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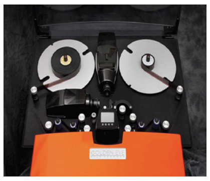
COUNTERING WMD

SCIENCE and TECHNOLOGY



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DIRECTOR NOTES

MR. DANIEL M. KLIPPSTEIN
Director, USANCA
Deputy Director of Army Strategy, Plans and Policy Directorate, HQDA

You've probably noticed the nuanced change in the name of the Journal, which is now the Countering Weapons of Mass Destruction (CWMD) Journal. Earlier this year HQDA approved the change of the Agency's name from the US Army Nuclear and Combating WMD Agency to the US Army Nuclear and Countering WMD Agency. A small but significant change that aligns the Agency's name with recently published defense strategy and joint doctrine, as well as the emerging Army CWMD Strategy.

There are several reasons for the Department of Defense (DoD) to revise its strategy and for the Army to follow suit. First, the term 'countering WMD' recognizes that this is a continuous effort to achieve the desired end states: that no new actors obtain WMD, that those actors possessing WMD do not use them, and if WMD are used that their effects are minimized. And second, in the fiscally constrained environment, we (DoD and the Army) find ourselves, needing to relook foundational documents to provide the basis for deterring state and non-state actors from considering the pursuit of a WMD program. This provides a greater opportunity for other agencies across the U.S. government as well as the international community to take on a greater role, and contributing their capabilities and resources to counter the threat from WMD.

As we move forward to fully implement the new Countering WMD Strategy, we must also develop new joint concepts, to support strategy execution and to inform the capabilities development process. The "Joint Concept for the Prevention, Use and Transfer of WMD" is in development by the Joint Staff. USANCA, in coordination with all Army stakeholders, has provided the Army's input to and review of the document. Following completion of this joint concept, the Joint Staff will initiate its sister publication, the "Joint Concept for CBRN Defense Operations." Together, these two documents will inform the development of Joint and Army capabilities for CWMD.

Along with the development of new strategy and policy for countering WMD, there is also the needed review and update of USANCA's foundational document. The Agency's publication, AR 10-16, is undergoing a revision, and in the coming months we will release it to Army organizations for review as we take a hard look at what the Agency is tasked to do and synchronize our work with that of the larger Army as well as the Joint and Interagency CWMD communities.

Additionally, in support of warfighter requirements, I am having the Agency increase the deployment and employment of our Nuclear Employment Augmentation Teams (NEAT) in support of Joint Force Commanders and contingency plan development. This is one of our essential tasks and directed to USANCA as part of the OSD and JCS planning directives. So far this year the teams of planners, modelers, and targeteers have already participated in exercises and conducted training visits to USFK, USSTRATCOM, USCENTCOM and NATO headquarters. The teams have routinely provided training on Preclusion Oriented Analysis to improve understanding among the combatant command and higher level staffs of the theater commander's role in nuclear planning and operations. A role that can be easily forgotten when planning special weapons use, but one that is being revitalized in our current strategic planning requirements.

To conclude, I'd like to add a final note about the recent USANCA Alumni Dinner, which the Agency hosted in March at Fort Belvoir. It was incredible to see the room filled with so many current and former USANCA members, as well as the greater FA52 community. It was a great evening—recognize that some of you were not able to attend due to the date change as we had to postpone the original date due to a snow storm. We plan to schedule again sometime in early 2016 which will represent the 10 year anniversary of the Agency's transfer back under the HQDA G-3/5/7 and hope to see you all there!

Establishment and Growth of Joint Radiological and Nuclear Defense

LTC Valentin Novikov (Retired)
United States Army

Lessons learned from the Fukushima reactor incident and Operation Tomodachi served as the impetus for a Joint radiological and nuclear defense initiative. The initiative began with the establishment of the Joint Project Manager for Radiological and Nuclear Defense (JPM-RND) within the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) at Aberdeen Proving Ground, Maryland. JPM-RND was established first as a provisional office in June 2011, and then officially activated on 17 December 2013. JPM-RND is responsible for the research, development, acquisition, fielding, and life cycle support of joint radiological and nuclear defense systems that support The National Military Strategy of the United States of America, 2011: Redefining America's Military Leadership.

Establishing the Foundation

As the acquisition organization was being established, relationships and partnerships were created across the radiological and nuclear defense community that were critical to the initiative's long term success. Working closely with the Office of the Deputy Assistant Secretary for Nuclear Matters (DASD (NM)), the military departments, the Defense Threat Reduction Agency, the Joint Staff, the Army's Test and Evaluation Command, the interagency and our allies, JPM-RND collaboratively develops and delivers radiological and nuclear defense capabilities to support the warfighters, our Nation, and our allies.

Unlike the U.S. Department of Defense (DOD) Chemical and Biological Defense Program, which was established at congressional direction, the joint radiological and nuclear defense acquisition initiative is sponsored by the DASD (NM) and the four military Services. The research and development is being funded by the DASD (NM), which also provides minimal procurement funding to start production and to achieve initial national response capabilities. The Services provide procurement funding for quantities needed to fulfill their total system requirements, providing capabilities needed for their respective missions.

The Defense Threat Reduction Agency, Nuclear Technologies (DTRA-J9/NT), provides Science and Technology support for the programs while leveraging pre-established agreements with the Interagency and International partners to pull in insights from others seeking similar capabilities. The partnership between DTRA-J9/NT and JPEO-CBD was informally established in 2011 and later codified in the 12 May 2014 Translational Teaming Agreement between the two agencies.

In Jan 2013, the Joint Staff's Joint Requirements Office (JRO) stood up the RN Integrated Concept Team which was the first formal joint requirements forum specifically focused on RN needs; and in Jan 2015 a Joint Requirements Oversight Council Memorandum was signed validating the first joint RN Defense requirement for the Radiological Detection System. In addition to the JRO's efforts, the Army Maneuver Support Center of Excellence is sponsoring several new requirements for RN defense, some of which have potential joint applications. All the Services have been providing subject matter experts in support of requirements development and acquisition efforts.

The Army Test and Evaluation Command was established as the lead Operational Test Agency and DUSA T&E as the Test Executive for Joint RN Defense. In addition, the Interagency (DOE/National Labs and DHS/DNDO) and the International Community (United Kingdom and Canada) have offered to assist and collaborate with RN Defense testing and infrastructure support. Agreements and Project Arrangements are being worked to codify this collaborative approach.

These agreements and relationships provide the foundation for Joint RN Defense acquisitions to succeed; and those involved are collaboratively leveraging efforts to reduce costs and achieve interoperability where possible.

Modernization of Legacy Passive Defense and Consequence Management Capabilities.

Currently funded efforts include replacement of the Army AN/PDR-77 and AN/VDR-2 Radiac Sets, Marine AN/PDR-77 Radiac Set, Navy Multifunction Radiac, and Air Force ADM-300 series instruments with a common joint system—the Radiological Detection System (RDS). This constitutes the first DOD joint radiological modernization acquisition program.

The RDS will employ different probes for alpha, beta, gamma, x-ray, and neutron detection; and it will consist of an open architecture that enables the upgrade of probes in response to emerging technological advancements, alleviating the need for future replacement of the entire system. And because the RDS will be a joint system that is common to all Services (and will also be used by the U.S Coast Guard), it will enable interoperability with common units of measure.

Furthermore, unlike the stand-alone

legacy equipment, the RDS will be able to interface with the military global positioning system (GPS). This will allow the RDS to capture the location and date-time group information from the GPS and to store it with the radiation detection information for use in creating a Chemical Biological, Radiological, and Nuclear (CBRN) 4 report[1]. It will also be possible to plug the RDS into a military radio, such as the PRC-154A Rifleman Radio, to transmit the data for the CBRN 4 report. If a radio is not readily available, the RDS will store the data needed to create multiple CBRN-4 reports that can be downloaded onto a computer at the end of the reconnaissance mission. These system improvements will address two of the lessons learned during Operation Tomodachi.[2] The first systems are anticipated to be fielded to units beginning in FY 20.

Due to an extended procurement timeline of the legacy AN/PDR-75, advancements in technology have enabled a buy of the AN/PDR-75A that of is vastly improved, smaller, lighter-weight, easier to use and has significantly better detection capability than the legacy AN/PDR 75. In FY14, JPM-RND completed fielding the AN/PDR-75A Tactical Dosimeter Systems to Army units that did not have legacy AN/PDR-75 dosimeters. Although the AN/PDR-75A was originally only planned to fulfill the remaining legacy AN/PDR 75 shortfalls within the Army, the PDR-75A's significant enhancements over the legacy system has resulted in the recent procurement of additional systems for the Army Reserves to replace many of their aging legacy systems. The AN/PDR-75A, like its predecessor, is a stand-alone system that requires the operator to manually record each Soldier's exposure data. However, a key benefit not found in its predecessor is the ability of the AN/PDR-75A to capture accurate, low-level exposure data that can be placed in the Soldier's medical record. The completion of the Army Reserve's AN/PDR 75-A fielding is anticipated in early FY 16.

JPM-RND is collaborating with the Navy on the development of a new Joint Personal Dosimeter (JPD) that can be used to replace the obsolete Navy IM-270 Casualty Dosimeter and the aging Army AN/PDR-75 dosimeter. In addition to capabilities similar to the AN/PDR-75A (such as capabilities of detecting low-level exposures during events like Operation Tomodachi and high-level exposures from tactical nuclear events), the JPD will be capable of being plugged into a computer to download Soldiers' exposure information. This will make entering the information in Soldiers' medical records easier and will reduce the possibility of transcription errors. It will also improve interoperability across the Services. JPM-RND will begin testing to verify the suitability and effectiveness of the JPD for use by ground forces in FY 16; fielding of the AN/PDR-75 replacement is anticipated to begin in FY 17.

JPM-RND, in collaboration with science and technology partners at the Defense Threat Reduction Agency, has developed several proposals for future programs to provide additional modernization capabilities. These include platform mounted radiological detection for ships to replace the aging Navy AN/PDR-65 warning and protection for critical infrastructure, forward operating bases, and fixed sites. This capability is expected to be available in multiple configurations for use, including perimeter-mounted configurations on forward operating bases, vehicle-mounted configurations, including perimeter-mounted configurations on forward operating bases, vehicle mounted configurations, and configurations that can be carried with Soldiers' load-bearing equipment. Proposals also include a squad level dosimeter to replace the aging Army and Marine UDR-13 Radiac Set, and the technical refreshment of medium resolution radioisotope detectors that will be required in the future. These radiological sensors will be network-capable so that they can automatically report contamination in excess of background levels for example to the bridge of the ship, installation mission command centers, or vehicle commanders.

Development of Future Interdiction, Elimination, and Forensics Capabilities

In addition to developing and acquiring radiological and nuclear defense capabilities in support of CBRN passive defense and consequence management, JPM-RND will provides acquisition support for radiological and nuclear interdiction, elimination, and forensics needs. JPM-RND is collaborating with the Maneuver Support Center of Excellence (MSCoE) and the U.S. Army Chemical, Biological, Radiological and Nuclear School (USACBRNS) on a future program to support search and identification of radiological and nuclear materials of interest, called the Man-Portable Radiological Detection System (MRDS), during sensitive-site assessment and exploitation missions. The system components include the Man-Portable Radiological Identification System, a communications package containing radios to transmit real-time data from the Man-Portable Radiological Identification System, and computers with a situational awareness tool. The Man-Portable Radiological Identification System consists of two components: a hands-free search device commonly known as a backpack detector and a handheld Radionuclide Isotope Identification Detector. The backpack detector allows the rapid interrogation of suspect areas to presumptively identify radiological materials of interest. The Radionuclide Isotope Identification Detector enables a detailed inspection of these areas to provide field confirmatory identification of the materials of interest and theater confirmatory identification of isotopes during sensitive-site exploitation missions. With the backpack detectors, radios, and computers containing the situational awareness tool, Soldiers will be able to safely and efficiently conduct initial-entry operations at suspect facilities to determine potential locations of materials of interest. Using the Radionuclide Isotope Identification Detectors, radios, and computers with the situational awareness tool, Soldiers will also be able to safely and effectively interrogate and characterize the suspect materials to accurately identify isotopes during sensitive-site assessment and exploitation missions. The communications package will enable the mission commander to see and track the progress of the initial-entry and characterization teams in finding and positively identifying the materials found. The MRDS requirement is currently in formal staffing for approval. In January 2015, MSCoE initiated the development of new requirement documentation that will address the need for airborne and vehicle-mounted search and identification capabilities that include airborne video recon and radiological mapping, which cuts across multiple mission areas.

The Way Forward

During summer 2014, JRO in coordination with the Services conducted an analysis of the radiological and nuclear passive defense capability investment areas. The results of this analysis identified three high priority areas, which are isotope identifiers, manned platform mounted detectors, and wide area unique search. Recently, JPM-RND and DTRA J9 Nuclear Technologies Directorate presented eleven capabilities within these three investment areas that could be initiated in the near term with relatively mature technologies. Service prioritization of these capabilities will help to determine the next joint requirements that will be documented by JRO and will also inform future Joint radiological and nuclear defense budget requests.

Conclusion

Although JPM-RND has only begun two acquisition programs (RDS and JPD) to date, it has proactively coordinated with other domestic and international organizations to understand the required capabilities for supporting future technologies and to develop cost-effective, collaborative acquisition strategies for the Soldiers, Marines, Sailors, Airmen, and Coast Guardsmen who are at the tip of the spear for the radiological and nuclear defense of the Nation. The foundation has been laid to achieve success, new capabilities are being developed and fielded, and Joint Staff and Service priorities and requirements are being established that will determine the future of Joint radiological and nuclear defense.

Endnotes

1. A sample CBRN 4 report (Reconnaissance, Monitoring, and Survey Results) is available in Graphic Training Aid (GTA) 03-06-008, CBRN Warning and Reporting System; Headquarters, U.S. Army Chemical, Biological, Radiological, and Nuclear School; October 2011.
2. Operation Tomodachi was a U.S. armed forces operation that provided disaster relief support to Japan following the 2011 Tōhoku earthquake and tsunami and the resulting Fukushima Daiichi nuclear incident.

References

1. The National Military Strategy of the United States of America, 2011: Redefining America’s Military Leadership, DOD, 11 December 2012.

BIOGRAPHY

Lieutentant Colonel Novikov, who retired as a chemical officer with 25 years of service in the Army, is the deputy Joint Project Manager for Radiological and Nuclear Defense. He holds a bachelor's degree in computer science from Hawaii Pacific University and master's degrees in operations research and industrial engineering from the University of Texas at Austin and national security and strategic studies from the U.S. Naval War College, Newport, Rhode Island. He was previously assigned as the Chief for Strategic Initiatives at the Joint Program Executive Office for Chemical and Biological Defense. His email address is valentin.novikov.civ@mail.mil.

FA52 Technical Support to the Radiological Detection System (RDS): The First Joint, Networked Radiation Detector

MAJ Jayna B. Reichert
United States Army Nuclear and Countering WMD Agency

System Overview. The RDS is a Joint Services Acquisition Category III program that will provide Joint Warfighters with a ruggedized Radiation Detection, Indication, and Computation (RADIAC) meter for near-real-time radiation monitoring. The RDS will consist of a handheld base unit and multiple detector probe options to measure alpha, beta, gamma, neutron, and low energy x-rays at or better than legacy equipment. A new feature enables fusion of measurement information with geolocation data for transmission via the tactical network. The RDS is intended to replace DoD's legacy RADIAC survey meters the Army's (AN/PDR-77 and AN/VDR-2, the Air Force's ADM-300, and the Navy's AN/PDQ-1 Multifunction RADIAC (MFR) Suite) as shown in Figure 1. The RDS will provide a Joint solution to increase detection capability, and interoperability while reducing life-cycle costs.

Figure 1. The RDS replaces the Army's AN/PDR-77 RADIAC and AN/VDR-2, the Air Force's ADM-300 Suite, and the Navy's AN/PDQ-1 Multifunction RADIAC (not shown). Images are reproduced with permission from Canberra.

Motivation. In addition to lessons learned from Operation TOMODACHI, both the PDR-77 and VDR-2 were nearing the end of their lifecycles. There was a need for a new RADIAC with interoperable, self-calibrating "smart-probes" with common display units for count rate, dose rate, total dose, and contamination levels dependent on the type of probe and radiation being detected. Along with incorporating geo-location data, the 'Net-Ready' RDS will be capable of providing data for entry on the network an enabling effective information exchanges with higher headquarters. Finally, in a time of fiscal austerity, the RDS program provides a means to avoid redundancy in research, development, and required capability testing and evaluation.

The Process & Our Partners. The support activity to the RDS program followed the framework and mandates of the Defense Acquisition Management System (DAMS) shown in Figure 2. The Joint Requirements Office (JRO) for Chemical, Biological, Radiological,[1] and Nuclear Defense (JRO-CBRND) is the sponsor. The Rad/Nuc-Integrated Concept Team (RN-ICT) provided the official forum for the Services and Combatant Commanders to identify requirements for the RDS based on current Rad/Nuc gaps, directed requirements, and operational lessons learned from events such as TOMODACHI. Within the RN-ICT, Nuclear and Counterproliferation Officers (FA-52s) worked most frequently with the Capabilities Developer[2] from Maneuver Support Center of Excellence (MSCoE) and the Materiel Developer from Joint Project Manager, Radiological & Nuclear Defense (JPM-RND)[3] with additional liaison activity with the 20th CBRNE Command, Defense Threat Reduction Agency (DTRA), and Army Capabilities Integration Center (ARCIC). USANCA provided RN technical expertise to assist the Capabilities Developer within the CWMD Branch, Requirements Determination Division of MSCOE writing the RDS Capabilities Development Document. The Capabilities Developer takes input from stakeholders across the RN community to ensure all concepts of the operation (CONOPs), the Basis of Issue Plan, DOTMLPF assessments were in alignment with directed requirements, the mission, and basic RN-user functionality. JPM-RND requested assistance from FA52's and Health Physicists (HPs) to ensure that the RDS system would meet warfighter needs for modernized, upgraded radiological contamination monitoring and detection to perform a range of missions. JPM-RND's goal for RDS development was to be diverse, robust, and flexible with a least cost solution to meet the Services' requirements. Mr. Valentin Novikov,[4] Deputy JPM-RND, stated the "FA52s and HPs from USANCA and the 20th CBRNE Command provided invaluable assistance to the RDS team's efforts that enabled us to derive technical requirements to define the systems performance specifications for the various types of detection probes within RDS based on the JRO-developed Capabilities Development Document."

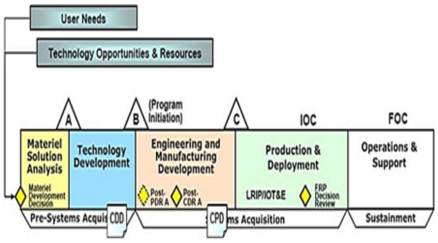

Figure 2. The Defense Acquisition Management System Framework, available from www.acc.dau.mil. FA52 technical input helped generate the Capabilities Development Document (CDD) and Performance Specification (not pictured).

Requirements Generation. The four services, the United Kingdom, and Canada all had representation within the program to ensure Joint requirements and service CONOPs were incorporated into applicable requirements documents. The RDS will support four Counter Weapons of Mass Destruction (CWMD) tasks from the National Defense Strategy for CWMD: Understand the Environment, Threats, and Vulnerabilities; Control; Safeguard the Force and Manage Consequences; and Cooperation With and Support to Partners.[5] Some supported Army CONOPs include: site assessment, monitoring or survey, CBRN reconnaissance and surveillance, and decontamination verification.[6]

NATO's Allied Engineering Publication (AEP)-75 outlines the majority of requirements for portable radiation detectors, to include: radioisotopes of military interest, energy range requirements, probe sensitivity requirements, test and evaluation requirements, and more. Adhering to NATO standards set forth in AEP-75 is required by Army Regulation 10-16. Commonality with NATO standards ensures the RDS will be interoperable with the Coast Guard and potential future allies.[7] DoD 3500.08, Nuclear Accident Response Procedures (NARP), provided requirements for detection and measurement of SNM. The Office of the Secretary of Defense published Clearance Criteria were used to help determine requirements for the measurement of radioactive surface contamination on equipment. Response time and accuracy requirements were determined largely by requirements set forth in ANSI N42.17A & ANSI N42.17C. Electromagnetic Environmental Effects (E3) requirements were derived from requirements in MIL-STD 461F and MIL-STD 464. Additionally, the DoD E3 Integrated Product Team was a valuable resource for spectrum supportability and hardening requirements.

In order to better understand how to integrate the aforementioned technical requirements into DAMS, FA52's should complete Fundamentals of Systems Acquisition Management (Acquisition 101). Acquisition 101 is a 25-credit hour course, available online via the Defense Acquisition University.[8] If supporting acquisitions programs is a FA52's primary duty, Intermediate Systems Acquisition (Acquisition 201) is also recommended.

RN Technical Design Considerations. The RDS will consist of a base unit and six optional probes to provide additional capabilities. Qualitative and quantitative metrics contained in the RDS CDD and P-Spec are not publicly releasable. However, general radiation detection and measurement design considerations that can be applied to any detection system will be discussed here. Radiation detection and indication can be accomplished with the following types of probes: gamma, neutron, alpha/beta, or a beta/gamma "pancake-style" probe. Detection of radioactive surface contamination missions can be supported with a combination of alpha/beta probes, beta/gamma probes, or even small-area beta-contamination probes.

High-energy (greater than 1 MeV) gammas and betas are the easiest to detect and measure. The main sources of concern for gamma and betas are RDDs/REDs, medical and industrial sources, and fission products from a nuclear yield or criticality event. Alpha and low-energy beta radiation have short ranges in air. Thus, even condensation (called overburden) significantly degrade the ability to measure. In some cases, only detection (vice - measurement) of alphas and betas is the plausible outcome. Neutron sources of concern include initial nuclear radiation from emissions from a damaged nuclear reactor, industrial neutron-sources like 241AmBe or 239PuBe, and spontaneous fission events from sources like Californium-252.

