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# West Point Department of Chemistry and Life Science: Nexus of Army Nuclear, Chemical, and Biological Intellectual Capital

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Countering Weapons of Mass Destruction (CWMD) is highly prioritized in nearly every strategic guidance document identifying threats to the United States and its allies as our adversaries continue to pursue a range of new capabilities.<sup>1,2,3</sup> Joint Publication 3-40 defines a WMD as “chemical, biological, radiological, or nuclear weapons or devices capable of a high order of destruction and/or causing mass casualties.”<sup>4</sup> Whether criminals, terrorists, or nation states, their “increased access to expertise, materials, and technologies heightens the risk that these adversaries will seek, acquire, proliferate, and employ WMD.”<sup>5</sup> The recent use of chemical weapons by both the Islamic State of Iraq and the Levant (ISIL) and the Syrian Government, the continued testing of nuclear devices by North Korea, aggressive posturing by Russia, and the Iran nuclear framework are issues concerning weapons of mass destruction (WMD) that confront combatant commands around the globe. Recent viral outbreaks such as Ebola in Western Africa, reports of a defecting North Korean soldier with anthrax immunity, as well as legacy bioweapons programs throughout the former Soviet Union suggest continued biological threats from naturally occurring events to state sponsored efforts.<sup>6</sup> Two former directors of the Central Intelligence Agency have stated that it is biological weapons and

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their potential use that keeps them up at night.<sup>7</sup>

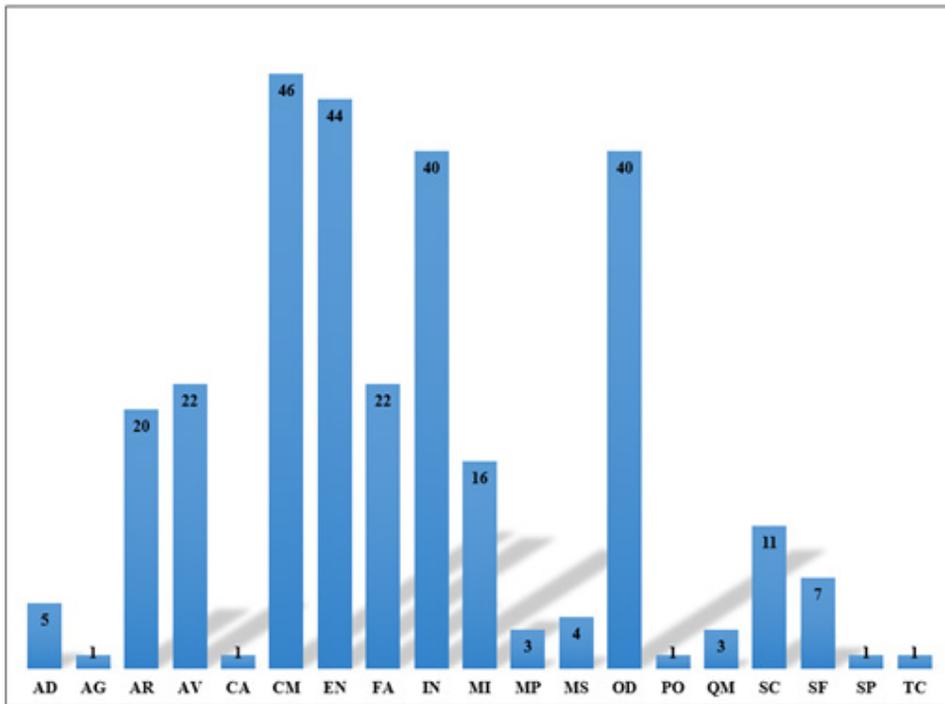
The asymmetric threat posed by chemical and biological weapons offers an inducement to adversaries looking for advantage over the United States, its allies, and coalition partners. Chemical and biological capabilities allow adversaries to shape the operating environment by inflicting casualties, creating conditions to deter or defeat entry operations, and eroding public support and ultimately the basic will to fight. For WMD, and more broadly considered the full spectrum of Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) threats, difficulty in the acquisition, development, and delivery of threats increases from Chemical to Biological to Radiological to Nuclear.<sup>8</sup> Inexpensive and easily produced low-yield explosives, accelerating technological development, and rapid communication will enable greater ease in development and employment. CBRNE threats are not restricted to nation states. Advancing technology such as additive printing, unmanned aerial vehicles, cyber, and synthetic biology will likely exacerbate WMD threats in the near future for not only single threat types, but also hybrid CBRNE threats delivered in parallel or serial across an area of operations.<sup>9</sup> Beyond the broad range of readily available conventional weapons,

