



SEPTEMBER 2016 – MARCH 2022

IMPACT SYNOPSIS

FROM THE UNIVERSITY AFFILIATED
RESEARCH CENTER OF
U.S. STRATEGIC COMMAND



NATIONAL STRATEGIC
RESEARCH INSTITUTE
at the University of Nebraska



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INTENT

Ten years ago, United States Strategic Command (USSTRATCOM) made an important executive decision — to be the first Combatant Command to charter a University Affiliated Research Center (UARC), designated by the Office of the Assistant Secretary of Defense (OASD). This monumental decision reflected USSTRATCOM's intent to access and support cutting-edge research capabilities at an academic institution that would provide the Command research solutions related to its mission priorities and national priorities.

After a rigorous review process, the Department of Defense (DOD) selected the University of Nebraska System (NU) as the 13th UARC, this one sponsored by USSTRATCOM. To engage its bench of more than 5,000 faculty members and 51,000 students across four campuses toward USSTRATCOM's objectives, NU created a non-profit subsidiary — the National Strategic Research Institute (NSRI).

On a five-year basis, the OASD for Research, Development and Engineering performs a Comprehensive Review to assess the impact and future of each UARC. Lt. Col. Hayes J. Weidman, Chief, Contracts Management Branch USSTRATCOM/DOD, requested inputs from Maj. Gen., USAF (Ret.) Rick Evans, NSRI executive director, regarding the following:

- ▶ Continuing long-term strategic needs for significant research in the area of Combating Weapons of Mass Destruction (CWMD) as it pertains to strategic deterrence
- ▶ NSRI's actions to ensure adequate technical and management performance, including the cost management practices that the institute believes establish the USSTRATCOM UARC as the "best value" for users of its services
- ▶ NSRI's management of potential and actual conflicts of interest

This document is NSRI's response to that request, demonstrating the institute's impact on its UARC core competencies from September 1, 2016, through March 31, 2022. This document also asserts NSRI's commitment, capacity and recommendations to remain the UARC of USSTRATCOM and reaffirms the institute's intention to provide substantial impact for decades to come.

NOT FOR DIST.

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***ENABLE DETERRENCE OF,
PREPAREDNESS FOR
AND RESPONSE TO
STRATEGIC NATIONAL
SECURITY THREATS ACROSS
MULTIPLE DOMAINS THROUGH
RESEARCH AND SUPPORT.***

INTRODUCTION

EVOLVING PARTNERSHIP

The political and military landscape across the globe has changed significantly in the several years since the DOD last validated the value of NSRI in the 2016 Comprehensive Review. As a result, the DOD has shifted its focus from a counter-insurgency war to the threats posed by peer and near-peer adversaries. Evolutions of just the past 12 months highlight this shift:

- ▶ Russia's unprovoked territorial assault on Ukraine raised nuclear deterrent questions that had remained latent since the Cuban Missile Crisis in 1962
- ▶ China's expanding and diversifying nuclear arsenal
- ▶ North Korea's frequent ballistic missile testing
- ▶ Iran's nuclear ambitions, which continue to be intentionally opaque

These security threats raise significant research and policy questions at the highest levels of the U.S. and ones that highlight USSTRATCOM's pivotal role in our nation's national security. Admiral Charles Richard, USSTRATCOM Commander, identified in his 2021 Deterrence Symposium that we are faced with the strategic challenge of two peer adversaries — Russia and China — for the first time in our Nation's history. Both have the capability to simultaneously hold our Nation's security at risk at a time of their choosing and with an arsenal of capabilities that are or soon will be on par with our own.

As the world's threats continue to evolve, USSTRATCOM's mission has evolved, and thus, its UARC has evolved with it. Today, the primary mission of USSTRATCOM is to deter strategic attack on the U.S. While adversarial nuclear employment certainly qualifies as a strategic attack, it is not the only type of strategic attack.



September 15, 2020 — Lincoln, Neb. — Lt. Gen., USAF (Ret.) Bob Hinson, NSRI founding executive director, speaks during the announcement of IDIQ III. VADM (Ret.) Ted Carter (right), University of Nebraska System president, and several researchers shared insights of their work through NSRI.



November 6, 2021 — Lincoln, Neb. — Nebraska Cornhuskers host Military Appreciation football game at Memorial Stadium. From left: Maj. Gen., USAF (Ret.) Rick Evans, NSRI executive director; Nebraska Governor Pete Ricketts; ADM Charles Richard, Commander, USSTRATCOM; VADM (Ret.) Ted Carter, NU president; Dr. Ronnie Green, UNL chancellor.

The COVID-19 pandemic illustrates how future threats extend beyond the nuclear capabilities of those adversaries, illuminating the need for constant assessment and reassessment of strategic attack prevention, mitigation and response across the full spectrum of chemical, biological, radiological, nuclear and explosive threats.

ADM Richard has specifically identified the importance of involvement with academia to help determine a new era of strategies to counter the existential threat posed by our enemies. Responsiveness to government needs is the hallmark of the partnership made possible through the DOD's UARC program. ADM Richard has made it clear that he will continue to rely on NSRI experts and, by extension University of Nebraska System researchers, to assist in developing new strategic deterrence strategy and to assist the Nation's warfighters and USSTRATCOM across its mission space.

As USSTRATCOM's UARC, NSRI has and will continue to think through the entire range of strategic attack scenarios — nuclear and non-nuclear, kinetic and non-kinetic — to offer USSTRATCOM, the DOD and the Nation the research and solutions required to successfully execute the mission of deterring strategic attack.

NSRI purposefully and successfully bridges research both in the USSTRATCOM mission space and the CWMD mission space — finding and filling gaps, assessing and asserting links, exploring and solving problems. The institute's mission and work are broad because the threat is broad. But there is a common thread that cannot be ignored — the scenarios are unthinkable, so think through them we must.



