PE) conducts applied research to address Warfighter protection and performance concerns, including efforts that focus on advanced Naval materials, biocentric technologies, decision support, intelligent and autonomous systems, human performance optimization, training and education technologies, social and cultural science, and biomedical technologies. This PE also supports the Office of Naval Research (ONR) Global mission to serve as the preeminent external facilitator for the Naval Research Enterprise. This is accomplished by establishing quality, relevant connections between the international research and development community, Naval fleet/forces, DOD, other US Government agencies and international partners.

Today's Sailors and Marines are enabled by Naval Science and Technology (S&T). Since 1946, the Office of Naval Research (ONR) has fostered scientific research related to the maintenance of maritime superiority and national defense. ONR manages the Department of the Navy's (DON) portfolio of Naval basic and applied research, and advanced technology development investments to ensure Naval forces can effectively deter conflict, but when called upon, fight, win and come home safe. Current investments hedge against uncertainty, providing solutions to commanders today, and options for the future. The Naval S&T budget supports higher guidance defined by the National Defense Strategy, and responds to requirements identified by the Secretary of the Navy through research priorities set by the Chief of Naval Research, coordinated across the Naval Research Enterprise (NRE), and outlined in the Naval R&D Framework.

This Program Element (PE) funds Applied Research, which is the systematic study to understand the means to meet a recognized and specific need. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments).

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	95.825	67.765	66.134	-	66.134
Current President's Budget	93.481	116.051	70.547	-	70.547
Total Adjustments	-2.344	48.286	4.413	-	4.413
• Congressional General Reductions	-	-0.204			
• Congressional Directed Reductions	-	-1.010			
• Congressional Rescissions	-	-			
• Congressional Adds	-	49.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.344	0.000			
• Program Adjustments	0.000	0.000	4.612	-	4.612
• Rate/Misc Adjustments	0.000	0.000	-0.199	-	-0.199

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 9999: *Congressional Adds*		
Congressional Add: *Laser peening technology*	3.861	0.000
Congressional Add: *Lightweight anti-corrosion nanotechnology coating enhancement*	4.827	5.000
Congressional Add: *Polymer coatings for reduced ice and fouling adhesion*	5.792	5.000
Congressional Add: *Undersea domain human performance requirements*	2.896	0.000
Congressional Add: *Engineered systems to prevent hearing loss*	4.827	0.000
Congressional Add: *Extreme environment warfighter safety research*	3.861	0.000
Congressional Add: *Female musculoskeletal research*	4.827	0.000
Congressional Add: *force Health Protection and Application*	0.000	5.000
Congressional Add: *Health and Safety Research of Underground Fuel Storage Facilities*	0.000	5.000
Congressional Add: *Human Performance and injury Rehabilitation Assessment tool*	0.000	2.500
Congressional Add: *Humanoid Robotics in Unstructured Environments*	0.000	5.000
Congressional Add: *Engineered Systems to Preserve and Restore Hearing After Deleterious Stimulation*	0.000	5.000
Congressional Add: *Hypersonics Material Acceleration*	0.000	4.000
Congressional Add: *Laser Peening Technology for Submarine and Carrier Shafts*	0.000	3.000
Congressional Add: *Physics Based Neutralization of Threats to Human Tissues and Organs*	0.000	5.000

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Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Social Networks and Computational Social Science*	0.000	2.000
Congressional Add: *Warfighter as a System Human Digital Twin Research*	0.000	3.000
Congressional Add Subtotals for Project: 9999	30.891	49.500
Congressional Add Totals for all Projects	30.891	49.500

Change Summary Explanation

The funding increase from FY 2021 to FY 2022 is due to realignment of previously programmed resources from the Budget Activity 1 Defense Research Sciences program element 0601153N, Medical and Biological Sciences Activity/Planned Program, into Budget Activity 2 Warfighter Sustainment and Applied Research program element 0602236N, Medical and Human Performance Technologies Activity/Planned Program.