Detection of special nuclear material can be accomplished by detecting alphas, betas, or low-energy X-rays. Despite uranium and plutonium being well-documented alpha emitters, alphas can be hard to detect for the above mentioned reasons. Plutonium is best detected by searching for the telltale signature of a 60-keV gamma ray emitted by Am-241. Uranium is best identified by measuring beta emissions from its thorium and protactinium progeny. SNM and their progeny also emit low energy x-rays. Low energy x-rays are defined in the NARP as 17 to 100keV,[9] therefore, the signal can be difficult to discriminate from background and can be further degraded by absorption, source-sensor distance and summation effects. DTRA is a great resource for more information on advanced post-processing software for pulse height discrimination.

The USANCA Team. The USANCA team providing RN technical advice consisted of an FA52 and HP from the Analysis Division and a Senior CBRN Scientist from the Capabilities Division. USANCA's Capabilities Division hosts monthly Army RN Synchronization meetings to facilitate Army concurrence between MSCOE, G-3, G-8, ARCIC, 20th CBRNE Command, AMEDD, and JPM-RND. Other technical partners outside of the Army, such as DTRA's Mobile Field Kit (CBRNE) and NETT Warrior programs, were regularly integrated into Army decision-making on the RDS via this forum.

Endnotes

1. Mr. Christopher McLane, GS-15, Senior CBRN Analyst, Joint Staff/J8-JRO CBRND.
2. Mr. Valentin Novikov.
3. Mr. Valentin Novikov, Deputy Joint Product Manager, Radiological & Nuclear Defense.
4. Ibid.
5. National Defense Strategy for CWMD, May 2013.
6. Mr. John McCann, Capabilities Developer, Material Systems Specialist, Requirements Determination Division MSCOE, Basis of Issue Plan, 27Jan 2014.
7. Mr. Valentin Novikov.
8. Nuclear Weapon Accident Response Procedures (NARP), DoD 3150.8-M, August 2013.
9. Defense Acquisition University Course Catalog, available from **http://icatalog.dau.mil/.**

BIOGRAPHY

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Recovering the Army's Nuclear Battlefield Proficiency

Richard Hart Sinnreich

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In the early 1980s, our South Korea-based 8-inch howitzer battalion, the general support artillery battalion of the Army's 2nd Infantry Division, received a long-awaited consignment of new and improved ammunition, including so-called supercharges, propellant charges 8 and 9.

At the time, the M110A2 howitzer was the Army's most accurate and lethal cannon artillery weapon as well as one of its two nuclear-capable ones. It had one limitation, though: compared with some of the artillery fielded by our putative North Korean adversaries, it lacked range. The new ammunition would help close that gap.

To use it effectively, however, we needed to know how it would perform with our weapons. Like all artillery firing tables, those accompanying the new propellant charges used nominal performance data. To shoot accurately, we needed to correct that data for our own weapons, a live-firing exercise called calibration.

Because of adverse weather, we were able on the first day of shooting to calibrate only four of our 12 howitzers, and those only at charge 8. Accordingly, having duly reported our activities to higher headquarters, we suspended further calibration firing until the following day.

Within hours, however, we received a peremptory order from division headquarters to freeze in place, not expend a single additional round and expect a visit from Eighth Army headquarters. Sure enough, the following morning, a helicopter arrived to disgorge a team of hard-faced officers from Eighth Army.

What, we were asked, did we think that we were doing? Mystified by a question that no field artilleryman would need to ask, we explained that we were calibrating our new ammunition and described the process and why it was necessary.

Our explanation made no impression whatsoever. Instead, we were instructed curtly to pack up immediately, return all unopened charge 8 and 9 propellant canisters to storage and never touch another one without explicit permission from higher headquarters.

It was weeks before we learned the reason for this bizarre overreaction to a routine gunnery procedure. The only purpose for which we had been issued the new propellants, it turned out, was to fire nuclear spotting rounds: conventional projectiles fired in advance of a nuclear delivery to ensure that the latter would land more or less where intended.

Since, for nuclear weapons as for horseshoes and hand grenades, close can be good enough, calibration wasn't deemed essential for that purpose. Instead, we discovered, our well-intended expenditure of four Zone 8 charges had prompted a Serious Incident Report that escalated all the way up to the Joint Chiefs of Staff. No wonder the visitors from Eighth Army were less than cordial.

Only Game In Town

The episode just described was scarcely the first case in which responsibility for ground-based nuclear delivery warred with effective preparation for conventional combat. The Army originally became involved in so-called tactical nuclear warfare in the early days of the

Davy Crockett, shown at Aberdeen Proving Ground, Md., in 1961, used the smallest nuclear warhead the U.S. ever created. (Credit: DoD)

Cold War, when, with the U.S. on the short end of a severe ground force imbalance with the USSR and China, conflict with either nation threatened to involve nuclear weapons from the outset.

With nuclear warfare the only game in town, so to speak, the Army quickly sought its own entries in the race to field nuclear capabilities. Starting in 1953 with the 280 mm Atomic Cannon, a host of theater nuclear delivery systems followed during the next four decades, ranging from the Davy Crockett, a recoilless weapon firing a sub-kiloton nuclear warhead roughly 2 miles—with, on a good day, about the same target error—to Pershing II, a GPS-guided ballistic missile able to strike targets more than 1,000 miles away with pinpoint precision.

Soldiers work with an 8-inch atomic projectile at Los Alamos National Laboratory, N.M.(Credit: U.S. Army)

Those weapons and others in between were designed uniquely for nuclear delivery. Apart from procurement, their principal cost to the Army's conventional capability was the associated commitment of generations of soldiers and leaders to their care and feeding. Not so for the so-called dual-purpose weapons of the Army's cannon artillery—the 155 mm and 8-inch howitzers furnishing the principal fire support of ground combat operations. For those units, among them our battalion in South Korea, maintenance of nuclear proficiency competed in a host of ways with preparedness to perform the conventional fire support mission.

Moreover, given the sensitivities associated with nuclear weapons—sensitivities that only mounted as the years went by, when sustainment of nuclear and conventional proficiency

Pershing II missiles are prepared for test launch at White Sands Missile Range, N.M., in 1987. (Credit: DoD/National Archives)

collided—the former invariably prevailed. Substandard performance in a conventional inspection or training exercise might embarrass the deficient unit's leadership; the slightest failure in nuclear operations threatened fatal career damage. Artillery unit commanders adjusted their priorities accordingly.

Going Nuclear

What made all this especially ironic was the Army's—indeed, anyone's—persistent inability to devise a convincing doctrine for employing tactical nuclear weapons, especially in the most likely context of a war between the Soviet-led Warsaw Pact and NATO. Repeated efforts to create one invariably fell afoul of both operational and strategic problems.

Operationally, every war game and simulation revealed that introduction of nuclear weapons on the battlefield would increase, not diminish, the advantage accruing to the numerically superior combatant. Strategically, no one could convincingly explain how nuclear employment could be confined to the battlefield without quickly escalating to a full-scale strategic nuclear exchange. Meanwhile, some of our NATO allies, notably West Germany, understandably were less than enthusiastic about restricting nuclear warfare to their soil while leaving the two major nuclear powers unscathed, rightly doubting that such a prospect would enhance deterrence.

Both defects applied to all forms of theater nuclear employment, but dual-purpose weapons like ours suffered from an additional problem. While deployment of nuclear-only systems would be unmistakable, that of dual-purpose weapons perforce would be ambiguous. Even their preparation to perform conventional fire support tasks might easily be misread as the precursor to nuclear pre-emption, especially if the associated nuclear warheads were dispersed in a crisis from their well-known, hence easily targeted, special storage locations.

The Army never satisfactorily solved those problems. In the early 1980s, a draft operational concept that attempted to revive the idea of nuclear weapons as tactical fire support prompted a political explosion in Bonn, Germany, and a bitter protest from NATO's supreme allied commander. The concept was quickly shelved, to be replaced not long afterward by AirLand Battle. But NATO's political neuralgia with respect to any tactical use of nuclear weapons lingered to complicate the formulation of Army warfighting doctrine as late as the 1986 revision of Field Manual 100-5 Operations.

In 1989, the implosion of the USSR and the dismantling of the Warsaw Pact rendered the issue moot, at least insofar as Europe was concerned. Two years later, President George H.W. Bush directed that the entire worldwide inventory of ground-launched theater nuclear weapons be returned to the U.S. and destroyed. By December 1991, South Korea had been denuded of artillery-delivered nuclear weapons. Europe's weapons followed, and in July 1992, the president announced that all ground-launched theater nuclear weapons had been returned to the U.S. During the next two years, the Army surrendered the remainder of its nuclear inventory. Few artillerymen shed any tears.

Circumstances Change

And so, until now, matters have remained. But Russia's revanchism in Eastern Europe and China's assertiveness in the Western Pacific, continued North Korean efforts to field a nuclear capability, and the possibility that failed nuclear negotiations with Iran might incentivize nuclear proliferation elsewhere in the Middle East have led some to wonder whether the U.S. might have been too hasty in abandoning what some have come to call—inaccurately—nonstrategic nuclear weapons.

As one former director of America's premier nuclear weapons research center argued not long ago, the U.S. should at least prototype small-yield nuclear weapons suitable for precision delivery, including electromagnetic pulse weapons to attack hostile communications systems and a penetrating warhead to destroy deeply buried targets.

More recently, Russia's imminent fielding of a new nuclear-capable cruise missile in what the U.S. considers to be a violation of 1987's Intermediate-Range Nuclear Forces Treaty, and the possibility that Russian President Vladimir Putin might position nuclear weapons in the newly re-annexed Crimea despite the 1994 Budapest Accord denuclearizing Ukraine, has led some to argue for reciprocal U.S. theater nuclear deployments to Europe.

The weapons in question of course wouldn't have to be ground-based, let alone Army-owned. Cruise missiles can be launched from sea and air, and both they and old-fashioned nuclear bombs are the province of the Navy and Air Force. The only remaining Army nuclear-capable missiles are in museum displays, their warheads long since destroyed or repurposed, while the Department of Energy dismantled the Army's last nuclear artillery projectile in December 2003.

Meanwhile, the operational and strategic drawbacks to using such weapons have in no way diminished since the U.S. abandoned them; neither has the likely political resistance in Europe to their reintroduction on European soil. Meanwhile, even maintaining the strategic deterrent has proved a mounting challenge for the Army's sister services. Many of today's deployed nuclear warheads are antiquated, and both the Navy and the Air Force have been plagued by troublesome security, training and morale problems among personnel committed to a capability whose employment remains as unlikely as sustaining it remains onerous.

With no such residual capability, the Army has been spared those problems, but it wasn't just nuclear warheads that the Army surrendered more than a decade ago. With them disappeared most of the Army's nuclear warfare-related doctrinal attention and virtually all of its education and training in areas ranging from nuclear targeting to conducting conventional operations under nuclear threat. FM 100-30, the Army's basic field manual on nuclear operations, was published for the last time in 1996, while its principal remaining repositories of radiological defense expertise are limited to the Army's Chemical, Biological, Radiological and Nuclear (CBRN) School and a Department of the Army field agency with fewer than 40 people, recently more consumed by Ebola than nuclear warfare.

It's above all that loss of doctrinal attention and institutional learning that has some observers concerned. No one—certainly no soldier—is calling for a modern version of the Davy Crockett, but as long as other nations retain—and nonstate actors pursue—the ability to employ nuclear weapons on a future battlefield, the Army can't afford to ignore the possibility that one of them might decide to do so, however strategically unwise such a decision might prove.

We don't need to revisit the days of technical proficiency inspections, emergency action messages and painted truck tires, nor should the Army contemplate diverting already overstretched dollars and manpower to a nuclear delivery capability that never contributed convincingly to either deterrence or warfighting. But neither budget nor force structure limitations prevent us from thinking about, writing about and wargaming the battlefield nuclear problem.

It wouldn't hurt to bring FM 100-30 up to date and to reinfuse examination of nuclear operations and operations in conditions of nuclear threat into Army professional military education courses. While ground commanders may no longer be responsible for executing battlefield nuclear strikes, they should study how best to exploit the effects of such weapons if delivered and, in addition to CBRN training aimed at individual soldier survival, how best to preserve tactical coherence and freedom of action in the event of similar strikes by a nuclear-armed adversary.

Study and learning are one form of military effort that costs relatively little. The Army once devoted a considerable mental effort to nuclear warfare. We can all pray that the nuclear genie remains bottled, but against the possibility—however remote—that it might escape, reinvesting even a modicum of that effort might one day produce a hugely disproportionate, if regrettably necessary, return.

BIOGRAPHY

Richard Hart Sinnreich retired from the U.S. Army in 1990. A 1965 West Point graduate, he earned a master's degree in foreign affairs from Ohio State University and is a graduate of the Army's Command and General Staff College, the National War College and the Advanced Military Studies Program. He helped found the Army's School of Advanced Military Studies and published widely in military and foreign affairs while on active duty. In 1977, he drafted NATO's Theater Nuclear Force Improvement Study and wrote the final draft of FM 100-5 Operations in 1986. Since retiring from military service, Sinnreich has worked as an independent consultant, columnist and historian.

Army Nuclear Targeting Tools through the Ages

Dr. Martin W. Moakler, Jr.
United States Army Nuclear and Countering WMD Agency

According to AR 600-3, Nuclear Operations and Counterproliferation Officers, Functional Area 52 (FA52) officers are "warfighters who provide the Army with a technically educated, operationally experienced and highly trained cadre specializing in all aspects of nuclear and combating WMD strategic and operational level planning and execution." FA52 officers "possess five functional competencies: strategy, plans, policy and operations; research, development and capabilities; doctrine, education and training; modeling and simulation; and combating WMD." Inherent responsibilities of the FA52 officer are to have a unique understanding of nuclear effects, limitations posed by radioactive contamination, and consequence management during post-blast crisis operations to advise commanders concerning operations on the nuclear battlefield. Of course, this necessitated that the FA52 officer have unique proficiency in nuclear targeting, preclusion analysis, and consequence management of the applications of nuclear weapons on targets. Throughout the years, FA52 officers have used nuclear effects computational aides, fast running computational algorithms, and generated staff planning tables to assist in their nuclear weapons effects staffing and planning. The US Army Nuclear and Countering WMD Agency (USANCA), in conjunction with the Defense Threat Reduction Agency (DTRA), have produced many of these nuclear weapon effects staff computational aides, which many of the "old timers" & "targeteers" fondly remember as they planned nuclear operations. USANCA has always had a close symbiotic relationship with DTRA, and its predecessor organization, the Defense Nuclear Agency, in the development and use of these numerous computational aides and tools. As technology improved over time, these computational tools developed from generated lookup tables to effects "whiz" wheels to TI59 programmable calculators to IBM DOS 5 ½" floppies to the current advance computer effects prediction models that DTRA supports. The purpose of this article is to take the nuclear targeteer trip down memory lane and relive those days of slide rulers and $150 calculators that could not take the squared root of a number. Back to the days where the Field Artillery was truly the King of the Battle with nuclear artillery and the Engineers had atomic demolitions. Back to the day when solitary FA52 officers planned nuclear operations without a computer. I hope that you enjoy this brief piece of Army history.

USANCA and its predecessor organization, the US Army Nuclear Agency (USANA), prepared staff officer field manuals for the Army providing doctrine and effects look-up tables to aid staff planners. Next, USANCA published the Joint Publication 3-12 series for the Joint Staff and USSTRATCOM, in which the Army incorporated into its nuclear doctrine and nuclear weapons effects planning. Every FA52 planner would have these documents in their reference library to plan nuclear operations. Below are the covers of some of the manuals published for nuclear operations planning.

Nuclear effect look-up tables for each nuclear weapon were calculated and published by USANCA in manuals such as those depicted on the next page. In particular, nuclear weapons effects tables for safety distances (troop safety, damage preclusion, and collateral damage distances), personnel effects, materiel damage effects, and target area coverage were calculated and published by USANCA. Depicted are unclassified representative samples of these tables (see Figure 1 & 2).

Another lost art in nuclear staff planning is nomograms. A nomogram (from Greek nomos, "law" and grammē, "line"), also called a nomograph, is a graphical calculating device; a two-dimensional diagram designed to allow the approximate graphical computation of a function (Nomogram, 2015). The field of nomograms was used extensively for many years to provide engineers with fast graphical calculations of complicated formulas to a practical precision (Nomogram, 2015). A nomogram consists of a set of n scales, one for each variable in an equation (Nomogram, 2015). Knowing the values of n-1 variables, the value of the unknown variable can be found by laying a straightedge across the known values on the scales and reading the unknown value from where it crosses the scale for that variable (Nomogram, 2015).

DEPARTMENT OF THE ARMY FIELD MANUAL FM 101-31-1
MARINE CORPS FLEET MARINE FORCE MANUAL FMFM 11-4

Staff Officers' Field Manual

Nuclear Weapons Employment Doctrine And Procedures

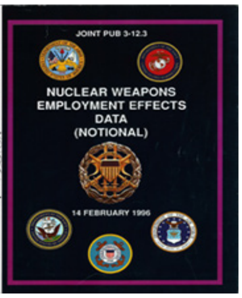
MARCH 1977

Change 1
FM 101-31-3
NWP 28-0-3
AFP 200-31 VOL III
FMFM 11-4B

STAFF OFFICERS FIELD MANUAL

Nuclear Weapons Employment Effects Data

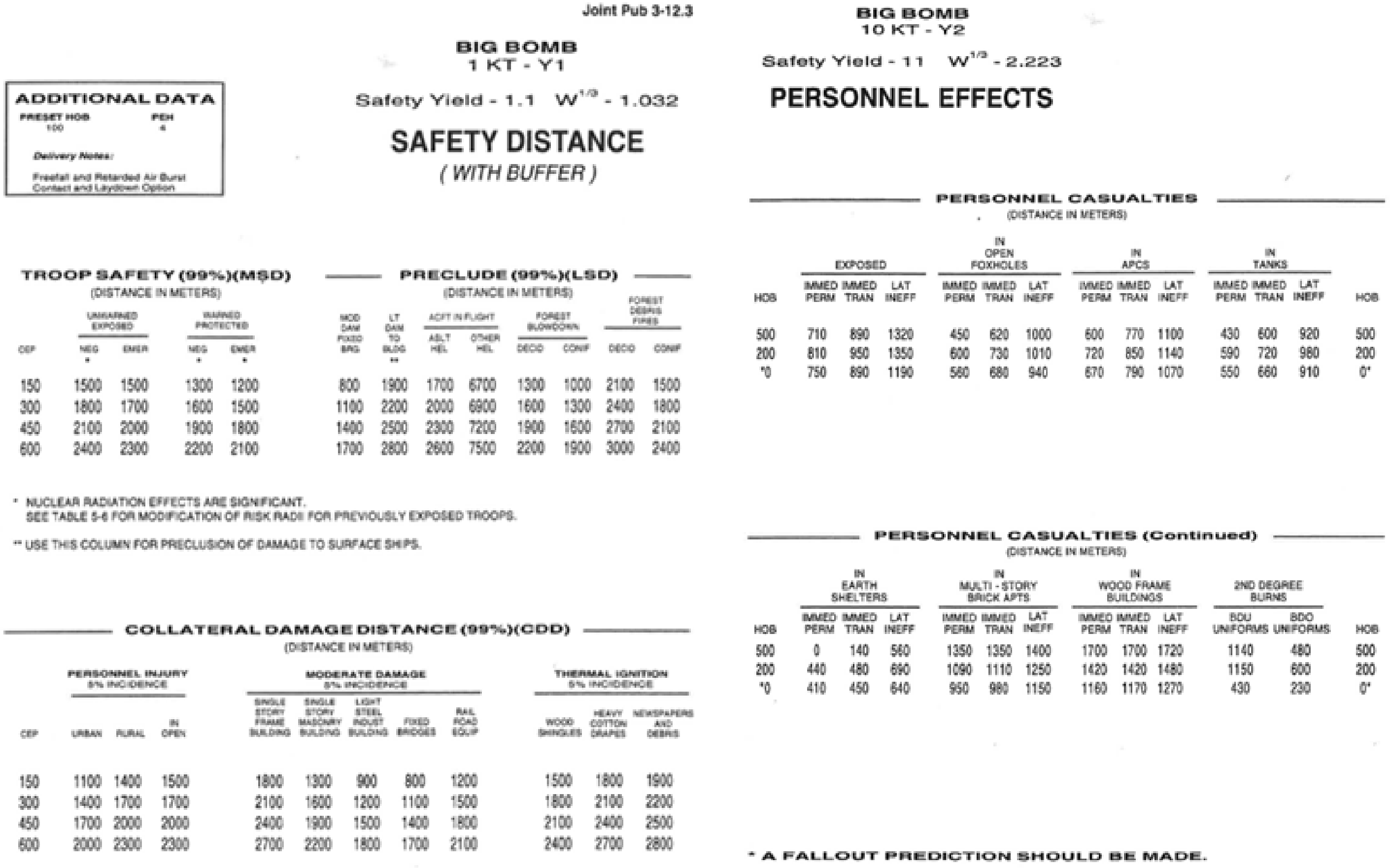
HEADQUARTERS, DEPARTMENTS OF THE ARMY, NAVY, AND AIR FORCE



JOINT PUB 3-12.3

NUCLEAR WEAPONS EMPLOYMENT EFFECTS DATA (NOTIONAL)

14 FEBRUARY 1996



Joint Pub 3-12.3

ADDITIONAL DATA

PRESET HOB 100 PEH 4

Delivery Notes:

Freefall and Retarded Air Burst
Contact and Laydown Option

BIG BOMB
1 KT - Y1

Safety Yield - 1.1 $W^{1/3}$ - 1.032

SAFETY DISTANCE
(WITH BUFFER)

TROOP SAFETY (99%)(MSD) (DISTANCE IN METERS) — **PRECLUDE (99%)(LSD)** (DISTANCE IN METERS)

	UNWARNED EXPOSED		WARNED PROTECTED				ACFT IN FLIGHT		FOREST BLOWDOWN		FOREST DEBRIS FIRES	
CEP	NEG *	EMER	NEG *	EMER *	MOD DAM FIXED BRG	LT DAM TO BLDG **	ASLT HEL	OTHER HEL	DECID	CONIF	DECID	CONIF
150	1500	1500	1300	1200	800	1900	1700	6700	1300	1000	2100	1500
300	1800	1700	1600	1500	1100	2200	2000	6900	1600	1300	2400	1800
450	2100	2000	1900	1800	1400	2500	2300	7200	1900	1600	2700	2100
600	2400	2300	2200	2100	1700	2800	2600	7500	2200	1900	3000	2400

* NUCLEAR RADIATION EFFECTS ARE SIGNIFICANT.
SEE TABLE 5-6 FOR MODIFICATION OF RISK RADII FOR PREVIOUSLY EXPOSED TROOPS.