state and non-state actors can select from numerous readily available technologies that can be adapted in unanticipated ways. One can look no further than direct attacks on U.S. soil, where the 9/11 terrorists coupled innovative delivery means with a combustible fuel, to see the imperative to anticipate unique and hybrid delivery of multiple elements of the CBRNE threat spectrum.<sup>10</sup> The combination of chemical and biological threats with improvised explosive devices poses a persistent tactical threat with strategic consequences.

CBRNE threats and hazards are not limited to military sources in operational environments. Industrial, energy, medical, pharmaceutical, and academic research sectors also present potential WMD/CBRNE threats, and may include an explosive component for dispersal. These pervasive factors in threat regions around the world present an integrated and complex threat environment by themselves. When these chemical and biological threats are combined with increasingly available technology, they result in a threat profile contrary to US interests that demands a cadre of Army officers expert in their chemical-biological knowledge, capable in their articulation of threats, and creative in their



**Figure 1. 20th CBRNE Command Soldiers during a National Training Center rotation.**



**Figure 2. Distribution of basic branches within the FA52 career field. The majority of the officers come from the Chemical, Ordnance, Engineer, and Infantry. (as of January 2018).**

problem-solving capacity to synchronize effective responses.<sup>11,12</sup> Senior commanders and leaders, not only in the U.S. Army but throughout the Department of Defense and U.S. government, require such advisors to help them understand chemical and biological threats and to make informed policy and operational decisions. In order to avoid ineffective, late, or ad hoc support, this chemical-biological expertise must be deliberately developed and integrated at echelon to form an effective network of intellectual capital to conduct research, analysis, policy formulation, and operations.<sup>13</sup>

### **Functional Area 52 Nuclear Operations and Counterproliferation Officers**

Nuclear and Counterproliferation officers are “warfighters who provide the Army with a technically educated, operationally experienced, and highly trained cadre specializing in all aspects

of nuclear and countering WMD strategic and operational-level planning and execution.<sup>14</sup> This includes expertise across the spectrum of nuclear and countering WMD operations from weapon design and effects to protection, detection, and consequence management.”<sup>15</sup> The functional area recruits officers with math, science, and engineering undergraduate degrees from across the basic branches as shown in Figure 2. Some basic branches, such as the Chemical Corps and Explosive Ordnance Disposal, which constitute a relatively large portion of the FA52 cadre, yield officers with direct and indirect WMD experiences that provide a foundation for functional area transition.

FA52 officers are expected to develop four competencies: 1) Nuclear & CWMD Operations & Intelligence; 2) Nuclear & CWMD Plans, Policy & Strategy; 3) Nuclear & CWMD Research, Development, Test and Evaluation (RDT&E) and

Line	Position	Grade	Position Code	Degree
07	Instructor / Researcher	O5	52B	Ph.D.
10 (Effective JAN19)	Instructor / Researcher	O4	52B	Ph.D.
11	Instructor / Researcher	O4	52B	Ph.D.
12	Instructor / Analyst (Photonics)	O4	52B	Ph.D.
21	Instructor / Researcher	O3	52B	M.S.

**Figure 3. United States Military Academy Table of Distribution and Allowances (TDA) Paragraph 102 FA52 authorizations for the Department of Chemistry and Life Science.**

capabilities; and 4) Nuclear & CWMD Doctrine, Education & Training.

While DoD doctrine and DA PAM 600-3 place a significant emphasis on the nuclear aspect of WMD, in terms of the three pillars nonproliferation, counterproliferation, and consequence management, consequence management requires a chemical-biological technical expertise.