Technical: No significant change.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy											Date: May 2021	
Appropriation/Budget Activity 1319 / 2					R-1 Program Element (Number/Name) PE 0602236N / *Warfighter Sustainment Applied Res*				Project (Number/Name) 0000 / *Warfighter Sustainment Applied Res*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
0000: *Warfighter Sustainment Applied Res*	0.000	62.590	66.551	70.547	-	70.547	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

U.S. Sailors and Marines underpin all missions. Advances in AI-enabled decision aides, autonomy, human-machine training, augmented performance, command and control and protective equipment will ensure their advantage in a complex, maritime environment. This Program conducts applied research to address Warfighter protection and performance concerns, including efforts that focus on advanced Naval materials, biocentric technologies, decision support, intelligent and autonomous systems, human performance optimization, training and education technologies, social and cultural science, and biomedical technologies. This PE also supports the Office of Naval Research (ONR) Global mission to serve as the preeminent external facilitator for the Naval Research Enterprise. This is accomplished by establishing quality, relevant connections between the international research and development community, Naval fleet/forces, DOD, other US Government agencies and international partners.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**
Title: Advanced Naval Materials	14.561	16.801	17.889	0.000	17.889
Description: Advanced Naval Materials efforts support several Science and Technology (S&T) Focus Areas, in particular Platform Design & Survivability, and perform research across a broad spectrum of technical areas including: structural materials to increase platform performance and survivability at reduced weight and cost; advanced, high-performance materials for energy systems; corrosion mitigation strategies; high-temperature propulsion systems; and enhanced sonar transducers. ***FY 2021 Plans:*** Materials: Conduct research to build Agile Manufacturing - Integrated Computational Materials Engineering (ICME) toolkit infrastructure. Conduct ongoing research efforts to improve affordability and reliability of piezoelectric transduction materials. Conduct research to develop advanced structural alloys and composites, joining and repair technologies. Conduct research to pursue commercially viable processing for nano-engineered materials, including ceramics, metals, and materials systems. Continue development of new, advanced, environmentally benign Anti-Fouling (AF)/Anti-Corrosive (AC) coating systems for Navy platforms. Sustainment & Logistics:					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Conduct applied research to investigate corrosion control modeling, high performance longer-life corrosion resistant coatings, compositionally complex alloys, corrosion resistant additive manufactured components and atmospheric corrosion of aluminum 5000 components. Manufacturing: Develop manufacturing technology to help accelerate capability to the fleet in areas such as high-energy laser (HEL) weapons, advanced electronic warfare, and electronic controls for unmanned vehicles. Initiate efforts focused on demonstrating the deposition of quality carbon phosphonitride materials for liquid-based additive manufacturing techniques tailored for use in true 3-D direct write processes. Efforts will enable this technology to produce inexpensive, high quality parts; and demonstrating that next generation TBCs can be optimized to meet 20-year survivability requirements for use in a marine diesel environment to support an increase in operating temperatures from 500 to 800 degrees Celsius. Materials and Chemistry: Ongoing efforts include designing new microfluidic system for direct write additive manufacturing to significantly improve the existing techniques, and efforts to determine thermal barrier coating (TBC) degradation mechanisms and susceptibility and apply that understanding to optimize TBCs for marine use and enable long service-life applications in severe environments. Efforts completing with reduced investment in FY21 include work on computational models of thermal, ballistic impact, blunt impact and blast overpressure effects on helmet design and account for biomechanical response and fluid dynamics associated with helmet design and materials testing. Effort employs optimization software that utilizes model results to design helmet pad material and helmet suspension geometry against multiple performance requirements. ***FY 2022 Base Plans:*** Materials: - Conduct research to build Agile Manufacturing - Integrated Computational Materials Engineering (ICME) toolkit infrastructure. - Conduct ongoing research efforts to improve affordability and reliability of piezoelectric transduction materials. - Conduct research to develop advanced structural alloys and composites, joining and repair technologies.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Conduct research to pursue commercially viable processing for nano-engineered materials, including ceramics, metals, and materials systems. - Continue development of new, advanced, environmentally benign Anti-Fouling (AF)/Anti-Corrosive (AC) coating systems for Navy platforms. Sustainment & Logistics: - Conduct applied research to investigate corrosion control modeling, high performance longer-life corrosion resistant coatings, compositionally complex alloys, and corrosion resistant additive manufactured components. Manufacturing: - Develop manufacturing technology to help accelerate capability to the fleet in areas such as high-energy laser (HEL) weapons, advanced electronic warfare, electronics technology for navigation and electronic controls for unmanned vehicles. - Continue efforts focused on demonstrating the deposition of quality carbon phosphonitride materials for liquid-based additive manufacturing techniques tailored for use in true 3-D direct write processes. Efforts will enable this technology to produce inexpensive, high quality parts; and demonstrating that next generation TBCs can be optimized to meet 20-year survivability requirements for use in a marine diesel environment to support an increase in operating temperatures from 500 to 800 degrees Celsius. Materials and Chemistry: -Continue Ongoing efforts include designing new microfluidic system for direct write additive manufacturing to significantly improve the existing techniques. - Continue efforts to determine thermal barrier coating (TBC) degradation mechanisms and susceptibility and apply that understanding to optimize TBCs for marine use and enable long service-life applications in severe environments. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** There is no significant change in funding from FY 2021 to FY 2022.					