NSRI REMAINS COMMITTED

AS A TRUSTED PARTNER

NSRI carefully manages personal and organizational conflicts of interest to fulfill its role as a trusted agent to the U.S. Government, a requirement of the DOD UARC Management Plan, the guidance which NSRI operates under. It is also the professional standard by which NSRI has established its reputation throughout the past decade. See Supplemental Attachment for the NSRI Conflict of Interest Policy.

NSRI's growing team of experts in collaboration with NU researchers, has supported 46 DOD and federal government partners, many of whom have returned to the institute for ongoing work. The breadth and depth of agencies served by NSRI demonstrate the trusted relationships the institute builds through its work. As part of this effort, NSRI continues to support USSTRATCOM directly, hiring deep expertise in the Command's mission area and regularly submitting project proposals and delivering on projects. In line with its role as a UARC, NSRI has also sought out the Command's strategic partners to fund research that directly targets needs within the strategic deterrence mission. NSRI can also provide subject matter experts to government entities through the Intergovernmental Personnel Act, having done so in this reporting period with the Joint Program Executive Office for a senior advisor role.

TO PROTECT THE WARFIGHTER

NSRI leverages capabilities across therapeutic development, biomechanics, engineering, computer science and more to better prevent, mitigate and respond to WMD events and their impacts on warfighters. Direct engagement with end users is the primary strategy the institute uses to ensure its solutions are relevant, timely and actionable. Several of the deliverables highlighted, starting on page 7 of this report, demonstrate this ongoing commitment to U.S. warfighters.

TO RESPONSIVENESS

Since its inception, NSRI has conducted 138 research projects valued at \$204 million. There are currently 28 active projects at the time of this report. From September 1, 2016, to March 31, 2022, NSRI delivered on 78 contracts valued at \$90,027,381, with 57 of these projects under the USSTRATCOM IDIQ contract vehicles.

NSRI's average time from receipt of a Request for Proposal to being on contract to starting work was only 35 days in FY21. This is an advantage USSTRATCOM and others used to ensure critical research was launched expeditiously. In addition, the institute's broad response to COVID-19 — from airflow testing on military aircraft to patient treatment to drug development and beyond — demonstrates its agility and capacity to respond quickly and maintain the highest quality of deliverables.

WITH INNOVATIVE ENGAGEMENT

NSRI convenes interdisciplinary teams from across NU and, when necessary, from an extensive network of recognized experts. Within the reporting period, NSRI established the NSRI Fellows program and the NSRI Independent Research and Development program to provide exponential growth in engagement and delivery to USSTRATCOM and the DOD. In total, NU and NSRI have invested \$315,000 in these programs and brought together more than 100 researchers, diving deeper into the NSRI mission space. Both programs serve as models for how to amplify academic talent and foresight to solve DOD challenges.

BY INSPIRING THE FUTURE WORKFORCE

One of the Nation's grandest challenges is the lack of a future workforce in national security areas. NSRI provides opportunities to qualified students from NU and beyond to intern with NSRI, work on DOD projects through NSRI and participate in wargames developed and facilitated by NSRI. The institute provided more than 50 such experiences in this reporting period.

THROUGH INVESTMENTS

To meet the requirements and needs of the federal government, the NU campuses have invested in human capital and key facilities. NSRI continues to provide exceptional value to the government, using cost-effective measures. Highlighted investments during this reporting period include but are not limited to:

New Initiatives

- ▶ Project NExT from the University of Nebraska Medical Center (UNMC) will improve the readiness of the U.S. health system to respond to a catastrophic disaster, another pandemic, accidents or overt attack
- ▶ The Nebraska Drug Discovery & Development Pipeline (ND³P) harnesses NU's capabilities
- ▶ Partnership with the Department of Homeland Security (DHS) to grow the DHS workforce in critical areas related to national security
- ▶ Seed funding for a University of Nebraska at Omaha (UNO) Big Idea focused on security and intelligence studies as part of the university's strategic planning process

New Laboratories

- ▶ Collaborative Biosecurity Laboratory at the University of Nebraska–Lincoln (UNL) with NSRI will provide foresight regarding WMD in the food, agriculture and environment sectors
- ▶ Second BSL-3 at UNMC met the research need for characterization of SARS CoV-2; UNMC has BSL-3 for select agent research, and it is a Tier 1 select agent program certified by the CDC
- ▶ Emerging Pathogens Laboratory at UNMC
- ▶ Behlen Laboratory renovation at UNL enables research at a higher security level

New Facilities

- ▶ State-of-the-art instrumentation and operation of shared facilities at UNL, including Nebraska Center for Materials and Nanoscience, Nano-Engineering Research Core Facility and Holland Computing Center
- ▶ Global Center for Health Security Clinical Research Unit at UNMC
- ▶ National Training, Simulation and Quarantine Center at UNMC
- ▶ Ron Rhoden Business Innovation Center addition to UNO Mammel Hall
- ▶ Biomechanics Research Building at UNO
- ▶ Engineering Research Center and construction of Kiewit Hall at UNL

New & Renewed Programs

- ▶ STRATCOM Fellows Program, annually since 2014
- ▶ UNMC Combat Casualty Care Research Program
- ▶ Military-Connected Resource Center to expand resources for UNO students
- ▶ Scott Scholars Summer Design Internship pairs students with USSTRATCOM

NSRI RESEARCH STRATEGY

LEADERSHIP

Lt. Gen., USAF (Ret.) Bob Hinson, NSRI founding executive director, retired in 2020. To ensure continued deep understanding of USSTRATCOM's needs, NU hired Maj. Gen., USAF (Ret.) Rick Evans as the second executive director of the institute. Immediately prior to joining NSRI, Evans served in several senior positions at USSTRATCOM, including Mobilization Assistant to the Director of Global Operations and Deputy Director for Joint Electromagnetic Spectrum Operations (JEMSO); Deputy Commander for Joint Functional Component for Global Strike; Mobilization Assistant to both the Deputy Commander and Commander; and Director of Reserve Forces. Evans also served as Acting Deputy Commander for four months in 2016 and as the Program Manager for USSTRATCOM's new Command and Control Facility from 2017 to 2019. VADM (Ret.) David Kriete, former USSTRATCOM Deputy Commander, was also recently appointed to NSRI's Board of Directors, joining VADM (Ret.) Carl Mauney and Maj. Gen., USAF (Ret.) Roosevelt Mercer Jr., to further expand NSRI's significant experience and expertise in USSTRATCOM's mission space.