DA PAM 600-3 outlines a number of unique knowledge, skills and attributes required of FA52 officers, which are:

- (1) Possess an undergraduate degree in any science, technology, engineering, or mathematics (STEM) discipline and/or operational experience with WMD at the company-grade level.
- (2) Apply highly technical scientific concepts to more military-specific issues and applications and be capable of communicating this technical expertise effectively in written and oral communications.
- (3) Be extremely adept at organizing workload,

assigning tasks, and mentoring civilian and military subordinates.

(4) Possess the ability to obtain a master's degree in a nuclear or countering WMD-related field.

(5) Qualify for and maintain a top secret security clearance in accordance with AR 380-67 throughout their careers.

Inherent in these skills is the ability to effectively communicate technical information regarding not just nuclear related material, but all WMDs to a non-technical audience. Despite being tactically proficient and leaders in their basic branches, most officers require developmental and broadening assignments to hone their technical knowledge and skills required to brief scientific data to both military and civilian non-scientists in senior leadership roles. While the Army Nuclear and Counterproliferation Officer Qualification Course, hosted by the Army Nuclear and Counterproliferation School in cooperation with the Defense Nuclear Weapons School, provides a FA52 officer with an initial exposure to the U.S. nuclear program and surety on which to develop the necessary professional skills,

advanced technical graduate degrees provide an enormous benefit, especially when coupled to a broadening assignment. DA PAM 600-3 provides a number of pathways to gain an advanced degree such as the “Air Force Institute of Technology (AFIT), the National Intelligence University (NIU), the Naval Postgraduate School (NPS) or any of the National Nuclear Security Administration (NNSA) Consortium schools which provide masters-level degrees in nuclear, nuclear-related, and countering WMD-related disciplines.”

### West Point Department of Chemistry and Life Science

Another route to develop the necessary FA52 skillset through an advanced technical degree is via a broadening assignment combining advanced civil schooling with a utilization assignment in the Rotating Faculty program at the United States Military Academy, at West Point. Two academic departments maintain dedicated rotating faculty positions for FA52 officers, the Department of Chemistry and Life Science (CLS), and the Department of Physics and Nuclear Engineering (PANE). The two departments have 5 and 11 Functional Area 52 positions respectively, each tied to an advanced civil schooling allocation for a master’s degree or doctorate. While the Department of Physics and Nuclear Engineering maintains a focus on fundamental physics and

related engineering degrees supporting the nuclear aspect of WMD threats, the Department of Chemistry and Life Science is uniquely poised to develop FA52 officers with not only an understanding of the chemistry of the nuclear fuel cycle, but also with the chemical and biological technical expertise to address many of the persistent threats described above.

West Point’s mission is: To educate, train, and inspire the Corps of Cadets so that each graduate is a commissioned leader of character committed to the values of Duty, Honor, Country and prepared for a career of professional excellence and service to the Nation as an officer in the United States Army. The Department of Chemistry and Life Science supports the achievement of the Academy mission with its own mission: To educate, train and inspire cadets with a firm foundation in the fields of chemistry, life science, and chemical engineering, so that each graduate is a commissioned leader of character who can leverage their understanding of science and engineering to implement solutions using critical thinking and problem-solving skills; and be prepared for a career of professional excellence and service to the Nation as an officer in the United States Army.

As highlighted in DA PAM 600-3 Commissioned Officer Professional Development and Career Management, a FA 52 officer is