Title: Biocentric Technologies	7.442	10.374	9.454	0.000	9.454

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Description: Applied research to develop knowledge and technologies for future Naval capabilities. Research areas include: bioinspired and biomimetic materials; synthetic biology for environmental surveillance and materiel production; bioengergy harvesting and electronics; warfighter augmentation and resilience; and marine mammal health. This research provides secure and agile options to enhance performance, increase novel power and energy solutions to safely extend operational duration, and improve stealth, maneuverability, and mission capability of platforms and autonomous systems. ***FY 2021 Plans:*** Bio-Inspired Autonomous Systems: Conduct applied research on bio-inspired underwater vehicle propulsion and control. Conduct applied research to develop precision navigation and advanced search behaviors. Integrate biosonar into a bio-inspired unmanned vehicle to evaluate obstacle detection and avoidance in congested spaces. Conduct applied research to develop and evaluate lateral line based intelligent sensing and control. Human Interaction with Autonomous Systems: Conduct applied research to develop agile humanoid robot teammates. This includes incorporating computer vision reasoning and human communication. Conduct applied research to train mission capable robots to perform complex manipulation skills. Conduct applied research to develop technology to enhance diver performance with small AUV assistants. Biocentric Technology: Conduct applied research on Naval biosensors, biomaterials, and bioprocess technologies. This includes conducting multi-month/year tests of microbial underwater energy harvesting systems (in various ports, rivers, test sites), expand to deep water marine environments and test ability to power new devices; decreasing efforts in study microbial electrochemical systems for ship/sub waste-to-energy conversion (including disabled submarine scenarios); conducting studies of prebiotic food additives/probiotics for effects on microbiome and performance in human subjects; developing strategies to incorporate programmable cellular controllers (sense-and-respond microbes) for environmental monitoring into relevant Naval platforms; and conducting research on the influence of sample source and rapid dilution of DNA sequencing for monitoring undersea environments. Bioengineering and Life Sciences:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Conduct applied research to assess new instrumentation for hastening the time of sequence analysis of viruses in clinical and environmental samples in the field; further develop bio-inspired and biomimetic adhesive materials for underwater applications; demonstrate more efficient proton exchange membrane fuel cells; determine whether an individual dolphin's vocalizations can be correlated with veterinary and trainer observations to develop a sound model for the animal that describes their welfare; and investigate serum and urine markers of kidney injury in bottlenose dolphins. Warfighter Augmentation: Applied research on the development of technologies to enhance undersea capabilities, including bio-inspired underwater geolocalization. Materials and Chemistry: Develop a semi-automated assay system that will enable our transition partners, the Naval Medical Research Center and Naval Medical Research Unit laboratories, to rapidly identify antibiotic resistance genes in bacterial pathogens of importance to the U.S. military. The science, technology and and resulting system will contribute directly to warfighter health, performance and survivability. Efforts completing with reduced investment in FY 2021 include demonstrations that the assay system provides better and greater identification of resistance determinants from clinical matrices than whole shotgun metagenomic sequencing. ***FY 2022 Base Plans:*** Bio-Inspired Autonomous Systems: - Conduct applied research on bio-inspired underwater vehicle propulsion and control. - Mature advanced search behaviors for autonomous vehicles. - Integrate sonar and image processing into a bio-inspired unmanned vehicle to evaluate obstacle detection and avoidance in congested spaces and neutralization maneuvers. - Applied research on bio-inspired cross-domain vehicles for amphibious and sea/air transitions. Human Interaction with Autonomous Systems and Human-Machine Teaming: - Conduct applied research to develop agile humanoid and quadruped robot teammates. This includes incorporation of computer vision, acoustic localization, reasoning and human communication.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Applied research on training mission-capable robots to perform complex manipulation skills essential for shipboard and urban operations. - Conduct applied research to develop technology to enhance diver performance with small autonomous underwater vehicle (AUV) assistants. Biocentric Technology: - Conduct studies of prebiotic food additives/probiotics for effects on microbiome and performance enhancement in human subjects, including divers and combat swimmers. - Develop gut microbiome-based tools to predict individual response to prebiotics for stress resilience. - Develop strategies to incorporate programmable microbial sensors for environmental monitoring into relevant Naval platforms (e.g., for non-acoustic anti-submarine warfare (ASW) or handheld devices for divers). - Initiate efforts to scale up production of biogenic mineral nanomaterials. Important for securing supply chain for electronic materials and microelectronic device fabrication. - Research effects of sample source and rapid dilution on marine environmental DNA sequencing for monitoring undersea environments. - Applied research to focus on deployment of benthic microbial fuel cells in deep water marine environments and testing the ability to power new devices (e.g., distributed mine systems, position-navigation-timekeeping transponders for unmanned underwater vehicles (UUVs)). Bioengineering and Life Sciences: - Conduct applied research to develop a sandcastle worm inspired adhesive effective in seawater with an on-demand curing mechanism. - Conduct applied research to determine the role of lung membrane integrity in marine mammal respiratory diseases; establish therapeutics to prevent kidney stone formation in dolphins; facilitate surveillance of marine mammal viral pathogens in marine waters and indigenous mussels/oysters/clams; and implement dolphin vocalizations as a tool for diagnosing their well-being. - Establish highly efficient proton exchange membrane fuel cells. Warfighter Augmentation & Resilience: - Conduct applied research in bio-inspired light polarization sensors and machine learning methods for predicting underwater geolocation and developing technology for underwater image dehazing. - Develop technologies to monitor and protect diver from environmental stressors such as temperature, pressure, and limited visibility and resources.