THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION
AND SUSTAINMENT

APR 2 2 2020

The Honorable Michael R. Pence
President of the Senate
United States Senate
Washington, DC 20510

Dear Mr. President:

On behalf of the Secretary of Defense, I am submitting the 2020 Department of Defense Chemical and Biological Defense Annual Report to Congress. This report fulfills the reporting requirements of title 50, U.S.C., section 1523, "Annual Report on Chemical and Biological Warfare Defense." The report details the Department's readiness to address chemical and biological threats and highlights Fiscal Year 2019 accomplishments.

I am sending identical letters to the Speaker of the House and the other congressional defense committees.

Sincerely,

Ellen M. Lord

Ellen M. Lord

Enclosure:
As stated

CHEMICAL AND BIOLOGICAL DEFENSE ANNUAL REPORT TO CONGRESS 2020

UNCLASSIFIED

The estimated cost of this report for the U.S. Department of Defense is $55,000 in Fiscal Years 2019-2020. This includes $42,000 in expenses and $13,000 in DoD labor.

Submitted on 6 March 2020

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Executive Summary

The 2018 National Defense Strategy (NDS) and Department of Defense (DoD) strategic guidance acknowledge an increasingly complex global security environment, characterized by the re-emergence of long-term, strategic competition between nations and the growing potential for strategic surprise stemming from advances in technology and science. The NDS recognizes the effects of Weapons of Mass Destruction (WMD) and prioritizes efforts to prevent WMD proliferation, defend the homeland from WMD, and manage the consequences of WMD attacks.

The strategic environment demonstrates an expanding range of possible challenges and emerging threats that have the potential to outstrip available resources, outperform traditional research and development processes, and outpace acquisition timelines. Foreign governments, entities, and terrorist organizations continue to weaponize chemical and biological (CB) agents. The incongruence of norms and expectations on the global level represent an increased risk to the United States and its allies. The severity of the threat environment is marked by recent and pronounced incidents. Recent examples include attempted and actual assassinations conducted by Russia and North Korea, as well as asymmetric engagements employed by the Syrian government and the Islamic State of Iraq and Syria (ISIS). These issues are increasing risk to our military forces, first responders, and citizens at large.

Future innovations that drive military and economic competitiveness will increasingly originate outside the United States, even as the overall U.S. lead in science and technology (S&T) shrinks. The competitive landscape is making the CB defense mission more complex due to the acceleration and convergence of S&T resulting in the emergence of new agents and threats. Rapid advances in biotechnology and engineering biology are likely to present new economic, military, ethical, and regulatory challenges worldwide as governments struggle to keep pace. A global resurgence in materials science and manufacturing technology will enable advanced states to create materials with novel properties and engineer structures not previously possible, while placing high-end manufacturing capabilities within reach of small groups and individuals. Going forward, a concerted and conscious effort is required to focus on mitigating emerging threats.

Throughout 2019 we have made the choices necessary to balance our investments between near-term readiness and future modernization. The recent Defense-Wide Review (DWR) implemented changes to the CB defense capabilities development portfolio resulting in a concentration of limited resources on the critical gaps for chemical and biological defense. Investments in lower priority efforts, including radiological passive defense and tactical disablement, were reduced to resource core efforts addressing emerging chemical and biological threats. We will continue to engage early and often with our Service partners to ensure our products are responsive to the highest priority operational requirements to close Joint Force gaps. Currently, we are focused on detection, identification, and characterization of next generation threat agents, improving personal and collective protection, advanced medical countermeasures, and diagnostics for clinical samples.

We see both challenges and opportunities in Defense Reform 2020 guidance to align the Chemical and Biological Defense Program to address emerging threats and advance the NDS. Capabilities development will seek opportunities to implement rapid acquisition authorities and look for novel methods to develop countermeasures. Services are continuing to seek opportunities to improve readiness through realistic and expanded training and exercises focused on countering WMD scenarios. Additionally, Services are employing innovative approaches and accelerated investments to ensure rapid fielding and effective sustainment of equipment for the Joint Force. Across the Department, we integrate efforts to ensure that we never enter an unfair fight. We maintain the lethality of the Joint Force by increasing the resiliency of our warfighters and supporting efforts to deter, prevent, mitigate, respond to, and recover from chemical and biological threats and their effects.

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INTRODUCTION

The 2020 Department of Defense (DoD) Chemical and Biological Defense Annual Report to Congress—pursuant to section 1523, title 50 of the United States Code, Annual Report on Chemical and Biological Warfare Defense—assesses and evaluates the DoD's Fiscal Year (FY) 2019 efforts and overall readiness to fight and win in a chemical and biological (CB) environment. This report details the Department's actions to improve Joint Force readiness through focused training and fielding of enhanced capabilities, while modernizing equipment, tactics, and techniques to address emerging threats and prepare the Joint Force for the future.

The hazards posed by Chemical, Biological, Radiological, and Nuclear (CBRN) weapons remain real and evolving. The 2018 National Defense Strategy (NDS) underscores the importance of defending against weapons of mass destruction (WMD). The threat of WMD acquisition and proliferation is increasing, and use against the United States, its allies, and its interests would be grave, compelling the DoD to prioritize countering WMD (CWMD) plans, programs, and activities.

To lead the Nation's defense against CBRN effects, the DoD established the Chemical and Biological Defense Program (CBDP) as a special interest program under the oversight of the Defense Acquisition Executive. The Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs (ASD(NCB)) serves as the principal advisor, providing strategic goals, objectives, and guidance for the research, development, and acquisition (RDA) of CBRN medical and physical defense capabilities required to support CWMD missions. The program is supported by a number of offices and organizations, as described in Enclosure A.

The mission of the CBDP is to anticipate future threats and deliver capabilities that enable the Joint Force to fight and win in CB-contested environments. The CBDP aligns to the NDS with its mission to counter current, evolving, and future WMD threats.

NDS Line of Effort One: Build a More Lethal Force

The DoD prioritizes investments that supply the Services with capabilities in the highest identified operational risk areas. For the CBDP, this translates to enabling operations through the challenges of a WMD event. Starting in FY 2019, capabilities development will focus and accelerate efforts to counter emerging threats. We will pursue new solutions through rapid acquisition, delivering the capabilities necessary to enhance the lethality of the Joint Force. The Services are focusing their efforts in this mission area by increasing the frequency of CBRN defense training, improving training scenarios to align with the NDS, and developing logistics chain enhancements to sustain a higher level of readiness. Comprehensively, these efforts and resources will strengthen the lethality of the Joint Force to operate in a CBRN environment.

NDS Line of Effort Two: Strengthen Alliances and Attract New Partners

Key to our success is the integrated, strategic engagement with our interagency and international partners. We leverage the expertise and complement the missions of the Department of Health and Human Services (HHS), Department of Homeland Security (DHS), and our global allies and partners. Examples of this ongoing cooperation include the DoD's partnership with HHS in accomplishing the goals of the 2018 National Biodefense Strategy. The Department supports Federal efforts to advance CB incident preparedness and response (CBIPR). Specifically, DoD CBIPR efforts seek to build capabilities that represent all applicable layers of medical defense, including information sharing, product development and support tools, therapeutics, vaccines, and diagnostics. These CBIPR efforts will add significant strategic capability to both the CBDP and U.S. Government (USG) writ large. To advance North Atlantic Treaty Organization (NATO) partnerships, DoD coordinated with the NATO Capability Development Group to initiate a NATO Fourth Generation Agent Capability Gap assessment to promote preparedness across our NATO allies. These efforts support and build established partnerships while improving outcomes and capabilities for the USG.

NDS Line of Effort Three: Reform the Department for Greater Performance and Affordability

In 2019, the Department conducted a Defense-Wide Review (DWR) focused on ensuring alignment of efforts in the Defense-Wide accounts and seeking efficiencies in order to find opportunities to re-invest in higher priority efforts. The DWR resulted in changes to the CB defense capabilities development portfolio that concentrate resources on the critical gaps for CB defense. Investments in lower priority efforts, such as radiological passive defense and tactical disablement, were reduced to fully resource core efforts addressing the CB threat. Additionally, the Department institutionalized reforms to address rapid acquisition and contracting authorities. The CBDP is taking advantage of these authorities to pursue rapid development and prototype efforts and to expand Other Transactional Authorities (OTAs), including the use of the Defense Innovation Unit (DIU).

READINESS–EQUIPPING AND TRAINING THE FORCE[1]

Readiness of the Joint Force is the highest priority for the Department, as outlined in the NDS. The Services, in coordination with the combatant commands, are advancing the readiness of the Joint Force through exercises, rapid equipping, and realistic training. These efforts are central to providing a force that can operate and succeed in a CB environment. Partnerships with interagency stakeholders and international counterparts support cooperation and integrated responses to the hazards of CB threats.

Fielded Equipment

Each Service maintains equipment designed to enable the Warfighter to detect, protect against, mitigate, and recover from chemical, biological, and radiological (CBR) hazards. These capabilities are critical enablers in sustaining Joint Force freedom of maneuver, allowing Warfighters to support the DoD global defense posture. Enclosure B includes all CB-related capabilities fielded to the Joint Force in FY 2019.[2]

U.S. Army

From battalion to corps, Army units incorporate the CBRN core functions—assess, protect, and mitigate—to gain real-time understanding, achieve inherent survivability and negate hazard effects. To meet current and future operational demands, the Army requires state-of-the-art CBRN equipment and protective wear that allows freedom of action, endurance, and flexibility on the battlefield while minimizing operational, logistical, training, and physiological impacts. During FY 2019, Army Commanders focused on CBRN equipment operation, maintenance, and repair part management. Leaders familiarized themselves with defense equipment that encompasses the Standard Individual Soldier Basic Load items, and units took inventory of equipment and ordered parts to reenergize the supply system to meet an increased CBRN-related demand. Overall, the Army increased readiness through CBRN defense equipment procurement, force structure enhancement, and training improvement.

[1] Title 50 U.S. Code 1523 (a) 1: The overall readiness of the Joint Force to fight in a chemical-biological warfare environment and shall describe steps taken and planned to be taken to improve such readiness.

[2] Title 50 U.S. Code 1523 (b) 1: The quantities, characteristics, and capabilities of fielded chemical and biological defense equipment to meet wartime and peacetime requirements for support of the Joint Force, including individual protective items.

An M1135 nuclear biological chemical reconnaissance vehicle during the Joint Warfighting Assessment 19, May 4, 2019. *(U.S. Army photo)*

The Army continues to implement the Army Chief of Staff's guidance to accelerate Nuclear Biological and Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite Upgrade (SSU) modernization, significantly improving stand-off detection, identification of CBRN emerging threats, and its unmanned detection and identification capabilities. Following the integration of the first capability set, stakeholders participated in the Joint Warfighting Assessment 2019, which validated and proved successful integration. Stakeholders will continue to apply detection and hazards-at-a-distance capabilities and incorporate new biological detection and assessment capability for Joint Warfighter Assessment 2020. The modernized NBCRV SSU is a key component to the Army's strategy to improve CBRN situational awareness and Integrated Early Warning (IEW).

To address contamination mitigation, the Army completed fielding of the M334 Decontamination Kit Individual Equipment, the first individual decontaminant that does not degrade the operational effectiveness of decontaminated equipment, enabling quicker restoration of combat power. To answer operational needs from the U.S. Indo-Pacific Command Area of Responsibility (AOR), the Army initiated modification of hazardous response companies into Heavy Decontamination and Reconnaissance Companies (HDRCs). These HDRCs provide U.S. Army Pacific (USARPAC) with enhanced fixed-site and terrain decontamination capabilities to mitigate CB attack effects to the Active Component at Aerial Ports of Debarkation (APOD) and Sea Ports of Debarkation (SPOD) during non-combatant evacuation operations (NEO). The current Eighth Army CBRN force structure in Korea is challenged to simultaneously support NEO and combat operations. This, coupled with the fact that there are no organic CBRN units in U.S. Army Japan, reinforces the need for additional, permanently stationed CBRN decontamination units to cover APODs and SPODs in Korea and Japan.

U.S. Navy

To ensure Sailors are ready to fight in a contaminated environment, the Navy closely monitors afloat and shore-based CBR readiness statuses. Its centrally managed Individual Protective Equipment (IPE)-Readiness Improvement Program (RIP) ensures afloat and deployed expeditionary Sailors have properly maintained and fitted equipment. This approach leverages organic logistics support, efficiently integrates CBR defense, and maximizes responsiveness to deployment needs. Historically, maintaining the material readiness of this equipment required man-hours that could have been better used supporting operations and training. Currently, the RIP team conducts pre-deployment readiness visits to relieve ships of this burden.

Throughout FY 2019, the RIP continued to make significant improvements in fleet CBR readiness, completing more than 100 missions to provide deploying and forward-deployed surface ships, carriers, expeditionary forces, individual augmentees, and installations with more than 24,000 properly fit-tested and fully serviceable CBR masks. In addition, the RIP team supported chemical, biological, radiological, nuclear, and explosive (CBRNE) equipment for installation fire and emergency personnel. The RIP team maintains asset visibility for all fleet-issued IPE, monitors the latest condition status, and proactively schedules replacements according to ship or unit availability.

Sailors wear a joint service mask leakage detection canopy to test the seal integrity of their MCU-2P gas masks. *(U.S. Navy photo)*

Besides maintaining all physical chemical defense equipment at a high state of readiness, the Navy actively manages its inventory of CB consumables. Waterfront Fleet Support Teams manage and store ready-for-issue items in warehouse/staging spaces located in Virginia, California, and Japan to replenish shelf-life expiring materials and maintain shipboard allowances for deployed and non-deployed ships. These teams participate in Readiness Assist Visits (RAV) to deploying units, providing technical assistance at an efficient cost.

During FY 2019, 59 ships received a CBRND-RAV. Examples of material centrally managed by Waterfront Fleet Support Teams include:

- M8 and M9 Chemical Warfare Agent (CWA) Detection Paper,
- M256A2 Detection Kits,
- Biological Hand-Held Assays,
- Reactive Skin Decontamination Lotion,
- Joint Biological Point Detection System (JBPDS) carrier box assembly, and
- Other consumables/biological response kits.

Naval Sea Systems Command (NAVSEA) installs and maintains collective protection systems (CPS) onboard Navy ships. In FY 2019, NAVSEA performed the following CPS activities:

- Maintained and sustained 100 surface-combatant and *amphibious*-class ships and one shore-based system.
- Performed initial filter installation onboard two new ships and one shore-based system.
- Performed full filter change-outs onboard:
  - 23 in-service Navy ships,
  - One Military Sealift Command ship, and
  - One U.S. Coast Guard ship.

CPS coverage ranges from one zone covering a limited number of shipboard spaces to nearly the entire ship, and typically spans command and control, medical, and crew berthing areas, allowing mission-critical efforts to continue unimpeded in a CBR environment. The CPS requirement for ships is expected to increase by two to five ships per year over the next several years and is expected to exceed 130 ships by 2030 as new ships are constructed.

In FY 2019, the Navy fielded 45 Dismounted Reconnaissance Sets, Kits, and Outfits (DR SKO) systems providing full-spectrum CBRNE/WMD detection and identification. The DR SKO provides Navy visit, board, search, and seizure teams with enhanced detection and identification capabilities to detect the presence of WMD in support of WMD interdiction missions.

The Navy is in the final phase of installing 230 CBDP-procured Improved Point Detection System–Lifecycle Replacements (IPDS-LR), which provide an automated chemical point-detection capability for Navy surface ships, carriers, and U.S. Coast Guard National Security Cutters. So far, 200 systems have been fielded via shock qualified retrofit installation, during new ship construction, or as a form/fit/function repair of legacy systems.

Fielding of the JBPDS M-98 is nearing completion. These systems provide automated, biological point-detection for Navy surface ships. Fielding will continue into FY 2023.