** USE THIS COLUMN FOR PRECLUSION OF DAMAGE TO SURFACE SHIPS.

COLLATERAL DAMAGE DISTANCE (99%)(CDD)
(DISTANCE IN METERS)

	PERSONNEL INJURY 5% INCIDENCE			MODERATE DAMAGE 5% INCIDENCE					THERMAL IGNITION 5% INCIDENCE		
CEP	URBAN	RURAL	IN OPEN	SINGLE STORY FRAME BUILDING	SINGLE STORY MASONRY BUILDING	LIGHT STEEL INDUST BUILDING	FIXED BRIDGES	RAIL ROAD EQUIP	WOOD SHINGLES	HEAVY COTTON DRAPES	NEWSPAPERS AND DEBRIS
150	1100	1400	1500	1800	1300	900	800	1200	1500	1800	1900
300	1400	1700	1700	2100	1600	1200	1100	1500	1800	2100	2200
450	1700	2000	2000	2400	1900	1500	1400	1800	2100	2400	2500
600	2000	2300	2300	2700	2200	1800	1700	2100	2400	2700	2800

BIG BOMB
10 KT - Y2

Safety Yield - 11 $W^{1/3}$ - 2.223

PERSONNEL EFFECTS

PERSONNEL CASUALTIES
(DISTANCE IN METERS)

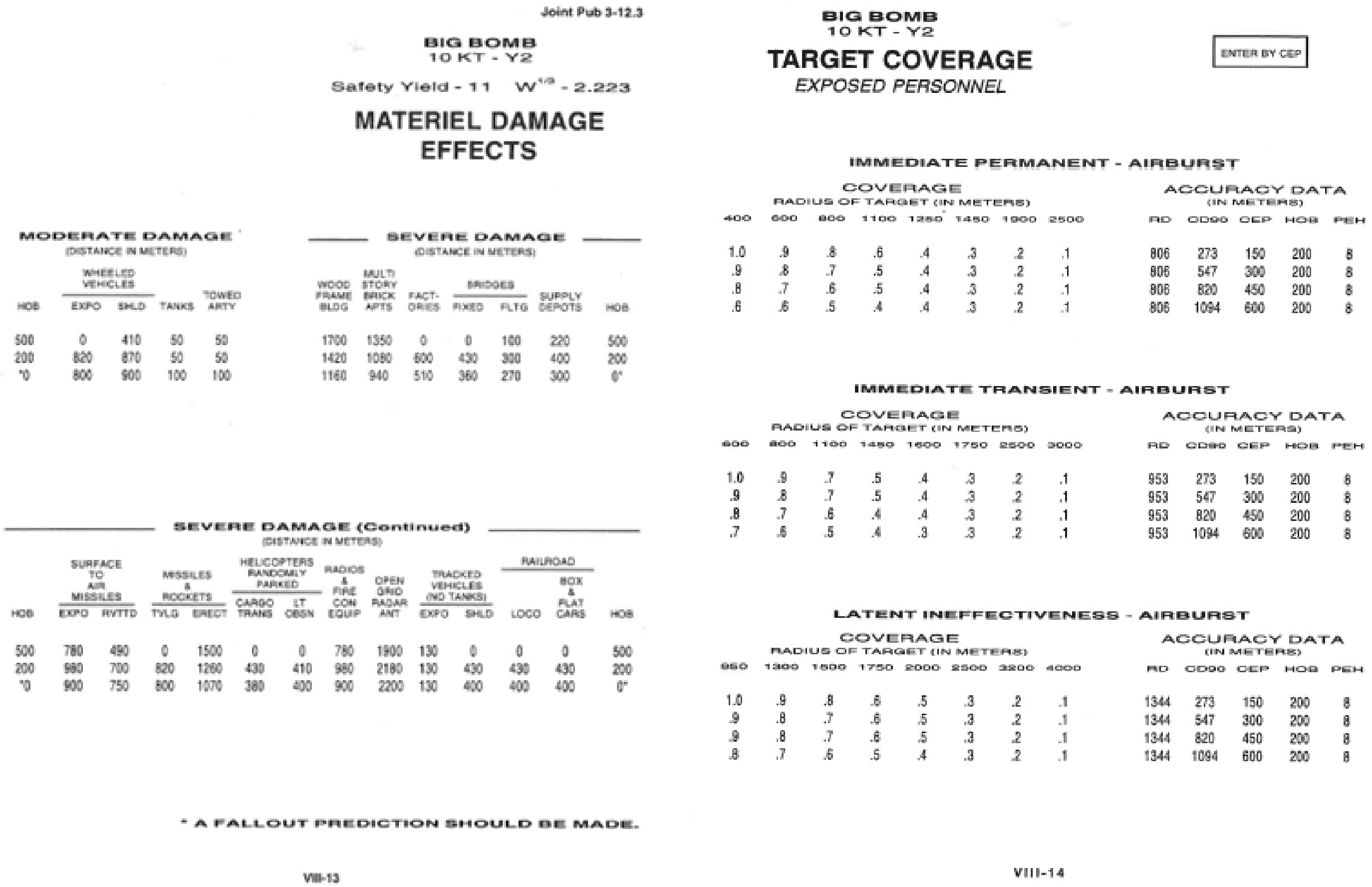
	EXPOSED			IN OPEN FOXHOLES			IN APCS			IN TANKS			
HOB	IMMED PERM	IMMED TRAN	LAT INEFF	IMMED PERM	IMMED TRAN	LAT INEFF	IMMED PERM	IMMED TRAN	LAT INEFF	IMMED PERM	IMMED TRAN	LAT INEFF	HOB
500	710	890	1320	450	620	1000	600	770	1100	430	600	920	500
200	810	950	1350	600	730	1010	720	850	1140	590	720	980	200
*0	750	890	1190	560	680	940	670	790	1070	550	660	910	0*

PERSONNEL CASUALTIES (Continued)
(DISTANCE IN METERS)

	IN EARTH SHELTERS			IN MULTI - STORY BRICK APTS			IN WOOD FRAME BUILDINGS			2ND DEGREE BURNS		
HOB	IMMED PERM	IMMED TRAN	LAT INEFF	IMMED PERM	IMMED TRAN	LAT INEFF	IMMED PERM	IMMED TRAN	LAT INEFF	BDU UNIFORMS	BDO UNIFORMS	HOB
500	0	140	560	1350	1350	1400	1700	1700	1720	1140	480	500
200	440	480	690	1090	1110	1250	1420	1420	1480	1150	600	200
*0	410	450	640	950	980	1150	1160	1170	1270	430	230	0*

* A FALLOUT PREDICTION SHOULD BE MADE.

Figure 1: Safety Distance And Personnel Effects Table Examples



Joint Pub 3-12.3

BIG BOMB
10 KT - Y2

Safety Yield - 11 $W^{1/3}$ - 2.223

MATERIEL DAMAGE EFFECTS

MODERATE DAMAGE
(DISTANCE IN METERS)

	WHEELED VEHICLES			
HOB	EXPO	SHLD	TANKS	TOWED ARTY
500	0	410	50	50
200	820	870	50	50
*0	800	900	100	100

SEVERE DAMAGE
(DISTANCE IN METERS)

WOOD FRAME BLDG	MULTI STORY BRICK APTS	FACT-ORIES	BRIDGES FIXED	BRIDGES FLTG	SUPPLY DEPOTS	HOB
1700	1350	0	0	100	220	500
1420	1080	600	430	300	400	200
1160	940	510	360	270	300	0*

SEVERE DAMAGE (Continued)
(DISTANCE IN METERS)

	SURFACE TO AIR MISSILES		MISSILES & ROCKETS		HELICOPTERS RANDOMLY PARKED				TRACKED VEHICLES (NO TANKS)		RAILROAD		
HOB	EXPO	RVTTD	TYLG	ERECT	CARGO TRANS	LT OBSN	RADIOS & FIRE CON EQUIP	OPEN GRID RADAR ANT	EXPO	SHLD	LOCO	BOX & FLAT CARS	HOB
500	780	490	0	1500	0	0	780	1900	130	0	0	0	500
200	980	700	820	1260	430	410	980	2180	130	430	430	430	200
*0	900	750	800	1070	380	400	900	2200	130	400	400	400	0*

* A FALLOUT PREDICTION SHOULD BE MADE.

VIII-13

BIG BOMB
10 KT - Y2

TARGET COVERAGE
EXPOSED PERSONNEL

ENTER BY CEP

IMMEDIATE PERMANENT - AIRBURST

COVERAGE RADIUS OF TARGET (IN METERS) 400	600	800	1100	1250	1450	1900	2500	ACCURACY DATA (IN METERS) RD	CD90	CEP	HOB	PEH
1.0	.9	.8	.6	.4	.3	.2	.1	806	273	150	200	8
.9	.8	.7	.5	.4	.3	.2	.1	806	547	300	200	8
.8	.7	.6	.5	.4	.3	.2	.1	806	820	450	200	8
.6	.6	.5	.4	.4	.3	.2	.1	806	1094	600	200	8

IMMEDIATE TRANSIENT - AIRBURST

COVERAGE RADIUS OF TARGET (IN METERS) 600	800	1100	1450	1600	1750	2500	3000	ACCURACY DATA (IN METERS) RD	CD90	CEP	HOB	PEH
1.0	.9	.7	.5	.4	.3	.2	.1	953	273	150	200	8
.9	.8	.7	.5	.4	.3	.2	.1	953	547	300	200	8
.8	.7	.6	.4	.4	.3	.2	.1	953	820	450	200	8
.7	.6	.5	.4	.3	.3	.2	.1	953	1094	600	200	8

LATENT INEFFECTIVENESS - AIRBURST

COVERAGE RADIUS OF TARGET (IN METERS) 950	1300	1500	1750	2000	2500	3200	4000	ACCURACY DATA (IN METERS) RD	CD90	CEP	HOB	PEH
1.0	.9	.8	.6	.5	.3	.2	.1	1344	273	150	200	8
.9	.8	.7	.6	.5	.3	.2	.1	1344	547	300	200	8
.9	.8	.7	.6	.5	.3	.2	.1	1344	820	450	200	8
.8	.7	.6	.5	.4	.3	.2	.1	1344	1094	600	200	8

VIII-14

Figure 2: Materiel Damage Effects And Target Coverage Table Examples

Nomograms flourished in many different contexts for roughly 75 years because they allowed quick and accurate computations before the age of pocket calculators and personal computers (Nomogram, 2015). Results from a nomogram are obtained very quickly and reliably by simply drawing one or more lines, and the user does not even need to know the actual equation used to calculate the result (Nomogram, 2015). Depicted in Figure 3 are representative examples of nomograms used in nuclear staff planning.

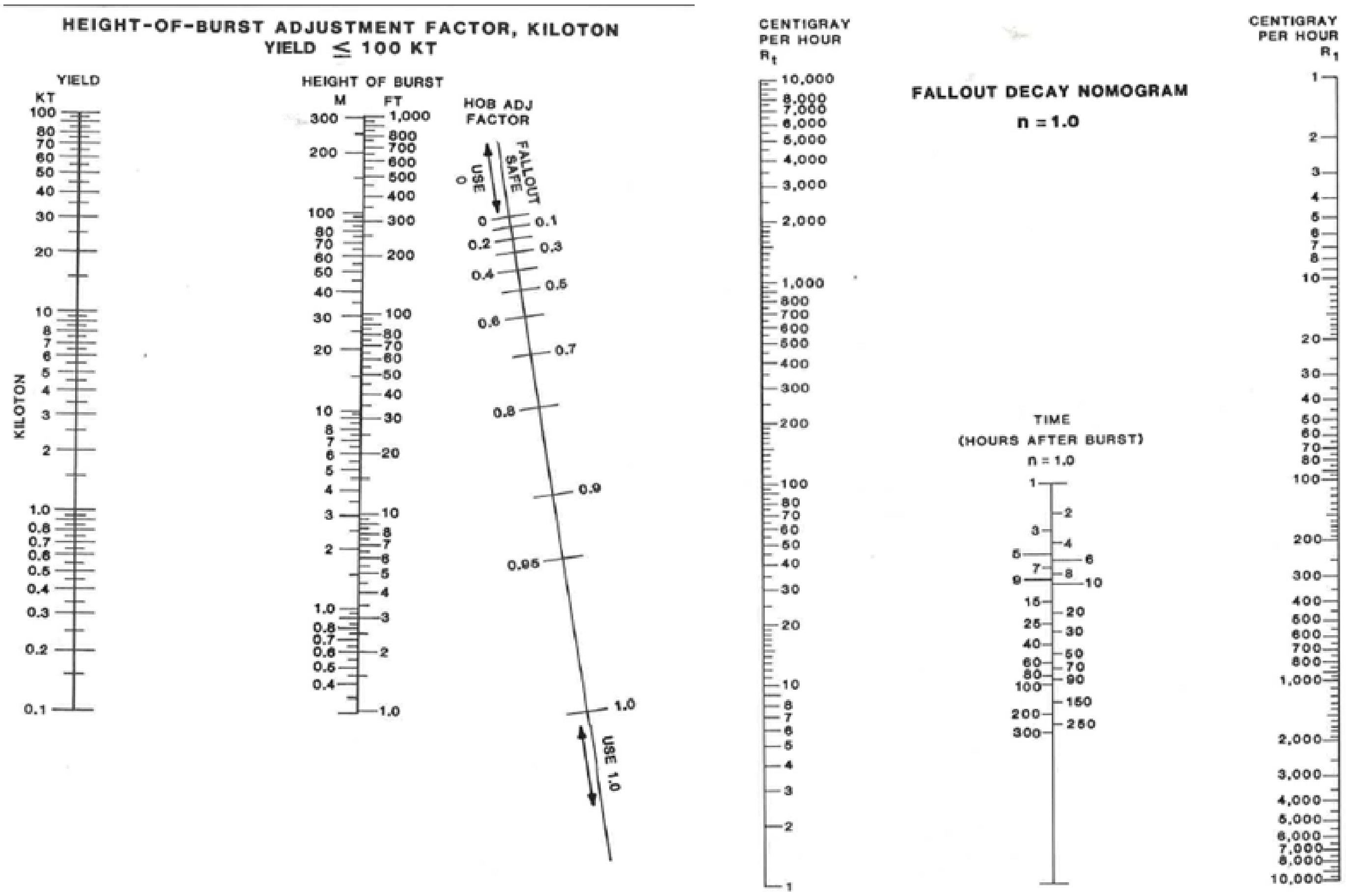


Figure 3: Nomogram Examples

The next advancement in nuclear operation staff planning aides was the Graphic Training Aides or fondly referred to "Whiz Wheels." They were very similar in concept to the paper nomograms, but typically prepared on plastic making the tool more ruggedized and handy for the staff planner. If you were issued one of the original printing of "The Effects of Nuclear Weapons," by Glassstone and Dolan dated 1977, you found the Nuclear Bomb Effects Computer (see Figure 4) in a paper pocket glued to the back cover. This computer is highly coveted today and sporadically seen on Ebay for a price (my recent Ebay search showed it for $100). Reprints of the 1977 edition of "The Effects of Nuclear Weapons" has a mapping to the equivalent DOS Computation Aides computer programs associated with the desired effect being researched, which could be requested from the Defense Nuclear Agency, today the DTRA.

A plethora of these whiz wheels were produced to assist nuclear planners. The Defense Nuclear Agency produce numerous aides, such as blast prediction (Figure 5), Cratering Prediction (Figure 6), and Weapons Effects (Figure 7). The Army also got involved in making effects graphic aides. Shown here are the Tactical Nuclear Slide Rule made by Harry Diamond Laboratory (Figure 8) and the RADIAC Calculator Set – GTA 8-5-57 (Figure 9).

As technology advanced, the Army nuclear staff planners began using the TI-59 Programmable Calculator to predict nuclear weapons effects (Figure 10). The Defense Nuclear Agency produced removable firmware memory chips, which were inserted in the back of the TI-59 Calculator that held the computational code for various nuclear weapons effects (Figure 11). The planner could load preset variables into the TI-59 registers using a magnetic strip (Figure 12). Results could be tabulated to paper using the printer cradle with thermographic paper, which would print the values of the TI-59 registers or variable inputs and outputs for record retention. As the personal computers (PC) came on the scene in the mid-1980s, the Defense Nuclear Agency provided the Army with IBM DOS program codes, first 5 ¼ inch floppies and later CDs, which could be loaded on their unit's PCs. This greatly increased the capability and efficiency of the nuclear planner. Meanwhile in the 1980's and 1990's, USANCA continued to produce weapons effects lookup tables using more sophisticated computers, such as the Sun Microsystem UNIX-based Scalable Processor Architecture (SPARC) and the Digital Equipment Corporation (DEC) VAX minicomputers.

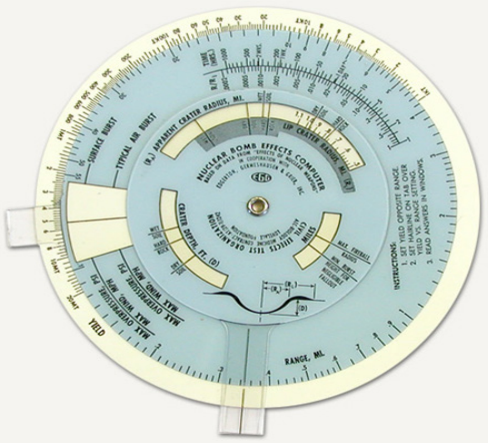


Figure 4: Nuclear Bomb Effects Computer – Glassstone & Dolan

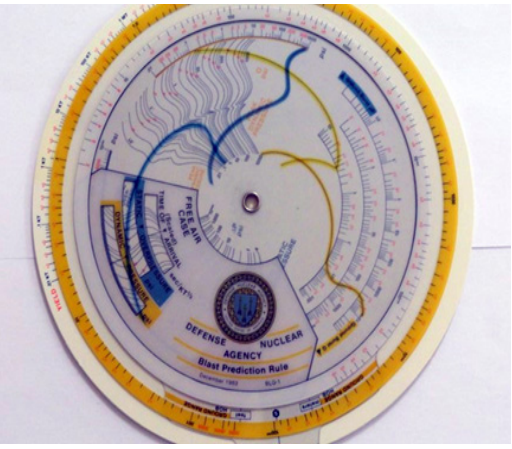


Figure 5: Blast Prediction Rule – Defense Nuclear Agency

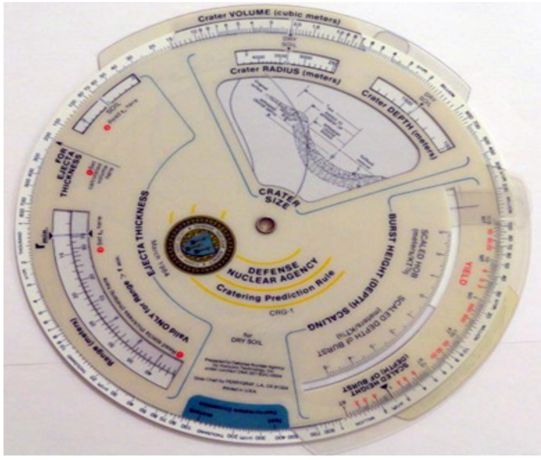


Figure 6: Cratering Prediction Rule – Defense Nuclear Agency

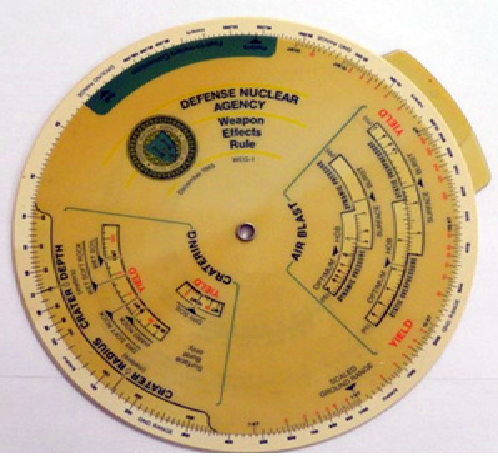


Figure 7: Weapons Effects Rule – Defense Nuclear Agency

Figure 8: Tactical Nuclear Slide Rule – Harry Diamond Lab

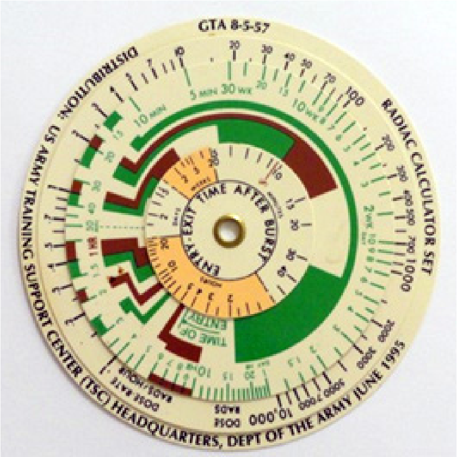


Figure 9: Radiac Calculator Set – GTA 8-5-57

Figure 10: TI-59 Programmable Calculator

Today, the computational power available in commercially purchased laptops far exceed that of the pre-2000 era minicomputers. The Defense Threat Reduction Agency (DTRA), the follow-on organization of the Defense Nuclear Agency, continues to provide nuclear staff planners with highly advance nuclear weapons effects computation programs that can be run on laptops in the unit. USANCA uses the Nuclear Weapons Effects Database (NWEDS) code (Figure 15), developed by DTRA to produce nuclear weapons effects lookup tables. Also available are the Hazard Prediction and Assessment Capability (HPAC) and the Consequences Assessment Tool Set (CATS), both capable of calculating the outcome of thousands of possible scenarios involving a variety of weapons and materials. These models can

Figure 11: Ti-59 Memory Chips

Figure 12: Magnetic Input Strips

Figure 13: Presonal Computer 5 ¼ Floppy – Defense Nuclear Agency

determine the human medical effects, toxicity levels, contaminated areas, population exposure, hazard areas and casualties should WMD materials be unleashed in an attack or dispersed in a military strike or by accident. On-line, DTRA offers the Integrated Weapons of Mass Destruction Toolset (IWMDT) for WMD planning. IWMDT consolidates validated DTRA modeling and simulation tools to enable rapid access for target planning, emergency response and consequence assessment capabilities. IWMDT is used by Combatant Commands, the Joint Staff, other government agencies, first responders, planners, managers and operational and technical personnel who have the mission to respond to the full spectrum of CBRNE threats. IWMDT is an internet net-centric implementation of the underlying DTRA computational tools, including the Hazard Prediction Assessment Capability (HPAC), and the Integrated Munitions Effects Assessment (IMEA).

