NBC REPORT

U. S. Army Nuclear and Chemical Agency

Fall / Winter 2005

The Strategy of Nuclear Deterrence: Why MAD Was Sane

Trinity— Secrets & Security (Part II)

Our Future Nuclear Stockpile: Risks and Opportunities

USANCA's Role in Combating Weapons of Mass Destruction

Estimating the Concentration of Radioactive Material in Air During Emergency Responses

"Blue to FA52" Two Success Stories and Counting

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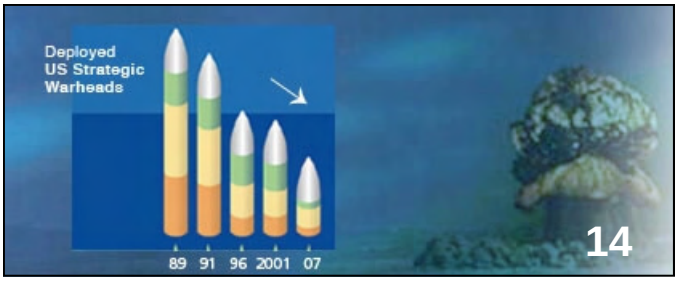

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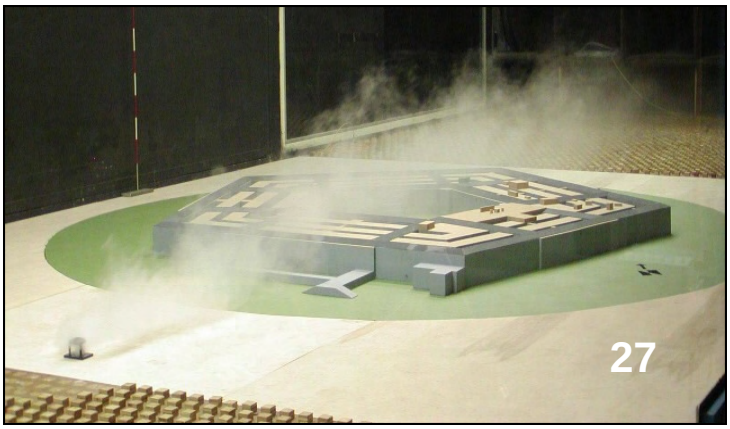

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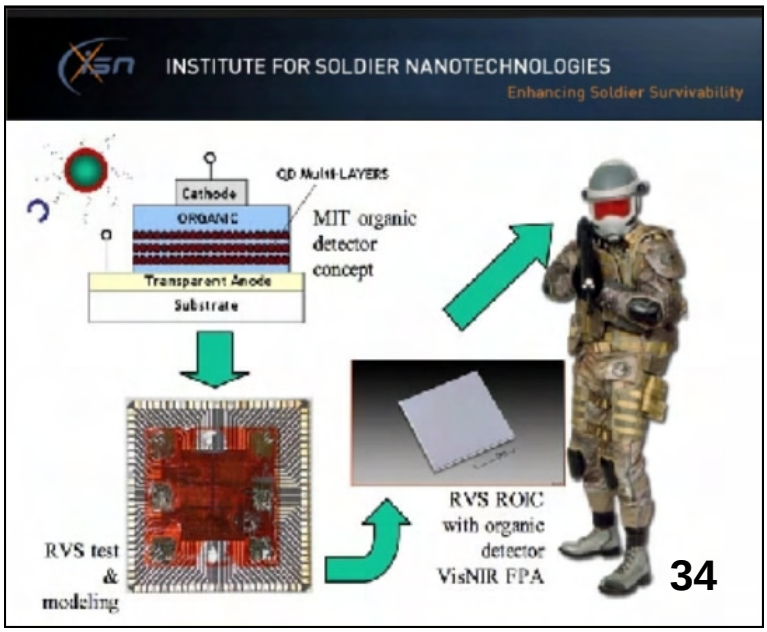

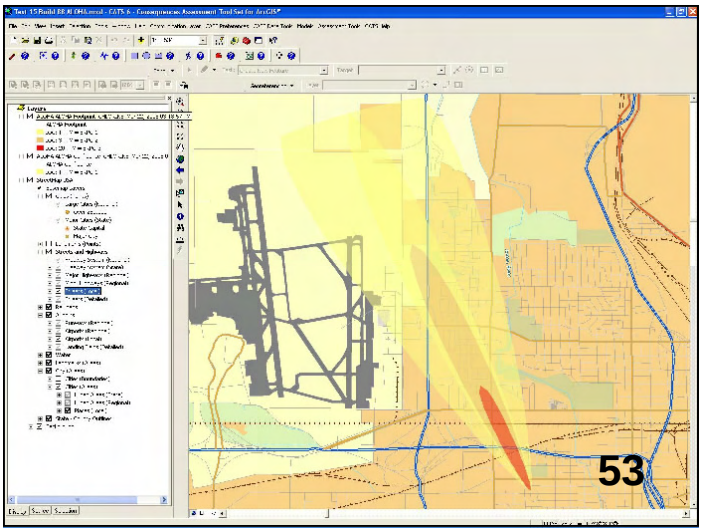

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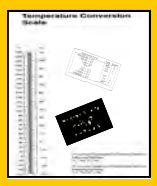

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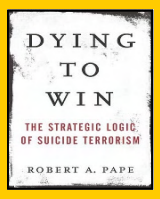

NBC Community News

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USANCA's Role in Combating Weapons of Mass Destruction

COL Jesse E. Daniels, Acting Director
United States Army Nuclear and Chemical Agency

COL Jesse E. Daniels
Acting Director
U.S. Army Nuclear and Chemical Agency

The recent Department of Defense (DoD) doctrinal and organizational changes associated with combating weapons of mass destruction (Cbt WMD) have been significant. Consequently, the United States Army Nuclear and Chemical Agency (USANCA) continues to evolve as an Agency and as a partner with the Services, Combatant Commands, Ground Component Commanders, Agencies, Staffs, and Allies. I believe it is important to reflect on these major changes and examine how they have impacted USANCA and some of its customers. Additionally, I will highlight some of the contributions USANCA makes to the Cbt WMD mission area and provide insight on the possible future of the Agency and its role in Cbt WMD.

Cbt WMD Doctrine and Guidance

The President's September 2002 *National Security Strategy* (NSS) dramatically shifted the way the United States (US) combats WMD. Prior to this document, WMD was seen as a battlefield event mitigated through NBC defensive measures. The strategy now focuses on denying enemy use of WMD. The NSS depicts three pillars that encompass a full spectrum approach. These pillars, Nonproliferation, Counterproliferation, and Consequence Management, start by engaging the international community through diplomatic means and culminate with the massive response measures necessary for consequence management operations.

The President detailed how he expects to combat WMD with the first of its kind, *National Strategy to Combat WMD*. The Joint Staff built on the President's strategy by publishing Joint Publication (JP) 3-40, *Joint Doctrine for Combating WMD*. Likewise, the Chairman of the Joint Chiefs of Staff updated his Chairman of the Joint Chiefs of Staff Manual 3500.04C, *Universal Joint Task List* (UJTL) to include combating WMD tasks at the operational through strategic levels. Soon, the *National Military Strategy to Combat WMD* will be published and it will integrate the eight joint mission areas into the three pillars depicted in the NSS (Table 1).

