

# A - ENERGY, MATERIALS SCIENCE & ENGINEERING

## ARMY AVIATION AND MISSILE RESEARCH DEVELOPMENT AND ENGINEERING CENTER (AMRDEC)

- 1.35. Basic Research & Concepts Development – Work undertaken to acquire new knowledge with DoD relevance, but without any specific applications in view. Basic research includes analyses of properties, structures and relationships with a view to formulating and testing hypotheses, theories or regularities pertaining Army Aviation S&T.
- 1.40. Autonomy & Teaming – Develop and proliferate autonomy, aiding, and teaming technologies and capabilities in order to make the Warfighter more efficient, survivable, and effective. Enhance and expand aerial manned-unmanned teaming concepts to enable single operator-unmanned team operations.
- 1.36. Sustainment – Lead the development of technologies and concepts to effectively and affordably sustain the Army’s rotary-wing fleet, and to strive for a “zero-maintenance” aircraft.
- 1.37. Concept Design – Create conceptual designs of advanced vertical lift platforms in response to notional or evolving user needs; evaluate aircraft concepts from responses to solicited and unsolicited proposals; assess the impact of incorporating advanced technologies; develop design and assessment methods to perform these tasks.
- 1.38. Avionics & Networks – Develop resilient architectures for affordable and effective integration and certification of complex mixed critical cyber-physical mission systems. This includes a high throughput, long range, low drag off-board network communication capability.
- 1.39. Engines – Develop/optimize sources of reliable propulsion for aviation platforms that emphasize fuel efficiency across spectrum of operations (high/hot or high/cold), affordability, durability, high specific power/specific weight, high power density/energy density, and variable output speed capability.
- 1.41. Survivability – Develop and transition affordable, integrated, balanced aviation survivability solutions to improve the ability to avoid detection, tracking, and engagement in a complex spectrum threat battlefield environment and survive given a hit/crash.
- 1.42. Engagements & Effects – Increase single-ship and team-based mission effectiveness through sensor and weapon concepts and technology applications for a reduction in the sensor-to-shooter timeline, enhanced situational awareness, and increased survivability and lethality.
- 1.43. Human Systems Interface – Optimize human performance in the aviation environment. Apply human performance concepts to manage workload and optimize performance in complex aviation environments. Develop crew station design principles to enable complex operations for manned and unmanned aviation crew stations.
- 1.44. Structures – Discover, develop, demonstrate, and transition efficient, durable, and affordable rotorcraft structural concepts and technologies.

- 1.45. Drives – Develop/optimize rotorcraft drives and power transmission (gearbox) technologies that improve power density to increase payload/ range capability, reduce costs to increase aircraft affordability, provide multi-engine variable-speed transmission capability, increase component life, and reduce internal noise to increase pilot endurance and reduce hearing loss.
- 1.46. Rotors – Conduct advanced R&D as the nation’s leader in rotorcraft aeromechanics, rotor systems and associated technology development. Develop and insert these new technologies for application to military helicopters, tilt-rotor aircraft, and other advanced vertical lift aircraft.
- 1.47. Subsystems – Develop technologies that enable the aircraft and occupants to operate and survive in a hostile military environment. Efforts are primarily in the area of vulnerability reduction, specifically in conventional threat protection (ballistics), crashworthiness, fuel containment, and directed energy weapon protection.
- 1.48. Computational Aeromechanics – Provide accurate and validated computational modeling and simulation capability for rotorcraft fluid dynamics, structural dynamics, flight dynamics, and acoustics.
- 1.49. Experimental Aeromechanics – Conduct cutting-edge basic and applied research to enable fundamental understanding of rotorcraft fluid dynamics, structural dynamics and acoustics, and develop critical experimental data for validation of computational methods.
- 1.50. Vehicle Management Systems – Enhance handling quality requirements and flight simulation/control concepts for vertical lift aircraft to enhance maneuverability and stability in complex military environments, including autonomous control of multiple UAVs/twin lift.
- 1.51. Airworthiness Assurance – Deliver responsive airworthiness assessments and solutions throughout the system life cycle. Sustain the leadership and engineering expertise necessary to provide valued products to our aviation customers.
- 1.59. System Engineering, Integration & Interoperability – Provide expertise to execute the traditional application of Systems Engineering “Vee” activities to enable the realization of successful systems. Apply appropriate application of SE processes in: development of system engineering plans, entrance and exit criteria, performance specification development, requirements management, risk management, and technical performance measures.
- 1.60. Software Engineering – Provide world-class system and software engineering life cycle management support to our customers and Warfighters.
- 1.61. Reliability, Availability & Maintainability – Plan, develop, implement, and manage RAM and System Assessment Programs for AMCOM Weapon Systems, SRP/Surveillance Programs, Reliability Improvement Programs, CBM/Reliability Centered Maintenance (RCM), and research into advanced technologies and methodologies.
- 1.62. Sustainment, Industrial Base, & Obsolescence – Develop and maintain an adequate industrial base, including organic and commercial capabilities, to support production, sustainment, operations, and future systems’ requirements. Apply supply chain, diminishing manufacturing sources and material shortages, and obsolescence management.

1.63. Quality Engineering & Management – Throughout product life cycle, provide interdisciplinary quality functions and best practices to reduce product and program risk, and ensure customer satisfaction and confidence by establishing sound quality requirement, verification of product and procedural compliance, and focusing on continuous improvement to reduce product and process failures, defects, and variability.

1.64. System Safety – Specialty within system engineering that supports program risk management. It is the application of engineering and management principles, criteria and techniques to optimize safety.

1.65. Manufacturing Technology & Production Support – Provide manufacturing expertise and production engineering and develop and transition technology and processes for the affordable, timely production and sustainment of missile and aviation systems. Provide parts, materials, and assembly processes expertise to assure performance in military applications.