As seen, the models and tools that the staff nuclear planner uses has greatly advanced throughout the years. With improvements in computational ability, accuracy, and speed of the nuclear effects prediction tools, the nuclear targeteer has a vast array of resources and tools to assist in the execution of their responsibilities. Remember, no matter how sophisticated the codes and computational aides become, it is the individual nuclear targeteer that makes them useful to the commander. Someone who can translate the science of nuclear weapon effects into operational guidance.

Figure 14: Presonal Computer CD – Defense Nuclear Agency

Reference

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Figure 15: NWEDS Logo

BIOGRAPHY

Dr. Moakler is the Chief, Analysis Division, USANCA and a retired Army FA52 Colonel. His previous assignments include: Chief, Nuclear Division, USANCA; Deputy Director, Technology Applications Directorate, DTRA; and Deputy Director, Weapons Effects Directorate, Defense Special Weapons Agency (DSWA). He is a graduate of the Army War College and the National Security Management Course. He earned an Education Doctorate from The George Washington University, M.S. in Nuclear Engineering and Computer Science from Rensselaer Polytechnic Institute; M.S. in Engineering Management from the University of Missouri-Rolla; and M.S. in Education from Old Dominion University. His e-mail address is martin.w.moakler.civ@mail.mil

White Sands Missile Range Nuclear Weapon Effects Life Cycle Support Capabilities

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Introduction

The Army historically has been concerned with the survivability of its equipment and systems, such as the M-1 Abrams and Stryker, in a nuclear environment. These concerns are usually expressed in terms of nuclear weapon effect survivability requirements for airblast, Electromagnetic Pulse (EMP), ionizing and thermal radiations. Survivability is a key component in meeting operational objectives, which ultimately, leads to mission success.

System hardening and its assurance is ideally done during the development and production phases, this is where Hardness Assurance (HA) is important. Once an Army system is hardened to the effects of a nuclear environment, sustainment of that hardness throughout the system's life is of paramount importance in continuing to meet the imposed survivability requirements. This sustainment usually entails Hardness Maintenance (HM) and Hardness Surveillance (HS). Two examples of Army systems that have undergone HA, HM, and HS, are the M1 Abrams tank and the Single Channel Ground and Airborne Radio System (SINCGARS).

In this article, we will discuss the Army's life cycle facilities and capabilities in the Survivability, Vulnerability, and Assessment Directorate (SVAD), at the White Sands Missile Range (WSMR). More details concerning SVAD and WSMR can be found in a previous article, in which some of SVAD's test and evaluation capabilities were described [1].

Hardness Maintenance, Hardness Assurance, and Surveillance

Hardness Maintenance is defined as all the processes, procedures, and methodologies used to ensure that nuclear hardness does not degrade in the post-production phases of the system or equipment acquisition cycle. HM is similar to HA but with subtle differences. In this portion of the life cycle a system is maintained in order to continually meet survivability requirements, such as replacing worn parts.

Hardness Assurance is defined as all the processes, procedures, and methodologies used to achieve nuclear hardness in the pre-production and production phases of the system acquisition cycle. Without this HM/HS is irrelevant. One such example of HA would be an inspection of units on the production line verifying that the proper hardening elements are in place and meet specifications.

Hardness Surveillance is defined as system or subsystem level tests, analyses, and inspections used to monitor nuclear hardness in the later production and post-production phases of the acquisition cycle. An example of this would be testing a piece of equipment in a (nuclear) threat level simulator, such as electromagnetic pulse (EMP) or gamma radiation, see Figure 1. For further details refer to [1,2].

Facilities and Capabilities Overview

The Survivability, Vulnerability and Assessment Directorate at White Sands Missile Range, New Mexico, has a wide range of support facilities and capabilities that are essential in meeting HA, HM, HS, and other life-cycle needs of the Army as well as other external organizations. In this article we will concentrate on the support facilities available at the SVAD that deal with ionizing radiation effects and long term storage of electronics. For further details and additional information the reader should contact the authors whose contact information is given at the end of this article. Also consult references [1] and [2].


Figure 1. An example of a system level threat level simulator: Gamma dose rate system test of a M2 Bradley fighting vehicle at Sandia National Laboratories' HERMES III facility. See reference [2].

Support Facilities

Semiconductor Test Laboratory (STL)

The SVAD STL tests a wide range of semiconductors to the effects of various types of ionizing radiation generated by a nuclear detonation. At the STL, test engineers characterize and then pretest samples of semiconductors before exposing them to the different types of ionizing radiation. After being exposed to radiation, the devices are then post tested and their raw data is recorded. Further analysis reveals the change in the semiconductor's electrical characteristics with respect to its pretest electrical behavior. The STL capabilities are mainly applicable to risk mitigation for HA and HM.

In the STL various test equipment and software are required to support the testing of the semiconductors, this includes: large mainframe Automated Test Equipment (ATE), see Figure 2, bench top test equipment, Printed Circuit Board (PCB) design software, PCB FR4 (Flame Retardant 4) double-sided etch/milling equipment, and network interface equipment. Currently the STL has a support staff composed of eleven Electrical Engineers (5 civilian, 6 contractor), and two electronic technicians (contractor).

Figure 2 (a) and (b). Two examples and views of STL's thirteen mainframe test systems. The SVAD recognizes customer and user community needs for the continued support of older device technologies. Additionally, the SVAD is conducting tester upgrades for speed in the future by utilizing the Army Major Nuclear Modernization Program.

Figure 2a.

Figure 2b.

Rapid Response Laboratory (RRL)

The RRL provides a variety of testing and test support operations. The laboratory can test semiconductors, of simple to medium complexity, to the effects of various types of ionizing radiation generated by a nuclear detonation. At the RRL, test engineers characterize and then pretest samples of semiconductors before exposing them to the different types of ionizing radiation. After being exposed to radiation, the devices are then post tested and their raw data is recorded. The RRL provides project support for Enhanced Low Dose Rate Sensitivity (ELDRS) projects, support for multiple customers utilizing SVAD's other ionizing radiation facilities [2], and support for electromagnetic and other radiation projects, as required in order to meet the personnel requirements for the Directorate. Equipment and software requirements for the RRL are the same as for the STL, but without the ATE. The RRL is supported by two Electrical Engineers (2 civilians) and Electronic technicians (1 civilian and 3 contractors). The RRL is mainly used for rapid testing related to HA and HM on electronic pieceparts, Circuit Card Assemblies (CCAs) and Line Replaceable Units (LRUs).

Figure 3 (a) and (b). Different bench setups in the RRL, showing some of the available test equipment. As described in the text, this facility does not have large mainframe testing capabilities as in the STL.

Figure 3a.

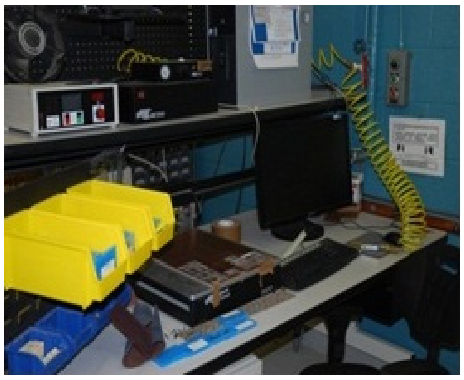

Figure 3b.

Radiation Tolerance Assured Supply and Support Center (RTASSC)

The RTASSC is responsible for the following missions: Monitor, track, and perform analysis of manufacturing design and process changes, new product, and identify potential Diminishing Manufacturing Sources and Material Shortages (DMSMS) and Radiation Tolerant (RT) problems. Management concentrates on DMSMS and supply solutions, on-time procurements (life-of-program-buys and/or multi-year buys), third party manufacturing, reverse electronic engineering, counterfeit investigations and state-of-the-art

Figure 4.

Figure 5.

fenced long-term storage (wafer/die, finished piece-part product and/or end-item level (anywhere from an engine to a washer)), see Figures 4 and 5. The RTASSC storage component is mainly concerned with life-cycle issues related to electronic/device obsolescence for currently fielded/upcoming systems. Figure 4. REMSTAR Space Saver Storage (15 vertical carousel) Units used for classified storage of piece parts. The parts are electrostatic discharge (ESD) shielded and placed in moisture-barrier bags. Figure 5. Dry Nitrogen Storage Units at the RTASSC. These units are used for long term storage that requires a moisture free (99.999%) environment and protection against air-borne contaminants.

Figure 6.

For the long term storage area shown in Figure 4, parts are visually inspected for damage and contaminants upon receipt and before they are stored. The storage area is temperature controlled to 25 degrees Celsius, plus or minus 5 degrees Celsius, is security controlled and all stored product are fenced to meet customer needs. In Figure 5, temperature control is the same as that in Figure 4, relative humidity of the storage area is less than 10%, the storage containers have a positive pressure of 0.5-1.0 pounds per square inch, there is complete Electrostatic Discharge (ESD) protection, and as in Figure 4, the facility is a classified storage area with customer fencing as needed.[3]

Metrology Laboratory

The Metrology Laboratory provides services in three areas to ionizing radiation producing facilities of the Survivability Vulnerability and Assessment Directorate (SVAD) and to the test engineers of SVAD engaged in nuclear survivability/vulnerability testing, radiation dosimetry, and advanced radiation and nuclear simulator technology.

The Metrology Laboratory provides routine radiation environment measurements to all users of the ionizing radiation producing facilities of the Directorate. This includes the Fast Burst Reactor Facility (FBR), the PI- 538 Flash X-ray, Gamma Radiation Facility (GRF), El Dorado Gamma Irradiator (ELD), and the Linear Electron Accelerator (LINAC). See reference [2] for more information concerning these facilities. The Metrology Laboratory provides specialized environment characterization capability for all facilities of SVAD. Metrology Laboratory personnel specialize in characterizing the radiation environments using a combination of theoretical modeling and experimental measurements. The modeling/prediction analysis programs are carried out using state of the art Monte Carlo, discrete ordinates, or other simulation modeling programs. The extensive nuclear data bases to support these modeling programs are also maintained by the Metrology Laboratory.

In addition to theoretical methods, the Metrology Laboratory capability includes advanced experimental measurement capabilities to provide key radiation environment metrics for current and proposed radiation test environments. The Metrology Laboratory personnel support neutron spectral definition, neutron fluence, fluence rate, gamma dose/dose rate, and neutron dose/dose rate characterizations of the FBR (see Figure 6). They also support gamma dose and dose rate characterizations for the PI-538, GRF, ELD, and LINAC. The characterization includes parameters for nuclear survivability/vulnerability testing of electronics as well as characterizations for the response of other materials to radiation environments. The current efforts are primarily directed toward DoD and Department of Energy (DOE) survivability requirements, Nuclear Regulatory Commission (NRC) licensed facility unique radiation environments, and evaluating dose monitoring equipment (Figure 6). Tennelec counting systems for Sulfur pellets. The pellets are used to measure neutron fluence by activation of the Sulfur. Metrology Laboratory personnel provide expert consulting services to all users, researchers, and developers of neutron and gamma radiation environments and sources. Personnel are active in the development of consensus standards related to the characterization and utilization of radiation sources and environments. The primary cooperative efforts in this area are with the American Society for Testing and Materials (ASTM) E10 Committee on Nuclear Standards, the European Working Group on Reactor Dosimetry, the DOE Laboratories, and Missile Defense Organizations.

Summary

In this article we described the life cycle support capabilities at the Survivability, Vulnerability and Assessment Directorate (SVAD) at White Sands Missile Range (WSMR). The capabilities discussed were those related to hardness assurance, maintenance, and surveillance. SVAD also has long term facilities for part and product storage for lifecycle maintenance and protection against obsolescence. The descriptions of the facilities and hardware in this article are by no means complete. If the reader would like further information on the support and life cycle capabilities at WSMR, one should contact the authors of this article.

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[1] Brady, R., and Les, J., White Sands Missile Range Nuclear Weapon Effect Test and Evaluation Capabilities, Part I: Electromagnetic Pulse, Airblast, and Thermal, Combating WMD Journal, Issue 11, 2014.

[2]Brady, R., and Les J. White Sands Missile Range Nuclear Weapon Effect Test and Evaluation Capabilities, Part II: Ionizing Radiation, Combating WMD Journal, Issue 11, 2014

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BIOGRAPHY

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Nuclear Atmospheric Test Film Scanning and Re-Analysis[1]

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INTRODUCTION

The Limited Test Ban Treaty (LTBT), signed by President Kennedy in 1963, prohibited space, atmospheric, and underwater testing of nuclear weapons in the United States. Until that time, scientists used high-speed scientific film to record nuclear tests allowing them to study nuclear phenomena as well as validate weapon yield and timing. The original films are the primary source of raw data remaining from the atmospheric tests. Since the United States no longer conducts nuclear tests in any environment, the scientific films are invaluable in current nuclear weapons research. Furthermore, the technology of the 1940-1960s limited the analytical potential of the films as scientists relied heavily on human judgment and mechanical means to extract weapon parameters from the films which introduced significant uncertainty. Photographic film, being partly comprised of an organic, light-sensitive emulsive layer, inevitably decomposes over time. Therefore, digital scanning of the original films not only preserves the invaluable data from the nuclear tests, but it also allows for new research opportunities using modern digital analysis techniques.

Dr. Gregory Spriggs of Lawrence Livermore National Laboratory (LLNL) in Livermore, CA leads the effort to digitally scan, archive and coordinate re-analysis of the films with other national laboratories and academic institutions. Potential research projects include investigations of shockwave and fireball development, shockwave measurement using edge detection techniques, yield measurements based on radial growth, early and late cloud behavior, light output characteristics, environmental effects, and test platform analysis. The results of this research benefit nuclear forensic analysts, weapon design laboratories and weapon effects planners.

PHOTOGRAPHIC THEORY

When light interacts with film, photons (light quanta) of various energies are incident upon the light-sensitive emulsive layer of the film. Some photons of higher energies are able to penetrate the film while lower energy photons are not. The fraction of a light source that penetrates the film is referred to transmission, *T*. A transmission of 1 indicates 100% of the photons were able to penetrate the film, a transmission of 0.1 indicates 10% of the photons were able to penetrate the film, and so forth. The optical density, D, represents the logarithm of the inverse of the transmission; it typically ranges from 0 (darkest) to 4 (brightest) after the image is developed (after a negative print is developed into a positive, the scale is reversed). Transmission is a measured value whereas optical density is calculated. These characteristics allow scanning technicians to convert transmission or density to digital values. Digital scanners use *frame-grabber* boards to measure the transmission of light in each pixilated area of the film, convert the transmission of each pixel to a density, and then store all the pixels in the image as a matrix of integer intensities.

SCANNING AND DIGITIZATION

The film laboratory at LLNL uses a Golden Eye II film scanner. Once loaded with film, the scanner reads each image based on the characteristics and dimensions unique to each film. The Golden Eye II scanner uses a 12-bit black and white camera capable of measuring 4096 (212) tones in an image (see Figure 1).

Figure 1. Golden Eye Scanner

However, these tones are typically stored as 16-bit values by multiplying each value by 16 (24). Each photographic image in the original film is stored as a pixel matrix of these integer tones or intensities which vary from 1 to 65535 where 1 represents the darkest pixel and 65535 represents the brightest pixel. Most digital image processing software reads images in terms of 16-bit intensities rather than values of optical density.

TIMING

In order to associate a discrete image with time, film operators utilized timing markers which marked the film strip periodically and consistently during operation. Analysts could then determine a frame-dependent timing function that associates each image with a precise time after detonation. The radial growth of the fireball, for example, could then be plotted against the time for each image allowing for a yield measurement. Additionally, light output features that are characterized in time may be used in identifying phenomena unique to nuclear weapons. All data collected from test films must be associated with a precise time relative to detonation to minimize uncertainty.

RAPATRONIC PLATES

Rapatronic cameras recorded nuclear fireballs as high definition still photographs on glass plates using a polarizing magneto-optical shutter. The very short exposure time of approximately 4-5 microseconds allowed for the capture of the rapid fireball evolution in much greater physical detail compared to other film types. Figure 2 shows an example of 3 rapatronic images.

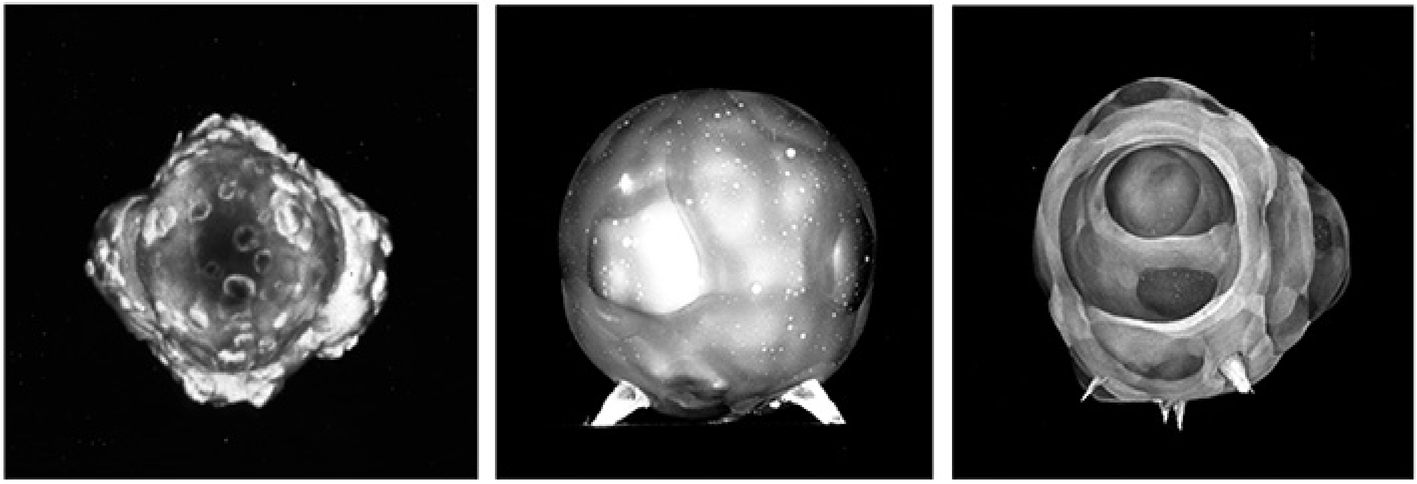

Figure 2. Three Separate Fireball Images Recording Using a Rapatronic Camera.

As shown in Figure 2, the photographs allow for study of fireball phenomenon, such as Rayleigh scattering, in much greater detail. Rayleigh scattering, or coherent scattering, accounts for light photons that are absorbed by an atom and reemitted with the same energy but a different angle. Because a camera only captures one perspective of the detonation, it will record only features unique to that viewpoint. Rayleigh scattering explains the apparent bubbling, or soccer ball-like appearance on the surface, seen in the far right picture.

Rapatronic plates also allow for yield determination based on the precise time the photographs are taken using the Phi-5th method, which uses Geoffrey Taylor's equation[2] for a point source energy released in air given by

$$Y = pK\phi^5$$

where Y is the yield in kilotons, K is a constant and ϕ is the ratio of the measured diameter to $t^{0.4}$ where t is the time since the explosion started. Although rapatronic images provide much greater detail in one photograph, fireball frames offer many images throughout the fireball's lifetime.

FIREBALL FILMS

Fireball films, or frame films, were a series of discrete and consecutive photographs typically recorded on 16 mm or 35 mm film. With the exception of special emulsive layers designed to record unique spectra emitted from nuclear detonations, these film types were identical to those used to make motion pictures in the early entertainment industry. Each discrete image was recorded using a high-speed rotating prism which acted as a shutter allowing for an incremental exposure of light. Most frame films operated at approximately 1000-3000 frames per second (fps). At the higher rate, this equates to a 0.3 millisecond exposure per frame, which is nearly 75 times longer than the exposure time of a rapatronic plate. An example of a frame film image (cropped to omit side perforations) is compared to that of a rapatronic image for the same test shot in Figure 3.