The eight mission areas are currently in the process of staff development and should yield respective functional analysis that will lead to updated Army tasks.

Table 1. Joint Mission Areas.

- Military Support to Nonproliferation Efforts
- Threat Reduction Cooperation
- WMD Interdiction
- WMD Elimination
- Offensive Operations
- WMD Active Defense
- WMD Passive Defense
- WMD Consequence Management

Organizational Changes

In January 2005, the Secretary of Defense (SECDEF) designated US Strategic Command (USSTRATCOM), the lead Combatant Command for integration and synchronization of DoD-wide efforts in Cbt WMD. To meet these requirements while providing the appropriate and timely global response, USSTRATCOM reorganized and developed four Joint Functional Component Commands. In addition, the US Army Space and Missile Defense Command/Army Forces Strategic Command SMDC/ARSTRAT), serves as the operational integrator for global missile defense and has been tasked by USSTRATCOM to be the interservice lead for WMD elimination (WMD-E). USANCA is supporting the respective Joint and Army elements that are leading these efforts. Specifically, USANCA is providing subject matter expertise in the areas of nuclear operations, WMD targeting, WMD-E operations, and NBC survivability.

In the previous issue of *NBC Report*, I mentioned the reorganization of the Defense Threat Reduction Agency (DTRA), specifically the announcement of the establishment of

the Combating WMD Directorate. DTRA continues to work closely with USSTRATCOM on meeting Cbt WMD challenges and this collaboration should yield some exciting methodologies aimed at accomplishing its new mission.

The new Cbt WMD focus caused G3 staff to analyze if it was adequately structured to meet increasing Army Cbt WMD strategy, plans, and policy requirements. The Army G3 section that oversees combating WMD issues is the Army G3/5/7 National Security Policy Division (DAMO SSD). Previously, the Division consisted of a Nuclear and Counterproliferation Branch, Chemical and Biological Policy Branch, and Conventional and Emerging Security Issues Policy Branch. During the summer of 2005 the Division reorganized into two branches, Combating WMD Policy and Nonproliferation. The Combating WMD Policy Branch was further divided into three sections, Counterproliferation Policy, Consequence Management, and Strategic Analysis and Policy. USANCA is actively engaged with DAMO SSD on many Cbt WMD issues.

USANCA's Specific Contributions to Cbt WMD

Supporting the Army Staff

USANCA is tasked by Army Regulation 10-16, *United States Army Nuclear and Chemical Agency,* to provide specific support to the Army G3 for Army Reactor, NBC Survivability, and Nuclear and Chemical Surety programs. In addition to these regulatory relationships, USANCA has supported the Army staff in a variety of projects surrounding the development of both Army and Joint combating WMD doctrine. Perhaps the most significant contribution USANCA has made in the Cbt WMD arena was in the initial development of the organizational design of a Joint Task Force WMD-E (JTF WMD-E) based upon the Army's 20th Support Command (20th SUPCOM) (CBRNE). This effort culminated in May 2005 when USANCA hosted a tabletop exercise (TTX) for the Army to further refine the JTF WMD-E organizational design. The TTX used a real world scenario to identify doctrine, organization, training, materiel, leadership, personnel, and facility (DOTMLPF) shortfalls. Subject matter experts from the Army staff, TRADOC Futures Center, United States Army Chemical School, USSTRATCOM, Joint Staff, 20th SUPCOM, USANCA, and other organizations and agencies all contributed to the effort. The Army is now utilizing the results of the TTX as the baseline for a formal review of 20th SUPCOM's Organizational and Operational Concept to more fully identify the DOTMLPF solutions necessary for 20th SUPCOM to be dual-hatted as JTF WMD-E.

Education and Training

As Cbt WMD doctrine evolved and the UJTL changed to reflect the doctrinal evolution, USANCA was asked by the Army's Battle Command Training Program (BCTP) Operations Group D to assist the group in observing and training supported Army units. Specifically, USANCA provides subject matter expertise to support the observation and training of the offensive subtasks tied to the UJTL operational tasks of Countering WMD in the Joint Operational Area. USANCA has successfully supported most of the major BCTP exercises involving Army Corps and above since the beginning of this relationship.

As Proponent for the Army's Nuclear and Counterproliferation officer career field (FA52), USANCA continually ensures the Nuclear and Counterproliferation officer course (NCP52), is synchronized with current doctrine and policy. Similarly, USANCA provides qualified instructors for the Theater Nuclear Operations Course (TNOC), which awards graduates the Army's 5H additional skill identifier. USANCA officers with recent WMD experience from OPERATION IRAQI FREEDOM (OIF) helped develop and instruct the curriculum for the Joint Planners Course for Cbt WMD. Future course dates for these courses can be found in the NBC Community News section at the end of this issue of *NBC Report*.

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Despite the current consolidation efforts for JPs, USANCA continues to maintain responsibility for JP 3-12.1, *Joint Tactics, Techniques, and Procedures for Theater Nuclear Planning*. This document is vital to nuclear planners in all Services and the cornerstone to the "hands-on" instruction at the TNOC course. The weapons tables in this document are based on data from the Nuclear Weapons Effects Database. USANCA also maintains the algorithm for this database. Finally, USANCA coordinates with DAMO SSD to develop "Army input" in the over-arching JP 3-12, *Doctrine for Joint Nuclear Operations.*

Specialized Teams

USANCA maintains two three-man worldwide deployable Nuclear Employment Augmentation Teams (NEATs). NEATs advise Ground Component and Combatant Commanders as well as Unified Command Army Components on nuclear operations and conducts target analysis emphasizing impacts to operational and strategic plans. NEATs have supported a number of recent joint and coalition exercises.

The Nuclear Disablement Team (NDT) completed the first NDT training since deployment in support of OIF. NDT members from USANCA, 20th SUPCOM, the US Army Center for Health Promotion and Preventive Medicine, Armed Forces Radiobiology Research Institute, and the DTRA participated. In all, 19 personnel trained including four Reserve FA52 and 72A officers. The NDT is currently comprised of 12 personnel; training of additional personnel ensures a pool of qualified subject matter experts and enhances NDT readiness. The training included stops at USANCA, Oak Ridge National Laboratory, and Idaho National Laboratory. Planning is underway with the 20th SUPCOM for a fiscal year (FY) 06 NDT training exercise. The 20th SUPCOM should assume primary NDT command and control from USANCA in FY07.

Products

USANCA, in coordination with the DTRA, developed the *Nuclear and Combating Weapons of Mass Destruction Handbook,* also known as the "FA52 Handbook." Feedback from all facets of the Cbt WMD community speaks very favorably of this reference and USANCA continues to receive numerous requests for printed copies. Unfortunately, the limited "hard copy" handbooks were printed for future FA52 graduates of the NCP52 course that I mentioned above. However, "electronic copies" of the handbook are available and the CD included within the handbook can be copied and distributed.