Dr. Christopher Yeaw, NSRI associate executive director of strategic deterrence and nuclear programs, was hired to expand the technical competence of NSRI executive staff to meet research objectives in support of USSTRATCOM. To increase NSRI's support physically located at USSTRATCOM Headquarters, NSRI hired Capt., USN (Ret.) Adam Carlstrom as research director for USSTRATCOM programs and Col., USAF (Ret.) Al Geist as director for EMSO programs. They collaborate with USSTRATCOM to create a detailed and relevant research agenda. Former Senior Executive Service Member Patrick Rhoads also joined NSRI as research director for nuclear weapons enterprise support. NSRI also hired Dr. Joshua Santarpia, NSRI senior science and technology advisor, and Dr. Neal Woollen, associate executive director for CWMD allied programs, to intentionally guide and maintain mission focus as the institute continues to grow.

GOALS

NSRI ensures effective technical and managerial performance through several processes and procedures that result in research projects that fully deliver on customer expectations. By closely working with the customer from project inception through performance work statement development and contract execution, NSRI maintains a level of performance that meets or exceeds customer performance expectations. NSRI organization and business processes enable the institute to achieve its strategic goals and objectives and remain focused on its core mission. NSRI has two synergistic research goals:

1. Provide research, development and training solutions directly impacting the USSTRATCOM and DOD mission space.
2. Provide and sustain long-term engineering, research and development capability for the USSTRATCOM and DOD mission.

NSRI's primary strategy for executing these goals is to consistently interact with the DOD end-user community to identify technology needs and work with federal sponsors to plan R&D initiatives to develop those technologies. This direct interaction allows NSRI to ensure its R&D products are focused on the needs of the Nation, including stopping the threat outside the continental U.S., preventing the threat from transferring into the U.S. and responding to threats within the homeland.

RESEARCHERS

NSRI and NU researchers are standouts in their academic fields, as evidenced by their significant contributions to the scientific body of knowledge. Since October 2012, NSRI and NU researchers have published more than 40 papers in peer-reviewed academic journals and academic conferences that were a direct result of research tied to NSRI-managed task orders.

PRIORITIES

As a UARC, the following core competencies guide NSRI's research portfolio.

Nuclear Detection and Forensics: Detection and characterization of nuclear proliferation programs and nuclear terrorism activities; Analysis of nuclear-related activities; Development of novel and field-deployable interrogation sources to detect special nuclear materials; Radiation detectors with improved sensitivity, noise characteristics, and operational capabilities; Standoff detection of nuclear debris; Rapid in situ forensic analysis of nuclear material; and in situ non-destructive testing of nuclear pits.

Detection of Chemical and Biological Weapons: Rapid, accurate, and highly efficient biological agent (bio-agent) identification; Sensors incorporating technology that identify, quantify, and detect chemical and bio-agents at the molecular or macro-level; Sensing technologies incorporated or integrated with autonomous and adaptive sensor networks for various applications; and Threat assessment tools for identifying emerging biological/chemical threats both man-made and naturally occurring.

Active and Passive Defense against Weapons of Mass Destruction: Countermeasures to central nervous system disorders; Rapid production of vaccines for bio-agents; Next-generation respiratory protection equipment; Genetic, immunological, and materials approaches to develop and deliver vaccine antigens in a manner to enhance their cellular uptake; Regulation of the metabolic process for warfighters in extreme environments; Materials development and design for personnel protective equipment and other protective measures; and Innovative approaches to drug delivery.

Consequence Management: Innovative solutions to avoid or mitigate the effects of a Weapons of Mass Destruction event on personnel and infrastructure through detection, technology development, modeling and simulation, protocols, and design; Visualization and simulation of critical infrastructure vulnerabilities: Disaster preparation and response, and human behavior patterns; Computer-based surrogates of real-world systems for training, analysis of alternatives, experimentation and exploration of system vulnerabilities; and Decision-making support tools to analyze complex data, assess risk, analyze exposure, and visualize impacts. Consequence management includes providing solutions to the challenges of protecting, responding and restoring personnel health and infrastructure after a chemical, biological, cyber, radiological, or nuclear incident triggered by human or natural disaster.

Mission-Related Research: Requirements of USSTRATCOM, its subordinate, supported and supporting agencies.

- ▶ Topics of importance include but are not limited to: (a) Space, Cyber, and Telecommunications (Telecom) Law; (b) policies and strategies affecting space traffic management, security and risk management of space and cyber assets, space/cyber/telecom threats, convergence of cyberspace and CWMD pathways that affect mission readiness and national critical infrastructure resilience, space/cyber/telecom deterrence theory and applications; (c) analysis of space/cyber/telecom legal issues; and (d) development of protocols based on international space/cyber/telecom law.
- ▶ Research includes but is not limited to the following: (a) Domestic and international laws, treaties, and agreements to determine impacts and influences of U.S. policy, deterrence strategies, and law on national security and commercial infrastructure; (b) evaluation of the consequences of failing to meet legal standards or requirements; (c) the necessity of legislative action to meet certain national security objectives; (d) analyses of DOD policies that govern action and reaction in the space or cyber theaters; and (e) legal deficiencies or ambiguity of frameworks for decision makers that highlight hard limits to action.