U.S. Air Force

U.S. Air Force (USAF) installations, at home and overseas, are power projection platforms from which our Airmen fly, fight and win. As such, bases must be postured to recover promptly from CBRN attacks to ensure zero or limited interruption of critical operations. Multiple career fields, including Bio-Environmental Engineers, Emergency Managers, Aircrew Flight Equipment, Fire Fighters and Explosive Ordnance Disposal, work together using available CBRN passive defense equipment to ensure the resiliency of USAF bases.

Quartermaster 2nd Class Nicholas Fields establishes perimeter security wearing a joint service lightweight integrated suit technology during a convoy training evolution. *(U.S. Navy photo)*

The USAF prioritizes capabilities that protect Airmen in a CBRN threat environment. While the ground crew's individual protective gear (M50 masks and Joint Services Lightweight Integrated Suit Technology) is adequate, continuous airfield operations in a CBRN environment require Airmen to have rest and relief unencumbered by their gear. To satisfy this essential requirement, the USAF fielded new Expeditionary Collective Protection (ECP) systems in 2019. The Tent Kit 2, one type of ECP fielded, is capable of converting the USAF's Basic Expeditionary Airfield Resource standard expeditionary shelters into Toxic Free Areas in a CBRN contaminated environment. In addition, the Shelter Kit Improved, another ECP system fielded, is designed to emplace Toxic Free Areas inside fixed facilities. Asset management is critical and fielding newer and more advanced capabilities is the objective of the USAF CBRN modernization efforts. Providing USAF operators with adequate protection that supports a seamless transition from ground to air is vital to establishing air superiority and neutralizing adversarial threats.

Legacy Aircrew CBRN (ACBRN) equipment includes First Generation Aircrew Chemical Defense Equipment in service on E-3/E-8 aircraft only and Aircrew Eye and Respiratory Protection. While the USAF Aircrew Flight Equipment community has been able to maintain the equipment through robust sustainment efforts, the equipment is quickly degrading due to age. The First Generation Aircrew Chemical Defense Equipment has been in service since 1979, and Aircrew Eye and Respiratory Protection was introduced in 1990, directly supporting the need to field Joint Service Aircrew Mask (JSAM) Strategic Aircraft as soon as possible.

The USAF Medical Services Home Station Medical Response program will complete fielding of 55 outpatient decontamination systems to all outpatient clinics and USAF Expeditionary Medical Support training sites by the end of FY 2020.

In the last six months of FY 2019, the USAF fielded Sentinel Panel Environmental Bio-surveillance Kits for analysis of biological warfare agents in environmental samples to laboratories that received Film Array systems. With this capability, military treatment facilities and installation commanders can qualitatively detect up to 17 traditional biological agents on several sample types.

U.S. Marine Corps

Managed by U.S. Marine Corps (USMC) Systems Command, the Corps' Family of CBRN Systems maintains fielded CBRN equipment, ensuring shortages are identified, problems are corrected, and asset visibility and sustainment trends are used to formulate budget submissions to meet required readiness levels. The Family of Incident Response Systems provides enhanced CBRN protection, detection, identification, reconnaissance, incident response and consequence management capabilities used by the Chemical Biological Incident Response Force, Explosive Ordnance Disposal, and the Marine Air Ground Task Force to train for and operate both within and outside the continental United States.

U.S. Marines CBRN specialists work alongside Marines with Explosive Ordnance Disposal, Marine Wing Support Squadron 172 during an EOD and Hazmat response training event. *(U.S. Marine Corps photo)*

In FY 2019, USMC Systems Command began fielding the Explosive Ordinance Disposal USMC Forces Special Operations Command Configuration of the CBRN DR SKO. The DR SKO set consists of both commercial-off-the-shelf (COTS) and government-off-the-shelf (GOTS) equipment to provide personnel protection from CBRN hazards including toxic industrial material and CBRN detection, presumptive identification, sample collection, decontamination and marking. The CBRN DR SKO set replaces the Marine Air/Ground Task Force CBRN Assessment and Consequence Management sets, Explosive Ordnance Disposal (EOD) CBRNE Kit, and select Chemical Biological Incident Response Force equipment. One EOD DR SKO USMC Forces Special Operations Command Configuration (TAMCN C00257B) was fielded to 1st Marine Raider Battalion in FY 2019, with fielding continuing through FY 2024.

National Guard

The hazards posed by CBRN weapons remain a relevant challenge for the Homeland. Illicit trafficking of Pharmaceutical Based Agents (PBAs) and threat of WMD use from near-peer adversaries and violent extremist organizations define the challenges facing National Guard efforts to protect the country. The Chief of the National Guard Bureau is responsible for providing the President, State Governors, and the Secretary of Defense a range of CBRN defense capabilities to prevent and respond to the use or threatened use of WMD in the Homeland. These capabilities include detection and identification of CBR agents, search and rescue, mass casualty decontamination, medical triage/stabilization, interoperable communications, and subject-matter experts able to advise and assist local, state, tribal, and federal responders in mitigating an attack on U.S. soil. The National Guard CBRN force is made up of 57 WMD Civil Support Teams (CST), 10 Homeland Response Forces (HRFs), and 17 CBRNE Enhanced Response Force Packages (CERFP). The National Guard participates in DoD processes supporting CBRND RDA, including the Joint Capability Integration and Development System; Planning, Programing, Budget and Execution cycle; and DoD support for strategic analysis to ensure that unique National Guard CBRND operational concepts, capability requirements, and functions are accounted for and supported as part of the CBDP.

In 2019, the CBDP improved National Guard domestic CBRN force readiness to confront emerging threats by improving CST capability to identify CB agents. The CBDP also laid the foundation for sustaining the future readiness of National Guard domestic CBRN forces by investing in the acquisition IEW capabilities, such as:

KC-135 Stratotanker with integrated early warning capabilities in exercise Sentry Aloha 19-2. (U.S. Air National Guard photo)

- improved remote CBR identification and CB detection adaptable to emerging CBRN threats;
- increased information systems interoperability; and
- modernized radiological detection.

Additional investments fill technology gaps, facilitate timely and effective military and civilian responder decision-making, mitigate the effects of a domestic CBRN incident; and provide medical countermeasures (MCM) to save the lives of Warfighters exposed to PBAs.

In FY 2019, the CBDP began fielding the Analytical Laboratory System (ALS) version A1A to the CSTs. The ALS A1A will improve CST readiness by replacing the obsolescing ALS and enable CSTs to perform joint-mission essential tasks through field confirmation and identification of CB threats to local, state, tribal, and Federal responders during domestic CBRN incidents.

The National Guard began fielding the CBRN Response Enterprise Information Management System and advanced trauma care equipment to provide National Guard forces with real-time integration, management, and monitoring of CBRN detection sensors and elements. The advanced trauma set ensures safety and installation standards for medical equipment and supports patient care during incident response. The equipment set provides:

- response shelters,
- generator modernization,

- oxygen generators,
- medical ultrasound,
- thermometers/vital signs monitors,
- environmental control units,
- portable alarmed refrigeration, and
- exterior lighting.

The National Guard continued development of its concept of operations (CONOPs) for the use of unmanned aerial systems and completed initial evaluation of existing technologies that would support requirements for remote detection and search and extraction capabilities.

U.S. Special Operations Command

U.S. Special Operations Command (USSOCOM), Theater Special Operations Commands (TSOC), and Special Operations Forces (SOF) are poised to fight in CBRN environments employing Joint, Service-specific, and SOF-unique materiel capabilities. SOF and TSOCs apply CBRN capabilities to meet the operational CWMD requirements of the geographic combatant commands.

USSOCOM continues to work closely with the Joint CBDP; Joint Staff, J8 Joint Requirements Office for CBRN Defense, Joint Program Executive Office – CBRND (JPEO-CBRND), U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center (CBC), and Defense Threat Reduction Agency (DTRA) to ensure CBRN defense gaps are addressed and requirements are met.

The JPEO-CBRND developed and improved capabilities by rapidly acquiring and equipping SOF with critical chemical, biological, and radiological defense equipment necessary to achieve mission success. JPEO-CBRND developed technologies necessary for the survival and unimpeded employment of SOF in toxic environments and to transition those technologies to other Programs of Record, enhancing the CBRND capabilities of the Joint Force.

Training[3]

The Department must be trained, ready to operate, and able to make decisions in CBRN environments across the breadth and depth of the battlefield. Military training based on doctrine and tactics, techniques, and procedures (TTPs) prepare units and staffs to respond to operational requirements for CBRN hazards deemed necessary by commanders to execute assigned missions. CBRN defense training programs include realistic individual and collective skills training, and maximize the use of emerging technologies including distance learning, computer simulation, and virtual reality. Training, exercises, professional military education, and leader development programs incorporate the principles for operations in CBRN environments and include realistic consideration of CBRN effects on sustained operations.

U.S. Army

To achieve mission success, the Army has reinvigorated its focus in the area of CWMD readiness, units at all levels are required to execute the tasks that support and advance their CWMD readiness. Leaders at all echelons incorporated and executed CBRN battlefield-readiness tasks in individual and collective-level MET during home-station training, Combat Training Center rotations, Warfighter Exercises, and multi-national live-agent CBRN exercises. Units routinely train for CBRN reconnaissance and decontamination using organic systems. Every battalion-level unit conducted operational decontamination and Mission-Oriented Protective Posture gear exchanges, separately and with other individual and collective CBRN protection tasks. Several companies scheduled, synchronized, and conducted annual training in conjunction with home station training on personnel, equipment, fixed-site, and area decontamination.

[3] Title 50 U.S. Code 1523 (b) 4: The status of nuclear, biological, and chemical warfare defense training and readiness among the Joint Force and measures being taken to include realistic nuclear, biological, and chemical warfare simulations in war games, battle simulations, and training exercises.

Indiana National Guardsman undergoes mask fitment during Toxic Valley 2019. *(U.S. Air National Guard photo)*

In FY 2019, U.S. Army Forces Command (FORSCOM) units continued annual participation in live-agent training during EXERCISE PRECISE RESPONSE 2019 in Canada and, for the first time, its units participated in EXERCISE TOXIC VALLEY 2019 in Slovakia. These efforts improved FORSCOM's readiness and lethality, as well as increased participation in exercises and planning in the U.S. European Command AOR.

The U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), Aberdeen Proving Ground, Maryland, continues to educate and train joint medical providers, non-medical responders and civilian counterparts as the gold standard for medical management of chemical casualties throughout the DoD. The USAMRICD is the proponent for three resident courses and multiple non-resident courses around the world to include filling training requests from combatant commanders within their AOR. The USAMRICD utilizes Defense Health Program funds to instruct between 1,000 and 3,000 students a year in the medical response to chemical exposure.

The USAMRICD Chemical Casualty subject matter experts coordinated with the U.S. Army Central Surgeon's office to validate training requirements for the medical management of CB casualties to increase the chemical casualty response readiness for medical units/elements/sections in role one through three supporting non-medical organizations entering the U.S. Central Command AOR.

The U.S. Army CBRN School, Fort Leonard Wood, Missouri, trains, educates, and develops the best-qualified CBRN Soldiers and civilian specialists, conducting more than 80 resident and non-resident CBRN courses and graduating more than 7,500 students from all U.S. Services and with international partners from 12 countries. In FY 2019, the CBRN School:

Soldiers in mission oriented protective posture suits during the 2019 Best Chemical, Biological, Radiological and Nuclear Warrior Competition on April 30, 2019 at Fort Leonard Wood. *(U.S. Army photo)*

- Developed an online resource of institutional, operational, and self-development training content for both CBRN and non-CBRN Soldiers.
- Graduated the first cohort of officers in its Master of Science, Defense and Strategic Studies/WMD degree program (in conjunction with Missouri State University).
- Renovated the Chemical Defense Training Facility to include 11 target sets uniquely tailored to CBRN defense and CWMD missions.
- Revolutionized live-agent training to meet Army training objectives.

The Army uses realistic CBRN simulations during training exercises. Training events conducted in New York City and Austin, Texas, included realistic scenarios that tested the Defense CBRN Response Force's ability to integrate into the civilian response to an attack on the Homeland. Participants in the Eighth Army's "WARRIOR STRIKE" exercises trained on a virtual network while simultaneously receiving live reports from Soldiers conducting WMD exploitation operations at multiple, simultaneous sites.

During EXERCISE AUSTERE CHALLENGE 2019, the U.S. Army Europe Protection Staff received augmentation from the Joint Program Executive Office (JPEO)-CBRN Defense, 20th CBRNE Command, and the U.S. Army Nuclear and CWMD Agency. The result was successful completion of CBRN Response tasks and setting conditions for an improved theater CBRN posture.

U.S. Navy

In FY 2019, the Navy updated training systems plans, course curricula, and shipboard practices for CB warfare defense and countermeasures. These changes included shipboard decontamination station training units fielded in Japan, Hawaii, and Florida. These units provided hands-on shipboard CBR decontamination training.

Sailors prepare to transfer a simulated casualty from a decontamination station to the medical bay during a CBR training exercise aboard the *San Antonio*-class amphibious transport dock ship USS *Anchorage*. *(U.S. Navy photo)*

The Shipboard CBR Defense Operations and Training Specialist Course extended the course for a day to include a hands-on CBR decontamination drill, and another day for live-agent training in the newly renovated Army Chemical Defense Training Facility. These training tools and exercises increased the fleet's operational capability and readiness to survive in a CBR environment and included dismounted CBRN reconnaissance simulations and scenarios involving chemical warehouses and laboratories, tunnels, trucks, and urban environments.

Approximately 500 sailors participated in divisional training and 150 sailors participated in focused on-the-job training during CBRND-RAV, which included training on fixed and portable CB detection systems, CB consumables, decontamination, CPS, Radiation Detection, Indication and Computation systems, and dismounted systems.

U.S. Air Force

USAF CBRN defense training give Airmen a basic understanding of war-time tasks necessary to survive, operate, and fight in a CBRN environment. The 368th Training Squadron at Fort Leonard Wood, Missouri, provides CBRN subject matter expert training through the Emergency Management Course and the CBRN Responder Course. Alongside other Services, USAF Emergency Managers train in live-agent conditions and gain confidence in issued protective gear. USAF Emergency Managers are responsible for CBRND at Airman Basic Training courses and installations. In 2019, the Aircrew Flight Equipment career field enhanced its ACBRN training portfolio and capabilities through attendance and participation at the 436th Training Squadron's Aircrew Flight Equipment Aircrew Contamination Control Area train-the-trainer course, NATO Toxic Trip, and individual Major Command Unit Type Code training and education. The USAF Medical Services developed and implemented new CBRN training, called Readiness Exercises and Assessments in a Goal-oriented Learning Environment (Ready EAGLE), designed to further increase medic full-spectrum readiness capabilities. Medical teams performed critical action sequences as part of a five-day event consisting of instructional training, hands-on coached scenarios, and a full-scale exercise. Additionally, CBRN training is included in USAF Medical Services Expeditionary Medical Support and the DoD Public Health Emergency Management courses.

U.S. Marine Corps

In August 2019, the Commandant of the USMC published planning guidance for the force and renewed the Corps' commitment to remain "trained and equipped as a naval expeditionary force-in-readiness." This commitment requires the continued review, analysis, and assessment of existing systems and the development and modernization of those CBRN capabilities required to support the future fight.

Guiding these efforts, the Capability Development Directorate is postured to publish a new functional concept for CBRN support to expeditionary naval operations. Leveraging the Service Operating Concept, Expeditionary Advance Base Operations, the CBRN functional concept will guide the development, prioritization, and resourcing of future CBRN defense capabilities across doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policies (DOTMLPF-P). The USMC also renewed Service policies to guide the fleet in preparing for and operating in a CBRN environment. Together these policies align organizational roles and responsibilities for CBRN defense and CWMD, including discrete training requirements for individuals, teams, and commanders.