USANCA also developed and maintains the Nuclear and Counterproliferation site on Army Knowledge Online (AKO). It is available with an AKO user name and password at: https://www.us.army.mil/suite/page/130213. This collaborative site has had a significant growth in membership and Cbt WMD products and files over the last year, to include the aforementioned FA52 Handbook.

Of course, *NBC Report* remains USANCA's primary method of publishing topical information on Cbt WMD and other nuclear, chemical, and biological matters. I would like to thank all the readers and potential contributing authors who took the time to complete our electronic survey. We take your input and insights to heart and will continually strive to make this the preeminent publication on Cbt WMD matters.

USANCA publishes the Army's Specific Military Requirements (SMR) for radiation and nuclear weapons effects research for the Army G-3. The current SMR is valid for FY05/06 requirements. The process for defining requirements and publishing the SMR for FY07/08 requirements is underway. The FY07/08 SMR document will be synched to the Joint Requirements Office-Chemical Biological Radiological and Nuclear (CBRN) Defense's Radiological and Nuclear Baseline Capabilities Assessment to be performed in parallel with the SMR process.

Survivability

An often overlooked aspect of Cbt WMD is the CBRN survivability of critical military assets, which is the main focus of the Army's nuclear and NBC contamination survivability programs. CBRN survivability is included within the Counterproliferation pillar of JP 3-40. NBC contamination survivability includes hardening, compatibility, and decontaminability. Nuclear survivability includes initial nuclear weapons effects such as electromagnetic pulse hardening. USANCA participates in many program manager working groups focused on CBRN survivability.

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United States Army Nuclear and Chemical Agency Fort Belvoir, Virginia.

USANCA reviews Army and Joint equipment and capabilities documents and issues CBRN survivability criteria for Army materiel requirements documents. On 26 October 2005, USANCA assumed the lead for the Army to develop plans, courses of actions, and Army positions regarding implementation of DoD CBRN survivability policy and its impacts on the Army. The Army Nuclear and Chemical Survivability Committee Secretariat, chaired by USANCA, is directing this effort.

Additionally, USANCA was recently tasked by the Assistant Secretary of Defense, International Security Policy, through the Army G3, to Chair the DoD Radiological/Nuclear Working Group (RNWG) to the CBRN Contamination Hazards and Risks Working Group. The first deliverable will be draft interim operational risk management guidance for the operational forces by 31 December 2005.

International

On the international front, USANCA continues to serve as DoD action agent for North Atlantic Treaty Organization Land Group 7 on Joint NBC Defence and Joint NBC Defence Interservice Working Group initiatives directed toward enhancing alliance CBRN defense standardization and interoperability, both for materiel and procedures. Today, NATO's number one priority is "Defence Against Terrorism (DAT)." To that end, considerable effort is directed at combating terrorist exploitation of CBRN. USANCA is coordinating formulation of the DoD position among the appropriate organizations on emerging issues to ensure US Heads of Delegation are prepared to present, defend, and advance those positions at working and sub-group meeting level.

In addition, USANCA provides the Chair for the American British Canadian Australian International Shield Capability Group (CG). The Shield CG is focused on interoperability aspects of Allied forces in the areas of Force Protection, Air Defense, Missile Defense, Counter-mobility, Survivability, Military Policy, and NBC Defense, including many areas associated with Cbt WMD.

Army Reactors

Cbt WMD and the Army Reactor Office (ARO) at USANCA are not often mentioned in the same sentence. Most people think the ARO's role is limited to ensuring public and worker safety and environmental protection. You might be interested to know that one of the four program goals is ensuring surety of nuclear material. Working with DAMO SSD, the Army's Test and Evaluation Command and Developmental Test Commands, as well as White Sands Missile Range (WSMR), the ARO ensures personnel are reliable and well trained and that the special nuclear material is secure and protected against diversion, theft, or damage. ARO also ensures the WSMR nuclear reactor, a unique, national asset, is operated in such a way as to maintain the support of the public and to ensure a testing capability for Army and DoD equipment and systems to survive in a nuclear battlefield environment.

"Way Ahead"

As you can see, USANCA's personnel are busy doing their share to support Cbt WMD. The receipt of new missions, such as chairing the DoD RNWG, assisting BCTP, and leading Army plans and courses of action regarding implementation of DoD CBRN survivability policy speaks highly of the professionals at USANCA. I expect this growth is an indicator of things to come. Our "tried and true" products remain relevant to the Cbt WMD community and some of our new, innovative products and techniques fill a niche that would otherwise be a void in the Cbt WMD area. Most importantly, our experienced workforce remains USANCA's number one asset. They all stand ready to accept new missions to more effectively Combat WMD for the welfare of our Nation and the success of our Soldiers.

Final Note

Recently, the Army 0-6 promotion list was released. I wish to extend my congratulations to all selectees, and best wishes towards your continued success. More importantly, I want to personally thank all our Servicemen and women and the civilians that are supporting the Global War on Terrorism. God bless you and your families for sustaining and defending our great Nation.

Bringing Nuclear Engineering Research to West Point: The United States Military Academy Nuclear Engineering Research Group

COL Edward Naessens, Dr. Brian Moretti, and CPT Michael Shannon
United States Military Academy

The establishment of the nuclear engineering academic major at the United States Military Academy (USMA) at West Point, beginning with the Class of 2005, has substantially broadened the dialogue on nuclear matters between the Academy, the civilian nuclear community, and the Army. The goal of the nuclear engineering program at USMA is to provide the Army with junior officers who have a broad understanding of the current social, political, environmental and technological challenges and issues in nuclear matters. Cadets graduating with a degree in nuclear engineering are exposed to the full spectrum of nuclear issues through lectures, colloquia, laboratories, computational exercises, and design projects. Our intent is that these cadets will be motivated to continue their study of nuclear engineering through future service as FA52 (Army Nuclear and Counterproliferation) officers.

The Physics Department enjoys a close working relationship with the FA52 community. Nearly 30 percent of all FA52 officers are West Point graduates, while nearly 30 percent of career field designated FA52 officers have served in one of the nine FA52 coded slots on the Department's Table of Distribution and Allowances (TDA). Along with the graduating cadets, USMA also returns members of the faculty who have completed their tour of duty to the Army. The Physics Department sends many of these departing officers to FA52 assignments. An important side benefit of the nuclear engineering major is the professional development opportunity for our FA52 rotating faculty. By integrating the real-world issues facing the nuclear community into our curriculum, we return FA52 officers to the Army who are more in tune with the issues they will face in their follow-on assignments.

Research is a key component to the establishment of a world-class academic program. Through a vibrant research program we can enhance the educational growth and the enthusiasm of cadets for nuclear engineering, increase the professional development opportunity for the faculty, and contribute to the solution of issues confronting the nuclear community.