1.66. Multidiscipline Acquisition & Project Engineering Leadership – Provide senior acquisition leaders and key technical experts who collaborate across functional boundaries to develop synergistic, innovative total system solutions in direct support of AMRDEC core missions and reimbursable customers.

1.67. Test & Evaluation – Employ life cycle T&E knowledge and skills to develop and manage effective T&E programs for customers to assess performance against their technical and operational requirements.

1.68. Maintenance, Life Cycle Cost Reduction & Logistics Engineering – Impact weapon system design for sustainment to keep them reliable, operational, sustainable, and affordable throughout their life cycle. Expertise in engineering and sustainment of TMDE and the utilization of the organic maintenance system for weapon systems sustainment. Provide expertise to systematically identify and implement changes resulting in cost reduction/savings, which improve the Army's buying power. Programs/ Efforts to support this include Technical Evaluation/should costs, OSCR, VE, AWCF obsolescence, and spares competition (Tech Loop).

1.69. Model & Simulation Design, Development, Verification, Validation & Accreditation (VV&A) & Analysis – Deliver collaborative and innovative engineering solutions in the areas of system design, development, integration, analysis, and modeling and simulation to advance aviation, missile, and defense capabilities.

1.70. Engineering Prototype Design & Development – Rapid design, development, fabrication, integration, and delivery of mechanical and electrical components, subsystems, and systems through collocation of multifunctional teams, reconfigurable facilities, and unique and streamlined processes.

1.71. Configuration Management – Develop and execute centralized weapons system configuration management programs that include preparing, releasing, controlling, ordering, marking and delivering the engineering data.

1.52. Basic Research – Basic research is a systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena. Basic research is executed without thought of a practical end goal, without specific applications or products in mind. In the context of Missile System

Technologies, it applies to all component and subsystem technologies necessary to perform the missile research, development and engineering mission.

1.53. Propulsion – Provide missile and rocket propulsion expertise, both air breathing and nonair breathing, for the Army and its elements. This includes all activities involved in the design, analysis, and fabrication of propulsion unit hardware, propellant formulation, mixing of propellant ingredients, loading/ casting of solid rocket motors and testing and demonstration of missile and rocket propulsion components and subsystems. Propulsion also includes the integration of propulsion components and subsystems into missile and rocket systems and their demonstrations in static and flight test, monitoring the health of propulsion components through stockpile reliability programs, and the demilitarization of these components at the end of their life cycle.

1.54. Electronics, Guidance, Navigation, Control & Sensors – Provide missile electronics, guidance and sensors expertise for the Army and its elements. This includes all activities involved in the design, analysis, and fabrication of electronics, guidance and sensors hardware and software algorithms, and testing of missile electronics, guidance and sensors hardware and software algorithm components and subsystems.

1.54.1. Electronics includes all electronics onboard and on the ground used to communicate with the missile, process sensor input, perform guidance calculations, provide output to control actuators, acquire, lock-on and track target, and arm and initiate the warhead.

1.54.2. Guidance, Navigation and Control includes technologies needed to launch, guide, navigate, and control the missile and provide missile fire control. This includes designing, analyzing, building, integrating and testing of guidance, navigation and control software/algorithms/ hardware, and fire control sensors.

1.54.3. Sensors includes the designing, analyzing, building and testing any and all sensor software and hardware across the whole electro-magnetic and acoustic spectrums needed to find, identify and track the target, and communicate with the missile. A key sensor area is the development, analysis, and testing of all Army Air Defense radars for surveillance and fire control, to include advanced radar hardware. This includes advanced radar hardware, signal processing, and non-cooperative target recognition algorithms. This also includes the designing, analyzing, building and testing of target acquisition and tracker algorithm and software.

1.55. Aerodynamics & Computational Methods – Provide aerodynamic prediction, analysis and modeling for missiles and other air vehicles across the engineering life cycle through the use of ground and flight test data, semi-empirical prediction techniques and fully-coupled Navier-Stokes computational fluid dynamics.

1.56. Lethality – Perform research, design, development, test, evaluation, integration and weaponization of fuzing, warhead (both lethal and non-lethal), protection systems and payload delivery technologies for Army missile systems. This includes threat vulnerability analysis and missile system effectiveness analysis of warheads and payloads, and the demonstrations of lethality systems in static, captured dynamic and flight test.

1.57. Launchers & Structures – Provide missile and rocket launcher solutions and expertise for the Army and its elements. This includes all activities involved in the design, analysis and fabrication of

launchers and associated electronics for both ground and air launched missiles, integration of launchers on both ground and air vehicles and their demonstrations. Provide materials solutions and expertise for existing and future missile systems and aviation platforms to the Army and its elements. Performing research and development with respect to composite structures and materials application as applied to missiles, launchers, and aircraft, including design studies of new system concepts, prototype fabrication, and performing various mechanical analyses. Included among those are failure analysis, dynamical analysis, structural analysis, fatigue life estimation, and vibration testing.

1.58. Concept Development – Capture and understand the Army’s current and future missile system requirements and needs; develop and analyze various missile component configuration alternatives against various technical and performance parameters to select an “optimized” material approach.

## **ARMY RESEARCH LABORATORY**

### **1.1. EXTRAMURAL BASIC RESEARCH**

1.1.1. Physical Sciences is focused on basic research to discover, understand, and exploit physical phenomena which are expected to create revolutionary capabilities for the Army of 2030 and beyond. Discoveries in this area are expected to lead to capabilities in communications and materials well beyond classical limits that restrict the performance of current Army systems.

1.1.4. Engineering Sciences is focused on basic research to discover, understand, and exploit new material systems, mechanical systems, electronics, and photonics that are expected to create revolutionary capabilities for the Army of 2030 and beyond. Discoveries in this area are expected to lead to capabilities in materials, the sciences for maneuver, the information domain, the sciences of lethality and protection, and Soldier performance augmentation, well beyond the limits facing today’s Army.