The CBRN Defense Operational Advisory Group convened to identify and address issues impacting operational readiness and the development, sustainment, and employment of CBRN capabilities. The working group received guidance and operational updates from Headquarters USMC, the Joint Staff, the Defense Intelligence Agency, and other DoD support agencies on current and emerging CBRN threats, operations, and actions around the world. Upon completion of the CBRN Operational Advisory Group, members returned to their parent commands with increased understanding of the current and future security environment as it relates to CBRN threats and hazards to better prepare and posture the force to mitigate their effects.

The USMC integrated CBRN training into over 350 formal events, including Marine Expeditionary Force, Major Subordinate Command, and battalion/squadron-level exercises. Marine Forces Pacific and Marine Forces Europe/Africa planned and executed 13 Theater Security Cooperation engagements in coordination with allies, partner nations, DTRA, Department of State foreign consequence management partners, and adjacent military Service components to exercise Joint Force interoperability. These efforts also strengthened partner-nation capacity to defend against CBRN threats and hazards in support of CWMD lines of effort for U.S. Indo-Pacific Command, U.S. European Command, and U.S. Africa Command. Allies and partner nations included Italy, Thailand, Philippines, South Korea, Japan, and New Zealand.

The USMC CBRN Readiness Calculator was updated in 2019 to more accurately assess organizational CBRN defense readiness. The calculator enables visibility of readiness at the individual unit and aggregate level, thereby allowing for efficient identification of challenges and improved training prioritization.

U.S. National Guard

The National Guard sustains training of forces of the CBRN Response Enterprise to meet mission requirements, and continues to develop, improve, and adapt individual and joint collective training venues, such as VIGILANT GUARD, to address systemic training issues and emerging threats.

To enhance CST, HRF, and CERFP operational capabilities, the National Guard continued to develop individual training courses on advanced detection/identification techniques; CBRN characterization, exploitation, and mitigation; and advanced equipment. In coordination with U.S. Northern Command (USNORTHCOM), the Chief National Guard Bureau (CNGB) included elements of the USNORTHCOM Command and Control CBRN Response Enterprise (C2CRE) into HRF and CERFP joint-exercise programs to enhance interoperability.

In FY 2019, NGB completed four beta tests to integrate Department of Energy-recommended simulants and virtual radiation training into HRF and CERFP exercise training programs and external evaluations.

U.S. Special Operations Command

In FY19, USSOCOM integrated CBRN and CWMD scenarios into senior leader seminars and table top exercises (TTX) and actively participated in the Joint Staff, J8-Joint Requirements Office exercises. CWMD/CBRN vignettes were integrated into select SOF exercises; the SOF vignettes and scenarios supported material development TTXs for CBRN and CWMD capabilities that reflect SOF contingency plans and mission requirements.

CAPABILITIES DEVELOPMENT[4] [5]

The CBDP is a critical component of the Department's efforts to prevent surprise on the battlefield by anticipating CB attacks through advanced scientific knowledge and research of emerging threats, then developing cutting-edge technologies and capabilities to detect and defeat those threats. The CBDP accomplishes this through a robust R&D program to study and characterize emerging CB threats; the development of state-of-the-art technologies and systems that can be transitioned to the Warfighter; and collaboration with government, industry, and academic partners across science, engineering, intelligence, and medicine specialties to deliver the fastest and most cost-effective solutions to the Joint Warfighter.

Requirements Integration[6]

The Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND) guided joint requirements development for several CBRN defense equipment initiatives in FY 2019 that streamlined capability validation. Modification Work Orders (MWO) for Enhanced Maritime Biological Detection (EMBD) and DR SKO systems allowed for improved Warfighter capabilities without establishing new programs. These endeavors will field within two years, modernizing already validated requirements to reduce sustainment costs and provide more precise detection capability. The JRO-CBRND led efforts to refine aircrew protection capability requirements (respiratory/ocular and percutaneous), reducing the physiological burden to aircrew personnel, with scheduled fielding in the next three years.

The JRO-CBRND led requirements development for multiple CBRN defense medical programs, including a joint requirement supporting the Rapid Opioid Countermeasure System (ROCS). Through collaboration with DoD stakeholders, the JRO-CBRND developed and approved the draft Opioid Medical Countermeasure, Rescue Therapeutic Capability Development Document as part of ROCS within the six-month approval benchmark timeline for selected programs.

[4] Title 50 U.S. Code 1523 (a) 2: Requirements for the chemical and biological warfare defense program, including requirements for training, detection, and protective equipment, for medical prophylaxis, and for treatment of casualties resulting from use of chemical or biological weapons.

[5] Title 50 U.S. Code 1523 (b) 2: The status of research and development programs, and acquisition programs, for required improvements in chemical and biological defense equipment and medical treatment, including an assessment of the ability of the Department of Defense and the industrial base to meet those requirements.

[6] Title 50 U.S. Code 1523 (b) 3: Measures taken to ensure the integration of requirements for chemical and biological defense equipment and material among the Armed Forces.

The JRO-CBRND developed and staffed two joint DOTMLP-P Change Recommendations (DCRs) to improve capabilities via non-materiel means. The IEW DCR supports the broader CBDP IEW Campaign Plan to enhance timely and accurate warning, enable effective decision-making, and prevent or reduce mission impact, while the Contaminated Human Remains (CHR) DCR helps ensure safe CHR repatriation for final disposition. It also coordinated completion of the CWMD Education DCR, enhancing CWMD professional education across the Joint Force.

The office supported the CBDP through varied concepts, studies, and analysis efforts. Refining its Force Planning Construct, it continued to incorporate the principles of dynamic force employment in procurement solution sets. Tailored to prioritize contingencies identified in the NDS, the Force Planning Construct represents the minimum CBRND investment required to equip a modernized force for peak demand.

JRO-CBRND continued to serve as a liaison between the intelligence community and the Services, USSOCOM, and the National Guard. In this role, it led development of the 2019 CBRN Defense Intelligence Requirements List, which addressed priorities and challenges outlined in the NDS and enabled focused planning and allocation of intelligence resources across the DoD CBDP Enterprise.

JRO-CBRND worked on CBRN defense related planning exercises, and conceptual and sponsored studies examining the effects of pathogens released against U.S. Forces. The JRO-CBRND developed an MCM CONOPs to counter toxic threats; determined improvements in WMD Pathway Defeat, a critical part of the Joint Concept to Prevent Use and Transfer of WMD; and proposed solutions to better understand and protect U.S. troops from Filovirus exposure. These studies assess various solutions to reduce operational risk and the benefits of complementary solutions, and propose integrated capability solution sets.

The JRO-CBRND ensured CBRN equities were addressed in multiple joint publication reviews and revisions; conducted and supported numerous training and educational events; and provided direct support to multiple CBRN-focused exercises at enterprise, Service, combatant command, and national levels. It completed a TTX to assess and evaluate PBAs risk and impact on the Joint Force in various scenarios, highlighting impacts at the operational, tactical, and capability levels. This exercise—the only one of its scope and breadth focused solely on CBRND in the DoD—was conducted with input and participation from all Services, various DoD stakeholders, the intelligence community, interagency partners, the joint scientific community, and international representatives from Canada, Australia, and the United Kingdom.

Finally, it coordinated the CBDP Enterprise-wide Global Threat Day, where USG stakeholders were briefed on the most current, validated CBRN capabilities of various state and non-state actors. In conjunction with this event, the office also hosted its first Vulnerability Day, where the Services, USSOCOM, and the National Guard assessed their top operational vulnerabilities to CBRN threats. Findings from these events, combined with other studies and analyses, informed the development of multiple products including the draft Joint Concept for Operations in a CBRN Environment; the JRO-CBRND Integrated Risk Assessment; the draft Joint CBRND Modernization Plan; and Joint Staff inputs to the Chairman's Gap Analysis. These foundational products and processes synthesized validated threats and the force planning needs of combatant commands, assessed operational risk to U.S. Forces, and provided resources and guidance to the Joint Force to best counter the highest operational threats.

Science and Technology

The Defense Threat Reduction Agency (DTRA) Joint Science and Technology Office – Chemical and Biological Defense (JSTO-CBD) directs and manages CBDP science, technology, and capability development investments that maintain the U.S. military's technological superiority in CWMD and asymmetric threats, mitigate the risks of technical surprise, and respond to Warfighter urgent technical requirements.

DTRA conducted two events at Guardian Centers in Perry, Georgia and Dugway Proving Ground, Utah with scientists participating in operational scenarios as part of the "Scientists in the Foxhole" program. This program develops opportunities for CWMD scientists that are relatively new to DoD and places them with Warfighters as they train and conduct missions in a CBRN environment. Embedding scientists enables the participants to experience and understand the needs of the Warfighter and the types of missions performed while protecting themselves from CBRN threats. These opportunities stimulate ideas towards technology innovations to enhance enduring CBRN defense capability needs.

The office is taking an integrated approach to dealing with synthetic biological threats as part of a layered response. JSTO-CBD continued development of a beta prototype point-of-care system that distinguishes between bacterial and viral infections using biomarkers generated from the response of a Warfighter's immune system to an infection. Detecting the response of the Warfighter's immune system to an infection allows for earlier and faster treatment options even if the pathogen is unknown.

JSTO-CBD scientists initiated efforts on the Rapid Analysis of Threat Exposure (RATE) early-warning system, which takes large data sets of more than 41,000 hospital cases and uses artificial intelligence (AI) capabilities across 165 biomarkers to develop an early-warning algorithm. Using this system, scientists determined that certain combinations of vital signs could strongly predict the likelihood of infection 48 hours in advance of clinical suspicion. For Warfighters, early identification of infection could allow medical interventions to occur sooner, reducing overall mission impact.

In capability development focused on naturally occurring biological hazards, JSTO-CBD partnered with the Jenner Institute and the Oxford Biomedical Research Centre in Oxford, United Kingdom in FY 2019 to fund a Phase 1 clinical trial of a melioidosis vaccine candidate. The effort is made possible by the Vaccine Development for Complex Intracellular Neglected Pathogens network, an international network of researchers accelerating the development of vaccines against globally significant diseases. Conducting the Phase I clinical trials at the Jenner Institute resulted in reduced cost and risk to the USG.

On December 20, 2019, the Food and Drug Administration (FDA) licensed Merck Pharmaceuticals' Ebola Zaire vaccine, ERVEBO®, developed in partnership with the National Institutes of Health, Centers for Disease Control and Prevention, and the Biomedical Advanced Research and Development Authority within the HHS Office of the Assistant Secretary of Preparedness and Response. Funding from DTRA in FYs 2015-18 played an integral role in accelerating the availability of the vaccine candidate for Phase I clinical trials in 2015 and Phase II/III Clinical Trials in 2015 and 2016. Advanced development transitioned to Biomedical Advanced Research and Development Authority (BARDA), part of the HHS Office of the Assistant Secretary for Preparedness and Response, in FYs 2018-19. Based on over 90,000 at-risk vaccinations in 2018-2019, the World Health Organization determined that the vaccine is at least 97.5 percent effective.

Synthetic opioids (e.g., fentanyls) pose a serious threat to troops and first responders. The Department has taken deliberate and coordinated steps towards ensuring an integrated layered defense against PBA use. Robust efforts to advance threat agent science are necessary to identify, characterize, and assess possible threats, including PBAs. Ongoing efforts also served to strengthen and inform the U.S. response to the synthetic opioid epidemic, as well as the homeland defense mission. JSTO-CBD, the JPEO, and the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center (CBC) (formerly known as the U.S. Army Edgewood Chemical Biological Center) are collaborating to assess COTS and GOTS portable chemical detection technologies against these compounds to ascertain the need for a new PBA detector. Stakeholders from the DoD and DHS have received the assessment results. Feedback is driving future strategic S&T investments for combatting this emerging threat.

The CBDP prioritized and made targeted investments towards preparing for and mitigating the operational risk of fentanyls and partners with other USG agencies to ensure that effective capability sets are available to Warfighters, civil support teams, law enforcement, and first responders. On May 20, 2019, USAMRICD shared promising initial proof-of-concept studies for three FDA approved drugs (naloxone, naltrexone, and nalmefene) as potential prophylactic products to protect against opioid intoxication. All three drugs demonstrated the ability to delay, decrease, and prevent the respiratory and behavioral symptoms of carfentanil intoxication. The particular levels of opioid treatment—and the promptness and completeness of behavioral recovery—are still being elaborated. Coordination of efforts with the Medical Countermeasures Consortium (MCMC) partners will efficiently address remaining gaps and further support the JPEO ROCS advanced development program.

The USAMRICD continued its partnership in the advanced development of the hand-held ChemDx test system that can provide rapid, early warning of exposure to cholinesterase-inhibiting nerve agents from a single droplet of blood. JSTO-CBD and JPEO-CBRND jointly supported the effort which leverages an OTA with industry partners. System optimizations and algorithm tuning throughout FY 2019 have provided real-time correction for ambient temperature along with normalization to red blood cell density. These enhancements allow accurate assessment in the austere conditions of the battlefield and certainly extend to a civilian application of the test system.

In August 2019, industry, academia, and Government laboratories shared CB defense prototypes and experimental models directly with Warfighters and operators at the 2019 Chemical Biological Operational Analysis event. During the event, technology developers placed prototypes, including the Field Forward Sequencing System and Tactical All-Hazards Ensemble, in the hands of Warfighters, provided minimal training, and let them use the technology to conduct realistic CB-based missions in adaptive scenarios. Military operators provided candid feedback on applicability, utility, and recommended improvements that will inform current and future capability documents and drive design decisions, expedite the acquisition process, and increase mission success probability.

JSTO-CBD conducted a successful field demonstration of novel CB agent early warning technologies at USMC Base Quantico as part of the IEW Advanced Technology Demonstration program. The demonstration event, called Perceptive Dragon 3, was a joint effort between DTRA, USMC, and USAF combat developers to showcase technologies expected to revolutionize threat-defense and reconnaissance capabilities. Marines and Airmen provided valuable feedback that will inform capability and technology development efforts across the CBDP.

In FY 2019, CCDC CBC continued the Advanced Respiratory Protection Initiative to improve protection capabilities of the Joint Service General Purpose Mask. Through a technology insertion process, new materials developed at CCDC CBC are being evaluated against a set of proposed requirements that increase protection against a wider range of toxic industrial chemicals while maintaining excellent protection against CWAs. To advance collective protection capabilities, CCDC CBC supported the second year of a three-year demonstration for the DTRA-funded Residual Life Indicator (RLI) technology in a building CPS to generate performance data in a field environment and support technology transition to JPEO-CBRND. The objective of the RLI is to determine the remaining M98 CBRN filter gas life at any given time during operational use. Current techniques require the removal and destructive testing of M98 filters from the collective protection filter bank. The RLI can provide an accurate estimate of remaining gas life that is less intrusive and more cost effective. Results from RLI prototype testing have shown excellent correlation to results achieved with destructive testing of M98 CBRN gas filters, and the demonstration will continue into FY 2020.

CCDC CBC continued its efforts developing and improving the pleated carbon filter to meet the varying needs of users against specific contaminants. A user has agreed to the use of their facility as a test site to prove these pleated carbon filters adsorbing sulfur dioxide will extend the life of the standard collective protection filter.


Using Sprayable Decon Slurry, warfighters demonstrate CWA vehicle decontamination (using a HUMVEE with simulated contamination). *(DTRA photo)*

Additionally, CCDC CBC continued to develop Sprayable Decon Slurry, demonstrating it to personnel from U.S. Indo-Pacific Command, U.S. Army Europe, and USAF Europe. The Sprayable Decon Slurry greatly simplifies the logistical burden of decontamination by its single-step process and significantly reduces the need for water in an intermediate decontamination step. CCDC CBC teamed with an industrial partner to further develop the Sprayable Decon Slurry and make it commercially available.