Establishment of a Nuclear Engineering Research Group

The USMA Nuclear Engineering Research Group (NERG) was created in August 2004. The group was formed in response to a growing need for a rigorous research program within the nuclear engineering program. The group consists of all members of the nuclear engineering academic program as well as other members of the Department of Physics. Membership is also open to other USMA faculty with a background or interest in nuclear engineering research topics. The mission of the NERG is "to conduct quality, rigorous research in nuclear engineering and the nuclear sciences to support our primary constituent, the United States (US) Army, and to enhance the [illegible] United States Military Academy." The goals of the NERG are:

- Advance the body of nuclear engineering and nuclear science knowledge.
- Publish research results and recommendations in:
  - Refereed journal articles
  - Peer reviewed conferences of professional societies
  - Other conference proceedings
- Provide faculty with opportunities to engage in scholarly research that continues their professional development
- Provide cadets with opportunities to engage in scholarly research that increases their understanding and enthusiasm for research and the discipline
- Aggressively seek research opportunities to include grants and other funding
- Ensure that research enhances the quality of the nuclear engineering academic program
- Execute the group's mission without hampering the number one focus of our faculty – to teach!

The primary emphasis of the research conducted by the NERG is to support the Army as part of the Department of Defense (DoD). As resources permit, research efforts may support the needs of US homeland security, and finally the nuclear power industry. Research topics range from non-proliferation issues to reactor fuel design to basic cross section measurements. At the center of everything the NERG does, is the Academy mission to "educate, train and inspire cadets." With the faculty emphasis on educating cadets, the centerpiece of our research effort is the creation of tools which assist in cadet education. The NERG has a robust effort underway of writing a series of nu-

clear engineering textbooks which not only complement the research effort but also greatly enhance the academic program. The NERG focus areas are shown in Figure 1.

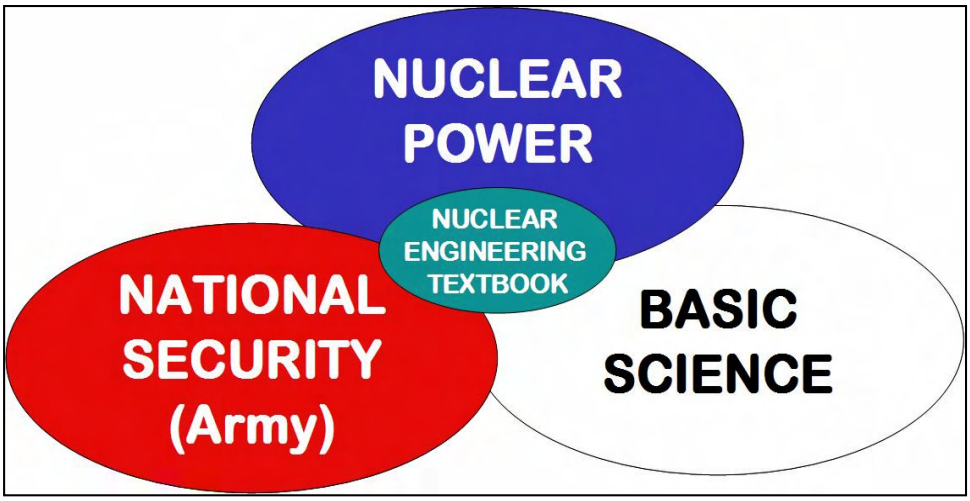

Figure 1. Nuclear Engineering Research Group Focus Areas.

These focus areas lead to the prioritization of research projects. Each fiscal year, the NERG will adjust priorities based on projects available, DoD needs, and the capability of the faculty to conduct research based on time available. Figure 2 shows the research areas of focus for fiscal year 2005 (FY05), to include collaborations with other major research universities as indicated in parentheses.

Most of the NERG's research work is theoretical and computational in nature; however, several projects may lead to experimental efforts in the future. NERG members are well versed in writing and running computer codes, such as the Los Alamos National Laboratory Monte Carlo N-Particle Extended (MCNPX), the Oak Ridge National Laboratory Standardized Computer Analyses for Licensing Evaluation (SCALE) package, the Defense Threat Reduction Agency Hazard Prediction Assessment Capability (HPAC) code and numerous others. This knowledge is complemented by the development of a robust computing infrastructure to run codes faster and better. This computing infrastructure consists of a stand-alone Beowulf cluster, as well as utilization of computers present throughout the Academy's academic area.

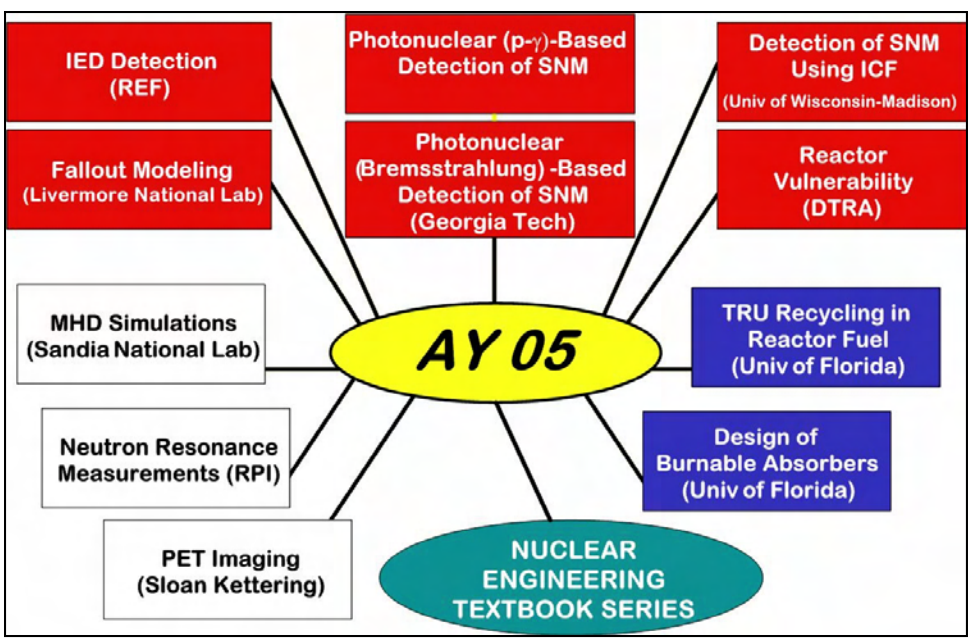

Figure 2. Nuclear Engineering Research Group Projects (Fiscal Year 2005).

[*Note: For more information on the computing capabilities in USMA's nuclear engineering program, see COL Naessens' and CPT Hasz's article on page 11 of this issue of NBC Report.*]

The NERG is task organized to execute its various research projects in two to three member faculty teams. Leading the NERG is COL Edward Naessens, who also serves as the Nuclear Engineering Program Director. He is assisted by CPT Michael Shannon, the NERG's deputy director and executive officer. COL Naessens provides overall technical and budgetary leadership to the group, while CPT Shannon handles day-to-day NERG activities including the tracking of each project, the group's budget, as well as finding funding opportunities and coordinating the submission of research grant proposals. The group is then task organized by research topical area. Each project is supervised by a principal investigator who serves as the project technical lead and who executes most of that projects' research efforts. Project supervisors have the option to call on other group members to "surge" on research activities, when necessary. The NERG conducts bi-weekly research meetings and a colloquia series that are focused on discussing the technical aspects of each research effort. These meetings are an opportunity for all group members to provide feedback and to serve as an "extra set of eyes" for the project technical lead. These meetings have proven to be a rewarding activity for NERG members as they provide quality feedback to project leads.