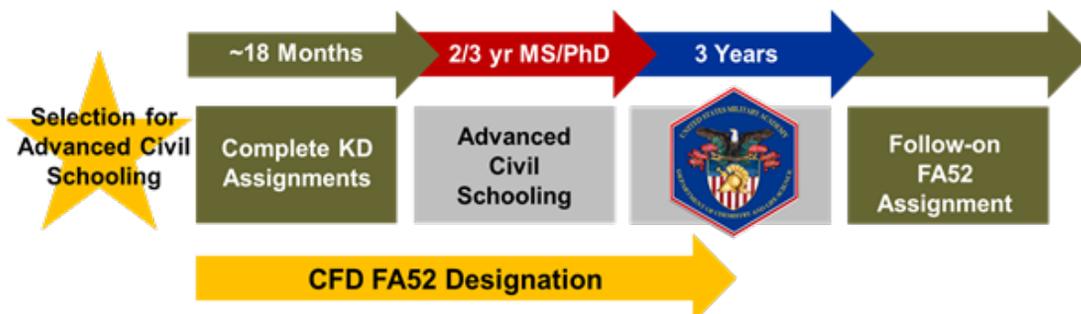


Figure 4. Timeline for advanced civil school selection, graduate school masters or doctoral program, utilization tour in the Department of Chemistry and Life Science, and follow-on FA52 assignment.

responsible for all WMD mission areas to include chemical and biological, not just nuclear.<sup>16</sup> Within the realm of nuclear weapons, an argument could be made that every process up until the highly enriched uranium or plutonium is encased in high explosives and post detonation is fundamental chemistry. This includes the uranium enrichment and separation processes, as well as the post denotation analysis of isotopes for attribution. For both chemical and biological weapons, CLS offers the opportunity for officers to become experts in the underlying chemistry and biological processes that these weapons are derived from and effect. Such an understanding enables FA 52s to be more proficient in distilling a breadth of complex scientific data about these weapons to non-scientists.

A faculty tour in CLS provides an enriching transition path to organizational leadership, building on the previous role of company grade officers with direct leadership and preparation of soldiers for combat. Field grade officers often perform their duties through direct and indirect leadership in mixed military and civilian workplace environments. West Point offers an opportunity to prepare for these roles through Advanced Civil Schooling (ACS) and subsequent utilization tour as a faculty member. Just as important as the faculty's role in developing Army leaders with each graduating class, West Point "second graduating" class is the cohort of field grade officers who complete their faculty experiences better prepared solve problems at the operational and strategic levels.

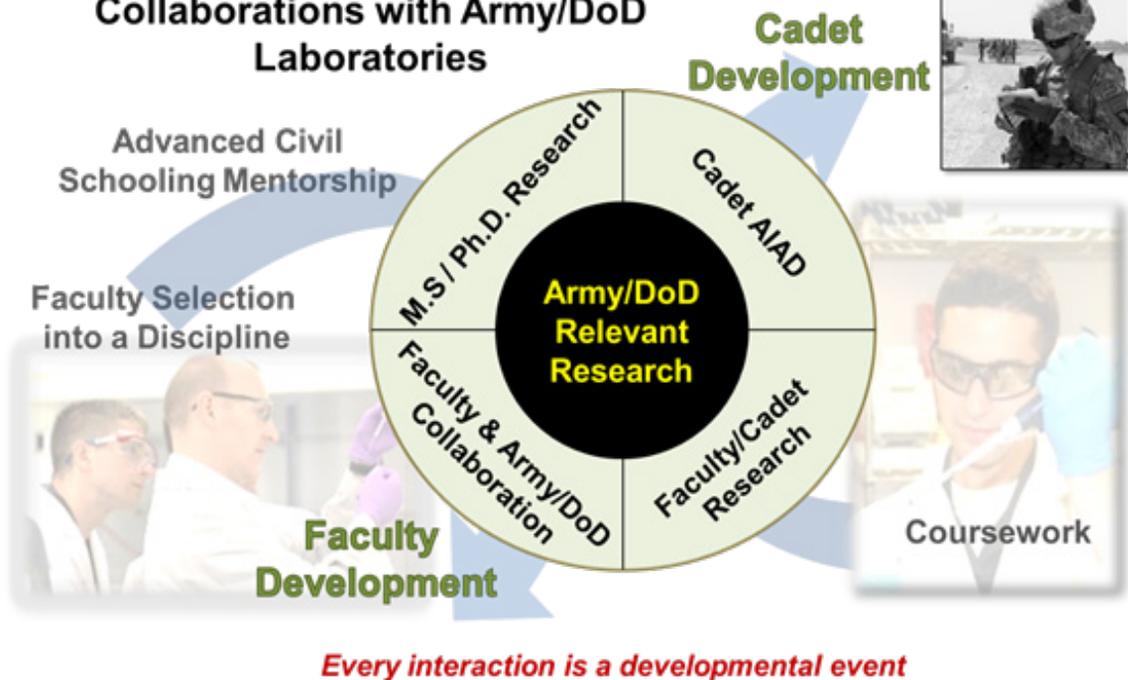
### **Advanced Civil Schooling - Faculty Selection and Timeline**