On May 15, 2019, USAMRICD briefed the National Center for Medical Intelligence, JSTO-CBD, and other government stakeholders on the effectiveness of extrapolated foreign MCM.

Defense Advanced Research Projects Agency[7]

The Defense Advanced Research Projects Agency (DARPA) collaborates with agencies across the CBDP to provide programmatic updates, identify technology transition opportunities, and leverage each component's technical expertise in the areas of threat reduction, biodefense, diagnostics, regulatory reviews, biosurveillance, and MCM development and manufacturing.

To address CB threats, DARPA-funded scientists are developing novel technologies and approaches for environmental detection, diagnostics, and countermeasures. The ongoing relationship between DARPA and JPEO-CBRND has advanced the DoD's ability to respond rapidly to a biothreat crisis. The DARPA Autonomous Diagnostics to Enable Prevention and Therapeutics and Pandemic Prevention Platform programs pioneered the use of nucleic acid-based vaccines and therapeutics in an effort to accelerate response timelines and simplify complex manufacturing methods. Specifically, nucleic acid-encoded monoclonal antibodies can be administered both post-exposure as an early treatment, and prophylactically as a transient, but fast-acting, MCM for Warfighters deployed to areas with a known pandemic or CBRN threat. In 2019, JPEO and DARPA signed a memorandum of agreement (MOA) to establish an in-house plasmid DNA manufacturing capability at the DoD Advanced Development and Manufacturing facility in Alachua, Florida. Establishing large-scale manufacturing capabilities of clinical-grade DNA plasmid and ribonucleic acid (RNA) material under current good manufacturing practice (cGMP) conditions at the DoD Advanced Development and Manufacturing facility would ensure the Government has a viable source of these resources for unimpeded development of nucleic acid-based MCM capabilities.

Building on these capabilities, DARPA is working to develop an integrated material-synthetic biology ensemble that simultaneously reduces protective equipment demands and increases CB threat protection for the individual. Another MOA between DARPA and JPEO-CBRND enables co-development of a biologics-on-demand platform that will provide DoD with a cGMP-grade radiation therapeutic. In order to further accelerate biothreat responses, DARPA is currently soliciting proposals for the new Deployable Medical Countermeasures for Warfighter Readiness program that will challenge scientists to develop a mobile, end-to-end platform for producing hundreds of doses of cGMP quality nucleic acid large-molecule biologic MCM daily. DARPA has engaged with CBDP partners since the inception of the program and will stay engaged throughout.

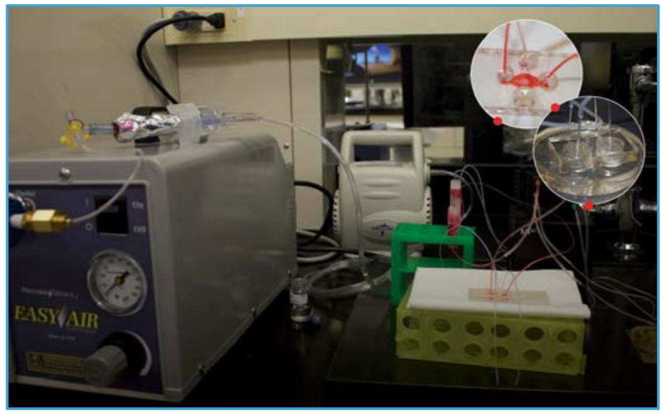
[7] Title 50 U.S. Code 1523 (b) 10: A description of the coordination and integration of the program of the DARPA on basic and applied research and advanced technology development on chemical and biological warfare defense technologies and systems under section 1522(c)(2) of this title with the overall program of the Department of Defense on chemical and biological warfare defense, including—(A) an assessment of the degree to which the DARPA program is coordinated and integrated with, and supports the objectives and requirements of, the overall program of the Department of Defense; and (B) the means by which the Department determines the level of such coordination and support.

DARPA is also working at the edge of automation and Artificial Intelligence to build, validate, and demonstrate new capabilities for the CBDP to enhance its urgent Warfighter response speed. For example, the agency's Chemical Processing for Force Protection program is automating chemical synthesis of known and new small molecules, engaging counterparts across the CBDP to demonstrate the ability to autonomously produce MCM-relevant molecules when and where they are needed. This program is also developing new, systematic approaches that reduce the discovery pace of high-performance molecules from years to weeks. Program partners include the Walter Reed Army Institute of Research and the USAF 59th Medical Wing to help discover and test novel CBDP therapeutics and prophylactics. This program will address known threats and enable faster responses to emerging threats.

Also within DARPA's Chemical Processing for Force Protection program, researchers are developing a portable prototype to neutralize bulk stores of CWAs and organic precursors at or near the site of storage. The CCDC CBC will test the completed system on simulant mixtures to evaluate the system's effectiveness. The JPEO-CBRND and DTRA, among others, have been engaged through the system design and test phases and will continue to be included as the demonstration progresses.

DARPA's Defense Against Mass Terror Threats program includes collaborations with DTRA, JPEO-CBRND, DHS, and the United Kingdom Home Office to develop and evaluate prototype, environmental sensors to enable real-time, accurate detection of chemical and biothreat agent releases within metropolitan areas. Initial field demonstrations in Boston, Massachusetts and London, United Kingdom, characterized and quantified background microbial signatures. Field trials in Indianapolis, Boston, and New York City characterized chemical backgrounds and signatures. The collaborators also initiated a project with DHS-CWMD to develop and evaluate environmental detection sensors, automated network data ingest, and real-time data analytics for rapid detection of biothreat agents. The program is also working with DHS-HSI to understand how advanced analytics applied to fuse sensor, contextual and transactional data can be used to detect adversary pursuit of CBRN capabilities.

To address the pressing need for "agnostic" biosensors that can detect unknown or engineered pathogens, DARPA's Biology for Security program is developing membrane disruption sensors designed to detect pathogenic behavior from a wide-range of microbes or viruses. The program is also developing several other high-speed systems that can extract unknown bacteria from complex samples and rapidly query them for pathogenic behavior.



Collaboration between DTRA, Chemical and Biological Technologies Department and Wake Forest Institute for Regenerative Medicine resulted in developing organ-on-a-chip technology. *(DTRA photo)*

To expand the capability to quickly characterize an advanced and emerging chemical threat, DTRA partnered with DARPA to transition and install at CCDC CBC two organ-on-a-chip systems developed under DARPA's Micro-Physiological Systems program and the multi-omic analysis pipeline created under the Rapid Threat Assessment program. Exposing human liver cells in these organ-on-a-chip systems to an unknown chemical compound and analyzing the exposure results in the genomic and proteomic analysis pipeline allows for a quick assessment of a chemical's mechanism of action. As part of a predictive toxicology capability, organ on a chip technology eliminates or greatly reduces costly and time-consuming animal testing. Leveraging the capabilities developed from both DTRA and DARPA under this partnership will allow for a faster toxicological understanding of emerging threats to help protect the Warfighter.

Acquisition Programs

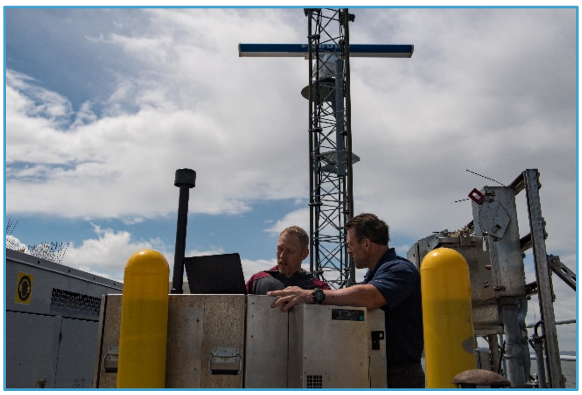
The CBDP, along with the Services, acquires materiel in required types and quantities to effectively conduct military operations (including support to civil authorities) in CBRN environments across the spectrum of conflict. The acquisition of physical and medical capabilities enables the Joint Force to maintain freedom of action and accomplish assigned missions in the presence of CBRN hazards, as well as defend against CBRN-capable threats with minimum degradation to Warfighter capabilities.

Deep Purple, a quad-rotor unmanned aircraft system, upgraded to the NBCRV. *(U.S. Army photo)*

The Stryker NBCRV SSU program delivered its first fully integrated prototype in just 100 days and was recognized as a 2019 Best in Class Government Innovation Award recipient. The NBCRV SSU integrates CBRN sensors, communications equipment, unmanned aerial and ground vehicles, and computing on the Stryker platform, transforming a suite of disparate systems into an integrated reconnaissance capability that reduces sustainment costs and improves NBCRV readiness. Testing of candidate sensors for the

Stryker NBCRV to perform on-the-move detection of CWAs and non-traditional agents (NTAs) commenced at Army Test and Evaluation Command (ATEC) Dugway Proving Ground, West Desert Test Center.

The JPEO-CBRND continued to field the DR SKO to the Joint Force during FY 2019, bringing the total fielded to 395 systems, and initiated production and fielding for EOD DR SKO variants. The DR SKO is a set of mission-specific kits that characterize and provide full-spectrum CBRN dismounted reconnaissance capability, providing timely and accurate characterization of suspected CBRN hazards to facilitate operations and support intelligence. To prevent obsolescence, the JPEO continued to update fielded DR SKO systems with more current technologies, while expanding detection and identification to include NTAs and PBAs.



DoD contractors test a rapid agent aerosol detector. *(U.S. Navy photo)*

The Joint Biological Tactical Detection System (JBTDS) program completed a mid-program assessment of state-of-the-art biological detection and identification equipment. Based on the results, the program office began integrating best-in-class components that will improve performance and lower sustainment costs. The JBTDS will be the first lightweight, man-portable biological detection system for the Joint Force. The EMBD program successfully produced 10 Rapid Aerosol Agent Detection systems. Rapid Aerosol Agent Detection is an essential component of the EMBD retrofit kit for the JBPDS, which the Navy already employs aboard ships. The retrofit will address challenges related to reliability, obsolescence, and sustainment.

The JPEO-CBRND initiated production under the ALS MWO, and successfully fielded nine units to the National Guard. The ALS provides field-confirmatory analysis to support identification of CB materials in environmental samples. Information produced by the system assists decision-makers with managing the effects of a CBRN attack. The ALS MWO effort addresses ALS operational-readiness issues by concentrating on the vehicle, shelter, and analytical suite.

Meanwhile, the Reactive Chemistry Orthogonal Surface and Environmental Threat Ticket Array (ROSETTA) is a modernization effort to provide an eye-readable colorimetric ticket to improve the currently fielded M8 chemical detector paper for liquid-chemical threat detection. In FY 2019, the team awarded three vendors contracts to develop prototype tickets for performance, stability testing, and user demonstrations. Upon completion of the effort, the ROSETTA ticket will transition to production for integration into the fielded M256 Chemical Detection kit.

The JPEO-CBD continued fielding the Joint Expeditionary Collective Protection (JECP) system during FY 2019. The system provides modular transportable and versatile collective protection capabilities designed for rapid assembly in expeditionary environments. The JECP program achieved Initial Operational Capability (IOC) for the Stand Alone Large and Standard Kit Improved systems in FY 2019 and is on track to meet IOC in FY 2022. With respect to individual protection, the USAF achieved Full Operational Capability (FOC) with JSAM RW in FY 2019 for HH-60G and UH-1N rotary wing platforms. The JSAM Strategic Aircraft program began fielding in February 2020 and will conservatively achieve USAF IOC delivery of 1,811 systems by December 2020. Finally, the Uniform Integrated Protection Ensemble Increment 2 – Aircrew (UIPE 2 Air) program is scheduled to reach Milestone C in the summer of 2020.

The JPEO-CBRND continued to leverage the Medical CBRN Defense Consortium it founded in 2016 to develop innovative, safe, and effective medical solutions to counter CBRN threats. The Medical CBRN Defense Consortium comprises over 190 organizations including biotech companies, large and small pharmaceutical firms, academia, and nonprofit organizations. The consortium uses OTAs, which are procurement instruments other than contracts, grants, or cooperative agreements. OTAs allow streamlined contracting that is not constrained by some of the requirements of the Federal Acquisition Regulation. They enable flexible business arrangements to acquire R&D to support technology advancement or to quickly develop a prototype.

The JPEO-CBRND received approval to use Middle Tier Acquisition (MTA) for the ROCS program, which maintains Warfighter lethality by ensuring high potency opioids are not successful as an enemy tactic. Using MTA, JPEO-CBRND carried out prototype development for a naloxone auto-injector to provide therapeutic treatment for exposure to highly-potent synthetic opioids. MTA is authorized under Section 804 of the National Defense Authorization Act for FY 2016, permitting "the use of innovative technologies to rapidly develop field-able prototypes to demonstrate new capabilities and meet emerging military needs." The use of MTA will allow the ROCS program to develop an FDA-approved auto-injector within the required five-year timeline, five to eight years sooner than projected with a more traditional acquisition approach.

The JPEO-CBRND earned FDA approval in March 2019 for fielded Soman Nerve Agent Pretreatment Pyridostigmine (SNAPP) tablets to be moved from refrigeration (2˚C to 8˚C) to controlled-room temperature (20˚C to 25˚C) at DoD distribution and storage locations worldwide. This allows the DoD to rapidly store, move, and preposition the SNAPP product in accordance with theater-based operational requirements and threat levels to reduce the logistical burden on Service members in locations that lack refrigeration capability.

The JPEO-CBRND established an Interagency Agreement with the CDC that allowed the CDC to acquire Next Generation Diagnostic System Increment 1 (NGDS Inc. 1) capabilities for its high priority domestic Laboratory Response Network (LRN) facilities. Following a year of internal CDC test and evaluation, CDC intends to make the FilmArray Warrior Panel available at multiple LRN facilities. The test is FDA-cleared to diagnose six different bio-warfare agents. The CDC-managed LRN is an integrated network of state, local, federal, military, and international laboratories that can respond to bioterrorism, emerging infectious diseases, chemical terrorism, and other public health contingencies. The FilmArray and Warrior Panel capabilities will enhance LRN capability to respond to CBRN events.

The JPEO-CBRND established a Cooperative Research and Development Agreement (CRADA) with Emory University Hospital's Serious Communicable Diseases Unit (SCDU), one of a limited number of entities possessing the capability to treat patients with viral hemorrhagic fevers (e.g. Ebola, Marburg). Under the CRADA, the NGDS Inc. 1 program will provide tests (Warrior Panels and Sentinel Panels) to aid in the diagnosis and treatment of patients infected with high-consequence pathogens. The CRADA provides for an immediate improvement in domestic medical response capacity, as well as valuable clinical performance information back to the NGDS Inc. 1 program.

RDT&E Support[8]

The DoD is transforming its business processes to meet increased performance demands, innovation, and speed at lower costs to the American taxpayer. In support, the CBDP is engaging with end users to ensure their needs are understood from the beginning of the program lifecycle; minimize risk through the best mix of investments that accelerate modernization and operationalize capabilities; and collaborate across the Enterprise to leverage existing knowledge and capabilities and maximize return on investment.

Infrastructure

The Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs/Chemical and Biological Defense (OASD(NCB/CBD)) currently monitors CB laboratory and test center infrastructure supporting the CBDP at DoD, Other Government Agency, industrial, academic, and international partner facilities. The CBDP coordinates with the Services and DoD partners to ensure that RDT&E infrastructure supporting the program is aligned to RDT&E activities.