### **1.2. MATERIALS RESEARCH**

1.2.1. Structural Materials is focused on novel and specialized materials to enhance the structural efficiency and systems performance of advanced platform structures while maintaining the same or greater levels of protection compared to today’s platforms.

1.2.3. Photonics is focused on materials and devices for photonic sensors and sources; scalable high energy lasers; secure communications via quantum networking and protection of sensors and human eyes against high power and short pulse laser threats.

1.2.4. Energy and Power is focused on materials and devices for more efficient power generation; energy storage; energy harvesting; fuel processing; micro power; and novel alternative energy solutions at lower cost.

1.2.5. Biotechnology and Bio-Inspired is focused on new biological materials derived through synthetic biology as well as classical approaches. Novel biological materials are combined with inorganic devices to sense chemical and biological agents; generate power from organic sources; and produce materials to create new protection designs inspired by nature.

1.2.6. High Strain Rate and Ballistic Materials is focused on novel and specialized materials to enhance the performance and efficiency of Army weapons and protection systems including lightweight, extreme performance materials; novel energetic materials; and energy absorbing materials.

1.2.7. Manufacturing Science, Processing, and Sustainment is focused on discovery, innovation, and maturation of manufacturing innovations to facilitate agile, adaptive, mobile processing and manufacturing capabilities to enable superior performance and implementation of cost reduction methodologies. Sustainability is focused on understanding material properties and degradation mechanisms to improve durability of Army systems in extreme environments.

### 1.3. SCIENCES-FOR-MANUEVER

1.3.1. Energy and Propulsion concentrates on understanding and exploiting the applications of energy generation, storage, conversion, and management. The goal of this research is to provide energy and power applications to enhance Army operational effectiveness, improve efficiency, and accelerate development of critical military platform systems ensuring Army Power Projection superiority.

1.3.2. Platform Mechanics focuses on fundamental research that enables the development of the highly maneuverable platforms for the Army of the future.

1.3.3. Platform Intelligence focuses upon fundamental research that enables effective teaming of Soldiers and robots to conduct maneuver and military missions. ARL's activities are centered upon enhancing the autonomous capabilities of unmanned systems.

1.3.4. Logistics and Sustainability focuses on fundamental research to enable the rapid and reliable assessment of future Army platform reliability, health, and usage.

### **COMMUNICATIONS, ELECTRONICS RESEARCH, DEVELOPMENT & ENGINEERING COMMAND (CERDEC)**

1.10. Tactical and Deployed Power – Initiatives entail providing advanced, smaller, lighter weight, higher yield, reduced cost Soldier-power and mobile-power sources, power generation systems, renewable energy systems, environmental control systems, and intelligent power grid technologies and systems.

### **DEFENSE THREAT REDUCTION AGENCY**

1.25. Science of WMD Sensing and Recognition – Research involves exploration of interactions between materials and electromagnetic frequencies, molecules, nuclear radiation or particles for developing techniques that generate information about the presence, identity, and/or quantity of material or energy that may indicate WMD in the environment.

### **ENGINEER RESEARCH DEVELOPMENT CENTER (ERDC)**

- 1.30. Geospatial Research & Engineering
  - 1.30.1. Technical Preparation of Joint Operating Environment (JOE)
  - 1.30.2. Geospatial Informatics and Framework
  - 1.30.3. Geo-Information Preparation of JOE
  - 1.30.4. Geo-Enabled Mission Command Enterprise
- 1.31. Installations & Environment
  - 1.31.1. Adaptive and Resilient Installations
  - 1.31.2. Sustainable Ranges and Lands
  - 1.31.3. Military Materials in the Environment
- 1.32. Military Engineering
  - 1.32.1. Force Protection in Base Camps
  - 1.32.2. Enhanced Tele-engineering Research
  - 1.32.3. Objective Force Reaching in Urban Terrains
  - 1.32.4. Weapons Effects in Urban Terrains
- 1.33. Water Resources
  - 1.33.1. Navigation and Hydropower
  - 1.33.2. Flood and Coastal Systems
  - 1.33.3. Water Supply, Emergency Management
  - 1.33.4. Environment – Restoration, Regulation, Stewardship
  - 1.33.5. Water Resources Infrastructure
  - 1.33.6. System-Wide Water Resources
  - 1.33.7. Basic Research

#### **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

1.73. Food Protection and Innovative Packaging – Advanced materials, polymer processing technologies and revolutionary packaging concepts that maintain, sustain, and provide the Warfighter with rations delivering the highest performance level, overall quality, nutrient retention and safety. Promotion of innovative primary and secondary packaging materials for the Warfighter from the laboratory to manufacturing scale. Current efforts include high-barrier non-foil polymeric structures, permeability modeling, advanced polymer processing technologies, polymeric microspheres, polymer/clay nanocomposites, alternative materials for secondary packaging, high-barrier coatings,

liquid-crystal polymers, bio-based, biodegradable, and sustainable materials for ration packaging systems, and lightweight and compostable packaging. These efforts seek to stabilize and protect foods against microbial, chemical and physical deterioration under extreme environments and the military logistics systems while increasing ration consumption and reducing food and packaging waste. Rapidly detect and identify microbiological and chemical hazards in food, including the development and validation of assays for commercially available instruments; the development and validation of microbiological predictive modeling tools to support food safety risk analysis; and, research and development of pathogen reduction technologies for ready-to-eat foods, novel food processing methods, and food service sanitation.