West Point's faculty is composed of approximately 25% civilians and 75% military officers. Within the military faculty there are three

groups: senior permanent military – Professors USMA (department heads and deputies) and Academy Professors; senior rotating faculty with Ph.D.'s; and junior rotating faculty with master's degrees. All faculty positions involve some form of committee selection at the Army, Academy, or department level. Ph.D. and masters rotating positions in CLS are selected at the department level. The Chemistry and Life Science department currently maintains four FA52 positions on its Table of Distribution and Allowances (TDA), with a fifth position becoming effective in January 2019 as shown in Table 1. TDA manning rules offer the flexibility to fill positions "one-up/one-down" in grade enabling the department to better manage talent and potential tour extensions.

Selection packets are submitted to the department for committee review and consist of a resume/curriculum vitae, personal statement, transcripts, GRE scores, and letters of recommendation. Committee selections are normally conducted in December with notifications occurring in January for graduate school start approximately a year and a half later. For instance selection and notification occurring in DEC17/JAN18 is for a graduate school start in the fall of 2019. This timeline allows officers to complete Key Developmental assignments and apply to graduate programs. Department FA52 officers have come from diverse undergraduate STEM experiences ranging from electrical engineering, engineering physics, to microbiology and immunology. There is a great latitude in pursuing chemical and biologically related graduate degrees that not only support the department's three program majors of Chemistry, Chemical Engineering, and Life Science, but also augment the chemical-biological expertise within the FA52 community. A few examples of graduate degrees attained by FA52 officers in the department are radiation chemistry, nuclear

## Developmental Integration of Faculty & Cadets through Scholarly Collaborations with Army/DoD Laboratories



**Figure 5. The Department of Chemistry and Life Science developmental model integrating faculty and cadets through scholarly collaborations with Army and DoD laboratories**

chemistry, radiation biology, chemical engineering, and biology.

The ACS program allows officers to attend a university of their choice ranging from both public and private schools to include Ivy League colleges, and military technical colleges such as the Air Force Institute of Technology (AFIT). Senior faculty mentorship assists selected officers in finding the best university fit aligned with department needs, officer research interest, and timeline feasibility. Two years are allocated for a thesis-based master's degree, and three years for a doctorate, with a three year utilization tour on the West Point faculty (see Figure 5). The graduate school broadening opportunity places the officer in a non-DOD environment.

Through the company grade and early field

grade ranks, many Army officers have limited interaction working with a non-DOD population. Graduate school provides an important opportunity for officers to work with current and future experts within their field of study. The graduate school experience also offers the unique leadership opportunity for officers to lead, interact with, and become part of a group where there is no rank structure. Ultimately, the officer and the Army benefit from better problem solving skills at operational and strategic echelons.

### **Faculty Experience - Teaching, Scholarship, Cadet and Faculty Development, and Service**

West Point faculty participate in activities across five domains – teaching, scholarship, cadet and faculty development, and service. CLS organizes all of those activities around Army and

DoD relevant research, often in collaboration with DoD laboratories. Teaching cadets in the classroom results in their technical knowledge and problem solving skills that are then applied in the laboratory both at West Point and during summer research internships for cadets and faculty – this integrative process depicted in Figure 5 leverages the synergies of all five domains of faculty activity, such that “every interaction is a developmental event” for cadets, junior, and senior faculty alike.