The 2019 CBDP continues to build on two existing and foundational infrastructure studies, the U.S. Army Research, Development, Test, and Evaluation Composition and Disposition Study for the CBDP and the JSTO-CBD-led Core Competency Study of the DoD Service Laboratories. Information and approaches from these studies provided a useful foundation for FY 2020, as the CBDP embarked on additional infrastructure management tasks that connected enterprise-wide capabilities with specific physical infrastructure at the CBDP laboratories. Specifically, in 2019, the Capability Analysis, Decision, and Development (CADD) process was developed by Deputy Under Secretary of the Army for Test and Evaluation (DUSA T&E) and successfully used to prioritize gaps identified by subject matter experts in the CBDP enterprise. The Department continues to integrate these assessments to deliver the most thorough appraisal of CBDP capabilities. In 2020, using the studies mentioned above in addition to other data products developed by individual components, laboratories, and test sites, CBDP initiated an effort to develop an agreed upon enterprise-level set of competencies that will help determine enterprise priorities and guide resourcing decisions.

In 2019, the second year in a row, CBDP infrastructure was captured as part of the Army JSPAR planning process. Inclusion in the JSPAR allowed Army senior leaders to gain insight into how various pieces of infrastructure that contribute to CBDP capabilities are functioning and when investing of funds might be required for sustainment. Key data derived from inclusion in the JSPAR process will eventually be used to influence the

[8] See footnotes 5 and 6 regarding Title 50 U.S. Code 1523(a)2 and 1523(b)2 requirements.

Program Objective Memorandum. The process was refined based on guidance from leadership and the 2020 data call will potentially provide key information for senior leaders to make investment decisions regarding CBDP infrastructure.

These studies and assessments are essential to support CBDP efforts in defining required core capabilities allowing for increased traceability of CBDP funds and alignment to research, development and test requirements. Results from these analyses will help ensure that the RDT&E capabilities at CCDC CBC, West Desert Test Center, USAMRIID, and USAMRICD are advancing the CBDP efforts and address the NDS.

CCDC-CBC and the West Desert Test Center are the only facilities in the United States capable of performing the function of testing the ability of all mission critical systems within the Army to operate following a CB attack. Potential reductions in CBDP funding of these facilities reduces our ability to provide inherent survivability against near-peer competitors and violent extremist organizations (VEO).

Industrial Base Assessment

The health of the CBRND industrial base continues to provide Warfighter products through sustainment of commercial and organic industrial base (IB) capabilities. These capabilities provide continual support in achievement of CBDP strategic goals. The FY 2019 assessment identified no areas possessing a high risk of fragility or criticality within the IB. However, a small number of manufacturers are critical suppliers of numerous CBRN systems across the CBDP Enterprise, and it is essential that risk mitigation approaches are undertaken to ensure potential problems are quickly resolved to maintain readiness.

Test and Evaluation

U.S. Special Forces Chemical Reconnaissance Detachment (CRD) soldier with 5th Special Forces Group (Airborne) inspects for source of radiation at Dugway Proving Grounds. *(U.S. Army photo)*

The development and fielding of CBRN defense equipment requires highly-specialized and robust T&E infrastructure including infrastructure, methodologies, and personnel resources. The dynamic nature of expanding CBRN threats challenges the capabilities of U.S. T&E infrastructure, which needs to adapt to test and evaluate advanced technology systems against evolving threats in operationally-realistic environments. During FY 2019, the Deputy Undersecretary of the Army for Test and Evaluation (DUSA-TE) continued multiple efforts to advance test and evaluation within the CBDP.

CBDP acquisition programs tested at Dugway Proving Ground in FY 2019 include contractor risk-reduction testing (agent trials) on the Multi-Purpose Chemical Agent Detector (MPCAD); field testing on the NBCRV SSU; live-fire field testing for IEW; blister agent indicator chamber trials for the Contamination Indicator Decontamination Assurance System (CIDAS); agent trials for the Contaminated Human Remains System (CHRS); and agent trials on the Chemical Analytical Laboratory System (CALS).

In FY 2019, multiple bilateral international CB T&E collaborations focused on advancing technology readiness levels of detection capabilities for improved battlefield awareness, and the development of TTPs for enhanced Warfighter interoperability on a shared, contaminated battlefield. Emerging threat countermeasures development continued under a multi-lateral agreement for characterizing chemical compound phenomenologies where each participant contributed subject matter expertise and technology.

In the personal protection area, the DUSA-TE worked collaboratively with a foreign partner to validate their unique CB test capability against DoD test requirements. These collaborations resulted in improved T&E methodologies, increased cost sharing, cooperation, and data exchange, ensuring cross-national expertise for the enduring CB mission.

DUSA-TE continued to operate the Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT), an interagency body that develops consensus standards for testing and evaluating CBRN defense systems. The TECMIPT ensures test fixtures and methodologies are developed and validated in time to meet the needs of acquisition programs and ensure synchronization among all T&E components to test as efficiency and effectively as possible.

During FY 2019, DUSA-TE continued to oversee the CBDP T&E CADD process that provides analyses-based recommendations to the CBDP senior leader Board of Directors on planning, prioritization, development, validation, configuration management, and sustainment of required CBRN Defense T&E infrastructure. This allows it to maintain awareness of CBDP test infrastructure needs and facilitates prioritization and resourcing of improvements based on evaluations of needs, capabilities, and requirements.

DUSA-TE offered its CBDP T&E Orientation Course for Service Operational Test Agencies, test personnel from Joint Project Managers under the JPEO-CBRND and JRO-CBRND, and additional CBDP Enterprise stakeholders. The tailored course included discussions on basic acquisition and T&E planning, execution, and documentation/products from a Joint perspective to baseline CBDP stakeholders, especially new employees with minimum acquisition and T&E experience, on relevant T&E policy, regulations, and best practices and promote participation and collaboration across the Enterprise.

Program Management

The CBDP continues to implement measures focused on improving overall management, integration, and coordination of the CBDP Enterprise. Specifically, the OASD(NCB/CB) is leading CBDP components to integrate and align activities toward fulfillment of the CBDP mission through initiatives and efforts to drive efficient and effective execution of activities, rapidly identify shortfalls in planning and execution, and enable corrective action and permit clear and consistent communication of products and impacts.

USFK Assessment

As directed by the FY 2019 National Defense Authorization Act, the Department completed a USFK material shortfalls assessment. Following publication, the Department briefed Senate Armed Services Committee Professional Staff Members on key findings, observations and recommendations. DoD continues to make progress in closing material shortfalls in Korea, most notably increased capability and capacity for detection, decontamination, and collective protection to respond to CB threats on the peninsula. CBDP remains partnered with the Under Secretaries of Defense for Policy, Personnel and Readiness, and Intelligence for improvements in Host Nation Support, Dependent Masks, Contaminated Human Remains, and

Intelligence support on the Korean peninsula, through a mix of materiel and non-materiel solutions. DoD anticipates receiving the U.S. Government Accountability Office (GAO) report on the same topic and continues engagement with the GAO team to crosswalk their recommendations against CBDP's implementation plan. DoD seeks to balance progress in Korea with resource constraints and the acceptance of assessed risk.

Synthetic Biology

The June 2018 National Academies Study on Biodefense in the Age of Synthetic Biology provided a "framework to guide an assessment of the security concerns related to synthetic biology, assess the levels of concern warranted for such advances, and identifies options that could help mitigate those concerns." As the CBDP addresses potential emerging threats enabled by advanced biotechnology, it collaborates with the Office of the Under Secretary of Defense for Research and Engineering to guide operational risk assessments and identify investment priorities.

National Biodefense Strategy

The National Biodefense Strategy (NBS), released in September 2018, set the course for the United States to combat serious biological threats, regardless of origin. As part of its implementation, National Security Presidential Memorandum-14 mandated completion of a Biodefense Assessment. In 2019, the DoD, along with 16 other Departments and Agencies, assisted with the development of the Biodefense Assessment—the first of its kind—establishing the baseline of U.S. biodefense activities and challenges. The information provided will be used by the CBDP to improve U.S. capabilities across the biodefense enterprise.

Chemical Biological Incident Preparedness and Response

In 2019, the Office of Management and Budget directed resourcing through the CBDP of $50 million per year for FY 2021 through FY 2024 in RDT&E funding for the advancement and strategic integration of medical capabilities spanning both S&T and advanced development to ensure successful transition efforts between components and result in capability delivery. Specifically, efforts seeking to build capabilities that represent all applicable layers of medical defense, including information sharing, product development and support tools, therapeutics, vaccines, and diagnostics. These CB Incident Preparedness Response efforts will add significant strategic capability to both the CBDP and USG writ large.

Integrated Early Warning

The CBDP initiated an IEW Campaign Plan to synchronize Service and combatant command IEW goals with CBDP efforts to deliver Joint Force capability. The Campaign Plan provided insight into IEW efforts and enabled capability developers to build Service interest, understanding, and support. Services documented their unanimous requests for cross-domain solutions, remote detection with unmanned systems, and integration of CBRN and non-CBRN data sources to inform future resourcing.

Adaptive Acquisition Framework

All acquisition programs require an acquisition pathway and a contracting strategy to execute program goals. In 2019, the CBDP implemented the Adaptive Acquisition Framework (AAF) and expanded use of all contract strategies to tailor acquisition program efforts and enable rapid capability delivery. It is leveraging these expanded pathways so acquisition strategies meet program needs in a way that is complementary and supports positive program outcomes. In 2019, the ROCS effort became the first medical program developed using the MTA pathway. It is anticipated to field a 10 milligram naloxone autoinjector to select DoD units and international partners within five years. This program, along with other CBDP efforts, takes advantage of OTA contract vehicles established with the CWMD and the Medical CBRN Defense Consortiums to leverage academia and industry in rapidly improving CWMD capability delivery and enabling more agile and rapid transitions from S&T to advanced development.

Defense-Wide Review

In 2019, the Department completed the DWR to align resources towards meeting the goals of the NDS. The CBDP participated in the review and leveraged information and outcomes to focus the program toward future and emerging CB hazards. These changes focus on ensuring resource alignment and performance to provide prioritized Warfighter capabilities in a timely manner.

Joint Strategic Program Assessment and Review

As the Executive Agent for the CBDP, the Army continued to instill focus and discipline to ensure the program met the highest priorities and addressed the most critical CBRN capability gaps of the Military Departments through the Joint Strategic Program Assessment and Review process and review of funding recommendations and decisions.

CB Agent Testing Disclosure[9]

No individuals were used as subjects of any CB agent tests in the United States since 1975. Human biological agent testing ended on November 25, 1969, and human chemical agent testing ended on July 25, 1975. The ASD(HA) continues to work with the Department of Veterans Affairs (VA) to identify and locate previous human test subjects so they can receive appropriate attention. To provide the VA with information on human exposures related to historic CB testing, the Office of the Assistant Secretary of Defense for Health Affairs (OASD(HA)) works with the U.S. Army to maintain the Chemical Biological Warfare Exposure System Registry. To provide the public with information on human exposures related to historic CB testing, the ASD(HA) updates the CB exposures sections of the Environmental Exposures website (http://www.health.mil/Military-Health-Topics/Health-Readiness/Environmental-Exposures) as needed.

Chemical Weapons Convention Preparation and Readiness[10] [11]

The United States plays a leading role in the Organisation for the Prohibition of Chemical Weapons (OPCW) mission to free the world of chemical weapons. In addition to working with international partners and the OPCW, the DoD continues to provide support around the world to reduce chemical weapon threats in compliance with Article X of the Chemical Weapons Convention (CWC).

The DoD continues to prepare for and assist in the implementation of the CWC, including activities such as training inspectors, hosting CWC Implementation Working Group Meetings, meeting CWC reporting deadlines, and proceeding with the destruction of the U.S. chemical weapons stockpile.

DoD hosted an OPCW delegation as required in the OPCW decision C-16/DEC.11, including the Chairperson of Executive Council, the Director General, to visit the Pueblo Chemical Agent Destruction Pilot Plant (PCAPP), Colorado during FY 2019. The visit provided an overview of the progress and efforts made towards achieving complete destruction of the remaining chemical weapons stockpiles.

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[9] Title 50 U.S. Code 1523 (b) 9: A description of any program involving the testing of biological or chemical agents on human subjects that was carried out by the Department of Defense during the period covered by the report.

[10] Title 50 U.S. Code 1523 (b) 7: A description of the chemical warfare defense preparations that have been and are being undertaken by the Department of Defense to address needs which may arise under article X of the Chemical Weapons Convention.

[11] Title 50 U.S. Code 1523 (b) 8: A summary of other preparations undertaken by the Department of Defense and the On-Site Inspection Agency to prepare for and to assist in the implementation of the convention, including activities such as training for inspectors, preparation of defense installations for inspections under the convention using the Defense Treaty Inspection Readiness Program, provision of chemical weapons detection equipment, and assistance in the safe transportation, storage, and destruction of chemical weapons in other signatory nations to the convention.

DoD, the Military Departments and Services, and Components maintained CWC implementation and compliance plans, and CWC Challenge Inspection (CI) Response Plans. DoD and the Military Departments and Services continued to maintain their preparedness for a CI by conducting annual exercises and training.

CCDC CBC, located in Edgewood, Maryland, one of two OPCW-designated laboratories in the United States for the analysis of authentic environmental samples, successfully passed OPCW's 45th Proficiency Test for the Analysis of Environmental Samples with its 24th "A" grade in June 2019. Additionally, as one of three U.S. OPCW-designated biomedical testing laboratories, the CCDC CBC passed the OPCW's fourth Proficiency Test on the Analysis of Biomedical Samples with its fourth straight “A" grade.

The USAMRICD Analytical Center passed its 2019 OPCW Biomedical Proficiency test with an “A” score, which allows USAMRICD to analyze the OPCW biomedical samples recovered from sites where there is a suspected use of CWAs.

USAMRICD is the only organization laboratory within DoD to receive full accreditation as a high complexity clinical laboratory for diagnostic testing on human samples to confirm exposure to chemical threat agents. Current accreditation covers one nerve agent in one biological matrix. Additionally, USAMRICD is the first DoD institute to achieve and maintain accreditation, as required by the DoD Clinical Laboratory Improvement Program, through the American Association for Laboratory Accreditation, an approved international accrediting body. CLIP accreditation enabled USAMRICD to become the only DoD facility capable of entering CWA exposure results into a Warfighter’s medical permanent record.

Challenges Facing the CBD Enterprise[12]

The DoD focus for CB defense is shifting from providing the next incremental solution to the Warfighter to truly modernizing how the Warfighter can fight and win in a CBRN environment. This is especially important in the face of growing adversary WMD capabilities and emerging CB threats. Modernization requires finding ways for CBRN equipment to be integrated into the Warfighter's daily environment with little to no additional operational burden. Improvements and realism in training and exercises are required to prepare our Forces for all situations. The challenges identified in this section are being addressed and present opportunities for reform and enhancement.

U.S. Army Medical Research Institute of Infectious Diseases

The USAMRIID, DoD's only medical biodefense laboratory capable of executing basic science through animal studies supporting FDA licensure at Biosafety Levels (BSL) 3 and 4, faced operational challenges beginning in 2018. Unexpected equipment failures in 2018 led to operational deficiencies prompting a CDC-directed shutdown. The suspension of biocontainment (BSL-3/4) operations at USAMRIID from May 2018 to February 2019 resulted in a delay of BSL-3/4 funded research. USAMRIID developed a five-phased approach to bring BSL-3/4 activities back online, with each phase progressively addressing laboratory safety and capacity. The first phase, employed in December 2018, enabled USAMRIID to perform non-animal BSL-3 research. Subsequent phases enabled USAMRIID to perform BSL-3/4 work and animal studies on a limited scale, with approval for each phase provided by the CDC and Army leadership. The long-term solution is to amend design and installation of systems in the replacement USAMRIID facility per recommendation of external authorities and experts.