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Aerial Delivery*

1.79. Airdrop Technology – Focused on increased mobility and logistic capabilities to the soldier by identifying and maturing technologies that show promise towards advancing the state-of-the-art in aerial delivery of equipment, supplies and personnel. Major thrust areas are:

1.79.1. Reducing the potential for airborne personnel injury/casualties through improved system reliability while reducing ground impact velocity, oscillation and exposure time to threats.

1.79.2. Accelerating and lowering the cost of parachute development, production and maintenance through novel new parachute designs using computational analytical methods to reduce manufacturing and testing requirements.

1.79.3. Improving airdrop survivability of fragile payloads and enhancing battlefield effectiveness by decreasing high opening forces for parachute systems deployed at high altitudes.

1.79.4. Increasing aircraft/airborne force survivability and expanding the airdrop operational envelope through the introduction of standoff precision guided aerial delivery platforms and low-level airdrop systems.

1.80. Aerial Delivery Engineering Support – Technical and engineering services for the development, acquisition, sustainment or use of products and processes that afford aerial delivery of personnel and equipment by parachute, aircraft and helicopter.

1.80.1. Helicopter Sling Load Certification: Planning, coordinating, conducting and documenting all activities required to certify the acceptability of an item for helicopter sling loading.

1.80.2. Engineering Support for Army Airdrop Equipment Procurement & Sustainment: Providing management and technical support to the field, ILSC, DLA and Airdrop Lifecycle Coordination Team.



1.80.3. Technical and Program Management Support for Product Development and Problem Resolution: Providing technical program management support for any product development and problem resolution effort.

1.81. Aerial Delivery Design and Fabrication – Fabrication of prototype parachutes, harnesses and accessories, modifications (such as upgrading or repairing existing fielded equipment), and provision of quick response production capabilities.

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Collective Protection Systems Team*

1.96. Chemically Protected - Deployable Medical Systems (CP-DEPMEDS): The 256-bed CP-DEPMEDS hospital is a 3-½ acre complex of TEMPER (Tent, Expandable, Modular, Personnel) tents, passageways and expandable shelters. CP DEPMEDS is heated or cooled and overpressured with filtered air to provide the 150-person hospital staff ability to treat and house patients in a "shirtsleeve" toxic-free environment. CP DEPMEDS is a complete hospital with surgeries, x-ray, dental, and a CB-protected water supply system.

1.97. Joint Expeditionary Collective Protection (JECF): JECF provides collective protection (ColPro) capability to shield and sustain the Joint Expeditionary force (JEF) during potential Chemical and Biological and Toxic Industrial Materials (CB/TIM) attacks. The Family of Shelters (FoS) provides three capabilities; a structure kit, a tent kit, and a standalone shelter. The structure kit will provide ColPro by exploiting existing buildings and other improved and unimproved host structures through the use of adaptive kits to enable personnel to render existing buildings and structures operational for C2, R2 and medical functions within a CB/TIM contaminated environment. The tent kit, provides an upgrade to several types of existing tents to enable personnel to collectively protect existing tactical tentage from CB/TIM. The JECF FoS is intended to share common components and be modular in design, but is not intended to be setup in a CB/TIM contaminated environment.

1.98. Chemical & Biological Protective Shelter (CBPS): CBPS is a highly mobile vehicle-mounted rigid wall enclosure with attached chem-bio (CB) protected airbeam supported tent. This provides a chemical and biological protected and environmentally controlled medical space where medical treatment teams can execute their mission without the encumbrance of individual protective clothing and equipment. The self-deploying shelter is used as a battalion aid station for forward medical treatment in a contaminated environment. The CBPS can be deployed/struck in a CB environment and several CBPSs can be complexed to form larger CB Collectively Protected areas.

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Combat Feeding*

1.74. Food Engineering and Analysis – Technologies that improve the nutritional quality, organoleptic properties, stability and shelf life of ration components for both individual and group rations. Better products through unique product formulation and employing advanced thermal and

non-thermal novel processing and preservation techniques. Ration preservation via ultrasonic agglomeration, microwave sterilization, novel dehydration techniques, and employing additive manufacturing techniques. Improving quality and stability of intermediate moisture foods using next generation hurdle technologies to develop new shelf stable sandwiches, breakfast and bakery items. Chemical and sensory analysis of foods to ensure safety and acceptance of shelf stable rations.

1.75. Performance Nutrition – Novel, nutrient-dense ration components for optimized Warfighter performance. Assess the nutrient bioavailability and physiological status in developed components for all environmental extremes. Cutting-edge research on bioactives, functional foods, and phytochemicals. Vitro screening of nutraceuticals, synergistic compounds to enhance bioactive absorption, functionality of encapsulated oils, advanced nano-systems with emerging rations and co-extruded alternate delivery systems; all of which have the potential to provide tomorrow's Warfighter with increased physical and cognitive performance on the battlefield. Chemical, microbiological and sensory analysis of targeted ration components to ensure safety, bioavailability and acceptance of supplemented shelf stable ration components.

1.76. Food Service Equipment – Engineering and manufacturing development and the production and deployment phases for foodservice equipment; that consistently provides Warfighters the capability to enjoy hot group meals in combat and/or training environments. Projects that field robust, efficient and proven equipment and systems for field feeding, ration storage and sanitation of field foodservice equipment.

1.77. Equipment and Energy Technology – Innovative research and development, demonstration, and transition of technologies that reduce the logistics of field feeding while improving the quality of food service. Field kitchen appliance design, burners for field kitchen appliances, refrigeration, combat ration heating technologies, solar and other alternative energy sources, cogeneration, sanitation, and greywater recycling. Technology for higher efficiency on the demand side and alternative energy on the supply side, to reduce fuel, water and waste and to support contingency basing initiatives.