This integrative developmental model also ensures that the research an officer begins in graduate school continues and evolves upon joining the West Point faculty. FA 52 officers have received funding for their research from organizations such as the Defense Threat Reduction Agency (DTRA), the Defense Advanced Research Projects Agency (DARPA), and collaboration with the Edgewood Chemical and Biological Center (ECBC) – these efforts have the further benefit that CLS FA52 faculty become directly engaged in the research programmatic efforts of the organizations in which they are likely to serve in the future. Additionally, there are ongoing research efforts in the department in the areas of material science and engineering for neutron sensors and energy based devices; molecular diagnostics and nerve repair; and explosives and pyrotechnics. The research conducted within CLS includes not only the basic sciences and engineering, but also policy. Previous faculty have published articles in conjunction with the West Point Combating Terrorism Center, and worked with National Defense University’s Center for Combating Weapons of Mass Destruction. These collaborative relationships have provided numerous unique opportunities for FA 52s to brief senior military and civilian leaders to include combatant commanders, the Secretary of

Defense, a Director of the Central Intelligence Agency, and members of the National Security Council. DTRA’s Nuclear Science and Engineering Research Center (NSERC) also resides in Bartlett Hall at West Point, the same building that houses the Departments of Chemistry and Life Science and Physics and Nuclear Engineering. This co-location provides opportunities for professional relationships between other FA 52s, as well as attend seminars “hosted by NSERC” for FA52 professional development while at USMA.

Given the time required to complete an advanced graduate degree and serve a three year utilization tour, career timelines often require careful management. To mitigate timeline challenges many FA52 officers serving in CLS may complete Intermediate Level Education (ILE) at West Point via distance learning, or satellite during the summer. Some officers who designate as a FA52 officer upon arrival to the West Point faculty attend the FA52 transition course during a summer, or en route to a follow-on assignment.

### **Faculty Service – Contributing to the WMD Community**

In addition to academic committee work associated with university faculty positions, CLS officers have contributed to the WMD community beyond West Point in a variety of ways. Given their technical expertise and research in chemical and biological fields, combined with operational experiences across various unit types, echelons, and theaters of deployment, CLS faculty offer the WMD/CBRNE network a unique perspective that facilitates the translation of basic and applied science into practical fielded systems, policies, and analysis. This service has included:

- Defense Threat Reduction Agency (DTRA), Chemical and Biological Defense Program



**Figure 6. West Point cadets conducting Chemistry and Life Science laboratory and classroom exercises**

- (CBDP) Basic Science Reviews (BSR)
- Defense Threat Reduction Agency (DTRA), Chemical and Biological Defense Program (CBDP) Program Management Reviews (PMR)
- Defense Threat Reduction Agency (DTRA) Chemical and Biological Defense Science and Technology (CBD S&T) Conferences - Warfighter panel members
- Edgewood Chemical and Biological Center Technical Advisory Board (TAB)
- Edgewood Chemical and Biological Center In-House Laboratory Independent Research (ILIR), and Surface Science Initiative (SSI) grant proposal reviewers
- U.S. Army CBRNE Imperatives Council of Colonels
- Joint Program Executive Office – Chemical and Biological Defense (JPEO-CBD), Chemical Biological Defense Acquisition Initiative Forum (CBDAIF)

for follow-assignments to contribute across the Department of Defense WMD community. Former CLS faculty have served at the:

- Office of the Secretary of Defense (OSD) – Joint Staff
- Defense Threat Reduction Agency (DTRA)
- Defense Intelligence Agency (DIA)
- National Defense University (NDU)
- Headquarters, Department of the Army (HQDA)
- 20th CBRNE Command
- Edgewood Chemical and Biological Center (ECBC)

Numerous former CLS faculty serve at the Defense Threat Reduction Agency in both military and civilian positions. Multiple field grade officers have transitioned to Nuclear Disablement Teams in the 20th CBRNE Command at Aberdeen Proving Ground. Additionally, CLS permanent military faculty - Academy Professors - have also contributed to the WMD community in six month to one year operational assignments with the 20th CBRNE Command with duties involving Contingency Operations (CONOPS) development, as well as science and technology and strategic-communications integration. Further, emerging chemical and biological faculty and research