NSRI DELIVERS MISSION IMPACT

NSRI harnesses the leading policy, science, engineering and medical capabilities of hundreds of researchers and students who work in state-of-the-art facilities across NU's four campuses. The combined efforts of all involved have generated a tremendous impact on NSRI's UARC core competencies. Following are highlights and details of all projects within each core competency during this reporting period of September 1, 2016, through March 31, 2022.

UARC CORE COMPETENCY 1

NUCLEAR DETECTION AND FORENSICS

NSRI's and NU's state-of-the-art and long-term research objectives focus on advanced photon sources to interrogate materials, particularly special nuclear materials (SNM); radiation detectors; and various techniques to detect and characterize nuclear material before and after detonation. An interdisciplinary team of researchers from physics, chemistry, material science, electrical and other engineering disciplines are developing solid-state neutron detectors, incorporating a broad range of novel materials. NU's research in radiation detectors spans the technology spectrum, from "proof of principle" devices to instruments for field use.

HIGHLIGHTED IMPACTS

R&D for Deployable Warhead Verification System

In 2020, the NSRI team conceived a treaty verification regime that would operate at the nuclear warhead level, unlike current and past treaties that capture and allocate warheads at the delivery vehicle level. The NSRI team developed the conceptual model of the Deployable Warhead Verification System (DWVS). This relocatable asset would afford high confidence to all parties to the treaty that warhead declarations were accurate while absolutely safeguarding sensitive information regarding the verified party's warheads. The system is self-contained, self-authenticating, highly cyber-secure, configurable to all warhead types and highly accurate. Possible system vulnerabilities and spoofing scenarios were considered when engineering the conceptual design. Use-control and mitigation techniques were outlined. The DWVS conceptual design was originally sponsored by the U.S. Department of State and is now ready to be transitioned to potential National Nuclear Security Administration sponsorship for prototype development in partnership with the University of Nebraska System and U.S. Department of Energy national laboratories.

Impact: When implemented, the DWVS will afford USSTRATCOM, national leadership and all signatories to future nuclear treaties that all parties are verifiably compliant with those treaties.

The Extreme Light Laboratory at the University of Nebraska–Lincoln. Research involves highly relativistic laser-matter interactions with petawatt-power and femtosecond-duration laser light.

Detecting Buried And Hidden Explosives Using Laser-Driven High-Energy Electron Beams

NU researchers developed an operational prototype based on a compact high-gradient laser-driven electron accelerator that can detect chemical explosives from a vehicle-based platform that could rapidly and accurately scan roadways and buildings for the presence of hidden, concealed or camouflaged explosive threats.

Impact: Provided the DOD with the ability to detect and identify chemical explosives when the line of sight between the detection system and the explosive is blurred, blocked or otherwise obstructed.

18 DTRA Postdoctoral Scholars Deliver CWMD Solutions

NSRI postdoctoral scholars work directly with the Defense Threat Reduction Agency's (DTRA) basic research and development program managers to support the CWMD mission. At one of the top DOD research institutions in the Nation, these scholars primarily contribute in nuclear technologies, but some have also participated in CWMD technologies, chemical-biological sciences and test science efforts. Within their roles, scholars learn firsthand from operators in the field about technological gaps.

Impact: NSRI has identified, attracted, recruited, advanced and retained intelligent and management-capable professionals to serve as DTRA postdoctoral fellows. Ultimately, the program develops human capital to support the CWMD research and development infrastructure. In total, 18 scholars have directly supported R&D programs to develop new technologies for CWMD warfighters.

TABLE 1: ALL PROJECTS FOR UARC CORE COMPETENCY 1

TOTAL VALUE: \$15.6 MILLION

PROJECT TITLE	SPONSOR	STATUS
DTRA Postdoctoral Scholars Program (PSP)	DTRA	Active
Detection of Explosives Using Laser-Driven High-Energy Electron Beams	DTRA	Complete
Studying the Human Technology Interface for Intelligence and Cyber Situational Awareness	USCYBERCOM	Complete
Fixed VTOL Sensor Emplacement	USSTRATCOM	Complete
COTS Autonomous Tracking and Indicating Prototype	USSTRATCOM	Complete
Detection of Nuclear Threats Using Deployable Sensors	USSTRATCOM	Complete



UARC CORE COMPETENCY 2

DETECTION OF CHEMICAL AND BIOLOGICAL WEAPONS

As technologies advance, so do the capabilities of America's adversaries when it comes to the development, manufacture and deployment of chemical and biological agents. Near-peer adversaries have active CBRN programs; threats are difficult to detect, mitigate, treat; and advances in technology contribute to emerging threats that enable the development of enhanced/novel agents that defeat countermeasures. Recent examples of adversaries willingness to demonstrate and employ CBRN threat-capabilities include: UK (novel nerve agent), Malaysia (nerve), Iraq/Syria (nerve, blister, chlorine).

NSRI and NU researchers are internationally recognized for their extensive expertise in the detection and identification of these agents and for the development of clinical methodologies that detect exposure to them. Their research focuses on the accurate detection of known and unknown threats and the development of detection tools that are field-deployable, provide rapid results, detect bioactive levels and require minimal training to use.

HIGHLIGHTED IMPACTS

Bolstering Perimeter Defense Via Early Warning

As part of NSRI's perimeter defense effort with the Defense Threat Reduction Agency (DTRA), NSRI scientists recently demonstrated a rapidly-deployable network of biological agent early warning detectors and collectors in New York City. The devices notify an end user that a potential biological attack has occurred, mapping the location, time and weather. Samples are automatically collected for additional analysis. NSRI worked with New York's 24th Civil Support Team to deploy and demonstrate the technology during the Department of Homeland Security's Urban Threat Dispersion exercise.