1.78. Joint Foodservice and Engineering – Best value, technologically advanced foodservice field-feeding equipment and systems to enhance the quality of life and performance for the Navy, Air Force and Marine Corps, and conducts engineering support and standardization for the Army, DLA, Integrated Logistics Support Center (ILSC) and the U.S. General Services Administration for fielded foodservice equipment. Product development of rations/menus for the Air Force and Navy, including production of Tube Foods for the Air Force. Support requirements and analyses of new military foodservice equipment in the design, development, fabrication, test and evaluation of concepts.

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Expeditionary Basing and Collective Protection*

1.86. Fabric Structures – Technology to advance the state-of-the-art in soft-wall shelters to include chemical, biological, radiological, nuclear (CBRN) collective protection, high efficiency insulation, and flexible lighting. Structural airbeam technologies for development and incorporation into rapidly-deployable shelters and adaption to other applications such as fenders for ships.

1.87. CB Closure – Effort to improve the closure system that connects modular sections of the M28 liner system. The goal of the program is to investigate alternative configurations and materials for linear connections, as well as novel approaches to meet the challenge of providing a fully separable liquid and vapor barrier for collective protection system.

1.88. Chem/Bio Materials – Provision of a family of material solutions to provide low cost high performance C/B protective fabric for use in shelters and liner systems. Concepts include nano-composite barrier films, lower cost fluoropolymer/fiber composite fabrics, coating treatments for general-purpose fabrics and a self-decontaminating reactive material.

1.89. Airbeam – Focus on high pressure, inflatable arches that replace metal structural frame members in tents providing a 50% weight reduction and 70% deployment-time reduction. Multiple spin-offs including space antennas, ballistic protection, C/B fabrics, inflatable bridge, and rapid deployable breakwater system. Also demonstrated a rapidly deployable 85' wide broad span shelter based on inflatable airbeam technology large enough for rotary and fixed wing aircraft maintenance, supply storage, and distribution.

1.90. Advanced Energy Saving Insulation for Mobile Shelters and Base Camps – In FY08, prototype fabrication, demonstration and testing of an advanced insulation to decrease energy consumption in shelters was completed. Aerogel is the most efficient thermal insulation known, and will provide a more efficient solution than the current shelter insulation alternatives, particularly in support of agile mission requirements. A high level of insulation can be provided using aerogel in a lighter, thinner package compared to existing flexible insulation technology. A full-scale inflatable airbeam shelter was fabricated and outfitted with an aerogel insulation system. Side-by-side testing was conducted and fuel savings, when compared to an un-insulated tent was 34%. Given these positive results, follow-on research to focus on manufacturing technology improvements for aerogel are being pursued.

1.91. Lightweight 1-2 Person Low-Pressure Inflatable Tents – To create improved military backpackable tents that are both lighter, pack to a smaller size and are more durable than past performers.

1.92. Improved backpackable shelters with reduced deployment and strike times.

1.93. Reduction in tent weight, i.e. reduction of the load burden on the expeditionary Warfighter.

1.94. Potential transition of the small scale airbeam technology to the Marine Corps and Spec Ops agencies.

1.95. Potential dual use applications may include dog kennels and vehicle bed covers.

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Warfighter*

1.83. Materials Science

1.85. Textiles & Fiber Sciences

## B - Computational, Information & Analytical Sciences

### ARMY RESEARCH LABORATORY

1.1.3. Information Sciences is focused on basic research to discover, understand, and exploit the mathematical, computational, and algorithmic foundations that are expected to create revolutionary capabilities for the Army of 2030 and beyond. Discoveries in this area are expected to lead to capabilities in materials, the information domain, and Soldier performance augmentation, well beyond the limits facing today's Army.

#### 1.4. COMPUTATIONAL SCIENCES

1.4.1. Predictive Simulation Sciences concentrates on understanding and exploiting the fundamental aspects of verified and validated computational simulations that predict the response of complex Army systems and guide Army materiel design, particularly in cases where routine experimental tests are extremely difficult to conduct or not feasible.

1.4.2. Data Intensive Sciences focuses on understanding and exploiting the fundamental aspects of large-scale, multi-dimensional data analytics. Experiments, observations, and numerical simulations are on the verge of generating petabyte-quantities of data. These massive amounts of data are distributed across disparate locations and pose a challenge in providing real-time analytics that support U. S. military operations.

1.4.3. Computing Architectures concentrates on understanding and exploiting the fundamental aspects of hardware and associated system software for emergent and future computing architectures for mobile, scientific, and data intensive applications. Computing systems include both mobile and fixed/virtual architectures optimized for fast communications, low power consumption, large hierarchical memory, novel and robust algorithms, high resiliency, and HPC networking.

1.4.4. Computing Sciences concentrates on understanding and exploiting the fundamental aspects of computer science research related to ease of programming, computing environments, languages, and reusable programming models for Army specific applications.

#### 1.5. INFORMATION SCIENCES

1.5.1. Sensing and Effecting research concentrates on understanding and exploiting information gained through sensing and exploiting data to drive effectors. Both sensing and effecting necessitate detailed understanding of corresponding physical behaviors that generate and utilize data, as well as effective means for storage, retrieval, and manipulation of data.

1.5.2. System Intelligence and Intelligent Systems research concentrates on understanding and exploiting interactions between information and intelligent systems, such as robots and software agents, wherein information is transformed between different levels of abstraction and roles within the intelligent system's cognitive processes – recognition, reasoning, predictions, and decision-making.

1.5.3. Human and Information Interaction research concentrates on understanding and exploiting interactions between information and humans, which involves complex mixed-initiative processes of information acquisition, transformation between levels of abstraction and relevance, comprehension, negotiation, and interactive tasking – mutually between humans and Army information systems.

1.5.4. Networks and Communications research concentrates on understanding and exploiting information's interactions with socio-technical networks, particularly communications, and command and control networks, both formal and social. Such interactions are heavily influenced by complex channels and protocols requiring complex analyses to understand and predict emergent behaviors of networks.