A disadvantage of a frame film, shown on the left side of Figure 3, is the lower image resolution which hinders edge detection. Finer resolution provides opportunity for more precise diameter measurements using enables edge detection and therefore potentially more precise yield measurements. However, frame films contain hundreds or thousands of consecutive images, which

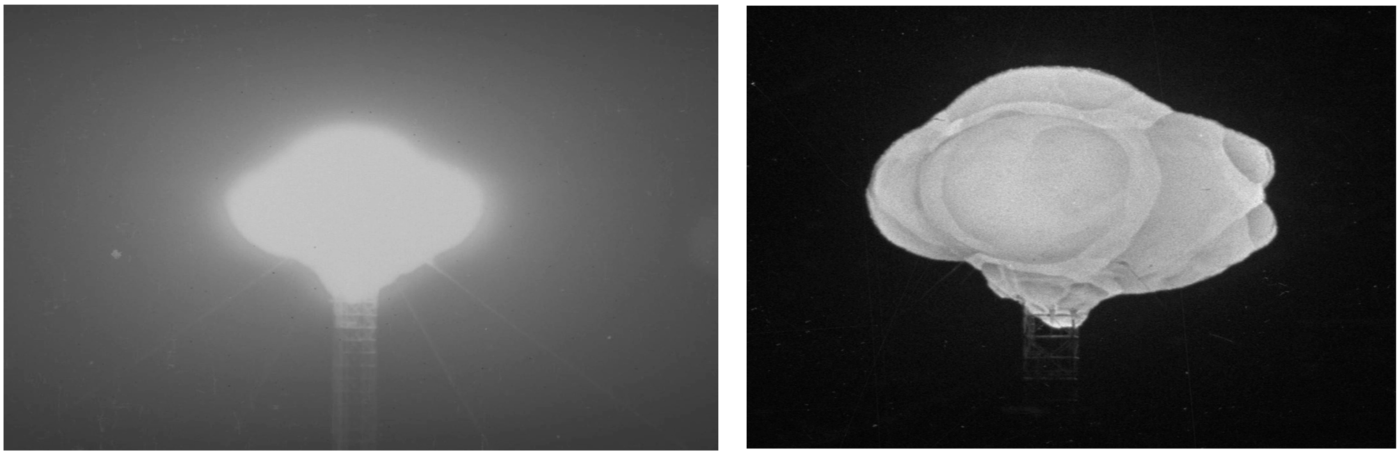

Figure 3. Frame Film Image of a Tower Shot (Left) Compared to One Recorded on a Rapatronic Plate (Right).

allow for many diameter measurements which reduces the uncertainty in the yield. Furthermore, frame films not only capture early fireball development, but also breakaway (the perceived shockwave separation from the inner fireball) and thermal and shockwave interactions with the environment.

EARLY/LATE CLOUD FILMS

Early and late cloud films were intended for time-dependent analysis of fallout cloud behavior. Cloud film photography was very similar to fireball film photography, but the film rate was significantly slower owing to the much slower cloud evolution, and the camera distance to ground zero was often farther from the point of detonation to accommodate filming massive clouds. The wind direction and velocity also affected cloud behavior whereas it had little effect on the fireball. Figure 4 shows two separate perspectives of the same nuclear cloud at the same time from different camera stations.

The cloud height relative to ground zero, the size of the cap, the camera angle, and cloud rise velocity are all important characteristics for modeling cloud behavior and measuring the yield of the weapon.

Figure 4. Two Perspectives of a Nuclear Cloud Taken From Different Camera Stations for the Same Nuclear Test.

STREAK FILMS

Streak films were intended to measure light output in time. They used open aperture slits, rather than lenses, with varying neutral density filters and recorded light intensity in streaks on a continuous strip of film rather than in discrete images. Therefore, they provide no discernible images of the detonations. Figure 5 shows a picture of a typical streak film image where the left edge of the streaks, or channels, represent the first recorded light, and time progresses to the right.

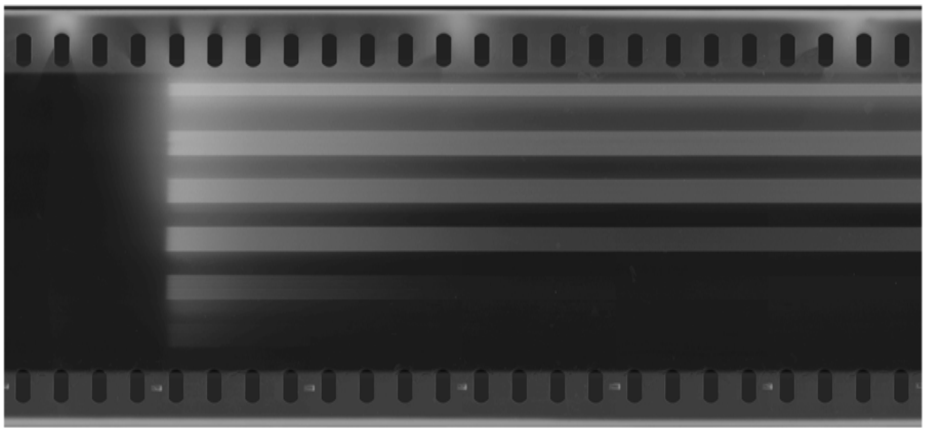

Figure 5. Streak Film Image.

The brightest channel in a streak film, shown at the top of Figure 5, is unfiltered while the other darker channels represent those filtered by varying optical densities. Time progresses along the length of the streak, and each data point is represented by a pixel width increment of that streak. As such, the time for each data point is on the order of 0.1 microseconds. Therefore this film type provides several million data points for the creation of plots in terms of light output. This information can then be used for comparison to other film types and to derive quantities such as the power output, temperature, and heat flux.

CONCLUSIONS

The decomposition of nuclear test films over time coupled with the ban on nuclear testing implies the need to permanently store the data recorded from the 1940s-1960s. The digitization preserves the data and it also allows for the re-analysis using modern digital image software of every test shot for which a film exists. The re-analysis of the films may provide deeper insight into nuclear phenomena not previously explored with older tools used during the testing era. It may also allow for more precise shockwave measurements and therefore more accurate yield measurements. The potential for more accurate empirical models and identification of unique features may contribute to improved nuclear forensics. Results of modern film research may also be used to validate codes developed by weapon designers. The United States may never test nuclear weapons again, which makes the film scanning project a priceless endeavor.

End Notes

1. All information contained in this article was derived from unpublished nuclear test film analysis course materials developed by Dr. Gregory Spriggs of Lawrence Livermore National Laboratory and the author's thesis research.
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BIOGRAPHY

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Viewshed Analysis of Nuclear Weapon Effects

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A nuclear detonation (NUDET) is, understandably, the most feared of all events involving weapons of mass destruction (WMD). First responders, emergency, and military planners must use all available tools at their disposal to assess, advise, and assist with events involving a NUDET. In recent years, advances in computer modeling have been invaluable in providing decision makers with casualty estimates and losses to infrastructure incurred from the use of a nuclear weapon. The complexities involved in predicting their behavior and effects can be greatly ameliorated by relying on the latest innovations in computer modeling.

Nuclear detonations are subject to a myriad of external and internal influences, which in combination or alone, can greatly determine the severity and extent of destruction. For example, the height of burst (HOB), yield of the weapon, type of burst (surface, sub-surface, air, high-altitude), and weapon design all contribute to the amount and type of energies produced by a NUDET, primarily blast and shock, nuclear radiation, and thermal radiation. In addition, a host of environmental factors including temperature, wind, humidity, pressure, precipitation and terrain act to modulate the tremendous energy inherent in a NUDET.[1]

The effects from blast, thermal, and prompt radiation can be heavily influenced by terrain features. Accounting for terrain is particularly challenging with regard to blast. The close proximity of buildings in an urban landscape constantly changes the overpressure and dynamic pressure of the blast wave due to reflections and channeling. As a result, little shielding from blast effects can be expected from surface features and is not strictly dependent on Line of Sight (LOS) considerations.[2] The light emitted from a light bulb is like prompt and thermal radiation emitted from a NUDET, in that it is emitted in all directions in a straight line. In contrast to blast, the thermal radiation effects of a NUDET is highly dependent on LOS unless scattered due to atmospheric attenuation. Incident thermal and prompt radiation on objects can be completely shielded by natural topographic features (hills, mountains, valleys, etc.) and man-made structures typically found in urban landscapes. Numerous accounts of this shadowing effect can be found after the bombings of Hiroshima and Nagasaki (Figure 1).

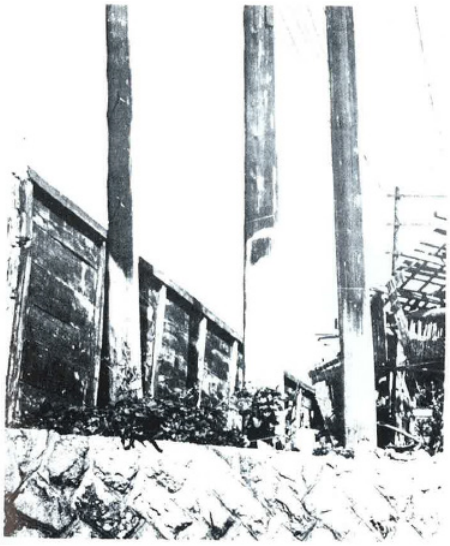

Figure 1. Flash burns on wooden poles (1.17 miles from ground zero at Nagasaki, 5 to 6 cal/cm2). The uncharred portions were protected from thermal radiation by a fence.[3]

The thermal radiation emitted from an air burst explosion (HOB < 100,000 feet) constitutes approximately 35 to 45 percent of the total energy of a nuclear detonation.[4] The intense, but brief duration of thermal radiation causes flash burns of exposed skin and was responsible for 20-30 percent of the fatal casualties during the nuclear bombings of Japan[5] (Figure 2).

Figure 2. Japanese youth with 2nd degree flash burns.[6]

The hazard that thermal radiation presents is often overlooked in lieu of blast effects. The blast is of course, associated with violent, destructive forces, but it diminishes within relatively short distance of ground zero. The potential to cause serious injuries in exposed, unsheltered victims from thermal radiation can extend at distances well beyond the effective blast radius (2.3-2.6 miles in the case of Hiroshima).[7]

As it stands, few nuclear effects models exist for emergency and military planners. There are even fewer that account for the LOS shielding of terrain and buildings when producing accurate casualty estimates. The Analysis Division of the U.S. Army Nuclear and Countering WMD Agency (USANCA) has developed the Army Nuclear Weapon Effects Program (ANWEP), which is a nuclear effects library that relates probability of damage levels (fatal injury, serious injury, etc.) to phenomenology levels (e.g. overpressure, radiation dose, thermal fluence). ANWEP now corrects for LOS shielding when computing the probability of damage (PD) to personnel. Several tools have been developed which use this library; a tool with an integrated GIS interface (ANWEP-GIS), and an Excel add-in (ANWEP-Excel). ANWEP's database is derived from Effects Manual 1 (EM-1), the Physical Vulnerability Handbook (OGA 2800), QSTAG 244, and other peer reviewed publications.

To accomplish the LOS correction, ANWEP-GIS leverages open-source geographical information system (GIS) software packages (Quantum GIS and GRASS) to provide unprecedented granularity of nuclear weapon effects. ANWEP-GIS conducts a type of spatial analysis called a "Viewshed" that calculates only the visible portion of the ground than can be "observed" by the weapon's vantage point in space (Figure 3). While accounting for the LOS visibility of a given object from the weapon, ANWEP-GIS also maps the extent of PD for serious and fatal injuries.

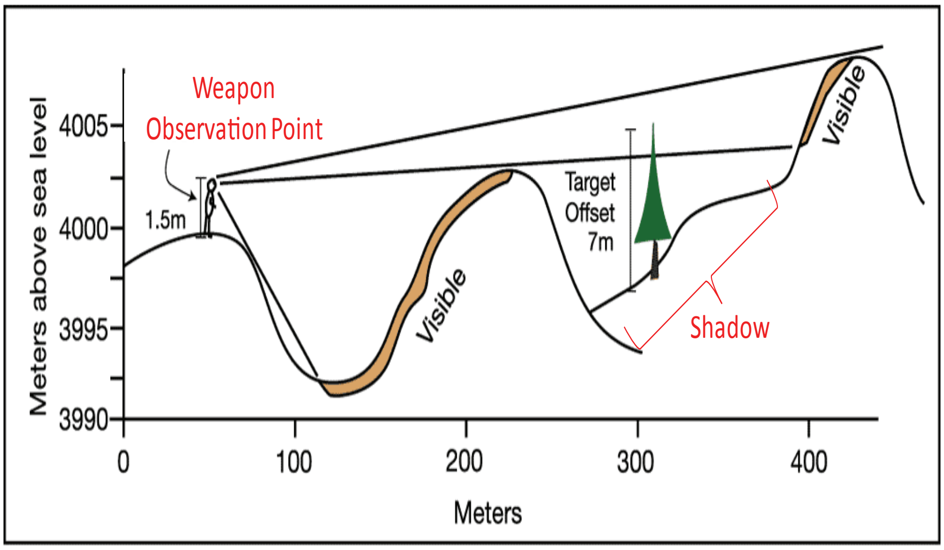

Figure 3. Line of Sight (LOS) from weapon to ground.[8]

The Probability of Damage (PD) maps in Figures 4-8 represent a scenario of a 10 kiloton (KT) NUDET at a height of 140 meters and assumes civilian casualties are exposed and unwarned in the open. ANWEP combines damage from blast, thermal and prompt radiation. The PD of Fatalities and Serious Injuries in Figures 4 and 5, respectively, were calculated with no LOS considerations for thermal injuries. Without LOS considerations the code predicts 86,000 fatalities and 87,000 serious injuries. Notice in Figure 5 the PD of Serious Injury is zero in the center because no one is alive to be designated as "injured"; ANWEP subtracts all of the fatalities from the serious injury calculation.

All visible surfaces (green highlights) from the weapon's vantage point are illustrated in Figure 6; the outer periphery calculated to where the probability of injury is <1%. To account for the shielding of buildings, building heights were added to the existing terrain elevation data. When ANWEP subtracts the civilian population residing in the shadows created by terrain and man-made features, the differences between the casualty estimates with and without the LOS correction are dramatic. In Figure 7, fatalities are caused primarily by blast and is represented by the central red portion. The outer-most red ring represents fatalities due to thermal radiation. The total number of fatalities is reduced from 86,000 to 37,000 (or 57%) with LOS correction.

For serious injuries, terrain and building shadowing reduces the civilian casualties from 87,000 to 24,000, a decrease of 72%.

Obviously, casualty estimates have been grossly over-estimated when the shadowing effects from terrain and build-

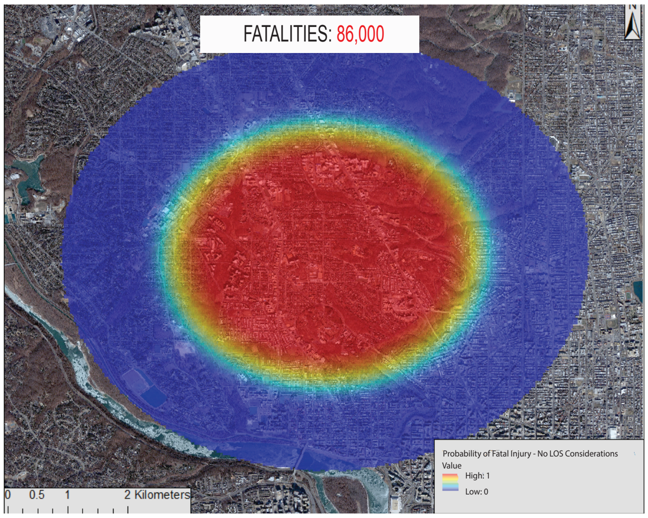

Figure 4. Probability of Fatality (Neglecting Line of Sight). Estimated Fatalities = 86,000

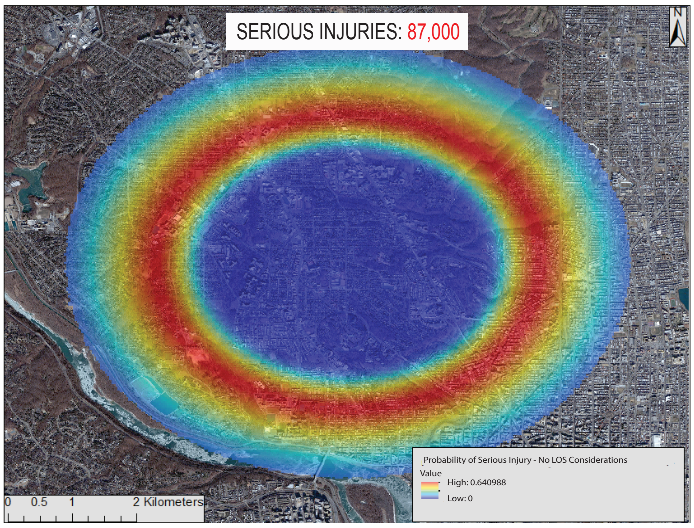

Figure 5. Probability of Serious Injury (Neglecting Line of Sight). Serious Injuries = 87,000

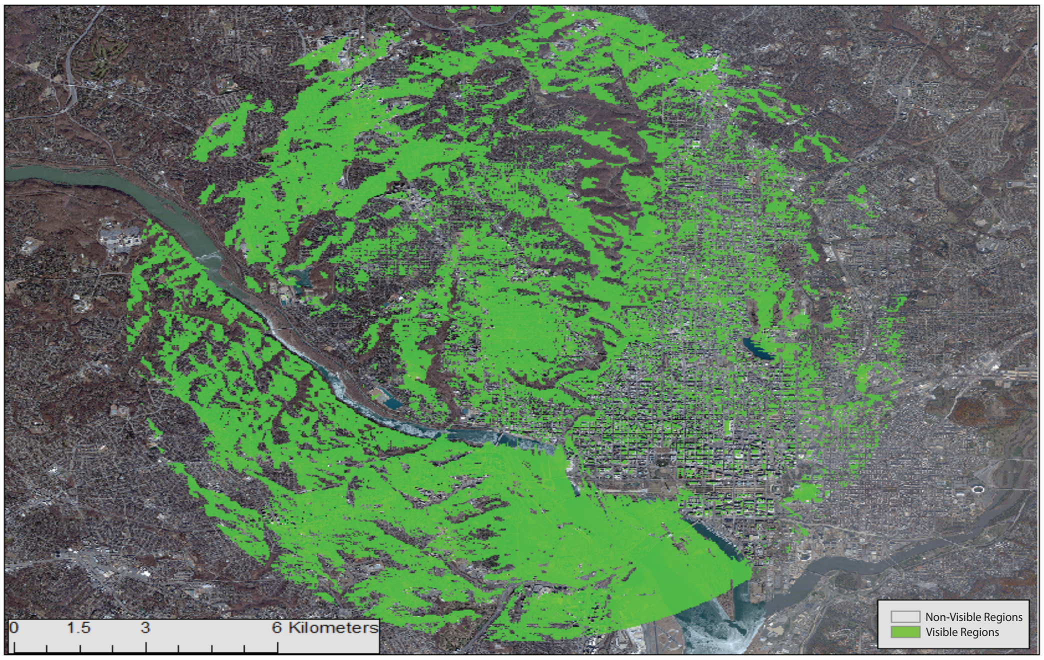

Figure 6. Viewshed Analysis

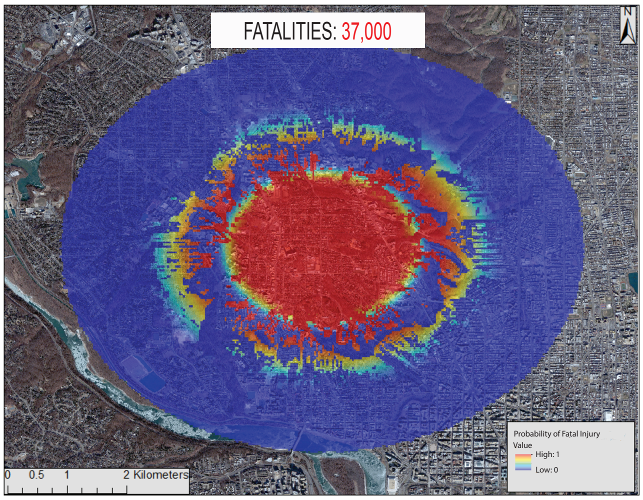

Figure 7. Probability of Fatality. Includes Line of Site (LOS) correction.

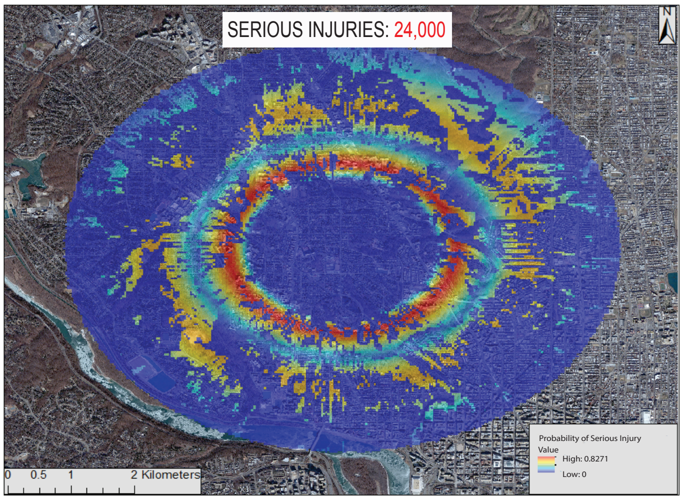

Figure 8. Probability of Serious Injury. Includes Line of Site (LOS) correction.

ings have not been accounted for. Many nuclear weapons effects codes were developed during the 1980's. Due to the lack of computing horsepower available at the time, most of the damage calculations assumed an "ideal" or flat surface. Additionally, the development of GIS tools were in their infancy and lacked the spatial analysis software and the terrain data necessary to conduct Viewshed analysis. Today, military and emergency planners can leverage recent improvements to outdated nuclear effects codes that can more accurately portray reality in a post-NUDET environment without over estimating casualties.