Impact: The event was a success, with all major goals accomplished throughout the week. Simulated biological attacks were detected at all locations the systems were deployed, which included Times Square, Union Square and the World Trade Center campus. End-user feedback and system testing improved the technology, which will help reach DTRA's perimeter defense biological detection goals.

UAV Detection Technology Development

Researchers across NSRI and the university continue to advance capabilities with unmanned aerial vehicles (UAV). Projects include both fixed-wing chemical and biological detection devices, which expands the chemical and biological work of the last couple of years.

Impact: The new UAV systems that have been and continue to be developed are being utilized by government, military and commercial end users to help protect military installations and other environments where biological WMD is suspected.

NSRI's perimeter defense biological detection and collection system deployed at One World Trade Center.

TABLE 2: ALL PROJECTS FOR UARC CORE COMPETENCY 2*TOTAL VALUE: \$49.1 MILLION*

PROJECT TITLE	SPONSOR	STATUS
Echo Skid #1, Echo Shell Shock, Echo Skid #2	Battelle	Active
Francisella Tularensis	Battelle	Active
Measurement of the Optimal Growth Conditions and Stability of Burkholderia mallei and Burkholderia pseudomallei	Battelle	Active
Yersenia Pestis	Battelle	Active
NSRI Support to DIA Office of Advanced Technologies Intelligence	DIA	Active
Biological and Chemical Threat Characterization and Medical Countermeasure Development	DTRA	Active
Research and Development to Support Advanced Detection and Decontamination	DTRA	Active
CWMD Field and Laboratory Support	DTRA	Active
Combating Weapons of Mass Destruction RDT&E CBRN Solutions	DTRA	Active
Development of an Aerosol Collection System for the Deep Purple VTOL UAS	DTRA	Complete
JWARG: Site Development for Microbiology Capability	HJF	Complete
PBA Detection and Identification CONOPs	JHU/APL	Complete
Targeted Acquisition of Reference Materials Augmenting Capabilities (TARMAC) Initiative*	JPEO-CBD	Active
Chemical and Biological Defense Technology Implementation and Guidance of Operational Research (TIGOR)	JPEO-CBD	Complete
Environmental Sampling and Subject Matter Expert Support	Sandia	Complete
Aerosol Science Support	Sandia	Complete
Detecting Enteric Infections in Northern Nigeria	WRAIR	Complete

* also Consequence Management



UARC CORE COMPETENCY 3

ACTIVE & PASSIVE DEFENSE AGAINST WEAPONS OF MASS DESTRUCTION

The effects of weapons of mass destruction (WMD) on human physiology and psychology are almost limitless in scope. Depending on the type of WMD, they will attack different parts of the human biological system. To counter the wide-ranging possibilities and effects of WMD on warfighters in the field, NSRI and NU researchers direct expertise, facilities and resources at the rapid development of medical countermeasures. This includes initial phases of exploration, design and development to the more advanced phases of piloting, manufacturing and clinical trial execution.

HIGHLIGHTED IMPACTS

Nebraska Drug Discovery And Development Pipeline

Launched in 2017, the Nebraska Drug Discovery & Development Pipeline (ND³P) makes it possible to produce critically needed drugs for the DOD that are financially risky for the pharmaceutical industry to pursue. For example, NU researchers are developing a therapeutic to mitigate the lethal effects of radiation exposure, as in a nuclear accident or nuclear weapons incident. Many of NU's top scientists are working on medicinal chemistry, metabolomics and bioinformatics to move potential drug candidates toward clinical trials.

Impact: ND³P helps the DOD shorten the U.S. military's wait for drugs that can prevent and counteract hazardous exposure.

Research & Development For Advanced Chemical Detection and Decontamination

NSRI and colleagues at NU and the DOD are screening novel active material that can potentially target and disrupt the growth of and/or kill harmful bacteria and viruses. The material could be used both for remediation of biological contamination and for detection of harmful bacteria and viruses. The team will work to produce functional products from this novel active material to meet the sponsor's needs.

Impact: In the theater of war, this research could be instrumental in mitigating agents of concern used for biological warfare and terrorism and agents that present significant health risks to active military forces.

Full-Scale Chemical And Explosive Training For Active-Duty Personnel

More than 100 active-duty personnel participated in full-scale chemical and explosive training exercises to advance their knowledge on threat synthesis, precursors and equipment. The training provided participants with the knowledge to identify the hazards associated with each process and to take appropriate precautions when encountering chemical or explosive production facilities supporting the CWMD mission set.

Impact: NSRI's subject matter expertise and logistics coordination increased the knowledge and skill of 100 active-duty personnel who keep our country safe.

Course participants in action at NSRI full-scale chemical & explosive training exercise.

TABLE 3: ALL PROJECTS FOR UARC CORE COMPETENCY 3*TOTAL VALUE: \$45 MILLION*

PROJECT TITLE	SPONSOR	STATUS
Fielding Proof of Concept: En Route Care Acute Respiratory Distress System (ARDS) Mitigation Using Oxygenated Microbubbles*	AFMSA	Active
Chemical and Biological Warfare Defense Research and Development, Test and Evaluation Support*	DARPA	Active
Medical Countermeasure Drug Discovery and Development Increment II*	DHA	Active
Medical Countermeasure Drug Discovery and Development*	DHA	Complete
MetaSyn	Draper Labs	Active
CWMD Diagnostics and Detection, Assay and Testing*	DTRA	Active
Nigerian Ministry of Defense Biopreparedness Site Assessment and Training	DTRA BTRP	Complete
Dispersal Device Threat	Sandia	Active
Hazardous Chemical Extraction System Integration and Evaluation*	SOCOM	Active
Target Enrichment*	USAMRIID	Complete
Cooperative Threat Reduction Support to US European Command	USEUCOM	Active

* also Consequence Management

CONSEQUENCE MANAGEMENT

NSRI views consequence management in terms of deterrence and response. For deterrence, researchers work to anticipate, identify and prevent the physical and virtual threats to the U.S. Should a threat develop into hostile action or disaster that requires an effective response during and after the crisis, the focus is on mitigating the event's negative consequences through decision-making driven by data.