### **Follow-on Assignments: Enriching the WMD Community**

After further developing technical chemical and biological expertise, honing communication skills in the classroom, and leading in a diverse military-civilian organization, CLS faculty depart



**Figure 7. The FA52 community network with the West Point Department of Chemistry and Life Science serving as the nexus of chemical and biological intellectual capital**

positions at the Air Force Institute of Technology and the Armed Forces Radiobiology Research Institute at the Uniformed Services University offer potential follow-on assignment opportunities to sustain long-term research efforts. The former military faculty serving as senior civilians in many of these organizations represent West Point's "third graduating class" and further demonstrate the department's positive influence on the WMD/ CBRNE community across three time scales – first, the graduating class of lieutenants; second, the graduating class of field grade officers departing for follow-on assignments; and third, the graduating class of chemical-biological leaders transitioning from military to civilian service. The Department of Chemistry and Life Science's integration and contribution across the WMD community establishes its role as a nexus of chemical and biological expertise as shown in Figure 7.

### The Way Forward

The Department of Chemistry and Life Science at West Point continues to develop synergistic relationships with the Functional Area 52 community and enrich the chemical and biological intellectual capital for the Army and Department of Defense. Continued partnership between West Point, the U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency (USANCA), and Human Resources Command (HRC) will ensure that the best officers pursue graduate technical degrees through the Advanced Civil Schooling program. Combining teaching, research, and service experience at West Point provides a developmental pathway to providing the Army and DoD expert problem solvers able to communicate and solve the most difficult chemical and biological challenges at the operational and strategic level now and into the future..

## Notes

- 1 Quadrennial Defense Review, 2014.
- 2 Army Strategic Planning Guidance, 2014.
- 3 National Security Strategy of the United States of America, December 2017.
- 4 Joint Publication 3-40, October 31, 2014, p I-1.
- 5 Department of Defense Strategy for Countering Weapons of Mass Destruction, June 2014.
- 6 John Bacon, "Anthrax antibodies in defector raises fears North Korea is developing chemical weapons." USA Today, December 27, 2017. <https://www.usatoday.com/story/news/world/2017/12/27/anthrax-defector-raises-new-fears-north-korea-developing-biological-weapons/983810001/>. Accessed January 1, 2017.
- 7 Comments made by former director Porter Goss to the author, MAJ Stephen Hummel, and comments made by former director John Brennan at the West Point Combatting Terrorism Center in March 2016.
- 8 James B. Burton and F. John Burpo. "The 20th CBRNE Command Transformation – Regionally Aligned CBRNE Task Forces." *Combating WMD Journal*. Fall/Winter 2015, (13), pp 29-34.
- 9 Michael Aaronson, Sverre Diessen, Yves De Kermabon, Mary Beth Long, Michael Miklaucic "NATO Countering the Hybrid Threat," PRISM 2:4, National Defense University Press, 2012: 111-124. Aaronson, 111-124. Hybrid threats are defined in ADP 3-0 only with respect to forces and the hybrid CBRNE threat definition offered here includes the combination of forces and CBRNE elements they employ.
- 10 James B. Burton, F. John Burpo, and Kevin Garcia. "20th CBRNE Command – Organizing, Training, and Resourcing for CBRNE Operations." *Military Review*. Jul-Aug 2016, pp 62-71.
- 11 Aaronson, 111-124.
- 12 Brian Fleming, *The Hybrid Threat Concept: Contemporary War, Military Planning and the Advent of Unrestricted Operational Art*, DTIC, 2011: 2.
- 13 Deputy Secretary of Defense Paul Wolfowitz remarks to the National Defense University WMD Symposium, May 13, 2003.
- 14 DA PAM 600-3.
- 15 DA PAM 600-3.
- 16 The Nuclear and Counterproliferation Qualification Course is the entry-level course into the FA 52 functional area. This six-week course taught at the both the Defense Nuclear Weapons School and the Army Nuclear and Counterproliferation School provides the in-depth education for officers about nuclear weapons components and an entry level examination into policy and effects. FA 52 officers can additionally take the Nuclear Weapons Effects, Policy, and Proliferation program offered through the Air Force Institute of Technology.