1.5.5. Cyber Security research concentrates on understanding and exploiting interactions of information with cyber attackers – human and/or intelligent agents. These interactions involve friendly operations against adversary information systems and networks, defense of friendly information systems and networks, and assurance of persistent information support to Soldiers even when parts of the friendly systems and networks are compromised.

## 1.8. ASSESSMENT AND ANALYSIS

1.8.1. Assessment of Science and Technology concentrates on understanding the costs and benefits of R&D efforts, their readiness levels, risks, potential payoffs, and integration challenges.

1.8.2. Science and Technology of Assessment concentrates on understanding the key types of analytical problems likely to confront the Army of 2030, exploiting the latest developments by our academic and industrial partners, and performing basic and applied research to develop the powerful new tools required.

1.8.3. Assessing Mission Capability of Materiel concentrates on understanding and exploiting systems' technologies, design, and employment together with current – and likely future – state of the art developments to optimize future designs and to inform evaluation and acquisition decisions with analyses that are both technically sound and practically efficient. Key to this effort, are methodologies to integrate technical assessments into the science and engineering domain with considerations of mission effectiveness for the materiel's operational user.

1.8.4. Materiel Capable of Assessing Mission Capability concentrates on understanding and exploiting developments in the other S&T campaigns to evolve assessment and analysis itself from a laboratory service to a technology that we transition to the warfighter.

## **COMMUNICATIONS, ELECTRONICS RESEARCH, DEVELOPMENT & ENGINEERING COMMAND (CERDEC)**

1.15. Intelligence, Analysis, Exploitation and Dissemination – There are mass amounts of information and intelligence to be acquired, extracted, analyzed, synthesized and delivered in effective, actionable formats to protect and arm U.S. Soldiers with the tactical and strategic advantage.

1.16. Intelligence, Surveillance, Reconnaissance and Targeting –Advanced collection capabilities with the flexibility to address changes in the operational environment and signatures of interest to develop the situation through action by acquiring precise and timely information.

#### **DEFENSE THREAT REDUCTION AGENCY**

1.28. Science to Defeat WMD - Research involves the creation of new energetic materials or physical approaches that enhance the defeat of WMDs by orders of magnitude, the improvement of modeling and simulation of these materials and various phenomena that affect success and estimate the impact (lethality) of defeat actions, and assessing event characteristics using various dynamic analytical methods. Basic science to defeat WMD involves furthering the understanding of explosives, their detonation, and problems associated with accessing target WMDs.

## **C - Medical, Healthcare & Human Performance Sciences**

#### **ARMY RESEARCH LABORATORY**

1.1.2. Life Sciences is focused on basic research to discover, understand, and exploit biological systems that are expected to create revolutionary capabilities for the Army of 2030 and beyond. Discoveries in this area are expected to lead to capabilities in materials and Soldier performance augmentation, well beyond the limits facing today's Army.

1.6.3. Battlefield Injury Mechanisms concentrates on understanding and exploiting the fundamental aspects of human combat injury mechanisms.

#### **1.7. HUMAN SCIENCES**

1.7.1. Human-Physical Interface fundamental research focuses on better understanding the relationship between the brain and the body, and interactions with the physical environment. Fundamental understanding gained in genetics and genomics; molecular biology; and human biochemistry and their impacts on brain structure-function coupling are expected to be essential in augmenting warfighter performance. Physical-cognitive interactions – especially in the operational environment – are expected to influence warfighter behavior; learning and decision making; and multisensory perception.

1.7.2. Human-Human Interface fundamental research is focused on better understanding one-to-one, one-to-many, and many-to-many interactions. The focus of this area is on providing and evaluating effective personnel training, leader development, and team building through fundamental understanding and enhancement of motivation, physical resilience, cognitive resilience, and trust. Understanding and exploitation of the fundamental aspects of social networks dynamics; organizational structure optimization; and ethics, values, trust, social-cultural, economic, and geopolitical effects are expected to be critical in influencing group dynamics and performance.

1.7.3. Human-Technology Interface fundamental research is focused on understanding how humans interact with materiel and information. Fundamental research areas of interest include ergonomics and biomechanics to increase Soldier performance while simultaneously minimizing injury probability; physical augmentation to improve physical load management; wearable and implantable systems and devices for protection and for medical applications; and brain-computer interactions dedicated to understanding and enhancing cognitive performance and protection against cognitive harm.

## **MEDICAL RESEARCH & MATERIEL COMMAND (MRMC)**

### **1.11. MILITARY INFECTIOUS DISEASES RESEARCH PROGRAM**

- 1.11.1. Medical Readiness
- 1.11.2. Vaccines
- 1.11.3. Biotechnology
- 1.11.4. Prophylaxis/treatment drugs
- 1.11.5. Diagnostics/prognostics
- 1.11.6. Vector control
- 1.11.7. HIV countermeasures

### **1.12. COMBAT CASUALTY CARE RESEARCH**

- 1.12.1. Damage Control Resuscitation
- 1.12.2. Traumatic Brain Injury
- 1.12.3. Combat Trauma Therapies
- 1.12.4. Health Monitoring & Diagnostic Technology
- 1.12.5. Combat Dentistry

### **1.13. MILITARY OPERATIONAL MEDICINE RESEARCH**

- 1.13.1. Injury Prevention and Reduction
- 1.13.2. Psychological Health and Resilience
- 1.13.3. Physiological Health
- 1.13.4. Environmental Health and Protection

### **1.14. CLINICAL & REHABILITATIVE & MEDICINE RESEARCH**

- 1.14.1. Neuromusculoskeletal Rehabilitation
- 1.14.2. Regenerative Medicine and Transplants