Since its inception in August 2004, the NERG has accomplished a great deal. To date, the NERG has received approximately $32,000 in funding from various organizations for work on numerous research problems. Furthermore, the group has submitted research proposals to both the Department of Energy and the National Science Foundation. Currently, the NERG is collaborating with the following universities: University of Florida, University of Wisconsin-

Madison, Georgia Institute of Technology, and Rensselaer Polytechnic Institute. Additionally, the NERG has teamed with Memorial Sloan Kettering Cancer Center to explore cancer-related medical physics problems utilizing the NERG's parallel computing platform. The group has also published two refereed journal articles, and upwards of ten conference papers at various professional society meetings, to include the American Nuclear Society and the American Physical Society.

The connection of the NERG to the FA52 community is quite strong. Almost all NERG members are FA52 officers who not only have graduate education in nuclear engineering, but also have operational experience in various FA52 assignments. Each NERG member will leave the Academy with a greater sense of the problems facing the community and have an enhanced ability to solve tough engineering problems. Some of the research projects currently being pursued by the NERG have come from FA52 officers who are in positions where research is required but not possible. A goal of the NERG is to provide a place for all FA52s to seek assistance with problems that require a research-based solution.

The establishment of the NERG has not come without challenges. The faculty participates in NERG activities when their teaching duties, which are often extensive, are complete. In addition, the faculty is encouraged to support cadet activities outside the classroom, leading to a shortage of faculty discretionary time for research activities. Early in the formation of the group, this constraint became immensely evident. In light of this constraint, the NERG leadership has spent the past few months evaluating the notion of transforming the NERG into a nuclear engineering center of excellence.

The Future: Nuclear Engineering Center of Excellence

The advent of the nuclear engineering major and the success of the NERG have convinced the Physics Department leadership of the potential for USMA to be a serious contributor to defense efforts in nuclear engineering and radiological research. While the NERG has successfully facilitated faculty research, and we are proud of the accomplishments of group members conducting research in addition to their teaching mission, the informal nature of the NERG prevents us from taking advantage of all of the many resources available to broaden our research efforts. To this end, we are contemplating the establishment of a Nuclear Engineering Research Center (NERC) with a full time research staff that will be augmented by the research efforts of our quality faculty and cadets. Though the primary focus of the faculty will remain teaching, we are convinced that the unique resources available at West Point will contribute to the success of the NERC, and provide strong benefit to the overall defense research effort.

The NERC will also enhance cadet research involvement. At present, nearly 50 cadets have expressed interest in the nuclear field by choosing to study nuclear engineering. These cadets, trained nuclear engineers, represent a future pool of officers that could serve in FA52. We believe that the meaningful and relevant research opportunities that will be available to cadets through the NERC will encourage and even broaden cadet interest in the nuclear field upon graduation. Such interest should lead some of these cadets to become FA52 officers. Such officers would enter the FA52 field well prepared to contribute to the solution of important issues facing the defense nuclear community.

We envision establishing the NERC under the Department of Physics, and being staffed by a full-time director and researcher. The director, in addition to his own research efforts, would coordinate the entire research effort of the NERC, process grant proposals, manage the budget, and interface with supported agencies to include faculty from the other academic departments and existing centers of excellence at West Point. The teaching faculty, freed by the NERC full-time staff from much of the administrative overhead inherent in research, will be able to concentrate their limited time on quality research. The Photonics Research Center, currently operating under the Departments of Physics, Chemistry and Life Science, and Electrical Engineering and Computer Science, uses this staffing model with great success.

Summary

The NERG has had great success in a very short period of time; however, it is time to mature the research effort by establishing a NERC. The NERC would provide the faculty, the cadets, and the Army a relevant research effort to support the Army's nuclear and radiological research needs as well as develop well-qualified researchers for the Army.

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Enhancing Cadet Development in USMA Nuclear Engineering Program Through the Use of Numerical Codes

COL Edward P. Naessens and CPT Ronald C. Hasz
United States Military Academy

Computer modeling and simulation have become integral in the Defense Threat Reduction Agency's (DTRA's) support to the stockpile stewardship program. The halt of nuclear weapon test detonations is a contributing factor to the rise of the use of models and simulations that help to assure the reliability of the nation's nuclear arsenal. Modeling and simulation in other areas of the Department of Defense have risen due to budget, facility, and manpower limitations, and much of this work is done at the national laboratories. Why then would it be advantageous to introduce these processes to cadets in the Department of Physics Nuclear Engineering Program at the United States Military Academy?

The Class of 2005 is the first class to be offered the opportunity to have an academic major in nuclear engineering. The program of study must ensure the graduates meet competencies in nuclear engineering, but it must also ensure the graduates are prepared to be platoon leaders. From an academic standpoint, the inclusion of nuclear engineering computer modeling is a clear benefit to the graduate due to the industry's reliance on modeling. However, the immediate customers of the cadets in our program are the tactical units of the Army. Are battalion and company commanders seeking platoon leaders who are familiar with particle transport modeling? The direct answer is probably no, but introducing these tools to our cadets will have a positive impact on the analytical abilities of our graduates as they become platoon leaders.

US Army Field Manual 101-5 (*Staff Organization and Operations*) describes the characteristics of a staff officer. The description includes, "the staff officer must be creative in researching solutions to difficult and unique situations. Creative thinking and critical reasoning are skills that aid the staff officer in developing and analyzing, respectively, courses of action." As platoon leaders and company commanders, the graduates of our nuclear engineering program must also possess these critical reasoning and analytic skills. It is these skills that we want to build in our cadets through the use of computer modeling.

In order to effectively use a numerical model, cadets must rely on analytical skills to determine what the output of the code actually means. This includes the ability to know when the output may not be meaningful. It also includes the ability to translate the output into an understandable conclusion and communicate that to the chain of command, or instructor. As platoon leaders and company commanders, our graduates will do very similar tasks in analyzing situations during an operation. The platoon leader and company commander receive reports from various sources, analyze the reports and must be able to summarize and communicate the results to both seniors and subordinates. These reports include personnel status, maintenance status, intelligence reports, enemy action spot reports, logistical reports, training reports, and operations orders. We believe the skills developed from doing these tasks with a numerical model will translate into skills that will be used in doing these tasks as a platoon leader in a military operation.

The decision to introduce computer codes into the nuclear engineering program does not come without associated overhead costs. The first is that classroom time must be devoted to instruction of the numerical modeling, which will reduce the time spent on nuclear engineering theory. The time that an instructor interacts with the cadets in the classroom and the time the cadets spend on class preparation are both fixed. In order for a new topic to be placed in the program, something must be scaled back to make time for the new topic. The second cost is that the computer resources needed to do the numerical modeling in an effective and timely manner must be present.