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Identify predictors of critical health and safety threats to divers through advanced physiological monitoring and algorithm development. - Support development of manned-unmanned teaming platforms to aide a diver in enhanced situational awareness and to expand diving windows of opportunity by eliminating current limitations such as restricted access (cold, depth, space), visibility, and gas supply. Materials and Chemistry: - Continue the develop a semi-automated assay system that will enable our transition partners, the Naval Medical Research Center and Naval Medical Research Unit laboratories, to rapidly identify antibiotic resistance genes in bacterial pathogens of importance to the U.S. military. The science, technology and resulting system will contribute directly to warfighter health, performance and survivability. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The funding decrease from FY 2021 to FY 2022 is due to the one-year increase of $3.3M in FY 2021 for the 1000 molecules program that supports the sustainable transition of critical synthetic biology capabilities. Additionally, funding was increased in FY 2022 by $1M due to a realignment of funding from the Medical and Biological Sciences R2 Activity in Program Element (PE) 0601153N. This realignment of funding from a basic research PE to an applied research PE will provide more opportunities to transition synthetic biology and bio-robotics research into mature technologies for warfighter performance enhancements.					
Title: Environmental Quality ***Description:*** Environmental Quality technologies enable sustained world-wide Navy operations in compliance with all local, state, regional, national and international laws, regulations and agreements. ***FY 2021 Plans:*** N/A ***FY 2022 Base Plans:*** N/A ***FY 2022 OCO Plans:***	2.518	0.000	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
N/A					
Title: Human Factors and Organizational Design	5.591	5.712	5.948	0.000	5.948
Description: Operational and tactical level decision-making requires making time-critical decisions with imperfect information. This activity seeks to identify how warfighters make decisions despite uncertainty, and develop practical strategies for managing uncertainty for Naval warfighter decision-making. These applied research efforts will improve mixed social-technical systems design, system interface designs and human-level decision support in Naval contexts. Research areas include human-machine teaming, social networks and computational social science, and command decision-making. ***FY 2021 Plans:*** Cognitive Science for Human-Machine Teaming Conduct applied research on system interface designs and human-machine interaction methodologies that enable or enhance Naval Warfighter performance and human-machine teaming. Efforts investigating physiological monitoring and cognitive state estimation are complete and the focus will shift to: Psychoacoustics and audio-visual scene interpretation implemented in computational models that serve as the front end for cognitive architectures and new human interfaces; construction of computational models that integrate top-down expectation; and gaze control to enable multisensory perception within a cognitive architecture for autonomous systems. Social Networks and Computational Social Science Conduct applied research in information environment assessment, civil-military communications (public affairs), information operations and strategic communication. Develop improved course of action guidance and capabilities to detect and defuse: disinformation, social hysteria and group polarization campaigns. Develop information conflict war-game capabilities relevant to international exercises. Command Decision Making Develop information display concepts to include alerting and decision aid algorithms for complex, multi-dimensional data. These concepts are critical for avoiding collisions, accomplishing rendezvous, determining the value of information, and planning courses of action. ***FY 2022 Base Plans:*** Cognitive Science for Human-Machine Teaming and Computational Neuroscience:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Incorporate realistic neural systems into autonomous systems for more robust on-board perception and intelligence. - Conduct applied research on system interface designs and human-machine interaction methodologies that enable or enhance Naval Warfighter performance and human-machine teaming. This includes psychoacoustics and audio-visual scene interpretation implemented in computational models that serve as the front end for cognitive architectures. - Construct new perceptual models for intelligent autonomous systems. - Conduct applied research to develop agile humanoid robot teammates with enhancements including: (i) Embedding computer vision with visual-spatial reasoning; (ii) Auditory systems to enable human communication; and (iii) Neuromorphic (brain-like) processors. - Conduct applied research to train mission-capable robots to perform complex manipulation tasks, integrated with self-learning. - Conduct applied research to develop technology to enhance diver performance with small autonomous underwater vehicle (AUV) assistants. Social Networks and Computational Social Science: - Conduct applied research in information environment assessment, civil-military communications (public affairs), information operations and strategic communication. - Develop improved course of action guidance and capabilities to detect and defuse: disinformation, social hysteria and group polarization campaigns. - Improve efforts to study effective methods for training military personnel operating in the information environment to discover, monitor, and counter adversarial maneuvers in digital and social media. Command Decision Making: - Explore how to explain recommendations and characterize uncertainty for recommendations derived from Machine Learning (ML) algorithms. - Initiate applied research for a knowledge/skill brokering system that can detect individual knowledge weaknesses / gaps related to task performance and deliver tailored training tutorials as job aids. - Conduct applied research to assist with authoritative and peer-to-peer curation of community generated multi-media content and fusion with authoritative sources. - Conduct research on team composition and social decision-making in order to design Naval decision tools that have reduced risk of human decision biases (e.g. implicit bias, preconceived notions, and social pressure).					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Conduct Human System Integration research activities in areas of human factors engineering and physical design layout (habitability, safety, personnel survivability) of naval platforms in order to understand best possible conditions for effective decision-making Naval settings. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The funding increase from FY 2021 to FY 2022 is due to efforts to study effective methods for training military personnel operating in the information environment to discover, monitor, and counter adversarial maneuvers in digital and social media as well as increased focal area on command decision making.					