While the measures are considered temporary, long term solutions are planned and include eventual certification and operation of a new biocontainment facility adjacent to the existing laboratory. The result of the USAMRIID shutdowns had second tier effects with delayed sponsor projects. CBDP leadership and project sponsors continue to engage with USAMRDC and USAMRIID staffs on solutions.

[12] Title 50 U.S. Code 1523 (b) 6: Problems encountered in the chemical and biological warfare defense program during the past year and recommended solutions to those problems for which additional resources or actions by the Congress are required.

As of November 20, 2019, the CDC has approved very limited in vitro activities on six specific projects, but only with very strict preconditions and continued evaluation of USAMRIID's newly implemented processes and procedures. This approval extends only to March 1, 2020. USAMRIID continues to make progress for a planned re-assessment by CDC and DAIG in March 2020.

Dugway Proving Ground Life Sciences Division

The DoD and the CBDP continued response efforts to the incomplete inactivation and shipments of Bacillus anthracis (i.e., anthrax) spores by the Life Sciences Division at Dugway Proving Ground in 2015. The Secretary of the Army moved the Life Sciences Division from the functional control of the U.S. Army Test and Evaluation Command to the CCDC CBC BioTesting Division effective July 1, 2016. In January 2019, the CDC issued a certificate of registration authorizing the BioTesting Division to possess, use, and transfer select agents and toxins under the conditions specified in its entity registration application. The BioTesting Division anticipates resumption of BSL-3 laboratory and aerosol chamber work in 2020. Throughout the re-establishment of BSL-3 operations at Dugway Proving Ground, the BioTesting Division has continuously supported biological acquisition testing at multiple government and contractor labs.

Readiness

U.S. Army

The Army experienced reliability issues with the NBCRV, particularly its CB Mass Spectrometer. Across the total force, systemic NBCRV maintenance issues consume unit annual training budgets and prevent CBRN forces from fully integrating this critical asset into a commander's reconnaissance and surveillance plan during home station training, Combat Training Center rotations, and contingency planning. This problem limits the ability to capitalize on the vehicle's unique capability to identify, locate and mark CBRN hazards and determine the extent of contamination. Early delivery of the NBCRV SSU prototype and successful demonstration during the Army Joint Warfighting Assessment in FY 2019 will ensure improved performance of replacement systems.

The M12A1 Decontamination apparatus fielded to Heavy Decontamination Companies possesses 1940s-era technology that has experienced sustainment challenges; currently repair parts are unavailable, as the system is no longer in production. The CBDP currently resources a number of modernization efforts to address the sustainment and logistical burdens posed by decontamination such as the Service Equipment Decontamination System, CBRN Coatings, Covers and Protective Overlays, and Tactical Contamination Mitigation System.

Army CBRN units are overwhelmingly dependent on COTS equipment, which creates challenges for sustainment due to dependence on contractors and a lack of repair parts within the Army supply chain.

Army-led efforts to build capacity and capability in subterranean operations provided training and equipment within the USARPAC AOR; however, it only outfitted, trained, and equipped two company-sized elements and the equipment only affords operators less than six hours of air in an oxygen deprived or enriched environment. Further refinement of subterranean operations doctrine, instituting a methodology of training the force, and equipping the force with durable, decontaminate-able, sustainable, and effective operational equipment is required to properly prepare the force for subterranean CWMD operations.

Total Army Analysis has significantly reduced active duty force structure. With these reductions, over 80 percent of CBRN capability resides in the reserve component. After the Army converts five HRCs to HDR, only ten HRC will remain in the Active Component. With six HRCs committed or validated to Defense Chemical, Biological, Radiological, Nuclear and Explosive Reactionary Force, there are few HRC available for Large Scale Combat Operations. Army force modeling should reflect Army Support to Other Services so that CBRN force structure remains a critical enabler for all combatant commands.

Similar to U.S. Army Japan’s situation, U.S. Army Alaska’s headquarters has not been authorized a CBRN officer of any rank since FY 2016, leaving only a Sergeant First Class as the CBRN Advisor to the Commanding General, U.S. Army Alaska. This non-commissioned officer’s primary responsibility is as an instructor and trainer to the force. Given U.S. Army Alaska's status as a non-deployable Table of Distribution and Allowances headquarters, coupled with the current and historic understrength assignments of CBRN personnel within U.S. Army Alaska's subordinate Modified Table of Organization and Equipment units, U.S. Army Alaska's staff CBRN non-commissioned officer position has been a historically low-priority fill.

Army medical CBRN requirements are falling short of need in the critical capabilities of collective protection for all roles of care and in other advancements in MCM for CBRN threats. CBDP requires additional resources to ensure the full breadth of medical support can be sustained in a CBRN environment. Collective protection provides necessary respiratory, ocular, and percutaneous protection for medical personnel and patients in a Role 1, 2, or 3 battlefield medical treatment facility located in a CBRN threat AOR, and protects the hospital thereby providing survivability for critical medical equipment. In rapidly aggregating and disaggregating operations, medical force elements must keep pace with the units they support. The Chemical Biological Protective Shelter serves as a medical shelter system providing the Commander with a Multi Domain Operations-ready, highly mobile, environmentally controlled, clean surgical environment either as an individual system or with several complexed together. The capacity gap in this capability make it very challenging to support the National Defense Strategy Dynamic Force Employment, likely requiring time of need lateral transfers to deploying units to ensure they are fully outfitted, but with little training on a system they were never fielded.

The vehicle-mounted mobile shelter is self-deployable and serves as a self-contained protective air-conditioned system that is contamination-free.

Chemically Protective Deployable Medical System (CPDEPMEDS) is a strategically maintained Operational Project Stock to provide collective protection in support of the Role 3 hospitals. This program received congressional funds to field additional systems to Army in 2000. To date, all fourteen CPDEPMEDS are non-mission capable due to obsolescence of components, expiration of filters, and a lack of adequate funding to support Care of Supplies in Storage (COSIS) overall. As Combat Support Hospitals (CSH) convert to a Field Hospital configuration enabling modernized medical support packages that are more agile and logistically scalable, the obsolescing CPDEPMEDS (first fielded in 1998) must be reconfigured/modernized as well.

U.S. Air Force

Air Base operations may be hindered by limited collective protection. A lethal force requires well-rested and hydrated Airmen. A work-rest program utilizing fixed installation, expeditionary and/or mobile collective protection is being developed. As part of the program, future at-risk permanent USAF bases will have some amount of fixed collective protection but will also have the ability to erect ECP both inside and outside of buildings. The current JECP Program of Record is scheduled to provide the USAF with at least part of the required capability and supports deployment agility to ensure the lethality of our air operations.

Aircraft and other equipment contaminated with any amount of liquid chemical agent contamination are not returnable to the United States without clearance level contamination mitigation. Landing rights and overflight to get our forces to support operations in other countries requires uncontaminated aircraft so we can ensure our allies that we will not contaminate their country. The JBADS was designed with the potential to add Chemical Contamination Mitigation as a follow-on capability. Current S&T work shows that the same basic ideas are adaptable for chemical contamination, so it is imperative that the JBADS capability be expanded to chemical contamination mitigation as well.

Challenges within the USAF ACBRN protection portfolio are mainly associated with the fiscal restraints that make it difficult to support “new starts”, emerging technology, CONOPs and TTPs, and innovative ideas that potentially relate to readiness for quick wins. One example is the theory of using aircraft Environment Control Systems (ECS) on aircraft to purge cockpit air and the proposed CONOPs/TTPs derived from ECS analysis that in turn would support; Step – Launch – Recover (SLR) CONOPs/TTPs and establishment of realistic threshold ACBRN protection values to support the Next Generation Aircrew Protective Ensemble (NGAPE) as a funded Program of Record. Initial ECS analysis from Fighter aircraft supports additional testing to further understand cockpit air exchange when aircraft engine settings are at 100 percent power. As of October 2019, test funding to support engine runs at 100 percent power settings and Step – Launch – Recover (SLR) CONOPs/TTPs Developmental Test was not available. USAF is proposing expansion of the ECS testing into additional USAF aircraft such as cargo, special operations, bomber, and reconnaissance with the goal of influencing readiness. Potential Solution: Receipt of the necessary funding to support all USAF aircraft ECS testing, to include SLR Developmental/Operational Testing (DT/OT), and recognizing NGAPE should become a fully funded program of record that would have a direct impact on the future of ACBRN readiness across the Total Force.

U.S. Navy

Rising O&S costs, growing obsolescence and declining reliability resulting from legacy systems remaining in the inventory beyond planned divesture dates stress sustainment efforts. For example, legacy shipboard JBPDS has begun to experience an increasing number of faults/false alarm rates. While many of these issues are being addressed (e.g., the EMBD program), repairs are becoming increasingly costly and system reliability is declining.

U.S. Marine Corps

Reliance on legacy decontamination systems and methodologies challenge the Fleet Marine Force's (FMF) ability to sustain and deploy required contamination mitigation capabilities. Frequent replenishment of the Marine Corps' immediate decontamination capability, Reactive Skin Decontamination Lotion, results in exorbitant sustainment costs for Marine expeditionary units and other forward-deployed rotational forces.

The U.S. Navy Concept for Distributed Maritime Operations and the Marine Corps Concept for Expeditionary Advanced Base Operations emphasize greater integration among the two Services and increased force distribution. Decontamination of these dispersed forces will be increasingly challenged due to the size, weight and significant resources necessary to employ the currently fielded M26 Joint Service Tactical Decontamination-Small Scale. Marine Corps Systems Command, in coordination with the Joint Program Manager- Protection, remains engaged in experimentation and assessment of contamination mitigation systems and approaches to ensure the necessary decontamination support to the FMF.

Medical

The Joint Force requires additional resources to ensure execution of the full range of medical support in a CBRN environment. Expeditionary collective protection provides shelter for medical personnel and patients in a medical treatment facility located in a CBRN contaminated area, and protects the hospital itself by ensuring survivability of critical medical equipment. Additionally, this program requires continued investment to ensure effectiveness against emerging NTAs and engineered bio-threats.

Having a single manufacturer for initial nerve agent treatment auto-injectors presents risk to meeting force health protection requirements. While the JPEO-CBRND is pursuing alternative manufacturers and auto-injectors, the risk remains. Risk mitigation through industrial base expansion drives innovation and industry competition, resulting in increased quality and more competitive pricing.

Extended timelines between discovery and FDA licensure for MCMs strained planning and programming efforts. Greater alignment and opportunities to shorten the timeline from the selection of platform technologies to a viable production system and candidate down-select were needed. The JPM CBRN Medical continues to work closely with the FDA to develop, expedite, and field MCMs that support U.S. Service members around the world. By leveraging additional engagement opportunities with the FDA through the Public Law 115-92, the program office is actively assessing ongoing programs for interim fielding capabilities (IFC) that can expedite MCM development and fielding.

Additional requirements for development included military working dog (MWD) CBRN protection and MCM development, and considerations for impacts on CBRN surveillance and detection solutions. MWD can serve as unintentional sentinels for CBRN hazards: they work low to the ground (where vapors may collect), they work forward of the handler and may encounter CBRN materials in advance of the human team, and they are affected by CBR contamination and will be a source of contamination for their handlers and medical responders. Given the important roles they play on the battlefield, the protection of these invaluable assets remains paramount. Increased awareness and prioritized, sustained resourcing is required to mitigate ongoing CBRN threats to MWD readiness.

The HHS is transitioning from Anthrax Vaccine Adsorbed (AVA) to AV7909 as their primary anthrax vaccine in the Strategic National Stockpile for post-exposure prophylaxis against anthrax. The DoD currently procures anthrax vaccine from the Strategic National Stockpile to meet its requirement for anthrax pre-exposure prophylaxis under its biodefense vaccination programs. Because of this enduring vaccination requirement, the DoD is exploring options to accelerate development of a pre-exposure prophylaxis indication for AV7909 while it continues to procure sufficient quantities of AVA to meet its annual and surge force health protection requirements.

Industrial Base

The 2018 CBDP Industrial Base (IB) Assessment determined that the CBRN manufacturing sector is stable. However, most capability areas were assessed as falling within the “conduct further analysis” range, signifying a need for continued monitoring through assessment, analysis, and trend monitoring to ensure needed manufacturing capabilities remain available. It continues to be an issue that certain IB capabilities are deteriorating due to reductions in Service requirements, extensions to the service life of items, and increasing reliance on single-source manufacturers.

Two critical commodities were identified during the assessment—carbon and rubber. Carbon is a serious concern because there is one primary producer of military-grade carbon. A second producer is coming on line, but currently does not meet all requirements to fulfill military-grade specifications. The concern with rubber is the supplier nations of the raw material are members of the Association of Southeast Asian Nations (ASEAN) [Vietnam, Indonesia, and Malaysia]. Although U.S.

relations with ASEAN have been excellent since its inception (according to the U.S. Department of State), continued monitoring of the trade status of these countries is recommended along with the development of composite alternatives. Both the carbon and rubber IB and supply chains require continued monitoring to ensure needed quantities are available to meet both current and future DoD demand.

In addition, there is also concern regarding foreign source active pharmaceutical ingredients and the supply chain associated with CBRN MCM and supporting parts and components.

Developing a long term IB sustainment strategy remains a critical component to ensure the healthy manufacturing and defense IB essential to U.S. national security and economic strength. The ability of the U.S. to maintain readiness, and to surge in response to an emergency, directly relates to the capacity, capabilities, and resiliency of manufacturing and defense IB and supply chains. Therefore, continued IB assessments with actionable mitigation recommendations represent a critical national security imperative to maintain proactive situational awareness.

PATH FORWARD[13]

Recent incidents across the globe concerning CB agents not only illustrate the reality of the WMD threat, but also undermine the norms that protected civilians and Warfighters from these weapons for decades. Proliferation of technology, increased ease of access, challenges to detecting illicit activity, and limited ability to anticipate how adversaries might employ WMD all heighten the risk of unforeseen and non-attributable attacks against the U.S. or its allies and partners. New chemical compounds were discovered and advances in biology have rapidly increased. The Department must remain at the leading edge of innovation, which is achieved by developing the technologies necessary to address the threats current and future threats.

The 2018 NDS and DoD strategic guidance address the increasingly complex global security environment, characterized by the re-emergence of long-term, strategic competition between nations and the growing potential for strategic surprise stemming from advances in technology and science. The NDS acknowledges the threat of WMD from rogue regimes and terrorists; it establishes the objective to dissuade, prevent, or deter state adversaries and non-state actors from acquiring, proliferating, or using WMD. We must remain vigilant in preparing and responding to threats from near-peer threat actors. Our adversaries' ambitions and increasing dominance in biotechnology, engineering, and computational science create challenges and opportunities for the Joint Force's battlefield superiority. Therefore, we must lean forward to leverage innovation, integrate our collective CB knowledge, and deploy adaptive solutions to mitigate these enhanced and emerging threats.

The proliferation of WMD continues to fall among the greatest challenges facing the United States. The Nation must prioritize improving our ability to counter WMD. Currently, eroding international norms regarding CB weapons use, knowledge proliferation in the areas of advanced biotechnology and unmanned systems, and a diminishing distinction between chemical and biological capabilities all fuel the current CB threat environment. The DoD must remain at the leading edge of innovation and develop technologies to address present and future threats. Accordingly, this budget enables the CBDP to increase the lethality of the Joint Force by ensuring that they can fight and win in CB-contested environments, preserving the security and freedom of our Nation.

[13] Title 50 U.S. Code 1523 (b) 5: Measures taken to improve overall management and coordination of the chemical and biological defense program.