HIGHLIGHTED IMPACTS

Senior-Level Advisement For Cyber Security

NSRI has supported the Air Force Life Cycle Management since the inception of its Integrated Strategic Planning and Analysis Network (ISPAN), Increment 5 (INC5) work for USSTRATCOM on cyber security activities, Enhanced Consequence Analysis (ECA) KPP 2 and the transition to agile software development practices. NSRI personnel have actively supported critical boards and working groups as senior advisors for the MPAS program manager. As INC5 KPP 2 Champion NSRI developed road maps for KPP completion, assessing progress and recommending actions to issues.

Impact: NSRI's experience with end-user needs, technical understanding of nuclear weapons effects and program management has helped bridge gaps and facilitate a better understanding of USSTRATCOM's needs and how to meet them.

Aircraft Airflow Testing To Combat Covid-19

At the onset of the COVID-19 pandemic in April 2020, U.S. Transportation Command requested a joint, urgent, operational need for a high-capacity airlift of COVID-19 passengers. With Air Mobility Command, NSRI and the Defense Advanced Research Projects Agency executed biological aerosol airflow tests on the KC-135 Stratotanker, C-17 Globemaster III and C-130J Hercules aircraft, followed by tests on the KC-46 Pegasus, KC-10 Extender and C-5M Super Galaxy aircraft — in just seven days.

Impact: NSRI's rapid response and deliverables assured the DOD that the U.S. could safely transport its warfighters home during the pandemic.

Treating Patients With Traumatic Lung Injury

Traumatic lung injury often leads to death since the body relies on the lungs to provide oxygen. NSRI and NU, in partnership with the University of Colorado Boulder, is developing and validating a proof-of-concept, life-saving solution to this problem using oxygenated microbubbles. These microbubbles are engineered to bypass the damaged lung tissue and release oxygen into the abdomen. This is especially important to injured warfighters in low-resource environments and to people in mass casualty events where medical needs overwhelm available resources.

Impact: To date, NSRI's research permits the treatment of multiple casualties with minimal equipment and without the need for mechanical ventilation.

Surface samples are collected during KC-135 Stratotanker aircraft testing. Photo by Senior Master Sgt. Shannon Nielsen.

Chemical, Biological, Radiological And Nuclear Preparedness Program

NSRI served as the lead for the planning and execution of the Chemical, Biological, Radiological and Nuclear (CBRN) Preparedness Program (CP2). A security cooperation effort, CP2’s mission is to build capability and capacity with international partners for responding to CBRN and all-hazard threats in support of U.S. Combatant Commands’ theater campaign plans. CP2 activities include whole-of-government capability assessments; development of country engagement plans; equipping, planning and execution of training and exercises; and lifecycle sustainment. NSRI provided technical and strategic subject matter expertise leading CP2 efforts while working with the U.S. Department of State, U.S. Combatant Commands, the Defense Threat Reduction Agency and partner nations.

Impact: This effort successfully increased capabilities to detect and respond to CBRN and all-hazard threats in seven foreign countries. NSRI effectively enhanced the Combatant Commands’ and their partner nations’ abilities to prepare for and respond to CBRN and all-hazard threats while strategically building interoperability between military and civilian agencies.

TABLE 4: ALL PROJECTS FOR UARC CORE COMPETENCY 4

TOTAL VALUE: \$48.8 MILLION

PROJECT TITLE	SPONSOR	STATUS
Nuclear Deterrence and Escalation Workforce Development Support - Phase II	AFGSC	Complete
Nuclear Deterrence and Escalation Workforce Development Support	AFGSC	Complete
Microbubbles - Phase II	AFSG	Complete
En-Route Care Technology	AFSG	Complete
Testing Super Polymer Absorbents	Battelle	Complete
Operational SME Support (DRC)	Battelle/CTTSO	Complete
Repeated Bouts of Physical Stress: A Lab Based Simulated Multiday Mission Scenario	CCDC Soldier Center	Active
Modeling to Support Evaluation of Advanced Diagnostics (M-AD)	CRAFT Tech (NSWC)	Active
Multi-Agent UAS Teaming for Extended ISTAR and Autonomous Resupply	DEVCOM ARL	Active

PROJECT TITLE	SPONSOR	STATUS
Surveillance of Pathogens Causing Severe Infections and Associated Antimicrobial Resistance (GEIS - Phase II)	DHA	Complete
Cyber BioSecurity	DOD	Complete
Evaluation of Liquid Decontaminant for the Hazard Mitigation	DTRA	Complete
Chemical, Biological, Radiological and Nuclear (CBRN) Preparation and Response Program (CP2)	DTRA/JPEO	Complete
Dragon's Horn	JHU/APL	Complete
Biocidal Efficacy Support for Rapid Energetic Medical Instrument Sterilization (REMIS)	JHU/APL	Active
Analysis of Cyber Threats for the Maritime Domain	NMIO	Complete
Nuclear Surety Policy and Guidance Research	ODASD(NM)	Active
Functionalizing Metallic Surfaces - Phase III	ONR	Complete
Traffic Calming Elements - Phase IV	SDDC	Complete
C-146A Airframe Particulate Testing	Sierra Nevada Corp.	Complete
Nebraska Regional Disaster Health Response System	Nebraska Medical Center	Complete
Nebraska Regional Disaster Health Response System Year 2	Nebraska Medical Center	Complete
Nebraska Regional Disaster Health Response System Year 3	Nebraska Medical Center	Complete