Title: Human Research Protection Program (HRPP) ***Description:*** The Federal Policy for the Protection of Human Subjects is codified in the Department of Defense (DoD) as part 219 of title 32, Code of Federal Regulations (also known and hereinafter referred to as the "Common Rule"). DoD Instruction 3216.02 establishes policy and assigns responsibilities for the protection of human subjects in DoD-supported programs to implement the Common Rule and requires Heads of DoD Components to establish and oversee DoD Component policies and procedures that ensure compliance with federal and DoD requirements. The Secretary of the Navy Instruction (SECNAVINST) 3900.39E CH-1 identifies the Chief of Naval Research as providing support and expertise for human research protection in research conducted or supported by the Navy and Marine Corps Systems Commands and institutions, operational forces, training Commands, and Department of the Navy (DON)-supported research involving human subjects performed by non-DoD institutions. The Human Research Protection Program (HRPP) protects the rights, safety, and welfare of human subjects in research conducted or sponsored by the Navy and Marine Corps by: 1) ensuring that research involving human subjects complies with federal regulations, DoD Directives, DON Instructions, and Marine Corps Orders governing research protection requirements; and 2) providing education and training programs in human research ethics to all levels of staff involved in the review, approval, conduct, management, or support of DON human subjects research (HSR). ***FY 2021 Plans:*** Build a Research Protection Community of Excellence; establish two new HRPPs; coordinate and finalize SECNAVINST 3900.39F; Program Management of the DON Research Protections Information Technology Management System for management and compliance oversight of ongoing human research protections activities; establish policy for single Institutional Review Board review; provide education and training programs	2.551	2.727	2.766	0.000	2.766

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
in human research ethics to all levels of staff involved in the review, approval, conduct, support, or management of DON HSR; provide subject matter expertise and guidance on all DON-supported research involving human subjects. ***FY 2022 Base Plans:*** - Develop Research Protection Community of Excellence; establish 5 new HRPPs; finalize SECNAVINST 3900.39F; Program Management of the DON Research Protections Information Technology Management System for management and compliance oversight of ongoing human research protections activities; provide training for updated DoDI 3216.02, provide education and training programs in human research ethics to all levels of staff involved in the review, approval, conduct, support or management of DON HSR; provide subject matter expertise and guidance on all DON-supported research involving human subjects. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** There is no significant change in funding from FY 2021 to FY 2022.					
Title: Medical and Human Performance Technologies ***Description:*** Medical and human performance applied research technologies have historically been funded out of the 0602236N Medical Technologies R2 Activity. Starting in FY21, this R2 Activity will be described in two categories to better explain the program areas related to medical and human performance research in this exhibit. Efforts categorized as Medical Technologies focus on research after injury. Efforts categorized as Human Performance Technologies focus on research before injury. The medical portion of this applied research activity focuses on reducing operational health threats, development of point-of-injury medical equipment, and medical diagnostic capabilities and treatments. This research will improve the Fleet's ability to save lives, especially during prolonged field care. The human performance portion of this applied research activity focuses on improving undersea performance of divers and submarine crews; sensory perception and performance to improve warfighter capabilities and prevent injuries during exposure to high levels of acoustic or electromagnetic energy; and physiological monitoring of Naval forces during training and operational environments. ***FY 2021 Plans:***	5.617	5.739	8.691	0.000	8.691