ACRONYMS

AAF	Adaptive Acquisition Framework
ACBRN	Aircrew Chemical Biological Radiological Nuclear
ADM	Advance Development and Manufacturing
AERP	Aircrew Eye Respiratory Protection
AETC	Air Education Training Command
AFSC	USAF Specialty Code
AFSOC	USAF Special Operations Command
AI	Artificial Intelligence
ALS	Analytical Laboratory System
AOR	Area of Responsibility
APOD	Aerial Ports of Debarkation
ASD(NCB)	Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs
ASEAN	Association of Southeast Asian Nations
BARDA	Biomedical Advanced Research and Development Authority
BoD	Board of Directors
BSL	Biosafety Level
BTD	BioTesting Division
C2CRE	Command and Control Chemical, Biological, Radiological, Nuclear Response Element
CAAD	Capability Analysis, Decision, and Development
CB	Chemical and Biological
CBDP	Chemical and Biological Defense Program
CBIPR	Chemical Biological Incident Preparedness and Response
CBMS	Chemical Biological Mass Spectrometer
CBPS	Chemical Biological Protective Shelter
CBR	Chemical, Biological, and Radiological
CBRN	Chemical, Biological, Radiological, and Nuclear
CBRND-RAV	Chemical, Biological, Radiological, and Nuclear Defense Readiness Assistance Visits
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosive
CCDC CBC	U.S. Army Combat Capabilities Development Command Chemical Biological Center
CCMD	Combatant Command
CDC	Centers for Disease Control and Prevention
CDD	Capabilities Development Document

CEDS	Chemical Effluent Decontamination System
CERFP	CBRN Enhanced Response Force Package
CFETP	Career Field Education Training Plan
cGMP	Current Good Manufacturing Practice
CHR	Contaminated Human Remains
CNGB	Chief, National Guard Bureau
CONOPs	Concept of Operations
COSIS	Care of Supplies in Storage
COTS	Commercial-Off-the-Shelf
CPDEPMEDS	Chemically Protective Deployable Medical System
CPS	Collective Protection System
CRADA	Cooperative Research and Development Agreement
CSH	Combat Support Hospitals
CST	Civil Support Team
CWA	Chemical Warfare Agent
CWC	Chemical Weapons Convention
CWMD	Countering Weapons of Mass Destruction
DAIG	Department of the Army Inspector General
DARPA	Defense Advanced Research Projects Agency
DCR	DOTMLPF-P
DCRF	Defense Chemical, Biological, Radiological, Nuclear and Explosive Reactionary Force
DHS	Department of Homeland Security
DHS-CBD	Department of Homeland Security Chemical Biological Defense
DoD	Department of Defense
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policies
DR SKO	Dismounted Reconnaissance Sets, Kits, and Outfits
DSAT	Division of Select Agents and Toxins
DT	Developmental Test
DTRA	Defense Threat Reduction Agency
DUSA T&E	Deputy Under Secretary of the Army for Test and Evaluation
DWR	Defense-Wide Review
ECP	Expeditionary Collective Protection
ECS	Environmental Control System
EMBD	Enhanced Maritime Biological Detection
EMEDS	Expeditionary Medical Support

EOD	Explosive Ordnance Disposal
FAR	Federal Acquisition Regulations
FDA	Food and Drug Administration
FOC	Full Operational Capability
FORSCOM	U.S. Army Forces Command
GOTS	Government Off-the-Shelf
HDRC	Heavy Decon/Recon Companies
HHS	Health and Human Services
HRC	Hazardous Response Companies
HRF	Homeland Response Force
IADS	Immuno-Assay Diagnostic System
IB	Industrial Base
IBA	Industrial Base Assessment
IEW	Integrated Early Warning
IOC	Initial Operational Capability
IPDS-LR	Improved Point Detection System–Lifecycle Replacements
IPE	Individual Protective Equipment
ISIS	Islamic State of Iraq
JBADS	Joint Biological Agent Decontamination System
JBAIDS	Joint Biological Agent Identification and Diagnostic System
JBPDS	Joint Biological Point Detection System
JECP	Joint Expeditionary Collective Protection
JPEO-CBRND	Joint Program Executive Office for Chemical, Biological, Radiological, and Nuclear Defense
JRO-CBRND	Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense
JSAM	Joint Service Aircrew Mask
JSAM RW	Joint Service Aircrew Mask Rotary Wing
JSPAR	Joint Strategic Portfolio Assessment & Review
JSTO-CBD	Joint Science and Technology Office-Chemical and Biological Defense
JTF	Joint Task Force
LRN	Laboratory Response Network
MCDC	Medical CBRN Defense Consortium
MCM	Medical Countermeasures
MPCAD	Multi-Phase Chemical Agent Detector
MTA	Middle Tier Acquisition
MTOE	Modified Table of Organization and Equipment

MWO	Modified Work Order
NATO	North Atlantic Treaty Organization
NAVSEA	Naval Sea Systems Command
NBCRV	Nuclear Biological and Chemical Reconnaissance Vehicle
NBS	National Biodefense Strategy
NCO	noncommissioned officer
NDS	National Defense Strategy
NEO	Non-Combatant Evacuation Operations
NGAPE	Next Generation Aircrew Protective Ensemble
NGDS	Next Generation Diagnostic System
OASD(HA)	Office of the Assistant Secretary of Defense for Health Affairs
OASD(NCB/CB)	Office of the Secretary of Defense for Nuclear, Chemical, Biological Defense Programs / Chemical Biological Defense
ODASD(CBD)	Office of the Deputy Assistant Secretary of Defense for Chemical and Biological Defense
OPCW	Organisation for the Prohibition of Chemical Weapons
OT	Operational Test
OTA	Other Transactional Authority
PACOM	U.S. Pacific Command
PBA	Pharmaceutical-Based Agent
PCAPP	Pueblo Chemical Agent-Destruction Pilot Plant
PD3	Perceptive Dragon 3
PHEM	Public Health Emergency Management
POR	Program of Record
R&D	Research and Development
R&S	Reconnaissance and Surveillance
RAAD	Rapid Aerosol Agent Detection
RATE	Rapid Analysis of Threat Exposure
RAV	Readiness Assist Visits
RDA	Research, Development, and Acquisition
RDT&E	Research, Development, Test, and Evaluation
Ready EAGLE	Readiness Exercises and Assessments in a Goal-Oriented Learning Environment
RIP	Readiness Improvement Program
RLI	Residual Life Indicator
RNA	Ribonucleic Acid
ROCS	Rapid Opioid Countermeasure System

ROSETTA	Reactive Chemistry Orthogonal Surface and Environmental Threat Ticket Array
RW	Rotary Wing
S&T	Science and Technology
SCDU	Serious Communicable Diseases Unit
SKI	Shelter Kit, Improved
SLR	Step, Launch, Recover
SNAPP	Soman Nerve Agent Pretreatment Pyridostigmine
sNDA	supplemental New Drug Application
SOF	Special Operations Forces
SPOD	Sea Ports of Debarkation
SSU	Sensor Suite Upgrade
T&E	Test and Evaluation
TAMCN	Table of Authorized Material Control Number
TD	Tech Drop
TDA	Table of Distribution & Allowances
TECMIPT	Test and Evaluation Capabilities and Methodologies Integrated Process Team
TEDS	Thermal Effluent Decontamination System
TFA	Toxic Free Area
TSOC	Theater Special Operations Command
TSR	Total Service Requirements
TTP	Tactics, Techniques, and Procedures
TTX	Table-Top Exercise
UIPE	Uniform Integrated Protection Ensemble
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense
USAMRIID	U.S. Army Medical Research Institute of Infectious Diseases
USARAK	U.S. Army Alaska
USARJ	U.S. Army Japan
USARPAC	U.S. Army Pacific
USCG	U.S. Coast Guard
USFK	U.S. Forces Korea
USNORTHCOM	U.S. Northern Command
USSOCOM	U.S. Special Operations Command
VA	Department of Veterans Affairs
WMD	Weapons of Mass Destruction
WRAIR	Walter Reed Army Institute of Research

ENCLOSURE A. COMPONENT RESPONSIBILITIES

- The **Deputy Assistant Secretary of Defense for Chemical and Biological Defense Programs (DASD(CBD))**, who oversees the coordination and integration of the CBDP, including all planning, programming, budgeting, and execution (PPBE) processes, and interagency and international partnerships;
- The **Assistant Secretary of Defense for Sustainment**, responsible for sustainment of critical infrastructure;
- The **Director, Defense Threat Reduction Agency (DTRA)**, which maintains the Joint Science and Technology Office for CBD to direct and manage the CBDP's science and technology (S&T) programs;
- The **Under Secretary of Defense for Research and Engineering (USD(R&E))**, who develops policy related to CBD laboratories and infrastructure;
- The **Director, Defense Advanced Research Projects Agency (DARPA)**, which may conduct basic and applied research and/or advanced technology development programs on CBD technologies and systems;
- The **Deputy Director for Developmental Test, Evaluation, and Prototyping**, who develops policy and guidance for the planning, execution, and reporting of developmental test and evaluation (T&E) related to the CBDP;
- The **Director, Test Resource Management Center**, which coordinates the infrastructure and personnel required to accomplish the T&E mission as it relates to the RDA of CBRN capabilities;
- The **Assistant Secretary of Defense for Homeland Defense and Global Security**, who develops, coordinates, and oversees implementation and integration of DoD CWMD policies set forth in the DoD Strategy for Countering Weapons of Mass Destruction and DoD policy for preparedness and response to domestic CBRN incidents;
- The **Assistant Secretary of Defense for Health Affairs (ASD(HA))**, who advises the CBDP on clinical healthcare and health surveillance for CBRN medical defense and deployment matters pertaining to force health protection and readiness;
- The **Under Secretary of Defense for Intelligence (USD(I))**, who identifies opportunities to exploit advances in technology to enhance CBRN defense-related intelligence, counterintelligence, and security capabilities of the Department;
- The **Secretaries of the Military Departments**, responsible for organizing, training, equipping, and preparing their forces to counter WMD, and developing and validating operational concepts for joint and Service-sponsored CB defense capability requirements;
- The **Secretary of the Army**, who serves as the DoD's executive agent for the CBDP, integrates research, development, test, and evaluation (RDT&E) and acquisition requirements across the military for CB defense programs, and maintains the Joint Program Executive Office for Chemical, Biological, Radiological, and Nuclear Defense (JPEO-CBRND), Joint Combat Developer for Experimentation, and the Joint CBRND Program Analysis and Integration Office;
- The **Chairman of the Joint Chiefs of Staff**, who advises the Secretary of Defense by identifying, assessing, and prioritizing joint CBRN operational capability requirements to meet the national military strategy;
- The **Chief, National Guard Bureau (NGB)**, who ensures that unique NGB CB operational concepts, capability requirements, and functions are coordinated and maintained; and
- The **Directors of DoD laboratories and test centers**, such as the U.S. Army Combat Capabilities Development Command Chemical Biological Center (CCDC CBC), U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), and West Desert Test Center, who perform RDT&E in support of CB defense programs.

ENCLOSURE B. FY19 FIELDING QUANTITIES

JPEO-CBRND Element	Product/System	Total Fielded (Military Services or Other USG)
JPM CBRN Sensors	Dismounted Reconnaissance Sets, Kits and Outfits (DR SKO)	86
JPM CBRN Sensors	Analytical Laboratory System (ALS) Modification Work Order (MWO)	9
JPM CBRN Medical	Joint Biological Agent Identification and Diagnostic System (JBAIDS) Assay Kits	696
JPM CBRN Medical	Next Generation Diagnostics System Increment 1 (NGDS Inc 1) Warrior Panel Kits	19
JPM CBRN Medical	Next Generation Diagnostics System Increment 1 (NGDS Inc 1) Sentinel Panel Kits	51
JPM CBRN Medical	Antidote Treatment - Nerve Agent, Auto-Injector (ATNAA)	461,525
JPM CBRN Medical	Soman Nerve Agent Pretreatment Pyridostigmine	29,000
JPM CBRN Medical	Convulsant Antidote Nerve Agent (CANA)	100,000
JPM CBRN Protection	Joint Service Aircrew Mask (JSAM), Rotary Wing (RW), MPU5 variant	1313
JPM CBRN Protection	Joint Service General Purpose Mask (JSGPM), M50/M51 variants	115,335
JPM CBRN Protection	Chemical-Biological Protective Shelter, M8E1 variant	94
JPM CBRN Protection	Joint Expeditionary Collective Protection (JECP)	71
JPM CBRN Protection	Joint Service Equipment Wipe (JSEW)	518,820
JPM CBRN Special Operations Forces	Uniform Integrated Protection Ensemble (UIPE) Inc. 1	16,000
JPM CBRN Special Operations Forces	Joint Handheld Bio-Agent Identifier (JHBI) Program Genedrive V2	50
JPM CBRN Special Operations Forces	Combination Self-Contained Breathing Apparatus (CSCBA)	357
JPM CBRN Information Management/Information Technology	Joint Warning and Reporting Network (JWARN)	Continuously updated software product
JPM CBRN Information Management/Information Technology	Joint Effects Model (JEM)	Continuously updated software product

JPEO-CBRND Element	Product/System	Total Fielded (Military Services or Other USG)
JPM CBRN Information Management/Information Technology	CBRN Information System (CBRN-IS)	Continuously updated software product
Total Product/System Units Fielded		**1,243,448**

JPEO-CBRND Element	Product/System	Total Fielded (Military Services or Other USG)
JPM CBRN Medical	Anthrax Vaccine Adsorbed (Doses)	747,480
JPM CBRN Medical	Smallpox Vaccine (Doses)	223,400
Total MCM Doses Acquired from the Strategic National Stockpile*		**970,880**

***** The CBDP coordinates with the Office of the Assistant Secretary of Defense for Health Affairs (OASD(HA) and the HHS for accessing licensed vaccines against anthrax and smallpox threats. During FY 2019, the CBDP Enterprise, through the OASD(HA), procured 970,880 medical countermeasures (MCM) doses of anthrax and smallpox vaccines from the Strategic National Stockpile to implement biological defense vaccination programs. The CBDP Enterprise managed, administered, and distributed the doses, as needed, to support operations.