PROJECT TITLE	SPONSOR	STATUS
Nebraska Regional Disaster Health Response System Year 4	Nebraska Medical Center	Active
Training, Simulation and Quarantine Services	University of Nebraska Medical Center	Complete
Assessment and Training of Procedural Skills for Combat Casualty Care	USAMRMC	Active
Operationalizing Cyber Situational Awareness Research: Capability Exploration	USCYBERCOM	Complete
Operationalizing Cyber Situational Awareness Research: Discovery Study	USCYBERCOM	Complete
Identification and Detection Platoon Chemical Biological Incident Response Force (CBIRF)	USMC	Complete
MPAS Risk Reduction - Phase II	USSTRATCOM	Active
Prototype Development of ICS Security Monitoring System	USSTRATCOM	Complete
MPAS Vulnerability and Risk Analysis	USSTRATCOM	Complete
Personnel Database Analysis and Data Management Tool	USSTRATCOM	Complete
DRRS Visualization Tool and Data Analytics	USSTRATCOM	Complete
Academic Perspectives on Perception Resistance	USSTRATCOM	Complete
All Hazards Academic Instruction and Training	WMD CSTs	Complete
Aircraft Aerosol Biosecurity Study	Zeteo Tech	Complete

UARC CORE COMPETENCY 5

MISSION-RELATED RESEARCH

Through the Unified Command Plan, USSTRATCOM, in collaboration with a broader community of interest, was assigned overall Combatant Command responsibilities for strategic deterrence; nuclear operations; nuclear command, control and communications (NC3) enterprise operations; joint electromagnetic spectrum operations (JEMSO); global strike; missile defense; analysis and targeting; and missile threat assessment. NSRI/NU provides a comprehensive program of 6.1- through 6.4-level engineering, analysis, research and development for of all USSTRATCOM mission areas, and the institute is available to any government agency requiring support within those mission areas.

HIGHLIGHTED IMPACTS

NNSA Support For Strategic Deterrence And Nuclear Threat Reduction Efforts

NNSA awarded NSRI a \$25 million IDIQ contract for nuclear weapon mission space and design parameters, iterative wargaming, warhead technical verification, policy research, wargaming knowledge management and more. ADM Richard stated in December 2020: "Our crucial partnership [with NNSA] keeps our Nation and our allies safe in this dynamic environment of great power competition. I extend my gratitude to the men and women of the NNSA, and we are very fortunate to have them as a partner."

Impact: The first \$1.1 million task order is underway with NSRI leading a series of workshops for administration personnel and researchers from the U.S. Department of Energy national laboratories.

Research For Strategic Deterrence In The Tripolar Era

ADM Richard recently sponsored a strategic multi-layer assessment (SMA) reach-back analytic effort to inform senior leader decision-making strategies that address the complex challenges now posed by having to face not one but two determined nuclear rivals. NSRI researchers were key players in the SMA team and produced three research papers pro bono in less than two months: "*China's Historical Plutonium Production*," "*Escalatory Attraction of Limited Nuclear Employment*," and "*The Challenge of Russia's Non-Strategic Nuclear Weapons*." (The papers are available at nsri.nebraska.edu/nuclear.) As a follow-on, NSRI's team of nuclear enterprise experts were contracted to research, analyze and recommend strategies to address the challenges posed in the "new" tripolar deterrence era, in which China, Russia and the U.S. are the key actors.

Impact: This research will center on the geopolitical features of this new tripolar era, directly producing additional solutions to the Commander of USSTRATCOM's 2022 Analytical Agenda. Case studies taken from various points in the past century will be performed to test and refine the international relations theory on triangular relations among "pole" powers. A framework within which to understand future possible conflict scenarios will be developed, aspects peculiar to nuclear deterrence highlighted and application of theory made to the current tripolar case of the U.S., Russia and China.

UNO student and NATO representative working through multiple-actor deterrence framework during workshop.

Limited Nuclear Conflict Wargame Development And Execution

NSRI developed a series of novel tabletop wargames for the Defense Threat Reduction Agency to help military leaders and decision makers explore nuclear escalation dynamics in the context of limited nuclear conflict. Russia's wholesale nuclear modernization program (strategic and non-strategic) corroborates the doctrinal evidence that Russia plans to employ ultra- and very-low yield theater and "battlefield" nuclear weapons (where "battlefield" must be defined as the entire extended region of military contact) in order to either escalate its way out of a failing non-nuclear conflict or escalate decisively and unexpectedly across the nuclear threshold early in a conflict. The complex wargame, which offers dozens of play-defined scenarios, immerses leaders into the throes of decision-making within the context of a conflict between NATO and Russia in Ukraine, in which the Russian side has chosen to escalate into selective very-low yield theater nuclear employment. The wargame is available for leaders across the DOD and federal government, provided by NSRI either in person or virtually.

Impact: NSRI's limited nuclear conflict wargame has challenged select DOD players to grapple with the wicked problem of nuclear escalation dynamics. Players have expanded their knowledge through lengthy discussions regarding nuclear signaling, strategic messaging, nuclear response options, escalation management, nuclear weapon effects in theater, coordinated nuclear-conventional operations and desired end states and off-ramps. The significance of the wargame experience is magnified by the current Russian invasion of Ukraine.

Time-Sensitive Research On Future Arms Control

Through a series of research efforts and strategic intelligence projects, NSRI brought to bear expertise from the University of Nebraska System, U.S. academia and the wider nonprofit and NGO community to provide the U.S. Department of State with extremely time-sensitive research on future arms control options: treaty architectures, core principles, national security implications, new technologies supporting treaty verification and foreign nuclear threat and treaty compliance assessments. As a trusted partner of the federal government, NSRI supported active negotiations with the Russian Federation in Vienna, Austria during 2020.