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Medical and human performance applied research technologies have historically been funded out of the 0602236N Medical Technologies R2 Activity. Starting in FY 2021, this R2 Activity will be described in two specific categories to better explain the program areas related to medical and human performance research in this exhibit. Efforts categorized as Medical Technologies focus on research after injury. Efforts categorized as Human Performance Technologies focus on research before injury. Medical Technologies Conduct applied research to treat impaired tactical auditory sense and sense-making. Identify near infrared medical treatment and mitigation of auditory temporary threshold shifts. Conduct applied research to enhance casualty identification, classification, and prioritization for manned and unmanned casualty care evacuation. Conduct research to provide therapeutic care using nanotechnology, pharmacological agents, and autonomy for casualties in disaggregated environments. Human Performance Technologies Conduct applied research efforts to develop technologies to monitor and protect divers from environmental stressors, such as temperature, pressure, and limited visibility. Develop manned-unmanned teaming platforms to aid a diver in enhanced situational awareness and expand diving windows of opportunity. Conduct applied research to understand impacts of loud noises within dive helmets and human exposure to electromagnetic energy; develop exposure monitoring and mitigation strategies; and improve personal protective equipment and communication technologies. Develop human physiologic and biologic sensors for real-time monitoring of performance status in training and operational environments. Continue applied research efforts to reduce high performance tactical aircraft jet noise including High Fidelity Modeling, Advanced Diagnostics, and Noise Reduction Concepts, for human protection. ***FY 2022 Base Plans:*** Medical Technologies: - Explore novel technologies including: (i) Nanotechnologies, microelectronics and autonomous materials and systems for improved casualty care; (ii) Non-invasive sensors in casualty prevention and treatment; and (iii) Novel designs of protective equipment for maritime casualty prevention. - Conduct applied research to improve casualty care with autonomous or 'smart' materials and systems during distributed maritime operations ashore and afloat. Mature application and treatment methods for novel anti-infectives for improved wound care.					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Use modeling, microelectronics and novel composite materials for biomedical sensing and therapeutic care in wearable designs, such as protective equipment to ensure optimal performance, prevent harm and equip the DON to provide the best care for its warfighters. Human Performance Technologies: - Conduct applied research to develop noise exposure and mitigation strategies, including improving and evaluating personal protective equipment, communication technologies, noise exposure estimations, and sound localization. - Applied research to determine biomedical effects and diagnostics of electromagnetic energy exposures. - Applied research to develop countermeasures that prevent and mitigate the safety risks of decompression sickness, oxygen toxicity, and supplement metabolic diver energy requirements to advance safe and optimized performance. - Applied research to develop human physiologic and biologic sensors for real-time monitoring of performance status in training and operational environments. - Continue to mature efforts by field testing of technological solutions in multi-domain environments for ruggedizing technological solutions in multi-domain environments. - Integrate applied efforts with autonomous air and sea-based platforms for monitoring solutions in forward deployed operators. - Applied research in the development of technology enabling the Fleet's ability to save lives, especially during prolonged field care. Efforts will focus on human physiologic and biologic sensors for real-time monitoring of performance status in training and operational environments. - Develop advanced algorithms using existing "big" medical data collected from humans (all continuous vitals data, drugs given, etc.) for autonomous triage of personnel in mass casualty scenarios. These capabilities will enable field medics to immediately treat and triage patients, increasing survival rates from historically non-survivable injuries and environments. - Continue applied research efforts to reduce high performance tactical aircraft jet noise through the evaluation of Noise Reduction Concepts, for human protection. - Develop lab scale capability to investigate jet noise at afterburner conditions. - Explore active control approaches through advanced analytics and simulations.					
FY 2022 OCO Plans: N/A					
FY 2021 to FY 2022 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
The funding increase from FY 2021 to FY 2022 is due to a realignment from the Medical and Biological Sciences R2 Activity in Program Element (PE) 0601153N. This realignment of funding from a basic research PE to an applied research PE will provide more opportunities to transition discoveries in physiology, neuroscience, biology, and mechanisms of human injury into mature technologies for warfighter lethality and survivability. Specific increased topics include: developing advanced algorithms for autonomous health data collection, triage, and communication during mass casualty scenarios and maturing discoveries in modeling, microelectronics and novel composite materials for biomedical sensing and therapeutic care in wearable protective equipment.					