End Notes

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BIOGRAPHY

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Disease as a Security Threat and the Militarization of the Response

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Human disease recently achieved an ominous distinction as a result of the current Ebola Virus Disease (EVD) epidemic. The United Nations Security Council (UNSC) unanimously adopted UNSC Resolution 2177 and declared the EVD epidemic in the sub-Saharan region of West Africa 'a threat to international peace and security' and urged 'UN member states to provide more resources to fight the outbreak'.[1] Resolution 2177 was sponsored by 134 member states making it the most broadly supported resolution since the UN's founding in 1945.[2] The United States (U.S.) alone has pledged upwards of 4,000 soldiers to support the civilian-led response effort through logistics, engineering, sanitation support and mortuary affairs expertise.[3] Though not unique in its focus on health, this resolution signifies that disease is no longer considered just a symptom of conflict or regional instability, but it is a potential catalyst for instability and an emergent threat to peace.[4] The ongoing crisis in West Africa is unique because it is 'the largest and most complex EVD outbreak since the virus was discovered in 1976. There have been more cases and deaths in this outbreak than all others combined'.[5]

While absolutely tragic and by no means insignificant this crisis must, however, be viewed with a broader perspective. Each year, more people die in the United States from seasonal influenza strains alone than have died of the current Ebola virus disease (EVD) epidemic.[6] During the 2009 H1N1 Influenza pandemic, the UN Security Council took no action even though an estimated 284k deaths occurred globally. Why then hasn't the United Nations Security Council declared a resolution in response to this year's influenza season? Because in fragile regions such as those found in West Africa and other developing countries, diseases with this kind of virulence have the potential to cause state failure. Until recently, the UNSC has left disease and health related crises to the UN General Assembly, World Health Organization (WHO), or relevant sub-committees. There are significant security challenges and areas of instability in the Middle East and Eastern Europe. Yet, an impoverished region of West Africa has been brought to the forefront of crisis management and is a leading security concern for the transnational body chartered with maintaining global peace and security. A criticism of the public health community is that military forces should not be used in disease response because of impacts to effectiveness that can result from mistrust of uniformed responders. This analysis will explore the role of the military in disease response and global health. A secondary goal is to gain understanding of and to identify factors contributing to the evolution in thinking regarding human disease as a global security threat.

> *Public health and war have long been close companions, and maybe strange bedfellows.*[7]

Relation of the Military and Global Health

The World Health Organization (WHO) characterizes public health as 'all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole.[8] Global health, therefore, extends this concept across international borders while incorporating international relations, economics and diplomacy. As a functional extension of a state's diplomatic objectives, military forces are often found at the seam of global health concerns. The public health profession and the military have a long history together. Stark examples of these deep roots are seen in the public health community's military-like dress/uniforms and globally recognized vernacular; i.e. campaigns, containment, and surveillance. The military's role in global health dates back to at least the 14th century when naval forces were first reported to have been used to enforce a quarantine of foreign vessels arriving from ports known to suffer from communicable disease.[9] Because of the squalor and sometime unique conditions associated with warfare, military ground forces have always had to consider sound public health practices and policies to prevent disease and injury. In sustaining a fighting force, one must consider the effects of non-potable water, poor food quality, and sanitation. As a result of these unremitting challenges, today's modern military possesses many of the necessary capabilities to support public health emergencies. Though not perfect, the military is adaptable, responsive and remains a trusted government entity domestically and, arguably, in many regions around the world today.

Though much of the military's role in public health is viewed through the spectrum of crisis, there are secondary and tertiary contributions to the broader world population. Many of these advances are in emergency medicine and technologies that have evolved in response to needs generated in the execution of our military's primary function—to fight and win our nation's wars. Over the past decade advances in prosthetics, rehabilitation, mental health, neurological disorders, and trauma care are just a few of the disciplines that have rapidly progressed. These efforts, which are focused on treating a patient after injury, compliment resources dedicated to preventing injury and ensuring resiliency. The significant research and development enterprise that is focused on denying an adversary the perceived/real advantage gained through the use of Weapons of Mass Destruction (WMD) has enjoyed many successes, but admittedly has earned some criticism as well. This dedicated body of government stands in the defense of the U.S. and her allies from natural and manmade disaster to include disease. Various technologies have been integrated into the national defense, at all echelons, and are seen through improved disease surveillance, modeling, detection, diagnostics, laboratory support, prophylaxes, therapeutics and force protection. While significant gains have been made so have significant costs been entailed. Fortunately, the litmus test for their true value against a CBRNe attack has seen little use.

Disease and Irregular Warfare

There are several similarities between disease and the irregular forms of warfare that have dominated the post-Cold War era. Conditioning to irregular warfare in recent years has opened the minds of leaders to nontraditional threats such as disease. In Rupert Smith's The Utility of Force: The Art of War the author explores irregular warfare (IW) and provides an exceptional model to compare warfare with disease. Smith contends that the future of conflict is irregular warfare where a 'war amongst the people' will be fought between non-state actors and states.[10] If irregular warfare is the new norm, then I argue that human disease is the ultimate non-state antagonist. The battlefield and key terrain are not among the people, but in the case of disease is the people. Smith posits that future conflicts will involve 'asymmetric tactics, urban environments and tend to be protracted'. Dating back to the earliest recorded history, man's conflict with disease has been ongoing and appears to be unending. The influenza disease has been a partner of the human condition for thousands of years with the first infections occurring shortly after the domestication of animals.[11] Even with improvements in healthcare and living conditions, influenza remains firmly in the top ten leading causes of death for the population of the United States today.[12] Smith further argues that states will seek to gain or maintain power, effective governance and a stable society. Non-state actors will seek to change the status quo using irregular techniques in the pursuit of resources, influence and power. Disease as an antagonist is not a rational actor seeking to sway the traditional balance of power; however, it does seek to influence behavior of a population. Disease spreads without regard to established geopolitical borders, but like many conflicts can be equated to a resource war. Victory, or at least advantage, is gained by the disease that can efficiently find, infect and reproduce in an abundant animal host species. Arguably, effectiveness is not measured in terms of deaths caused by a disease, but how rapidly and how far it can spread to exert its influence and control. As Jenkins indicates, 'terrorists want a lot of people watching and …listening, not dead."[13] A disease or violent armed group that is too vicious or deadly will quickly burn out or drive away the very target of their ideology.

To disease, this conflict is purely a resource war, though it uses the same tools as other forms of irregular warfare. Kilcullen's model in the Insurgent Operational Art-The Self-Synchronizing Swarm can be applied to the threat of multiple diseases acting unintentionally to create synergy. Diseases, like violent armed groups, act as an 'inchoate and disorganized swarm…(with) independent cells and micro-movements cooperating in constantly shifting alliances of convenience'.[14] While they lack a united front the combined burden suffered on several fronts diseases works to erode resolve and destroy both individual and national defenses. The subject EVD in West Africa is complimented by a significant background disease burden in the form of HIV/AIDS, cholera, tuberculosis and malaria in the region. When EVD accelerated in the summer of 2014, these four diseases together took an already fragile health care system and crippled it with their collective impact. Hospital staffs were sickened and simple attrition led to the failure. Others were driven from their facilities as social tensions raised and frustration boiled over into protest. Similar to terrorism, the EVD pandemic has unconsciously used fear and terror as a tool to modify the behavior of its victims and to undermine supporting institutions. This, in turn, helps to 'establish the conditions in which the outcome may be decided'.[15] Like violent armed groups who leverage resources to coerce afflicted populations, disease uses resource scarcity to drive victims from rural areas into the cities in search of services and treatment. Also like today's terrorist, this threat constantly evolves and has been shown to 'find new uses for old weapons'. Previously seen strains of disease, for which there is no longer a natural immunity, reemerge within a population to have devastating effect; ie: polio, measles.[16] Smith further argues that in a counterinsurgency one cannot attempt to kill their way to victory. This approach in disease response results in yet additional evolution of the threat as seen by the increase in antibiotic resistant strains of bacteria today. Smith's urban terrain is the ideal environment for disease to flourish. The rising number of megacities with mushrooming populations elsewhere in the world indicate Africa is not alone in the threat of disease.

> *Megacities are those metropolises with populations of more than 10 million people. In 2015, it is forecasted that there will be as many as 22 megacities worldwide; that's up from just two in 1950. The same forecast shows that developing countries will account for 17 of these 22 megacities.*[17]

Increased globalization and urbanization will sustain this threat in areas of high population density. This battleground, hallmarked by a lifestyle of competition for basic survival, is unsustainable and a risk of significant impact from disease, given high population densities and an unsustainable lifestyle of competition for basic survival.

Reduction in Inter-state Armed Conflict

Recognizing that disease is not a sentient enemy with any strategy beyond an unconscious self-preservation, there remain numerous similarities between man's conflict with disease and the irregular warfare that has dominated the last 21st century. The fact that the United States and many of its allies have been at war for more than a decade fighting terrorism and insurgencies, in both Iraq and Afghanistan, focuses us on the similarities between man's conflicts (disease and irregular warfare) versus the admitted differences. After all if your most effective tool in the metaphorical toolbox is a counterterrorism and counterinsurgency skillset, then everything looks like irregular warfare. This attitude may be another reason for pandemic disease's ascent up the ranks of irregular threats in the minds of world leaders and transnational security organizations such as the UNSC.

Another reason disease now maintains an elevated standing in the global security arena is the decrease of state-on-state conflict. With the exception of Russia's aggression this past summer in Crimea, the steady state tensions normally associated with the Chosin peninsula, and the South China Sea there is a relative stability in the world between major powers. It is true that many states are very unstable, but those can be attributed to internal or transnational threats. These same states are forced to look internally and at their regional neighbors while civil unrest marches across the Middle East and violent armed groups such as the Islamic State in Syria/Levant (ISIS/ISIL) gain power. With this exception, there is little threat of traditional geo-political boundaries changing. Members of the World Health Organization's (WHO's) primary staff describe this opportunity posed by the current environment and subsequent shift in security focus:

> *The diminished threat of interstate armed conflicts allowed consideration of "non-traditional" security threats, including disease outbreaks, and an increasing emphasis on the anthropocentric notion of "human security".*[18]

A conventional force-on-force conflict between major powers is unlikely. The potential use of a WMD by an attributable state actor is extremely low given the international condemnation and response that would follow. Pundits and security experts have long toted weapons of mass destruction (WMD) as the preeminent threat to U.S. national security. Whether it is a malicious release or natural outbreak of disease, the effects and response in terms of crisis management are nearly identical. In the years leading up to the overthrow of Saddam Hussein the threat of a state sponsored WMD program causing regional instability, with the potential for global effects, was a leading threat model. The loss of state control of such weapons to a violent extremist organization (VEO) remains a threat consideration today. The summer of 2014 witnessed a global outcry against the Assad Regime for the possession and purported use of chemical weapons. Global opinion remains fixed against these devices, yet states such as Iran and North Korea still chose to pursue strategic nuclear weapons and other forms of WMD. Over the last decade the U.S. and her allies have devoted significant resources and effort in the planning for and defense against the threat of WMDs for which there has not been a significant attack. This absence of attack should not be viewed as wasted effort, but an opportunity to repurpose policy initiatives, equities and capabilities that were originally devoted to the prevention and response to WMDS for humanitarian response. Efforts against a malicious biological attack can, and should, support the U.S. Government's response to a natural pandemic. Efforts previously conducted in the name of countering weapons of mass destruction can add value now to assistance projection and humanitarian relief operations. The Department of Defense (DoD), Department of Homeland Security (DHS), Department of Health and Human Services (HHS) should continue to collaborate and spin-off this foundation of defense capability into real-time public health applications both meets a dire need and improves a state's preparedness for future response.

Securitization of Public Health

Von Hippel believed that no matter how well-intentioned, time and money will constrain even the most noble of humanitarian assistance operations.[19] The use of military forces in disease response should come as no surprise to the public health community and the robust, standing resources of the DoD should be welcomed. No other government organization can rapidly and securely deliver the capabilities needed in times of tragedy- strategic lift, logistics, security and operational control. Militaries will continue to be the expeditionary response force of choice for many crisis scenarios to include those related to public health. Should militaries, however, use health as a means of achieving security objectives? Global health is a bridge for other, though clearly related, national interests such as security, economics and diplomacy. The extent to which this statement is true differs in accordance with the state's resources, challenges and global engagement strategy. As an extension of the United States Government's (USG's) diplomatic policy, our military is capable of securing itself and rapidly deploying. This proven expeditionary capability will continue to be the first course of action for a nation's crisis response, domestic or foreign. A trained and professional military knows how to sustain and coordinate complex operations over time and in harsh conditions. This application can result in civil-military coordination problems based on different organizational objectives—the military seeks a stable security environment, the public health community seeks only a healthy population.[20] Further, the integration of military and civilian forces is extremely difficult in hybrid operations. This is especially true in peace enforcement/keeping operations that are coupled to a humanitarian crisis response. The two are clearly linked, but the primary mission of both organizations can interfere with the other's success because of culture, government credibility, and historical context. The heavy dependence on nation building during recent COIN operations in Iraq and Afghanistan has helped to improve the integration of and reliance upon non-governmental organizations. Improvements in these relationships have occurred, but require additional effort for future success before crisis has struck.

Role of the Military in the 2014 Ebola Virus Disease (EVD) Response

The following components of the EVD response will be addressed in this section: the assistance provided by the U.S. Department of Defense, the United Nations Mission in Liberia (UN-MIL) and the United Nations Mission for Ebola Emergency Response (UNMEER). In recognition of the security and diplomatic elements required of this response, the United Nations has embraced a hybrid model. Under the authorities of General Assembly resolution 69/1,and UNSC Resolution 2177, a 'United Nations emergency health mission'[21] has been formed which recognizes the need for an integrated response of functional capabilities.

> The resolutions establish a functional relationship and distribution of competences, with the United Nations focusing on the international peace and security implications of the outbreak through the Council and the coordination of the Ebola response through UNMEER, and with the WHO focusing on the technical side of the response...[22]

The UN's approach to this complex crisis has the potential to set precedent given health as its trigger, but the hybrid composition is not new. American peacekeepers have been working in conjunction with non-governmental organizations for decades as viewed through interventions in Bosnia, Kosovo, Iraq, and Afghanistan. Unlike those actions, this crisis has no clear security phase to uproot a belligerent followed by a rebuilding phase. In the fight against EVD, the military does not lead the way. This crisis intervention model has both security forces and non-governmental organizations entering the fight hand in hand.

UNMIL is a peacekeeping operation that has been in Liberia since 2003. It consists of military, police and civilian personnel charged with 'assisting the Government of Liberia in the consolidation of peace and stability and the protection of civilians.'[23] Until the outbreak of EVD, this mission was under active draw down from a peak force of over 15,000 personnel to 3,750 by June 2015.[24] In light of the impacts of EVD on the government institutions of Liberia, UNSC Resolution 2190 was passed authorizing current force levels be maintained at the current strength of 4,811 military and 1,795 police personnel through the end of September 2015. The resolution encourages a renewed emphasis on transition of security responsibility for the protection of its civilians from physical violence to the Liberian National Police. The resolution further speaks to UNMIL's role in 'facilitating humanitarian aid provision... by helping to establish the necessary security conditions…(and to) coordinate with the United Nations Mission for Ebola Emergency Response (UNMEER), as appropriate'.[25] This extension was first reviewed in September 2014 via UNSC Resolution 2176, just before Resolution 2177 which thereafter encouraged member states to consider the disease outbreak a 'threat to international peace and security'.

The United States Government has the responsibility to protect its citizens, whether employees or volunteers, from harm as they support the response effort. Using members of the military sends a clear message to both those volunteering as well as any who would threaten their efforts and assistance. The American military task force, OPERATION UNIFIED ASSISTANCE, is capable of protecting itself while providing security and support to the other members of the civilian-led response effort. Following this decree the U.S. DoD was tasked to deploy upwards of 4,000 soldiers to aid in the response.[26] Thus far, the U.S. government's total fiscal commitment towards the response is over $685 million to include $500 million of DoD contingency operations funds that were re-tasked to provide humanitarian assistance and fight the current disease epidemic, (see Annex 2).[27] Support includes construction of Ebola treatment facilities, personnel protective equipment and medical supplies, logistics and engineering support, and subject matter experts in support of sanitation and mortuary affairs.[28] This translates on the ground as members of the CBRN force, military policemen, engineers, medical services personnel and logisticians. These troops are not fighting pathogens and few are directly being exposed to infected patients or samples. They are focused on enabling the health professionals in the conduct of their work by providing them the protection, the materials, and facilities they require.

Way Ahead

The UN Security Council's resolution and actions of the General Assembly in support of this crisis is significant. The UN resolutions have provided the necessary framework to increase ground forces, if required by the security environment. This allows responding member states the ability to adapt their response force quickly and decisively with the necessary authority already in place. This is not a revolution in military affairs either in capabilities or application. The use of military capabilities in a collective UN humanitarian response to crisis has both precedent and is just practical. The extent to which this hybrid security measure proves prescient for future crises should be reserved, however, and must be weighed in terms of the current security environment. When the United States representative, Ambassador Samantha Power, called for an emergency meeting on the subject health crisis in West Africa, the U.S. was well on its way to departing Afghanistan and was not yet fully re-embroiled in Iraq fighting Islamic State of Iraq and the Levant (ISIL).[29] An external security apparatus is required now to enable the other most severely affected countries, Guinea and Sierra Leone, the time needed to build and strengthen state systems and effectively respond. Evidence for this requirement is seen in the relative success of Liberia which has, at the time of this draft, not reported a new incidence in over three weeks.[30] Disease does not fall under traditional security concerns and threats to peace, but it does have a place in the discussion of global threats. The extension of United Nations Mission in Liberia (UNMIL) and the wide support for UN Security Resolution 2177 are indicators that the traditional triggers for use of force may be changing, but so is the global security environment.

The 2014-15 Ebola Virus Disease (EVD) epidemic grew to crisis because of inadequate government systems to prevent, detect and respond to an emerging threat. The EVD outbreak has spread fear globally and serves as a reminder of man's fragility and interconnectivity in today's globalized society. In terms of the crisis model, it is premature and risky to surmise that we are beginning transition to the Post-Crisis phase.[31] The international response is beginning to have an effect and positive results are emerging. While not directly attributable, the use of military forces played some part in the reversal of infectivity trends over the last six months. The United States military response, Operation Unified Assistance, is rapidly drawing down its forces from a peak of approximately 2,800 to less than 100.[32] The EVD epidemic did not blossom into a sustained global pandemic, but is remains a regional, complex emergency that warrants further action and analysis. Generalizations from future research could prove significant to other regions with burgeoning populations, including Asia, the Middle East, India, and Latin America. Early in the response, WHO leadership publicly stated that Nigeria and Senegal's success in "preventing the spread of EVD in both countries included strong political leadership, early detection and response, public awareness campaigns, and strong support from partner organizations".[33] Doubtless that is a true statement, however, additional analysis is required to determine the proximate cause of their success while others rose to crisis. Perhaps it was a combination of factors, or possibly just plain luck.

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BIOGRAPHY

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Overview of Current Nuclear Power in the Ukraine

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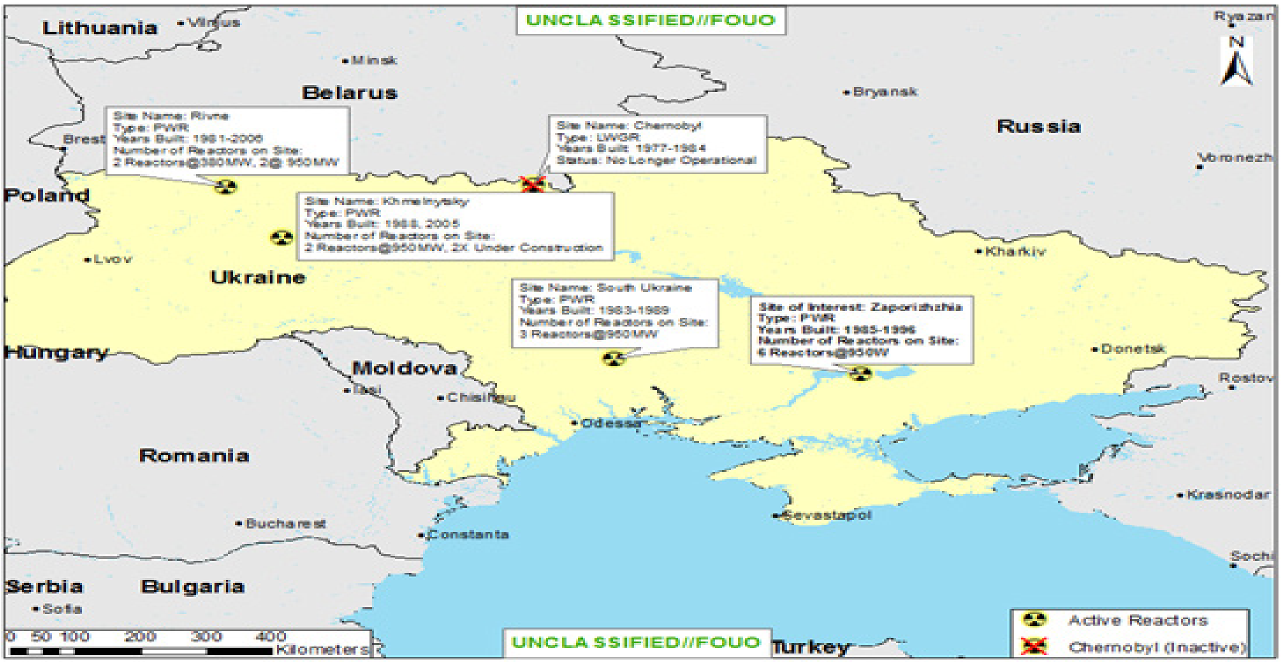

Figure 1. Ukraine Nuclear Sites

The Chornobyl Nuclear Power Plant is located in Northern Ukraine. The construction lasted over a decade and came to a halt in 1983 with the explosion of reactor #4. The Chernobyl disaster was the most devastating nuclear power plant accident in history in terms of cost and casualties. It was Classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale. The battle to contain the contamination and avert a greater catastrophe ultimately involved over 500,000 workers and cost an estimated $18 billion US dollars.