Based on the limited time available to introduce numerical codes, we have selected one code which will be used as a thread to link one course to the next. Using only one code also allows cadets to become very familiar with it, and be able to use it to inde-

pendently analyze complex situations in their final semester. The Los Alamos Monte Carlo N-Particle Transport Code, Extended (MCNPX) is a code used throughout the nuclear engineering community to analyze a variety of situations. Although it is not the only code in the field, we believe a cadet who later goes to graduate school or works in the industry will be able to learn an additional code faster based on their understanding of MCNPX. In order to efficiently use this tool in our program, the cadets must first learn the theory on which the code is based and the science behind the situations they are analyzing. The initial classes in the program accomplish this. As a modeling tool is introduced, the cadets must learn the specifics of the input and output of the code, and they must understand the fundamental inner workings as opposed to viewing it as a "black box."

The learning model in each class of the program is organized to have the cadet progress through a "model/coach/fade" process of learning. In a model class, we build on the cadet's knowledge gained from reading and studying the textbook and other materials and the instructor explains the fundamental concepts and demonstrates how the fundamental concepts can be used to solve problems. In a coach class, we build on the cadet's conceptual and problem-solving abilities by applying concepts introduced in a model class and the instructor, acting as a coach, offers opportunities to apply the fundamental concepts to solve problems and coaches when the cadet's problem-solving has stalled. In a fade class, cadets demonstrate their mastery by applying the fundamental concepts to solve problems and the instructor's role transitions to the role of assessor.

This same model is used to introduce MCNPX to the cadets over their last four semesters. During NE300 Nuclear Reactor Analysis in the fifth semester, cadets learn the fundamentals which apply to transport. The focus is on diffusion theory as the method of solving the transport problem. During NE355 Advanced Nuclear Reactor Design in the sixth semester, the model portion of MCNPX learning occurs. The cadets will install the code on their own computer to analyze problems that they have solved with diffusion theory. Because they are analyzing a problem they have already solved, they are better prepared to understand the output and see the differences in a code using transport theory rather than diffusion theory. This is reinforced through the use of MCNPX in the design project in this course. In the seventh semester, NE456 Nuclear Weapons and Weapon Effects is the coach portion of cadets learning MCNPX. We build on their initial knowledge of the code and extend the situations they analyze. The instructor is present to coach cadets through problems in forming input files or analyzing output files. The use of MCNPX is an integral part of the design project in this course. NE496 Advanced Nuclear System Design is the fade portion of the learning. During this eighth and final semester, the cadets will demonstrate their ability to use MCNPX as they solve an open ended problem such as "design a mobile nuclear power reactor for use in a military deployment." This capstone project will allow them to refine the critical reasoning and analytical skills associated with using the code to solve such a problem. These are the same skills they will need to reason through and analytically solve problems as a platoon leader or company commander.

The second overhead cost associated with introducing this into the program is the availability of computer resources. The Class of 2005 was the first class to go through this academic major with the MCNPX thread in the courses. This class is the last class at USMA to have desktop personal computers. Follow on classes all have laptop computers, which allows them to bring the computer to class, and turn any classroom into a computer lab. Because the Class of 2005 could not bring their computers to class, a computer lab had to be created. CPT Mike Shannon accomplished this by setting up a computer lab with eight student computers and one instructor computer.

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A typical class size is sixteen cadets, so this made it possible to have one computer for each pair of cadets as they used the code during class. Because the follow on classes have lap-

top computers, this lab is not needed as a classroom, but has been transformed into a parallel computing cluster.

Computing time is another problem associated with computer resources. During the initial learning of MCNPX, the problems cadets are running are basic enough that their laptop computer can solve them relatively quickly. As they progress to being able to input more complex situations into the code, additional computing time is needed. The cadets cannot have their laptops unavailable for hours or days while they wait for them to process and solve complex problems. In light of this, CPT Shannon configured the eight computers in the computer lab into a cluster. With one master node and seven slave nodes, he gave cadets the ability to execute MCNPX jobs seven times faster than on their own laptops, while their own computers remain available to the cadets. The ability to remote to this cluster is also present. As more computers become available, they will be added to this cluster, with each slave node added further reducing the computing time for an MCNPX job.

This computing resource issue has also led to an opportunity for one cadet to research an "out of the box" solution to decrease computing time for a job. The department has 17 lab rooms for the core physics course. Each lab room has five computers, one for the instructor, and one for each lab group. These computers are used only during physics labs, between four to six hours per week. Cadet Blake Huff, Class of 2005, is conducting research to determine if these computers can be formatted into an additional computing cluster to be used during the time they are not being used for lab. Results of this study are still forthcoming, but there is promise that this will be a great source of additional computational time.

Although these computing resources are being created for cadets to use as they learn MCNPX, they also give the department a tremendous resource that the faculty can use for research. The newly founded Nuclear Engineering Research Group can use these computer resources to help outside agencies, such as the DTRA, analyze real world problems.

Introducing and using MCNPX in our program does not come without costs, but we believe the skills learned are directly transferable and critical for our cadets when they become platoon leaders. The program has been structured such that this code is introduced with our "model/coach/fade" methodology and allows cadets in their final semester to solve much more complex problems than if we did not introduce the code. Adjustments have been made to ensure the computational resources do not hinder effective and timely use of the code. This enhancement to the program ensures we continue to develop cadets into leaders of character who are prepared to lead platoons in future operations.

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Our Future Nuclear Stockpile: Risks and Opportunities

Mr. Jeffrey H. Davis
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During the Cold War, the United States (US) and the Soviet Union engaged in a nuclear arms race resulting in both sides building arsenals that were beyond credible. According to some sources, the US had tens of thousands of nuclear warheads at the peak of the nuclear stockpile in the 1960's, but the number of deployed weapons has decreased dramatically since 1989 (Figure 1).[1]

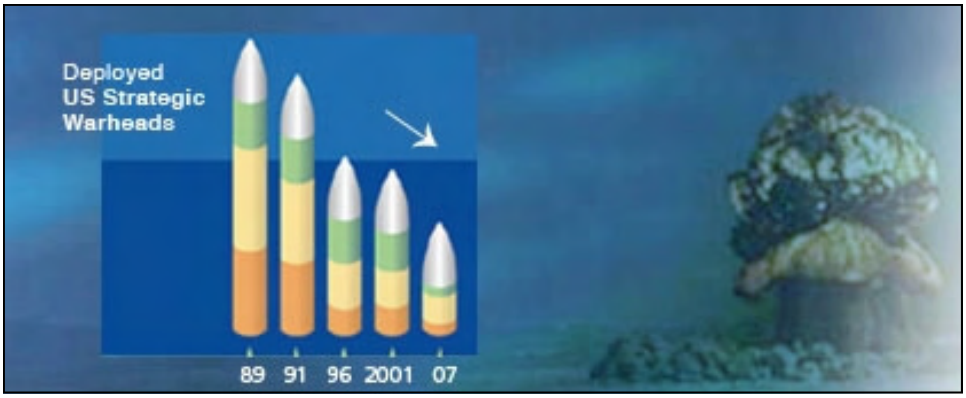

Figure 1. Reductions in US Nuclear Weapons Since 1989.