- 1.14.2.1. Extremity Regeneration
    - 1.14.2.2. Craniomaxillofacial Regeneration
    - 1.14.2.3. Burn Injury and Skin Regeneration
    - 1.14.2.4. Genitourinary/Lower Abdomen Reconstruction
    - 1.14.2.5. Composite Tissue Allotransplantation and Immunomodulation
  - 1.14.3. Vision Restoration
  - 1.14.4. Pain Management
- 1.15. MEDICAL CHEMICAL BIOLOGICAL DEFENSE RESEARCH
  - 1.15.1. Medical Biological Defense
    - 1.15.1.1. Vaccines
    - 1.15.1.2. Therapeutics
    - 1.15.1.3. Diagnostics
    - 1.15.1.4. Basic Research
  - 1.15.2. Medical Chemical Defense
    - 1.15.2.1. Pretreatments
    - 1.15.2.2. Therapeutics
    - 1.15.2.3. Diagnostics
    - 1.15.2.4. Basic Research
  - 1.15.3. Laboratory Infrastructure
- 1.16. MEDICAL SIMULATION & INFORMATION SCIENCES RESEARCH
  - 1.16.1. Theater/Operational Medicine
  - 1.16.2. Medical Resourcing
  - 1.16.3. Information Technology Infrastructure & Data Management
  - 1.16.4. Military Health Services
  - 1.16.5. Combat Casualty Training
  - 1.16.6. Medical Readiness Initiative
  - 1.16.7. Health Focused Initiative
  - 1.16.8. Tools for Medical Education
- 1.17. BLAST INJURY RESEARCH



- 1.17.1. Injury Prevention
- 1.17.2. Acute Treatment
- 1.17.3. Reset

## **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

### *Warfighter*

- 1.82. Human Sciences

## **D - CBRNE Defense Research**

### **CBRNE**

- 1.18. RESPIRATORY, OCULAR & PERCUTANEOUS PROTECTION – TAILORABLE, FLEXIBLE, INTEGRATED PROTECTIVE ENSEMBLE (FAMILY OF SYSTEMS)
  - 1.18.1. Dynamic Multifunctional Materials for a Second Skin
  - 1.18.2. Multifunctional Materials for Protection
  - 1.18.3. All-Hazards Integrated Protection
- 1.19. PERSONNEL AND MATERIEL CONTAMINATION MITIGATION
  - 1.19.1. Contaminated Human Remains (includes ATD)
    - 1.19.10. Handheld biological detection kit
    - 1.19.11. Next generation pathogen & protein threat identification
    - 1.19.12. End-to-end whole genome sequencing platform with integrated bioinformatics
    - 1.19.13. Integrated environmental biological sensor platform
    - 1.19.14. Low visibility and early warning sensing
    - 1.19.15. Automated sample collection
    - 1.19.16. Health-based Orthogonal Lightweight Manned Early warning Suite (HOLMES)
    - 1.19.17. Fieldable MS technology evaluation for BW detection
    - 1.19.18. Device-to-Cloud integration of multisource detection and diagnostics results to inform command decisions

- 1.19.2. Personnel Decontamination (includes ATD)
- 1.19.3. (Sorbent) Formulations for Immediate Decontamination
- 1.19.4. Catalytic-Based Decontamination
- 1.19.5. Wide Area Decontamination of Anthrax Spores
- 1.19.6. Enhanced CB Survivability Coatings
- 1.19.7. Sorbent Formulations for Immediate Decon
- 1.19.8. Small Scale Disablement ATD
- 1.19.9. Universal sample collection, preparation, and preservation technologies
- 1.20. CBRNE HAZARDS – IDENTIFY, CHARACTERIZE, ASSESS AND EXPLOIT
  - 1.20.1. Next Generation Chemical Detection Increment 3 variant (sample analysis)
  - 1.20.2. Advanced remote concepts for liquid and vapor chemical detection
  - 1.20.3. Next Generation Chemical Detection Increment 4 variant (on the man)
  - 1.20.4. Next Generation Chemical Detection Increment 1 variant (detector alarm for vapor and aerosol)
  - 1.20.5. Remote/early warning technology evaluations
  - 1.20.6. Enhanced colorimetric sensors
  - 1.20.7. Chemical surface detection
  - 1.20.8. Low burden sensor support
- 1.21. EXPEDITIONARY COMMUNICATIONS SYSTEMS – FACILITATE SITUATIONAL AWARENESS AND PROVIDE REAL-TIME REACH BACK CAPABILITY FOR TIMELY FORCE PROTECTION DECISIONS
  - 1.21.1. JEM Science and Technology Prototypes
  - 1.21.2. Open-air, urban, interior and waterborne transport and dispersion
  - 1.21.3. Source term release event modeling for traditional and non-traditional agents
  - 1.21.4. Missile intercept release modeling
  - 1.21.5. Health and human effects modeling
  - 1.21.6. Risk-based Planning and Analysis/Ops Effects for Naval, Air Force and Army Needs
  - 1.21.7. Further work establishing the Chemical and Biological Agent Effects Manual Number 1 (CB-1) as the definitive CB information resource.
  - 1.21.8. Analytic Support Program (ASP), providing short and long term study capability leveraging experts in several areas.

1.21.9. Toxic Industrial Chemical toxicology studies

#### **DEFENSE THREAT REDUCTION AGENCY**

1.27. Science for Protection - Research involves fundamental investigations to advance the knowledge of physical, biological, chemical, and engineering sciences to protect personnel, sensitive electronic systems, and structural infrastructure from the effects of weapons of mass destruction. Protection includes both passive and active defense against threats.

1.29. Science to Secure WMD - Research involves monitoring and securing WMD using innovative techniques to neutralize chemical, biological, radiological, nuclear, or explosive (CBRNE) materials and components, discovery of revolutionary means to secure components and weapon-usable materials, and studies of scientific principles that lead to novel physical tags or other methods to monitor compliance and disrupt proliferation pathways.