Impact: During 2020, an NSRI team of over a dozen senior consultants worked at the highest level of the U.S. government on urgent arms control issues. The weekly advice, recommendations and products were directly given to the President's Special Envoy for Arms Control, the National Security Council and the Acting Assistant Secretary for Arms Control, Verification and Compliance. The impact to ongoing nuclear arms control negotiations with the Russian Federation was substantial at the national and international levels. Additionally, the NSRI team produced research and analysis on other high-visibility arms control issues, to include the probable Wuhan Institute of Virology origin of the COVID-19 virus and the likely radiofrequency and acoustic phenomenology behind the "Havana Syndrome."

International Security Implications Research

Through NSRI, an NU researcher led a team of students on the institute's first North Atlantic Treaty Organization (NATO) research contract. The team developed a methodology that could be adapted to future challenges within a complex international system to enable coherent deterrence within a multiple-actor deterrence framework. The team also worked closely with NATO colleagues to begin testing the methodology and is developing further experimentation opportunities.

Impact: In addition to providing a valuable methodology for future defense decision-making, the project provides an opportunity to involve students in real-world solution formulation. This approach allows students to gain valuable skills for future careers and provides a fresh perspective to assist current decision makers.

TABLE 5: ALL PROJECTS FOR UARC CORE COMPETENCY 5*TOTAL VALUE: \$9.6 MILLION*

PROJECT TITLE	SPONSOR	STATUS
Space Strike Weapons Military Utility and Feasibility Study	DOD Office of Net Assessment	Active
Technical and Intelligence Research in support of AVC Mission Objectives	DOS	Complete
Limited Nuclear Conflict TTX Series	DTRA	Complete
Magnetic Tunnel Junction - Phase II	Honeywell (KC Plant)	Complete
Enabling Coherent Deterrence Concept Development	NATO	Complete
Multi-Domain Escalation Management	NATO	Active
Future Warhead Pathways Workshop Series	NNSA	Active
Nuclear Certification Assessment	OASD (NCB/Nuclear Matters)	Complete
Weapon Engineer Professional Development Mentor	Sandia	Active
SPACECOM J8 Strategic Planning Initiative	USSPACECOM	Complete
Research Effort on Risk of Strategic Deterrence Failure	USSTRATCOM	Active
Establishment and Leadership of the NC3 Technical Analysis and Research and NC2 Operational Workshop Consortia	USSTRATCOM	Complete
Space, Cyber & Telecommunications Law Training & Education	USSTRATCOM	Complete
Gender-Based Deterrence	USSTRATCOM	Complete
Space Law Research and Conference	USSTRATCOM	Complete
Study on Legal Responsibilities, Limitations, and Requirements for Nebraska National Guard Cyber Capabilities	USSTRATCOM	Complete

RECOMMENDATIONS

This review of accomplishments has afforded NSRI leadership time to reflect on the immense progress the institute has made throughout nearly a decade of operation as USSTRATCOM's UARC. It has also provided further clarity about how to position both institute and NU researchers to continue to deliver responsive solutions to USSTRATCOM and the DOD in the future. Based on the insights gained throughout this process, NSRI leadership recommends the following to the Office of the Assistant Secretary of Defense.

1. RETAIN NU'S UARC DESIGNATION WITH SPONSORSHIP FROM USSTRATCOM

As demonstrated throughout this report, NSRI serves USSTRATCOM, the DOD and the Nation as a responsive trusted agent. Convened through the institute, researchers and sponsoring partners are solving problems and providing critical, high-quality solutions to urgent challenges and unthinkable scenarios across the threat spectrum.

NSRI is also continually enhancing its efforts to be proactive with USSTRATCOM. The institute has hired specific expertise related to the Command's needs, staffed the Command headquarters full time, submitted multiple project proposals, provided cutting-edge research to the Command pro bono, elicited funding for strategic deterrence research and delivered solutions. Unequivocally, NSRI continues to fulfill its role as a DOD UARC, creating mission impact in each of its core competencies during this reporting period and demonstrating capacity and capabilities for decades to come.

2. REVISE CORE COMPETENCY 5 AND ADD A SIXTH

NSRI has deliberately adapted to the evolving needs of our primary sponsor, USSTRATCOM, both in the research it has executed for the Command and in the related research that it has executed for USSTRATCOM's mission partners, for example the National Nuclear Security Administration and the U.S. Department of State. It has become evident that a core competency specific to strategic deterrence research would more accurately reflect both the mission-focused demand signal and NSRI's actual executed research in this critical mission space. However, maintaining a mission-related core competency would allow NSRI and NU to continue to operate with the appropriate scope.

- ▶ **Suggestion for core competency 5 title:** Strategic Deterrence Research
- ▶ **Suggestion for core competency 5 definition:** Research on the ever-evolving requirements of strategic deterrence; nuclear command, control and communications (NC3) and electromagnetic spectrum operations (JEMSO); foreign threat assessments; nuclear employment policy, operations, options, targeting and consequences; conventional-nuclear integration issues; strategic wargaming and experimentation; 21st century nuclear weapon concepts; and arms control innovations. This core competency addresses not only the entire range of USSTRATCOM mission areas, but also the research needs of its strategic deterrence mission partners by applying the organic capabilities of NSRI as well as the complementary capabilities of other divisions of the University of Nebraska System.
- ▶ **Suggestion for core competency 6 title:** Mission-Related Research
- ▶ **Suggestion for core competency 6 definition:** Mission-related and public-service oriented research, technology development, test evaluation and systems analysis required to provide a quick response to rapidly evolving DOD and other government agency requirements through the application of the core competencies 1 through 5, along with the complementary capabilities of the other divisions of the University of Nebraska System.

**NSRI PURPOSEFULLY AND SUCCESSFULLY BRIDGES
RESEARCH BOTH IN THE USSTRATCOM MISSION SPACE
AND THE CWMD MISSION SPACE — FINDING AND
FILLING GAPS, ASSESSING AND ASSERTING LINKS,
EXPLORING AND SOLVING PROBLEMS.**

**THANK YOU FOR MAKING THIS WORK POSSIBLE
THROUGH YOUR SPONSORSHIP.**



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