When the Cold War ended and the Soviet Union dissolved, the US nuclear stockpile's role in national security was no longer as clear as it had been. US underground nuclear testing ended with the 1992 moratorium. The last new nuclear warhead, the W88, was added to the stockpile in the late 1980's. The budget for the US nuclear weapons complex declined sharply between 1991 and 1995 (Figure 2), [2] but then began to increase with the inception of the science-based Stockpile Stewardship Program (SSP).

Nuclear warheads in the current stockpile were all developed during a time when the stockpile turned over every ten to fifteen years. New warheads were designed, prototyped, tested, tweaked, and then produced in quantity while older warheads were dismantled. The nuclear weapons community did not foresee this stockpile lifecycle methodology coming to an end in the late 1980's, but the end of the Cold War and moratorium on nuclear testing also brought an end to new warhead research, development, and production. The US was left with a nuclear weapons stockpile populated entirely by warheads that were not designed nor built for longevity. They were also designed during a period when new designs were proven to be safe and reliable (or not) by full-scale nuclear testing.

Between the inception of the SSP in November 1993[3] and the 2001 Nuclear Posture Review, the Department of Defense (DoD) and the Department of Energy (DOE) nuclear weapons complex operated with the understanding that research and development on new nuclear weapon concepts would not be acceptable. The harsh Congressional reaction to an Air Force-led concept study in the early 1990's reinforced this belief.[4] Clinton Administration officials in the highest levels of both DoD and DOE discouraged ideas to add any new capabilities to the nuclear stockpile, but were supportive of maintaining the current stockpile through a series of Life Extension Programs (LEPs). The LEPs were envisioned as programs to replace aging components in nuclear warheads. Some components cannot be exactly replaced due to the use of obsolete technologies in the original manufacturing and advances in electronics. For example, many original components used vacuum tubes that are no longer available. The closure of Rocky Flats in 1989 ended the US capability to make plutonium pits in quantity. The prospect of introducing new components to the nuclear warheads and not being able to confirm reliability and performance through full scale nuclear testing created unease in DoD as well as in some DOE personnel.

A Navy-DOE program in the late 1990's was created to mitigate some of the perceived risk of the submarine-launched warhead LEP's. The Submarine Warhead Protection Program (SWPP) presented the two nuclear labs with the challenge of designing warheads that would closely replicate the output of current stockpile submarine-launched ballistic missile warheads without requiring a nuclear test to verify performance. Lawrence Livermore National Laboratory (LLNL) chose a design that would make use of nuclear components from obsolete warheads. Los Alamos National Laboratory (LANL) began early concept work on a new warhead design

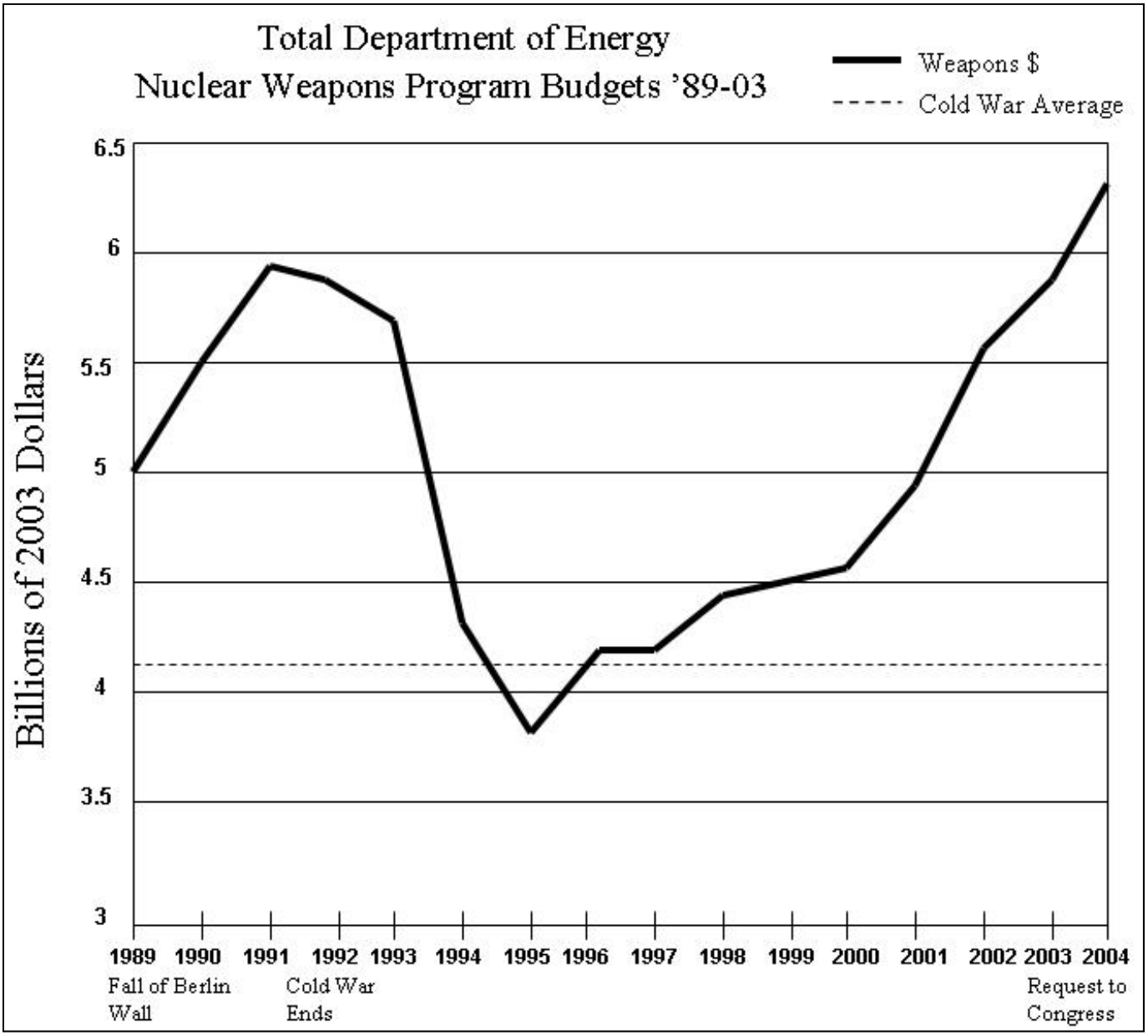

Figure 2. Nuclear Weapon Complex Budget 1989-2003.

with a philosophy markedly different than the philosophy that resulted in the current stockpile designs, while being capable of replicating the current stockpile's military outputs. LANL's design made use of historical test data to avoid technically risky parameters, and avoided the use of complex manufacturing steps and exotic materials. In other words, the LANL concept made use of the previous 50 years of nuclear warhead design and production experience to create a less optimized, but more practical design.[5]