ENCLOSURE C. FY19 TRAINING & EDUCATION COURSES

JRO-CBRND Sponsored Leader Development and Education Courses	Attendees
JCWS CWMD Focus Study and PURPLE GUARDIAN CBRN Response/Defense Support to Civil Authorities (DSCA) Seminar	365
USA CGSC CWMD and CBRN Response Modules	137
USA Chemical/Engineer/MP Captain's Career Courses CBRN Response Modules w/ DSCA Phase II Certification	178
USA Engineer WO Advanced Course CBRN Response Module	20
Joint Senior Leader's Course	94
Joint and Service War College JLASS-SP CWMD Academics and TTX	93
Joint Special Operations University Combating Terrorism Course, CWMD Module	55
USMC CGSC National Response to Catastrophic & Disruptive Threat (NRCDT) CBRN Response Course	212
USMC Staff Planner's Course	14
USMC CBRN Warrant Officer's Course, CBRN Response Module	18
CWMD Senior Staff Planner's Course	13
Mobile Training Team FORSCOM CRE CBRN Response Module and DSCA Phase II Certification	31
CBDP Staff Officer Orientation Seminar (SOOS)	28
FY19 Total Number of Students	**1,258**

Defense Medical Readiness Training Institute Courses	Attendees
Emergency Preparedness Response Course (EPRC) – Clinicians Course (distant learning)	18,211
EPRC – Operator/Responder Course (distant learning)	11,473
EPRC – Basic Awareness Course (distant learning)	37,632
EPRC – Executive/Commander Course (distant learning)	1,338
Emergency Preparedness Response Course – CBRN for Medical Personnel and First Responders (distant learning)	5,979
Combat Casualty Care Course (C4)	898
Public Health Emergency Management Course (PHEMC)	199

Defense Medical Readiness Training Institute Courses	**Attendees**
FEMA IS300 Intermediate Incident Command System (ICS)	52
FEMA IS400 Advanced Incident Command System (ICS)	0
Introduction to Hospital Incident Command System (HICS)	66
Public Health and Medical Services in Defense Support of Civil Authorities (PH MED DSCA)	61
Joint Medical Operations Course (JMOC) Basic	218
Joint Medical Operations Course (JMOC) Advanced	31
Joint Senior Medical Leaders Course (JSMLC)	103
FY19 Total Number of Students	**76,261**

Armed Forces Radiobiology Research Institute Courses	**Attendees**
Medical Effects of Ionizing Radiation (MEIR) Course	330
FY19 Total Number of Students	**330**

USACBRNS Courses	**Attendees**
USACBRNS Distance Learning Courses	
CBRN Specialist	151
CBRN Captains Career Course (Reserve Component (RC)) Phase 1	67
CBRN Captains Career Course (RC) Phase 3	40
USACBRNS Resident Courses	
CBRN Basic Officer Leader-Branch	329
CBRN Captains Career	97
CBRN Captains Career Course (RC) Phase 2	54
CBRN Captains Career Course (RC) Phase 4	37
CBRN Warrant Officer Basic	27
CBRN Warrant Officer Advanced	16
Basic Radiological Safety	77
Advanced Radiological Safety	22

USACBRNS Courses	Attendees
Radiological Packaging	27
CBRN Reconnaissance for Brigade Combat Teams	261
CBRN Pre-Command	14
Decontamination Procedures (Non-U.S.)	92
Biological Integrated Detection System	68
Joint Senior Leader	44
CBRN Specialist	1548
Civil Support Team Operations (Transferred to SC 807)	43
Civil Support Team Pre-Command Course (Transferred to SC 807)	49
Civil Support Skills (Transferred to SC 807)	183
CBRN Responder Operations	1100
CBRN Responder Technician	456
CBRN Dismounted Reconnaissance	90
Technical Escort	266
CBRN Senior Staff Planners	14
Analytical Laboratory System Operator (Transferred to SC 807)	27
Unified Command Suite Operator (Transferred to SC 807)	19
Shipboard CBR-D Operations and Training Specialist (USN)	102
NBC Defense (USMC)	164
CBRN Basic Warrant Officer (USMC)	18
CBRN Planner (USMC)	23
Emergency Management Craftsman (USAF)	64
Emergency Management Apprentice (USAF)	105
CBRN Advanced Leader Course (ALC) Phase 1	273
CBRN ALC Phase 2	381
CBRN ALC Phase 3	364
CBRN Senior Leader Course (SLC) Phase 1	262
CBRN SLC Phase 2	262
CBRN SLC Phase 3	358
FY19 Total Number of Students	**7,594**

U.S. Army Medical Department Center and School Courses	Attendees
FY19 Total Number of Students	**X,XXX**

USAF CBRN Courses	Attendees
CBRN Defense Training	236,571
CBRN Contamination Control Area	236,571
CBRN Fundamentals	236,571
AERO First and Emergency Responder	5,250
Emergency Operations Center	5,362
Shelter Management Team	572
Unit Emergency Management Representative	5,296
CBRN Command & Control	48
CBRN Information System (IS)	423
Emergency Management Craftsmen (USAF CBRN Specialist)	86
Emergency Management Apprentice (USAF CBRN Specialist)	202

USN Courses	Attendees
Damage Control Basic Engineering Common Core A School Virtual Pipeline	381
Damage Controlman A School	347
Damage Control Petty Officer	14
Shipboard CBR-D Operations & Training Specialist	95
Damage Control Repair Party Leader	696
Damage Control Assistant Senior Enlisted (DCA/SE)	292
JBAIDS Schoolhouse Navy Environmental and Preventive Medicine Unit & Fleet Surgical Team (Navy-Shipboard, NEPMU & FST)	16
NGDS Schoolhouse Navy Environmental and Preventive Medicine Unit & Biological Defense Research Directorate/ Naval Medical Research Center (Navy-NEPMU & BDRD/NMRC)	8

USN Courses	Attendees
Expeditionary Shore Based Chemical, Biological, Radiological Defense Operations Specialist	69
Command Center Staff CBR-D Operations	123
CBRD Personal Protection and Decontamination	2,323
Chemical Biological Radiological Defense Team Training	535
METOC for Chemical, Biological, Radiological, Nuclear and High Explosive Effects (CBRNE)	74
Chemical/Biological/Radiological Defense (Navy Cargo Handling Battalion)	139
Mobile Diving and Salvage Chemical, Biological and Radiological Fundamentals	103
FY19 Total Number of Students	**5,215**

USAMRICD Courses**	Attendees
Field Management of CB Casualties (FCBC) Course	207
Medical Management of CB Casualties (MCBC) Course	249
Hospital Management of CBRNE (HM-CBRNE)	78
Off-Site (Ft. Bragg, NC, 44th Medical BDE)	30
Off-Site (Camp Casey, Korea, 2ID)	71
Off-Site (Hunter AAF, GA, 75th Rangers)	26
Off-Site (Indianhead, MD, CBIRF)	30
Off-Site (Quantico, VA, EMF Bethesda)	50
Off-Site (Ft. McCoy, WI, PDS TTX)	175
Off-Site (Camp Pendleton, CA, 1st Logistics Group)	94
Classified	266
FY19 Total Number of Students	**1,276**

USAMRIID Courses**	Attendees
FIBWA - Civil Support Team (CST)	8
FIBWA - Manager’s Course	23
FIBWA	25
FCBC Course	249

USAMRIID Courses**	Attendees
Medical Management of CB Casualties Course	207
HM-CBRNE Incidents Course	78
Outbreak Response Course (Health and Human Services & DoD)	69
Medical Management of Biological Casualties DL Course - DHA US-071 (29hrs)	8,253
Off- Site (Quantico, VA)	50
Off- Site (Camp Pendleton, CA)	94
Off- Site (Indianhead, MD)	30
Off- Site (Hunter AAF, GA)	26
Off- Site (Ft. Bragg, NC)	30
Off- Site (Camp Casey, Korea)	71
FY19 Total Number of Students	**9,213**

** The expertise in CB research and development at the United States Army Medical Research and Development Command laboratories, USAMRICD, and USAMRIID, was leveraged to support operational activities by providing medical training and education to thousands of DoD healthcare providers and support individuals. Training is provided for CB casualty care, hospital management, field identification of biological warfare (BW) agents, and other specialized courses to military units and individuals from the Joint Forces, as well as interagency and international partners.

CCDC CBC Courses	Attendees
Biological Agents/Small Scale Production	66
Chemical Agents/Small Scale Production	70
Advanced CBRNE for CSTs	20
Emerging Threats	506
CBRN Planner Course	36
Chemical Biological Agent Topics	52
Chemical Warfare Agents/Biological Warfare Agents	48
Advanced Chemical Biological	82
Target Recognition Course	114
Decontamination Topics	32
Advanced Sampling	70
CST Survey Operations Course	43
Advanced Field Equipment Detection Course	28
Single day field Training Exercises	902

CCDC CBC Courses	Attendees
FY 19 Total Number of Students	**2,069**

NGB-Sponsored Leader Development and Education Courses	Attendees
Advanced Decontamination	37
Chemical Warfare Agent/Biological Warfare Agent (CWA/BWA)	75
Emerging Threats	251
Advanced Applied Science (Chemical)	15
Advanced Applied Science (Biological)	17
Applied Radiological Response Technique Level (ARRT) 1	370
Survey Equipment Capabilities Course (formerly Basic Survey Equip)	91
Applied Radiological Response Techniques (ARRT) 2	0
Advanced Radiological Detection Training	105
Advanced HAPSITE ER Training (formerly GCMS)	55
Communication Intermediate Course (CIC)	35
Advanced Life Support Response to Hazardous Materials Incidents (ALSRHMI)	6
Advanced Equipment Capabilities Course (ECBC)	86
HAZMAT Awareness	370
IS 700.a Intro to NIMS	370
IS 100.b Intro to IC	370
IS 200.b ICS for Single Resources	370
IS 300 Intermediate ICS	98
IS 400 Advanced ICS	98
IS 800.b National Response Framework	370
IS 300 Intermediate ICS	370
Civil Support Skills Course	183
CST Pre-Command Course	49
IED Awareness	89
Analytical Laboratory System Operators Course	27
Advanced Shimadzu (formerly Advanced GCMS)	18

NGB-Sponsored Leader Development and Education Courses	Attendees
Basic Microscopy	16
Advanced Microscopy	10
CST Operations Course	43
FIBWA	10
CompTIA Boot Camp (Network Technician I)	34
Unified Command Suite (UCS) Basic	19
CCENT (Network Technician II)	23
Windows MCSA (Network Admin I)	22
Windows Server (Network Admin II)	24
UCS Intermediate IT Course	18
UCS Intermediate Radio Course	16
Emergency Vehicle Operations	370
Pro Board Certifying Confined Space/Collapsed Structure	56
Joint Effects Model (JEM) 2.0	18
Applied Science	63
WMD-CST Logistics	22
WMD-CST Modeling	29
HRF/CERFP Search and Extraction Course	460
HRF/CERFP Mass Casualty Decontamination Course	464
HRF/CERFP WMD Command Post Operations Course	426
FY19 Total Number of Students	**6068**
Total CST Students	**4,830**

ENCLOSURE D. FY19 S&T TRANSITIONS

Transition Partner	Project	Description
JPEO-CBRND	Ultra-Compact Micro-Gas Chromatograph-Mass Spectrometer	The Micro Gas Analyzer (MGA) program completed an ultra-compact gas chromatograph-mass spectrometer (GC-MS) to detect and identify chemical threats in highly cluttered environmental backgrounds. The MGA will enable high-performance, lab-quality chemical a
JPEO-CBRND	JEM S&T Prototype (STP) 6.5 - Includes enhancements to previously transitioned capabilities and CCMI-compliant Missile Intercept module	Software for atmospheric modeling and transport and hazard prediction. Includes enhancements to urban models, CB source term models, and new material data files.
JPEO-CBRND	Missile Intercept Modeling	This effort developed an integrated missile intercept and debris fly-down model for intercepted and nominal functioning chemical, biological, and nuclear payloads. The model is designed to integrate into HPAC and JEM.
JPEO-CBRND	Select Biosurveillance Ecosystem Capabilities - TD7	Select Biosurveillance Ecosystem Capabilities - TD7
JPEO-CBRND	Novel Mechanism Antibacterials for Gram Negative Biothreats Establishing FDA Indications for Omadacycline to in treatment of Nonhuman Primate Animal Models of Infection (Anthrax and Plague indications).	Drug Repurposing of Omadacycline for Inhalational Plague (sNDA)
JPEO-CBRND	Personnel Decontamination – Chemical Feasibility Study	Wide Area Decontamination – Chemical Feasibility Study
JPEO-CBRND	Wearable Respirator Protection Assessment System (WRPAS)	Develop and Deliver tested, wearable, water-based particle counter respirator assessment instrument meeting all JSTO-CBDB-15-BAA-RIF-001 requirements
JPEO-CBRND	Zirconium Hydroxide ($Zr(OH)_4$) Sorbents for Detox of Chemical Warfare Agents - Phase 1 Addendum	Conduct a feasibility study of using zirconium hydroxide slurries for the

Transition Partner	Project	Description
		detoxification of CWA and emerging threat laden CARC panels.
JPEO-CBRND	Antimicrobial Resistance Determinant Data for High Priority Agents	This project will develop baseline data on the spectrum of resistance mechanisms and their distribution in high priority threat agents
ARL	Chemical Agent Coating Methodology Development for Assessment, ARL published new MIL-SPEC	Improved test methods for measuring agent resistance to update the CARC MIL-DTL
JPEO-CBRND	Integrated Protective Fabric System (IPFS) Data Increments 1-4. This includes V& V of the UK Porton Man Whole System Live Agent Test Process and the IPFS agent test data.	Data Transition Agreement (DTA) Porton Man V&V (Part of TacHazE)
JPEO-CBRND	Decision Methodology	Develop tactical decision methodology for “forces on the move”
JPEO-CBRND	Host-based Synthetic Data	Demonstrate host-based synthetic data moving from a company of Marines (who suffer exposure to a bio attack) across services architecture for IEW
JPEO-CBRND	Maneuver Force Sensing Needs Analysis	Conduct a Remote Sensing mission utility analysis for as-is capabilities and to-be technology options
JPEO-CBRND	Multi-service Demonstration	Demonstrate a viable and compatible approach to share IEW information across service architectures using a “forces on the move” scenario
JPEO-CBRND	Novel Early Chemical Warning	Provide enhanced networked detection so field commanders can make timely and proactive decisions
JPEO-CBRND	Personal Protective Equipment (PPE) Physiological Monitoring Data Management Demo	An application that enables specific decisions based on heat strain indications
JPEO-CBRND	Tactical Commander's View	Provide the commander a CB picture across echelons and Services command and control systems

Transition Partner	Project	Description
JPEO-CBRND	UxS Payload and Platform Analysis	Conduct analysis of existing Service platforms and identify sensing SWaP requirements
JPEO-CBRND	Empowering the Development of Genomics Expertise Test Demonstration	Technology/products will be delivered to the test location of Institut Pasteur de Dakar in Senegal. Empowering the Development of Genomics Expertise (EDGE) bioinformatics will be evaluated in FY18Q1. After the conclusion of this demonstration JSTO-CBD and
JPEO-CBRND	Filter Performance	A decision support tool for hazard prediction associated with chemical weapon attacks, and consequence assessment to the Warfighter via mobile solutions. Specifically, a chemical attack response recommendations (CARRs) application for smart phones, tablet
JPEO-CBRND	Material Files for HPAC and JEM	Transitioned material files for Carfentanil and Remifentanil
Commercial	Rapid Analysis of Threat Exposure (RATE)	A data science solution for both early warning of exposure and to facilitate rapid and effective use of countermeasures. This will include identifying the optimal number and type of physiological, biochemical, neurological, etc. metrics and pathways that
HHS	SPR994 for biodefense indications	Development of a direct acting antibacterial candidate SPR994 (oral tebipenem) against infections caused by Burkholderia pseudomallei (BP), Francisella tularensis (FT), Burkholderia mallei (BM), Bacillus anthracis (BA), Yersinia pestis (YP), Coxiella bu
DIA/DTRA/ NGIC	Environmental Fate of Carfentanil	Provided Report on Environmental Fate of Carfentanil Oxalate in Soil and Relevant Waters
DIA/DTRA/	Environmental Fate of Remifentanil	Provided Report on Environmental Fate of Remifentanil in Soil and Relevant Waters

Transition Partner	Project	Description
NGIC		
DTRA/JPEO/ NGIA	PBA Agent Characterization	Provided Report on Gas Phase Pyrolysis of PBAs Part 1: Relative Thermal Stability and Identification of Breakdown Products
DIA/DTRA/ NGIA/NGIC	PBA Dissemination Report	Provided Report on Pyrotechnic Dissemination of Pharmaceutical-Based Agents
JPEO-CBRND	Anti-fog Coating for Respirator Lenses	Develop a superhydrophylic surface with sustained fogging resistance and optical clarity, for superior durability to chemicals, abrasion and ultraviolet (UV) radiation. Scale up the process and verify coating performance for delivery of prototype lenses
JPEO-CBRND	Wearable Respirator Protection Assessment System (WRPAS)	Lightweight portable quantitative protection factor measurement and storage device
JPEO-CBRND	Whole System Test Methodologies (Improved/Photographic Aerosol System Test)	Develop and demonstrate the ability to measure an aerosol deposition using a photographic technique. Ensure that human components do not adversely impact the measurement process.