Ukraine is heavily reliant on nuclear energy, with 15 reactors at four nuclear power plants producing 40-50% of the nation's electricity. Russia supplies most of Ukraine's nuclear services and nuclear fuel.

Ukraine's strategic energy objective is to reduce dependence on Russia and develop ties to European power grid, by utilizing established pipeline infrastructure for transporting fuel from developed shale gas deposits in the Ukraine. Currently this pipeline is used to transport Russian petroleum resources.

In 2004 Ukraine commissioned two large new reactors. The government plans to maintain the current nuclear share in electricity production to 2030, which will involve substantial new build of additional units at Khmelyntskyi (figure 1).

As shown in Figure 4, there are large rural sections of the Ukraine lacking electrical power density for private use. Most of the power grid support is directly to towns and cities with little rural use.

Interestingly enough all current nuclear reactors are housed inside of containment buildings which are highly reenforced steel concrete structures. The kinetic action against these structures will have relatively small effects in a radiological sense as compared to Chernobyl or Fukishima. But let's consider the larger impact which will likely be the loss of electrical power to the power grid servicing the Ukraine. Unfortunately the loss of power could be affected by easier means than direct strikes against the reactor buildings themselves.

Let's take a look at the short term handling of the reactor shutdowns. They would likely happen automatically or by operator actions. It would take a long-term loss of emergency power to create safety issues at the reactors such as days not hours. With backup power systems co-located at the reactors, they would likely be able to safely handle the aftermath of an external strike against reactor containment. Additionally, nuclear containment vessels are designed for protection against conventional weapon missile strikes.

The areas of interest that adversaries are likely to be exploited include grid related vulnerabilities: power lines, transformer stations, control centers, communications networks, and cooling capacities for equipment are some of the more obvious ones. While the safety issues at the reactors may be handled, the impacts to a nation using an energy load roughly equivalent to that of California should not be under estimated (note: population of Ukraine ~ 45 million, population of California ~ 38 million). With loss of 40-50% of power capability there will be impacts to economic stability, survivability (water, sewage, health and transportation infrastructures), and social and political stability. The populatioun itself likely will not be cognizant of the design differences between Chernobyl and Ukraine's current operating reactors.

There is possible propaganda value in exploiting the historical Ukrainian experience of the world's most fatal reactor accident. History has shown strategic plans in the past have included loss of national infrastructure to produce strategic effects. Examples are the bombing of ball bearing factories in WWII and targeting of the power supply to marine ports creating an economic impact that ultimately toppled Milosevic's internal support in the Serbian conflict.

BIOGRAPHY

Mr. Phil Shubert currently heads the Army's Reactor Office. He is a Mechanical Engineering graduate from the University of Tennessee and served in the Navy as a Naval Flight Officer, with over 200 carrier landings on the USS Forrestal. He later served as a Senior Reactor Operator for the Tennessee Valley Authority (TVA), where he supervised the loading of the first fuel assembly at Watts Bar and was Unit Operating Supervisor for the initial critical for Watts Bar in 1996. From 1997-2007 he served with the Joint Warfare Analysis Center (JWAC), a joint command located at Dahlgren Naval Base. From 2007- 2011, he was a U.S. manager for Alstom, which is a French multinational conglomerate. Phil returned to U.S.government service in 2011 as the Army Reactor Program manager under the U.S. Army Nuclear and Countering WMD Agency (USANCA).

LTC Robin Farmer is the Deputy Chief, Analysis Division at USANCA. She has a M.A. in Environmental Management. Her previous assignments with Army G3 include Chief Army Emergency Manager and Chief Operations Branch. Prior to her assignments in the National Capital Region, LTC Farmer was with the Fort Riley IG office as Chief of Inspections and Battalion Executive Officer for 2nd Brigade, 1st Infantry Division Special Troops Battalion. Her email is robin.k.farmer.mil@mail.mil.

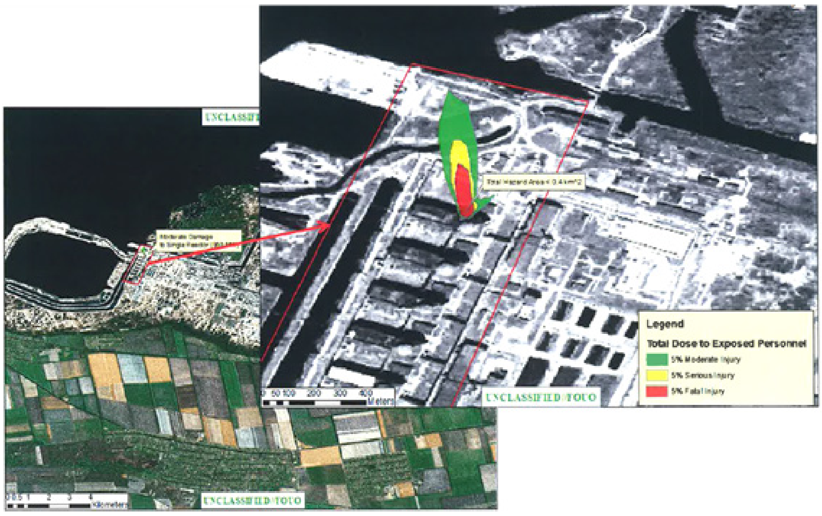

Figure 3. Injury Assessment

Figure 2. Ukraine Power Grid

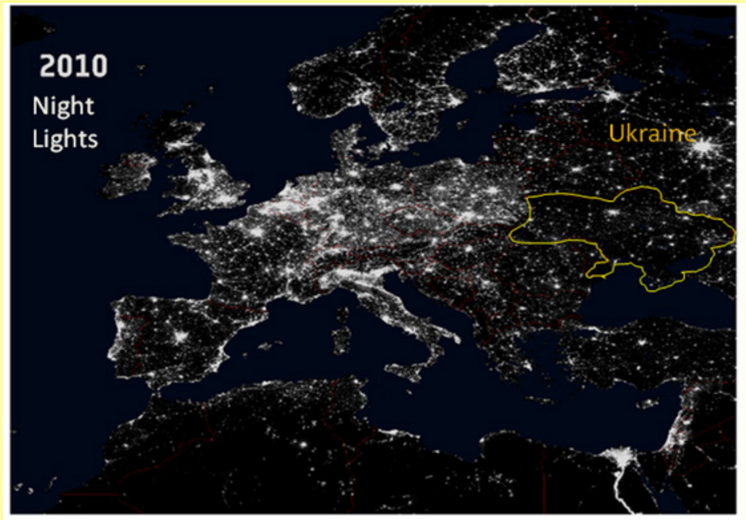

Figure 4. Night Light Satellite photography

Building CWMD Officers at West Point and Beyond

MAJ Andrew Decker
Nuclear Science and Engineering Research Center (NSERC)
Defense Threat Reduction Agency (DTRA)

"The existence of thousands of nuclear weapons is the most dangerous legacy of the Cold War. . . In a strange turn of history, the threat of global nuclear war has gone down, but the risk of a nuclear attack has gone up. More nations have acquired these weapons. Testing has continued. Black market trade in nuclear secrets and nuclear materials abound. The technology to build a bomb has spread. Terrorists are determined to buy, build, or steal one. Our efforts to contain these dangers are centered on a global non-proliferation regime, but as more people and nations break the rules, we could reach the point where the center cannot hold."
- Prague Speech 2009, President Barack Obama

Within the unassuming rooms of Bartlett Hall's Suite 100 operates a research cell unlike any other at the United States Military Academy (USMA) shown in Figure 1 and 2. These rooms house the Nuclear Science and Engineering Research Center (NSERC), an office of the Defense Threat Reduction Agency (DTRA) whose primary mission at West Point is to partner with the institution's cadets, faculty, and academic departments to conduct research in combating weapons of mass destruction (CWMD). No other USMA research center so directly enhances the CWMD effectiveness of the Department of Defense (DoD) nor supports the growth and development of future CWMD officers for our Army and Nation.

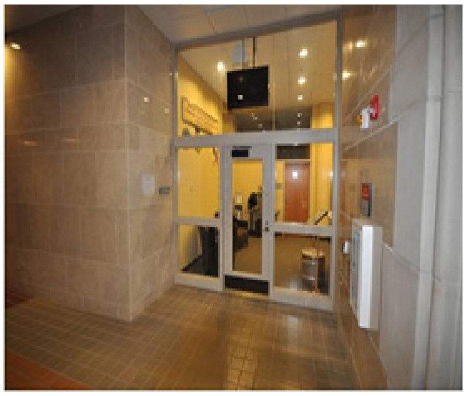
Figure 1 – Suite 100, Bartlett Hall Entrance


Figure 2 – NSERC Meeting Room

History and Background

Just a decade ago, the NSERC first opened as a small room located in the basement of Bartlett Hall. From the start, faculty belonging to Functional Area 52 (FA52), Nuclear and Counterproliferation, led the establishment of an early nuclear engineering research group to stimulate collaborative research and publication among West Point's Nuclear Engineering faculty. Despite full teaching schedules and no budget, their exhaustive efforts in academic outreach and funding solicitations were eventually rewarded with patronage under DTRA, the DoD's lead combat support agency for CWMD. Between 2004 and 2006, the small research group conducted a series of successful projects for DTRA, and the agency recognized a tremendous capability present within the granite walls of USMA's academic buildings.

Figure 3: NSERC Faculty

Specifically, West Point cadets and faculty possessed exceptional education and training, world-class research facilities, and the necessary security clearances to undertake valuable research on behalf of the DoD. For DTRA, West Point also represented a largely untapped resource in CWMD, but in order to benefit from its potential pool of researchers, DTRA first needed an office on West Point to coordinate research support.

To USMA, the partnership with DTRA guaranteed DoD-relevant research topics and funding support for the Academy's cadets and faculty. However, this relationship also provided cadets and faculty with a greater appreciation for our nation's CWMD mission, and it facilitated their exposure to the breadth of agencies, test facilities, and national laboratories working together in concert to protect America and her allies from WMD.

Figure 4: NSERC Display in Bartlett Hall

The relationship between USMA and DTRA became fully codified in 2007 through the signing of an official memorandum of agreement, which formally established the NSERC as it operates today. From its humble beginnings and an initial DTRA project budget of only twenty-five thousand dollars, the NSERC now operates on a budget of more than a million dollars annually.

Present Operations

Along with an increase in resources, the mission of the NSERC has also expanded since 2007. While maintaining a strong relationship with the Department of Physics and Nuclear Engineering (D/PaNE), the NSERC now coordinates and funds research across many academic departments on West Point. Current initiatives include research with D/PaNE and Systems Engineering, as well as the Departments of Math, Social Sciences, Humanities and Behavioral Science and Leadership. Faculty-funded research at the Academy is also more prevalent than ever and includes projects related to consequence analysis, nuclear detection and nuclear forensics.

Concurrent with its operations at West Point, the NSERC also funds and coordinates CWMD research on behalf of DTRA at both the United States Naval Academy (USNA) and the United States Air Force Academy (USAFA). For the investigation of more long-term or sensitive research initiatives, such as nuclear weapons effects or design, the NSERC supports military graduate students from all Services at the Air Force Institute of Technology (AFIT) in Dayton, OH.

In addition to facilitating DoD-relevant research for students and faculty from all of these institutions, the NSERC also supports their professional training and education in the field of Nuclear Engineering, an effort deemed essential by DTRA for the growth and development of future CWMD leaders for our nation. The most prominent example of this support is through the annual funding of cadet and faculty academic internships by DTRA. In FY14, the NSERC funded nearly 50 academic internships, sending cadets and faculty from all three Service Academies to locations like the national-capital region, national laboratories, Service laboratories, and many other research sites across America.

Figure 5 & 6: USMA Cadets Conducting Radiological Survey Exercise Training

At West Point, NSERC personnel also assist in developing the Army's future CWMD leaders by lending their expertise in nuclear weapons technology and weapon effects to the D/PaNE. NSERC officers supervise cadet nuclear engineering research, instruct courses in physics and nuclear engineering, and direct the NE400 seminar course, which brings CWMD experts from across the Country to speak with cadets at West Point.

Conclusion

Today the entire NSERC mission is accomplished by just three Army FA52 officers and one contractor; however, despite the rapid pace of current operations, the NSERC continues to generate new influence. The Center recently connected with both the Naval Postgraduate School (NPS) and the U.S. Army War College in an effort to partner more students and faculty with complimentary DTRA projects. In other words, the NSERC continues to enhance and expand research collaboration across all DoD-degree granting institutions on behalf of DTRA. These efforts produce partnerships, experiences, and research results which improve DoD effectiveness in CWMD and support the growth and development of future CWMD officers for our Nation. This is precisely the mission of the NSERC and the principle reason it stands apart from all other research centers on West Point.

BIOGRAPHY

MAJ Andrew W. Decker graduated from the United States Military Academy in 2002 with a B.S. in General Psychology. Commissioned into Military Intelligence, he served in a variety of staff and leadership positions for the first ten years of his military career. MAJ Decker then functionally designated to FA52 (Nuclear and Counterproliferation Officer) and pursued a M.S. in Nuclear Science at the Air Force Institute of Technology (AFIT) in 2012. Upon his graduation from AFIT in March 2014, MAJ Decker was assigned to the Defense Threat Reduction Agency with service at the Nuclear Science and Engineering Research Center (NSERC) located in West Point, NY.

SERPENT User Workshop Hosted by USANCA

Yvette B. Gonzalez
Air Force Nuclear Weapons Center
Kirtland Air Force Base, NM

Chuck Tobin
Exelis, Inc.
Colorado Springs, CO

A Simulated Environment and Response Program Execution Nesting Tool (SERPENT) user workshop was hosted by USANCA in October 2014. Attendees from government and industry participated in a two-day hands-on introduction to creating inputs, weapons and targets and interpreting analysis results

The SERPENT is a Windows®-based software application that simulates weapon attacks on hardened, buried, soft, fixed, or mobile targets. SERPENT allows the user to configure the target and the weapon and computes agent release and dispersion results in numeric and graphic form. SERPENT is sponsored and distributed by the USAF Nuclear Weapons Center and developed by Exelis, Inc.

Originally SERPENT was first applied to scenarios where chemical and biological agents are stored in thin-walled containers arranged inside underground bunkers or in soft above-ground structures. This included agent defeat analysis of alternate scenarios. SERPENT has since been applied to situations involving IEDs, tunnels, interior fires and open-air releases. SERPENT supports sequential or nested execution of specified algorithms to account for parameter variations and stochastic weapon placement. Statistics are reported and graphical tools aid in the analysis and interpretation of results.

SERPENT performs end-to-end simulations of chemical and biological releases using physics-based modeling techniques to account for container damage, agent release, interior environments, internal dispersion and neutralization, and venting of agents into the atmosphere.

SERPENT Instructors and Students

Casualty estimates are provided by HPAC and initial penetration of conventional weapons is simulated by PENCURV.

The next major version of SERPENT is planned for release in the summer of 2015. SERPENT 3.0 will incorporate improved physics for container response and agent environments both inside structures and during plume rise. Capabilities have been added in the areas of container crush and motion, multiple agent release, and elementary chemical reactions.

SERPENT 3.0 will include an interface to RUSTIC MESO, providing alternatives for improved temporal and spatial fidelity of transport and dispersion particularly in urban terrain. SERPENT was the recipient of both the 2007 Air Force and DoD Modeling and Simulation awards. For further information, please contact me or Chuck Tobin:

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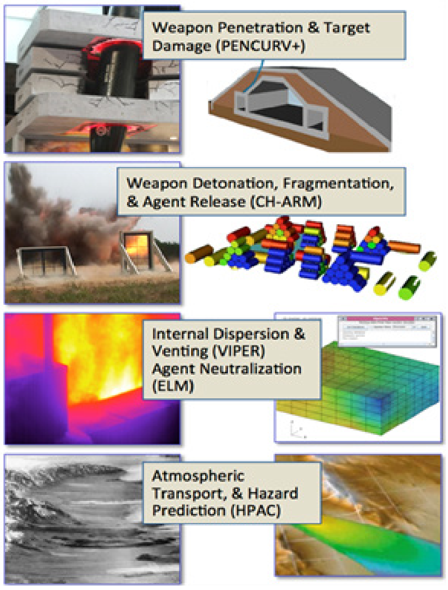


Nuclear Weapons Distance Learning Graduate Certificate Program

LTC John Leahy
United States Army Nuclear and Countering WMD Agency

The Air Force Institute of Technology is now offering a distance learning graduate certificate program entitled Nuclear Weapons Effects, Policy & Proliferation or NWEPP. The U.S. Air Force, Air Education and Training Command conceived the program to reinvigorate nuclear related education for the Air Force Nuclear Enterprise. Nuclear education for the nuclear workforce is a top Air Force priority. The program director, Dr. John McClory, welcomed the first class in the Fall of 2011.

> Dr. McClory states: "I have been gratified by the enthusiasm, knowledge, and dedication of our distance learning students as both an instructor and as the program director. Our students bring a wealth of knowledge on nuclear deterrence tactics, operations, and strategy which they share and which elevates the level of discussion. Student contributions along with our structured course material makes the program a valuable resource for those of any service preparing for a position in the national nuclear enterprise."

The program targets "non-quota", mid-career officers, non-commissioned officers and government civilians with current or future assignments in the DOD nuclear enterprise who would not normally have any other way to pursue nuclear weapons related formal education. The program is open to students in residence at AFIT and candidates who are nominated by the Air Education and Training Command (AETC) A10 in consultation with Air Force Global Strike Command (AFGSC). Interested students outside of AFGSC must coordinate attendance through AFIT and AETC/A10. U.S. Army Nuclear and Counterproliferation (FA 52) officers coordinate through the US Army Nuclear and Countering WMD Agency, USANCA. Although open to AFIT resident students, there is neither a residency requirement nor is there a security clearance requirement. Similarly, there is no requirement for a science or engineering background. The only academic requirement is undergraduate degree completion with a GPA of 3.0 or higher to include a college algebra level math course with a grade of "C" or higher. All students must also be U.S. citizens.

The program consists of three, 4-credit hour courses. The three courses last for 10 weeks each. Each course may accommodate up to 40 students. The entire program may be completed in as little as 9 months but must be completed in no more than two years after starting the first course. Students should plan to spend at least 16 hours per week and those who complete the formal program with a minimum GPA of 3.0 or higher receive the AFIT graduate certificate.

Students work both independently and in groups to perform educational investigations over a broad range of topics. These include weapon effects, nuclear technologies including the fuel cycle, non-proliferation challenges, and the evolution of U.S. nuclear weapons policy since the Manhattan Project. Students develop the skills necessary to advise and develop future nuclear strategy and policy. They develop an understanding of technical issues which will be sufficient to allow them to interface with the technical communities in the DOD and DOE where the U.S. nuclear stockpile is maintained. They develop an understanding for what makes nuclear weapons unique. Lastly, they develop an understanding for how these unique weapons have enabled the U.S. to deter war over the past six decades.

Term	Credits	Course	Title	Prereqs
FA,WI,SP	4	NENG 500	Nuclear Weapons Strategy and Policy	None - NENG 591 and NENG 596 recommended
FA,WI,SU	4	NENG 591	Nuclear Weapons and Proliferation	None - NENG 596 recommended
FA,SP,SU	4	NENG 596	Nuclear Weapons Effects	None

NWEPP Course Requirements

For more information, readers may contact Amanda Zehring at AFIT, email: Amanda.Zehring.ctr@afit.edu (937) 255-3636 x-4706 http://www.afit.edu/

Chemical Warfare: The 100th Anniversary of Modern Chemical Warfare

Mr. A. Mark Diglio
United States Army Nuclear and Countering WMD Agency

USANCA's CWMD Journal has reviewed the origins of chemical warfare, the original weapon of mass destruction, to the modern era and uses today. In this issue, we somberly reflect upon the 100th Anniversary of the first modern use of chemical agents with the following test to those that work in chemical defense or those who are simply interested in honing their knowledge in chemical defense.

TOXIC TRIVIA TEST

1. Who first used chemical in warfare?
   a. Japan 1660 BC
   b. Chinese 1,000 BC
   c. Muslims 683 AD
   d. Mongols 1241 AD
   e. Germans 1914 AD
   Hint: Arsenical smokes were used to sicken enemy troops making them combat ineffective.

2. When did the Greeks first use *unquenchable* fire?
   a. 424 BC
   b. 200 BC
   c. 678 AD
   d. 1241 AD
   Hint: These were critical in Greeks winning many naval engagements.

3. What chemical was called "The King of Poisons or The Poison of Kings" until the Marsh test 1836?
   a. Belladonna
   b. Amrutanjan
   c. Yellow cake
   d. Arsenic
   Hint: Gold colored compound popularly used for royal assassinations prior to easy forensic detection.

4. What chemical attack is infamous for starting The Modern Age of Chemical Warfare in WW I?
a. October 27, 1914 – dianisidine chlorosulfonate
b. January 31, 2015 – lachrymatory agent (tear gas), xylyl bromide
c. April 22, 2015 – chlorine gas
d. July 15, 2015 - sulphur mustard
e. November 3, 2015 – phosgene
Hint: The responsible agent is still used in today's conflicts. It leaves a green tint to objects it touches.