#### **NATIK SOLDIER RESEARCH, DEVELOPMENT & ENGINEERING CENTER (NSRDEC)**

##### *Warfighter*

1.84. Chemicals & Biosciences

## **E - Communications, Electronics & Cyber Research**

#### **ARMY AVIATION AND MISSILE RESEARCH DEVELOPMENT AND ENGINEERING CENTER (AMRDEC)**

##### *Cross Center Engineering Specialties*

1.72. Cybersecurity – Risk management process to protect Army Aviation and Missile interests, DoD operational capabilities, and DoD individuals, organizations, and assets from the DoD Information Enterprise level, through the DoD Component level, down to the IS level.

#### **ARMY RESEARCH LABORATORY**

1.2.2. Electronics is focused on specialized electronic materials and devices to achieve Army dominance over the entire electromagnetic spectrum, particularly in contested environments. The two primary thrusts of this area are Energy Efficient Electronics and Hybrid Electronics. Energy Efficient Electronics is focused on low-power-demand electronic components having increased performance capabilities; and Hybrid Electronics focuses on high performance, conformable, and flexible electronics for advanced sensors and processors.

## **COMMUNICATIONS, ELECTRONICS RESEARCH, DEVELOPMENT & ENGINEERING COMMAND (CERDEC)**

1.11. Tactical and Strategic Networks – The infrastructure, tools, vehicles, architectures, interfaces, standards, hardware, protocols, antenna, satellites and bandwidth used to establish, maintain and secure operational connectivity.

1.12. Army Cyberspace Operations include a broad spectrum of capabilities and initiatives that provide tactical decision makers with the assurance, awareness and protection needed to operate effectively in the cyberspace environment and the ability to exploit, deny and disrupt the adversary's use of it. The cyber domain continues to grow, and the DOD has identified cyber as a defense domain much like air, land, maritime and space; however, unlike the other domains, there is not a specific military service to deal with cyber.

1.13. Electronic Warfare includes military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. Electronic Warfare allows Soldiers to detect, disrupt, deny, degrade, or destroy enemy systems, and protect against the adversary's ability to do the same.

1.14. IED, Mine & Minefield Detection & Defeat – This core area includes identifying and combating explosive hazards that include improvised explosive devices (IEDs) and mines employed individually or in minefields, buried under ground, on the surface, or otherwise camouflaged, set and triggered by various tactics.

1.8. Assured Positioning, Navigation and Timing (PNT) – Assured PNT, a system-of-systems approach, provides soldiers with integrated solutions to obtain trusted PNT information while operating in conditions with potentially limited, impeded or denied GPS. Assured PNT solutions enable soldiers to leverage information critical to complex combat operations, increase platform/soldier protection, maintain or acquire signals in challenged environments, improve situational awareness, and synchronize advanced weapon systems and tactics seamlessly for unified execution of the mission.

1.9. Mission Command Capabilities and Computing Platforms efforts focus on providing the commander the ability to effectively manage resources to achieve a successful mission. Mission Command augments the skill and experience of Soldier leaders with Soldier-intuitive technologies to effectively plan, control, adapt and execute mission objectives. Mission Command Capabilities & Computing Platforms coordinate and enable the seamless integration of six Warfighting functions - Intelligence, Fires, Protection, Maneuver, Sustainment and Mission Command in order to achieve mission success.

## **DEFENSE THREAT REDUCTION AGENCY**

1.26. Network Sciences - Research involves analytical or computational means to (a) derive actionable information from social networks that identify adversarial intent to acquire, distribute or use WMDs; or (b) model physical networks before, during or after attack to assist with identifying vulnerabilities, prioritizing preventive measures, and planning for consequence management and rapid reconfiguration.

# F - Munition & Armament Systems Technologies

## ARMY RESEARCH LABORATORY

### 1.10. ENABLING TECHNOLOGIES

- 1.10.1. Application of Advanced Materials
- 1.10.2. Enhanced Propulsion Science
- 1.10.3. Advanced Manufacturing
- 1.10.4. Verified and Validated Modeling and Simulation Tools
- 1.10.5. Reduced Lifecycle Environmental Impact
- 1.10.6. Logistics Automation and Reduction

### 1.6. SCIENCES-FOR-LETHALITY AND PROTECTION

- 1.6.1. Lethality Research for Soldiers and Army Platforms concentrates on understanding and exploiting the fundamental aspects of launch and control; electronic attack; directed energy mechanisms; and target effects.
- 1.6.2. Protection Research for Soldiers and Army Platforms concentrates on understanding and exploiting the fundamental aspects of protection against ballistic threats; directed energy threats; and CBRNE threats.

### 1.8. MUNITION TECHNOLOGIES

- 1.8.1. Smart/Collaborative Munitions
  - 1.8.10. Advanced Fuzing
  - 1.8.11. Extended Range Effects
  - 1.8.12. Interceptor Munitions
- 1.8.2. Highly Directional Explosives/Warheads
- 1.8.3. Multi-functional Munitions
- 1.8.4. Reduced Health Impact of Expended Munitions
- 1.8.5. Design for Demilitarization and Disposal
- 1.8.6. Non-Kinetic Effects
- 1.8.7. Scalable Munitions
- 1.8.8. Enhanced Precision

1.8.9. Counter-Measure Hardened Munitions

1.9. WEAPON TECHNOLOGIES

1.9.1. Directed Energy

1.9.2. Fire Control

1.9.3. Robotic and Autonomous Systems

1.9.4. Collaborative Fires

1.9.5. Signature Reduction

1.9.6. Modular, Common, Multi-use Components

1.9.7. Non-Volume Suppressive Effects

1.9.8. Improvised Explosive Neutralization

1.9.9. Fires from Enclosure