Title: The Office of Naval Research Global	19.579	20.335	20.833	0.000	20.833
Description: Supports the Office of Naval Research (ONR) Global mission to serve as the preeminent external facilitator for the Naval Research Enterprise. This is accomplished by establishing quality, relevant connections between the international research and development community, Naval fleet/forces, DOD, other US Government agencies and international partners. Science Advisors (SA) This effort ensures that the operational Naval fleet/force help shape the DON investment in science and technology (S&T), develops teaming relationships to rapidly prototype, experiment, demonstrate and transition technology, supports development of technology-based capability options for Naval forces, and enables warfighting innovations based on technical and conceptual possibilities. The SA Program also informs capability-based war games using current and future technology to identify future capability strengths and shortfalls that assist in shaping the DON investment strategy. The ONR Global SA Program enables continuous communication and collaboration between the warfighters, the Naval Research & Development Enterprise, and strategic development commands. International science The ONR Global mission is also accomplished through PhD-level scientists located in Asia, Europe and South America, providing coverage in these regions as well as Africa, Australia/New Zealand and the Middle East. ONR Global scientists actively search the globe for emerging scientific research and promising technologies, collaborating with international organizations and researchers through liaison visits and grants in innovative applied research. The direct impact of this investment is to leverage international research during increasingly dynamic global interdependence and improve the ability to solve DON S&T challenges through shared knowledge and technologies with partners. In addition, this investment builds global S&T awareness to					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
reduce the risk of potential technological surprise, and supports theater security cooperation goals to sustain cooperative relationships with an expanding set of international partners. International engagement ONR Global also supports international engagement with partner nations through the development and maintenance of bilateral and multilateral relationships, international agreements, and other activities that promote RDT&E collaboration and interoperability. ***FY 2021 Plans:*** Support all Science Advisor program efforts across Fleet and Forces Commands; objectively assess placement of current Science Advisors and requests for additional support in terms of impact to the Fleet and S&T return on investment. Support PhD-level scientists, in seven overseas offices, continuing to engage with international scientists and engineers through liaison visits to research institutions and continue actively fostering international collaboration by awarding research grants. Support international engagement with ten partner nations, three multi-lateral groups, and support to the Northern Atlantic Treaty Organization (NATO), in order to increase collective Naval capability, capacity, and interoperability. ***FY 2022 Base Plans:*** - Support all Science Advisor program efforts across Fleet and Forces Commands; objectively assess placement of current Science Advisors and requests for additional support in terms of impact to the Fleet and S&T return on investment. The increase will allow the flexibility of hiring approximately 1 additional science advisor. - Support PhD-level scientists, in multiple overseas offices (Asia, Europe, South America and Australia, Africa and the Middle East) by continuing to engage with international scientists and engineers through liaison visits to research institutions and continue actively fostering international collaboration by awarding research grants. The increase will allow the flexibility of hiring approximately 1 additional PhD-level scientist.					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Support international engagement with ten partner nations, three multi-lateral groups, and support to the Northern Atlantic Treaty Organization (NATO), in order to increase collective Naval capability, capacity, and interoperability. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** There is no significant change in funding from FY 2021 to FY 2022.					
Title: Training Technologies ***Description:*** Applied research to enhance the ability to train and educate Naval forces from time of recruitment through separation from the military. This includes use of modern knowledge, skills, and abilities assessment techniques and simulated environments in classroom and deployed environments. Improved efficiency is achieved by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the development, delivery, evaluation, and execution of training and education. ***FY 2021 Plans:*** Technologies for Naval Training Conduct applied research for measuring cognitive ability, interests, and aptitude on Naval forces throughout their military career. Develop tools to track training and education efficacy and develop instructional strategies as needed to improve performance. Advanced Integrated Maritime Mission Modeling Apply advanced modeling and simulation tools to develop live-virtual-constructive training at both pier side and at-sea of navigation teams on Naval surface platforms. ***FY 2022 Base Plans:*** Technologies for Naval Training: - Mature immersive environments to train unit commanders in decision-making, tactics, and strategies. - Expand new methods and techniques for enhancing problem solving ability of autonomous, artificial intelligence agents. - Continue to develop methods and techniques to identify individual differences to optimize training. - Continue to mature game technology to build innovative job-performance and decision-aids.	4.731	4.863	4.966	0.000	4.966

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
- Conduct applied research on learning-based techniques to improve decision-making and develop warfighters who are able to integrate and adapt to new technologies and threats. This effort will focus on delivery of interventions to representative populations and evaluation of intervention. Advanced Integrated Maritime Mission Modeling: - Continue work on Live-Virtual-Constructive simulation-based training technologies for Anti-submarine Warfare to include a greater range of simulated target types, behaviors, and scenarios. - Create training technologies to enhance the ability of shipboard operators, supervisors and crypto-technicians to rapidly detect cyber incursions into their radar, GPS, radio, and remote imaging systems, and to efficiently mitigate the effects of these incursions on combat effectiveness. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** There is no significant change in funding from FY 2021 to FY 2022.					