5. What chemical agent caused the most casualties in World War I?
   a. Chlorine
   b. Phosgene
   c. Mustard
   d. Hydrogen Cyanide
   e. Lewisite
   Hint: This agent is estimated to have caused 90% of the estimated 1.3 million chemical casualties in WW I. Oddly enough, only a smaller number, 91,000, died on the battlefield.[1]

6. This chemical caused more fatalities in WW I than all chemicals combined?
   a. Sarin
   b. Phosgene
   c. Mustard
   d. Hydrogen Cyanide
   e. Lewisite

Hint: This agent is colorless and sometimes faintly smells like moldy hay. Some estimates are 85% of the chemical deaths during the war came from this chemical agent alone.

7. What year did the Chemical Warfare Service become an official part of the U.S. Army?
   a. 1917 Originally called, “The Gas Service” at the behest of General Pershing
   b. 1918 U.S. War Department officially created the U.S CWS with MG William Sibert as its 1st Director
   c. 1920 Congress approved the CWS with MG Amos Fries at the helm
   d. 1930 The Judge Advocate General ruled CWS chemical training good for the entire U.S. Army

Hint: The CWS, predecessor to the U.S. Chemical Corps was temporary until this event.

8. What is not a definition for LD50?
   a. The dose at which 50% of an exposed population (animals) die within 24 hours
   b. The standard measurement for acute toxicity required to kill 50% of a population
   c. The mean lethal dose
   d. The dose at which 50% of an exposed population is expected to survive without malady.
   e. All of the above

Hint: A common myth is that LD50 is a gage of human survivability and quality of life

9. This popular poison was used for beauty treatments and as a sleep aide?
   a. Castor Bean
   b. Belladonna
   c. Hemlock
   d. Strychnine
   e. Formaldehyde

Hint: Referred to as Deadly Nightshade, poisoned Marcus Antonius troops during the Parthian wars. This chemical was also used as a beauty aid and was popular with ladies of the night. One to three grains is good for beauty rest (do not experiment at home), more than that is utterly fatal.

10. Name of the US Liberty ship responsible for the most chemical casualties in WW II?
   a. John Harvey
   b. John Bascom
   c. John L. Motley
   d. Joseph Wheeler
   e. Samuel J. Tilden

Hint: Over 628 suffered from mustard gas exposure of which 69 died within two weeks of the December 2, 1943 attack.

11. What is the estimate of Iraq caused soldier chemical casualties in the September 1980 to August 1988 Iraq-Iran war?
   a. 50
   b. 500
   c. 5000
   d. 50000
   e. 500000

Hint: Iraq used chemical agents (mustard and GB) to reduce superior Iranian force numbers.[2] Estimates of total fatalities are 150-340K Iraqis and 450-730K Iranians. For those that didn’t die, their quality of life will be chronically diminished. Those exposed to mustard will carry a significantly higher risk of cancer for the rest of their lives.[3]

12. What are the chemical agents most frequently used in attacks over the last 20 years and most likely to be used by non-state actors today?
   a. Chlorine, Mustard, GB
   b. Phosgene, Chlorine, Mustard
   c. Mustard and Sarin
   d. Mustard, GB, VX

Hint: Syria is reported to have used all of these on their people and rebels in the past 2 years.

13. Which of the following were not involved with a major modern age of chemical warfare milestone?
   a. Gerhard Schrader
   b. Fritz Harber
   c. Otto Ambros
   d. Robert Pfeffer
   e. Van der Linde

Hint: Some of the above are credited with the creation of GB. Developed in the late 1930s G-series agents were named so because they were discovered in Germany. GC was already taken for gonococcus, but GA, GB, GD and GF were the first four (respectively Tabun, Sarin, Soman and Cyclosarin). The last discovered was named VX because it was venomous and some argue the deadliest. The "go to" latest greatest entering WW II were the "Trilon Group" (GA, GB and GC).[4]

If this trivia test does nothing more than pique your interest in learning more about chemical agents or to ask the question, "Why are chemical agents a serious threat today?" it will have served its purpose. Despite the CWC and best efforts of the OPCW, while only 5 countries had chemical defense programs in the 1960's, with today's global chemical industrialization, the number has increased by 300%. Today, the ability for countries to make a sizable chemical threat is in terms of weeks (or minutes), not months or years. Why? Binary duel use components can be readily available in a moment's notice sparing the costs and risks associated with conventional chemical stockpiles. The costs for stockpiling conventional chemical weapons are high. Long term storage has become passé due to OPCW efforts by the CWC, environmental hazards, safety risks, declining potency and reliability. Aging stockpiles need to be monitored and maintained. If taken to task for safely destroying an aging chemical munitions stockpile, the cost is conservatively 10 times the cost to make it. These all serve as deterrents to stockpiling chemical munitions. Also, if a country has no direct chemical weapons stockpile, it gives the "appearance" there is no chemical threat. But we know better. The threat of chemical attack and its actual use are very much alive today. This includes human insecticides from binary compounds freshly toxic when mixed to deadly toxic industrial chemicals (TICs) transported globally every day.

Consider this, risk is a combination of the likelihood something is used by the impact of its use. In this author's opinion, arguably the risk of chemical attack is higher than that from biological or nuclear weapons. This much is a certainty - the day a military stops preparing and planning to deal with chemicals is the day we become significantly weaker as a force and in our nation's defense.

Note: Unless specifically referenced, most answers to the Modern Warfare Toxic Trivia Test can be found in prior issues of the CWMD Journal in our four part series on the history of chemical warfare.

ANSWERS: 1b, 2c, 3d, 4c, 5d, 6b,7c, 8d, 9b, 10a, 11d, 12a, 13d

Endnotes.

1. Chemical Weapon, Weapons of Mass Destruction by Barry R. Schneider - Encyclopedia Britannica, Jan 1, 2014, http://www.britannica.com/EBchecked/topic/108951/chemical-weapon/274179/Weapons-of-mass-destruction.
2. Wright, Robin (2008). Dreams and Shadows: The Future of the Middle East. New York: Penguin Press p. 438.
3. Bryant, Terry (2007). History's Greatest War (1st edition). Chandni Chowk, Delhi: Global Media.
4. Medical Aspects of Chemical Warfare, Office of the Surgeon General, US Army, from the Borden Institute Textbooks of Military Medicine (2008), p. 47.

BIOGRAPHY

Mr. A. Mark Diglio is the Chemical Branch Chief at USANCA in Fort Belvoir, MD. He has a B.S.in Chemical Engineering from the Pennsylvania State University and an MBA from the Florida Institute of Technology. His previous assignments include Associate Project Manager at the Program Manager for Chemical Demilitarization, Deputy Project Manager for Long Range Biological Standoff Detection System and Team Chief for Collective Protection at the U.S. Army Edgewood Chemical and Biological Center. His email address is anthony.m.diglio.civ@mail.mil

USANCA Hosts the Armed Forces Radiobiology Research Institute Medical Effects of Ionizing Radiation Course

LTC John Leahy
United States Army Nuclear and Countering WMD Agency

On 14-16 April 2015 USANCA hosted the Armed Forces Radiobiology Research Institute, AFRRI, Medical Effects of Ionizing Radiation, MEIR, course at their LTG Leslie Groves Building on Ft Belvoir. AFRRI is part of the Uniformed Services University of Health Science located in Bethesda, MD and its primary mission is to conduct research on the medical effects of ionizing radiation and to develop countermeasures to mitigate and reduce the effects.

The Course is designed to improve the operational capabilities of the military services by providing medical and operational personnel with up-to-date information concerning the biomedical consequences of radiation exposure, how the effects can be reduced, and how to medically manage casualties. The training has recently been updated to include information about and lessons learned from the Fukushima Daiichi incident in Japan.

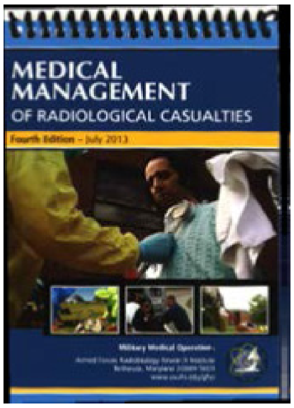


Figure 1. Course materials include the Medical Management of Radiological Casualties handbook.

The course is beneficial for military physicians, nurses, CBRNE specialists, health physicists, medical planners, and first responders. Course topics include: the physical principles of ionizing radiation, ionizing radiation interactions with cells and organs, management of internal contamination, late effects, and diagnosis and treatment of acute radiation syndrome and combined injury. Students received training on the effects of radiological/ nuclear weapons, radiological terrorism, and radiation accidents, and their psychological effects as well as the logistics of radiation incident response. The instructors demonstrated the use of Radiation Detection, Indication and Computation (RADIAC) equipment, on-line radiation resources, the Biodosimetry Assessment Tool (BAT) and the First Responder Assessment Triage (FRAT) software programs. The course is also offered on-line and is a source of accredited continuing medical education and continuing nursing education.

Figure 2. MEIR Course Director, CPT Christopher Duncan, responding to a student question.

USANCA participants commented favorably on the course. CPT Scott Julich "The MEIR course provided me with that critical connection between the scientific and technical aspects of ionizing radiation and their corresponding health effects and treatment requirements. I now feel completely equipped to explain, advise, and act appropriately in a radiation event." Mr. Mark Diglio stated "I wanted to learn about radiation threat, detection, protection, medical treatment, response, equipment and decontamination. The MEIR course and its interesting instructor vignettes exceeded my expectations. I recommend it for those involved with CWMD analysis, planning, policy and requirements."

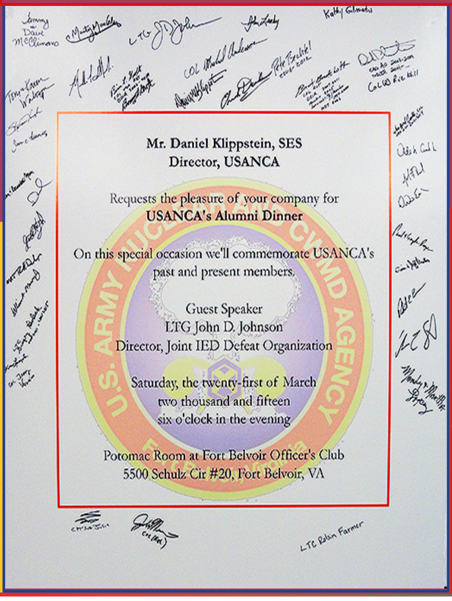
Immediate Response

- Local first responders arrive on scene
  - Fire, EMS, HAZMAT, Law Enforcement
- Responding agencies establish a unified command consistent with ICS
- Functional nearby MTFs are notified
  - Stand up EOCs
  - Activate Emergency Management Plans
  - Recall personnel in anticipation of MASCAL
- Governor mobilizes state resources

Figure 3. MEIR Instructor, Mr. C. Robert Woodruff, points to a list of those who make an immediate response to radiation emergencies.

Visit the AFRRI web site at https://www.usuhs.edu/afrri.

USANCA Alumni Dinner



Mr. Daniel Klippstein, SES
Director, USANCA

Requests the pleasure of your company for
USANCA's Alumni Dinner

On this special occasion we'll commemorate USANCA's
past and present members.

Guest Speaker
LTG John D. Johnson
Director, Joint IED Defeat Organization

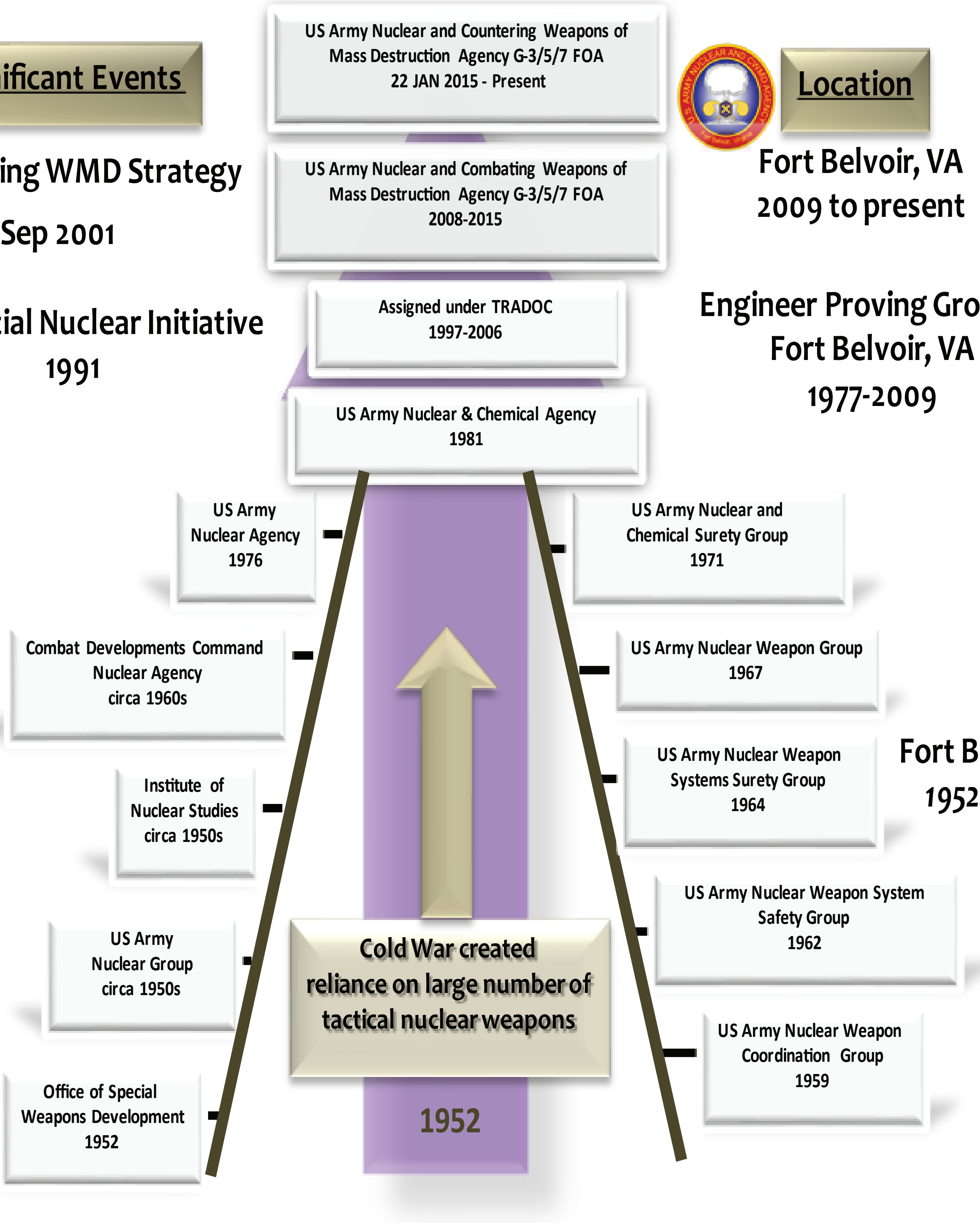
Saturday, the twenty-first of March
two thousand and fifteen
six o'clock in the evening

Potomac Room at Fort Belvoir Officer's Club
5500 Schulz Cir #20, Fort Belvoir, VA

Thank you to all for attending the USANCA Alumni Dinner on 21 March 2015, and making it such a successful event. USANCA has a rich history within the Army, a great legacy that continues today. So it was fitting to gather to remember those who made the organization what it is today – a leading resource to the Army. The evening was hosted by our Director, Mr. Daniel Klippstein, and the guest speaker was LTG John D. Johnson, Director of the Joint IED Defeat Organization. Honored guests include three previous Directors and three prior Deputy Directors.

The dinner was also a perfect opportunity to formally announce that the Agency's name officially changed. On 22 January 2015 the Director of the Center of Military History approved USANCA's request. The acronym "USANCA" remains intact but "Combating" has been replaced with "Countering" to be consistent with National policy, DoD strategy and Joint Doctrine. We are now the United States Army Nuclear and Countering Weapons of Mass Destruction Agency.

We are looking forward to the next Alumni Dinner in March 2016 and hope you are available to attend. Details about the event will be in next issue of the CWMD Journal.



Significant Events

Combating WMD Strategy

11 Sep 2001

Presidential Nuclear Initiative

1991

Location

Fort Belvoir, VA

2009 to present

Engineer Proving Ground,
Fort Belvoir, VA

1977-2009

Fort Bliss, TX

1952-1976

US Army Nuclear and Countering Weapons of Mass Destruction Agency G-3/5/7 FOA
22 JAN 2015 - Present

US Army Nuclear and Combating Weapons of Mass Destruction Agency G-3/5/7 FOA
2008-2015

Assigned under TRADOC
1997-2006

US Army Nuclear & Chemical Agency
1981

US Army Nuclear Agency
1976

US Army Nuclear and Chemical Surety Group
1971

Combat Developments Command Nuclear Agency
circa 1960s

US Army Nuclear Weapon Group
1967

US Army Nuclear Weapon Systems Surety Group
1964

Institute of Nuclear Studies
circa 1950s

US Army Nuclear Weapon System Safety Group
1962

US Army Nuclear Group
circa 1950s

US Army Nuclear Weapon Coordination Group
1959

Office of Special Weapons Development
1952

Cold War created reliance on large number of tactical nuclear weapons

1952

U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency (USANCA)

MONA-CWZ
Command Group

Director**	**x7868**
Deputy Director *	**x7852**
Executive Officer	x7857
Agency Secretary	x7846
Office Manager	x7851
Budget Analyst	x7853

MONA-CWO
Operations Division

Chief *	**x7855**
Deputy Plans and Operations *	x7859
Nuclear Operations Branch	
Chief	x7139
CWMD Plans Branch	
Chief	805-9505

MONA-CWC
Capabilities Division

Chief *	**x7883**
Deputy Capabilities Div	x7871
International Programs	x7874
CBRN Survivability	x7870
CBRN Capabilities	x6500

MONA-CWA
Analysis Division

Chief *	**x7860**
FA52 Proponent Manager	x7866
Army Reactor Office	x7861
Biology Branch	
Chief	x7878
Chemical Branch	
Chief	x7877
Nuclear Branch	
Chief	x7864
Information Management/Web Portal	
IM Chief	x7848
IT/IM/Portal Manager	x7801
VTC Facilitator/Manager	x7801
On-Site IT Specialist	x7875

USANCA
5915 16th Street, Building 238
Fort Belvoir, VA 22060-5514

Commercial	(703) 806 XXXX
DSN	656 XXXX
FAX	x7900
STE FAX	x7842

* indicates secure capable phone

**USANCA Director, Pentagon, Room 2E366
Exec Admin Asst: (G-3/5 ARSTAF)
(703) 692-6855 DSN 222-6855

USANCA G-3/5/7 Bolte Portal Sharepoint Site:
https://g357.army.pentagon.mil/USANCA/SitePages/Home.aspx

Highlighted Courses available at the Defense Nuclear Weapons School (DNWS) and Defense Threat Reduction University (DTRU)

Theater Nuclear Operations Course (TNOC)

TNOC is the only course offered by a Department of Defense organization that provides training for planners, support staff, targeteers, and staff nuclear planners for joint operations and targeting. The course provides overview of nuclear weapon design, capabilities and effects to include U.S. nuclear policy, and joint nuclear doctrine. TNOC meets U.S. Army qualification requirements for the additional skill identifier 5H. The course number is DNWS-R013 (TNOC). Call DNWS at (505) 846-5666 or DSN 246-5666 for quotas and registration information.

Next class availability:
August 10, 2015 - August 14, 2015

Nuclear Weapons Orientation Course (NWOC)

The Nuclear Weapons Orientation Course (NWOC) is a 4.5-day course that provides an overview of the history and development of nuclear weapons, management of the U.S. nuclear stockpile, and the issues and challenges facing the program. The modules focus on four functional areas: nuclear weapon fundamentals, nuclear weapon effects, nuclear weapons stockpile, and nuclear weapons issues. The course can be taught at the customer's location as a Mobile Training Team course (NWOC, NW110M).

Objectives
. Define the scope of the national nuclear weapons program. Recall basic nuclear physics and materials
. List key elements of nuclear surety
. Recall development, testing, command and control, and weapons effects from stockpiled nuclear weapons
. Name international agreements concerning nuclear weapons
. Discuss current nuclear weapons issues

Next class availability:
August 24, 2015 - August 28, 2015

May 4, 2015 - May 8, 2015 (MIT)
June 1, 2015 - June 5, 2015 (MIT)
July 20, 2015 - July 24, 2015 (MIT)
July 27, 2015 - July 31, 2015 (MIT)

Nuclear and Counterproliferation Officer Course (NCP52)

NCP52 is the Functional Area 52 qualifying course. Initial priority is given to officers TDY en route to a FA52 assignment or currently serving in a FA52 position. There is limited availability outside of the FA52 community. Please call the FA52 Proponent Manager at (703) 806-7866 to inquire on available seats.

Next class availability:
July 13, 2015 - August 7, 2015

U.S. Nuclear Policy

This course covers U.S. Nuclear Policy and its history; reviews NATO policy; discusses nuclear deterrence: theory, principles, and implications; discusses instruments of national power and implications for nuclear weapons; reviews nuclear surety and intelligence; discusses nuclear treaties and arms control.

This course is taught at the Defense Nuclear Weapons School (DNWS) Albuquerque, New Mexico.

Next class availability:

Email: dnws@abq.dtra.mil
Fax: (505) 846-9168 or DSN 246-9168
Online registration:
https://dnws.abq.dtra.mil/StudentArea/Login.asp

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U.S. ARMY NUCLEAR AND CWMD AGENCY
Fort Belvoir, Virginia