Accomplishments/Planned Programs Subtotals	62.590	66.551	70.547	0.000	70.547

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy												Date: May 2021
Appropriation/Budget Activity 1319 / 2					R-1 Program Element (Number/Name) PE 0602236N / *Warfighter Sustainment Applied Res*				Project (Number/Name) 9999 / *Congressional Adds*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	0.000	30.891	49.500	0.000	-	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Congressional Add: Laser peening technology ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** N/A	3.861	0.000
Congressional Add: Lightweight anti-corrosion nanotechnology coating enhancement ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Identified and executed several large-scale, cross-domain pilots to determine potential cost savings and improved fleet-wide readiness via the adoption of functional coatings and surface treatments. Supported various pilot demonstrations aimed at improving performance, protect the base metal and reduce corrosion in various DOD systems including storage tanks, aircraft skin, heat exchangers, undersea vehicles and ship hulls.	4.827	5.000
Congressional Add: Polymer coatings for reduced ice and fouling adhesion ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Analyzed solids shedding mechanisms resulting in an improvent to ice release capabilities of Navy topside coatings and the biofouling release capabilities of Navy below the water line antifouling coatings.	5.792	5.000
Congressional Add: Undersea domain human performance requirements ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** N/A	2.896	0.000
Congressional Add: Engineered systems to prevent hearing loss ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** N/A	4.827	0.000
Congressional Add: Extreme environment warfighter safety research	3.861	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: N/A ***FY 2021 Plans:*** N/A		
Congressional Add: Female musculoskeletal research ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** N/A	4.827	0.000
Congressional Add: force Health Protection and Application ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Conduct research on what occurs inside the brain after experiencing a blast event. The research will leverage partnerships with academia and the national laboratories to acquire a better understanding of the human cellular response and the interface between humans and their protective equipment during blast impulses. These research efforts may lead to predicting injury following a blast event using future wearable sensor systems and may inform the design of advanced protective equipment to reduce blast injuries.	0.000	5.000
Congressional Add: Health and Safety Research of Underground Fuel Storage Facilities ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Develop plans and evaluate technologies to improve the health and safety of the underground Red Hill Fuel Storage Facility in Hawaii, and other underground fuel storage tanks in the Asia-Pacific AOR. Perform research for fuel tank inspect and repair protocols; advanced microscope analysis of tank corrosion products; concrete tank degradation inspection and retrofit; and advanced nanomaterials coating.	0.000	5.000
Congressional Add: Human Performance and injury Rehabilitation Assessment tool ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Conduct applied research in Human Performance and Injury Rehabilitation Assessment tool.	0.000	2.500
Congressional Add: Humanoid Robotics in Unstructured Environments ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Investigate issues in robotic learning of manipulation skills, natural language interaction with robots, robotic tasks relevant for shipboard maintenance, robot navigation and human-robot collaboration. Research will be conducted in humanoid robotics in complex unstructured environments.	0.000	5.000
Congressional Add: Engineered Systems to Preserve and Restore Hearing After Deleterious Stimulation	0.000	5.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: N/A ***FY 2021 Plans:*** Exposure and extended exposure to high levels of noise can cause hearing damage, which severely impacts operational performance and can lead to permanent hearing loss. While advances are being made in developing therapeutics for auditory injury and delivering them to the inner ear to restore hearing, drug placement remains a major challenge to realizing optimal and consistent outcomes. The primary objective of this effort is to develop a noise-level enabled drug dosing and delivery system that would prevent cochlear damage. Such a system would respond in real-time to prevent noise-induced hearing loss and protect the warfighter from subsequent ear trauma.		
Congressional Add: Hypersonics Material Acceleration ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** This funding is anticipated to use the membership and resources of the LIFT Institute to increase the manufacturing base for the US hypersonics industrial base. The work will focus on additive processing of large 3D structures, joining of dissimilar metals, establishment of powder supply chain for refractory metal alloys, and ICME tools leading to the development of new materials and processes, as well as characterization of existing materials and prediction of properties for future materials.	0.000	4.000
Congressional Add: Laser Peening Technology for Submarine and Carrier Shafts ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Complete development and activities qualifying to certify laser peening of ship propulsion shafts. This proposed work will follow on an existing program that is addressing shaft operational risk issues and evaluating the efficacy of the laser peening process to reduce risk when applied to propulsion shafts.	0.000	3.000
Congressional Add: Physics Based Neutralization of Threats to Human Tissues and Organs ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Conduct research into a multiscale, physics-based approach to for use in preventing and mitigating both mild traumatic brain injuries (mTBIs) and blast-induced traumatic brain injuries (bTBIs). Preventing and mitigating bTBI and mTBI requires advancing the understanding of injury at a cellular level, as the exact force magnitudes and directions that initiate TBI at the cellular scale are still unknown. Knowledge of neuronal TBI thresholds is a critical and currently missing component of developing improved protective equipment, as well as equipment that addresses the full range of injury.	0.000	5.000
Congressional Add: Social Networks and Computational Social Science	0.000	2.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: N/A ***FY 2021 Plans:*** Develop new metrics for social media analysis of social cyber-threats to military missions, to include threat characterization, behavior and tactics modeling, coordination structures, action dynamics, narrative evolution and studies of polarization and, multiplatform mapping, and platform vulnerabilities and bias. Anticipated deliverables include published papers, book chapters, and presentation, technical demonstrations, and a capstone project to validate results via a technical demonstration.		
Congressional Add: Warfighter as a System Human Digital Twin Research ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Continue development of the human digital twin project known as I-PREDICT. The research will involve development of the roadmap for integration and the integration process itself of the human body model with sub-system human models, simulations of aircraft, aircraft components and equipment, personal protective equipment and specialized equipment for casualty transport.	0.000	3.000
Congressional Adds Subtotals	30.891	49.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A