The 2001 Nuclear Posture Review (NPR) resulted in a number of recommendations that were very much in line with the previous 2001 Quadrennial Defense Review which called for capability-based forces and equipment, vice threat-based, due to the uncertain nature of the post Cold War world. The 2001 NPR report to Congress stated that nuclear forces should be capabilities-based and would be combined with other capabilities in a New Triad made up of offensive forces (the Old Triad together with conventional weapons and forces), defenses, and military industrial infrastructure to include the Nuclear Weapons Complex. The report also recommended that NNSA form small advanced warhead concept teams at the labs and headquarters. This recommendation was the basis for forming NNSA's Advanced Concepts Initiative (ACI). [6]

In the 2004 National Defense Authorization Act, a restriction imposed in 1994 against research and development which could lead to the development of low yield nuclear weapons, was repealed[7]. Optimism about the possibility of introducing new capabilities into the stockpile began to take root in the DoD and the NNSA. The most obvious benefit would be the chance to make the stockpile more relevant to 21st century threats. If new warhead designs could be developed and fielded with new components, a possible additional benefit would be to alleviate concerns about

the safety and reliability of the warheads in the current stockpile due to complex aging mechanisms. Unfortunately, a number of developments combined to quickly quell the optimism. Many anti-nuclear groups began a strong campaign to halt any possibility that new capabilities could be introduced into the stockpile and they had many allies in Congress.[8] With the Global War on Terrorism, DoD has many competing priorities and proved unable to sufficiently justify the need for any changes in the stockpile. In the 2005 Energy and Water Development Appropriation, the ACI and the Robust Nuclear Earth Penetrator feasibility study were both unfunded. The bill did approve funds for studies of the Robust Reliability Warhead (LANL's SWPP concept), which the administration had not requested. These Congressional actions indicate a willingness to continue the capabilities of the current stockpile, but a strong skepticism of the need to consider any different nuclear warhead capabilities.[9]

What are the implications for the future of the stockpile in these recent developments in Congress, combined with national and global trends? Although there are many possibilities, five salient possible futures seem most likely. Three can be characterized as resulting in decreasing our nuclear deterrence and two would increase our nuclear deterrent capability. The former will be called "risks" and the latter, "opportunities."

Risks

Our current trend is the most likely to continue, but cannot be continued indefinitely without serious degradation in the nuclear deterrent capability of the stockpile. At this time, we have no idea how long it can be continued without ill effect – it may be for many decades. The current strategy is to carry out LEPs on nuclear warheads without replacement of a key component, the pit. A manufacturing capability to replace pits, the Modern Pit Facility, has been delayed every year by Congress and under current plans, would not come on line until after 2020. Even with the capabilities to replace pits, we still run into another issue and that is verifying the fidelity of replacement components versus original components. All efforts are made to use modeling and simulation and validation experiments short of full scale nuclear testing to ensure that warheads using replacement parts perform as originally designed – the essence of the SSP. But, inevitably there is less confidence in the warheads with new parts and the tools, equipment, and methods of SSP are expensive. Perhaps the most critical issue though, is the relevance of the Cold War warheads to 21st century security problems. The current trend is to spend increasing resources to maintain warheads that are increasingly removed from the time and circumstances in which they were originally designed and built. This is the risk of obsolescence through the inability to change warhead capabilities. One way to decrease the cost side of the equation would be to decrease the warhead types in the stockpile, but that even further decreases the flexibility of the stockpile and entails additional risk of reliability and relevance.

There are factors which could sway Congress, DoD, and the public away from supporting the existence of any US nuclear stockpile. We have a stockpile now because the perceived benefits of having it outweigh the perceived costs. The benefit of deterrence is very hard to quantify or even characterize. What is the stockpile deterring exactly and how? How much deterrence does one warhead yield? Who determines the deterrent value? There are many papers and books written about this subject with little truly resolved. It seems reasonable to assume that deterrence is in the heart and mind of the adversary we are trying to deter and that our perceived capability and willingness to use our stockpile are the key components of the deterrent value of the stockpile. The costs of having nuclear weapons go beyond the resources allocated to DoD platforms, nuclear command and control infrastructure, nuclear trained personnel, and the NNSA Nuclear Weapons Complex costs. There are the risks of accidents or terrorist incidents involving nuclear warheads and the measures taken by DoD and the NNSA to prevent and mitigate both possibilities. If a nuclear weapons incident were to occur, Congress, DoD, and the public could change their perceptions and conclude that the cost/risk of having a stockpile outweighs the benefit. Escalating security costs due to a general increase in the perceived threat of terrorism could have the same effect over time.

The nuclear weapons community did not foresee this stockpile lifecycle methodology coming to an end in the late 1980's, but the end of the Cold War and moratorium on nuclear testing, also brought an end to new warhead research, development, and production.

The US was left with a nuclear weapons stockpile populated entirely by warheads that were not designed nor built for longevity.

A third risk to the stockpile is political risk. With no changes to the factors listed above, but with a change in Administration and Congress, a lack of political support for the stockpile could result in a gradual or even abrupt lack of funding to maintain the stockpile (as seemed likely in 1993) or even direction to dismantle the stockpile and the supporting Nuclear Weapons Complex.

Opportunities

For those of us who think the US should maintain a nuclear deterrent, there are things to be done to help lessen the risk of the stockpile being removed from our national security strategy.

First and foremost, DoD and NNSA must work with Congress to develop a comprehensive and more generally acceptable nuclear policy. As stated by the Commander USSTRATCOM, it is vital that we -

> *Consider a new national dialogue on nuclear policy. This nation is ready for a genuine policy debate on the role of nuclear weapons within the context of the current global environment and the potential offered by The New Triad concept. We must build a long-term nuclear investment plan suited to national security goals.*[10]

Second the Reliability Replacement Warhead concept, originally conceived by LANL in the SWPP, and transitioned to constitute the entire next generation of US nuclear warheads, should be programmed and funded. This appears to be the most viable long-term solution to maintaining the stockpile, but it will require the continued support of Congress, subsequent administrations, and DoD to be a successful solution. This support will require the completion of the new nuclear policy referenced above.

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ENDNOTES / ACKNOWLEDGEMENTS

Valuable background material and a better understanding of the origins of NNSA Stockpile Stewardship Program came from an unpublished paper written by Colonel Michael Baehre for a course at the National War College.

Most references below are from anti-nuclear organization web sites. Similar material is not available on pro-nuclear organization web sites.

Classification officials at NNSA Service Center in Albuquerque, New Mexico assisted the author in ensuring this article is unclassified.

[1] Fig 1. is from http://www.lanl.gov/natlsecurity/nuclear/index.shtml. Any actual numbers of stockpile sizes since 1961 are classified.

[2] Fig 2. is found on the web site of Nuclear Watch New Mexico. The specific location of the source document, "NWNM Analysis of the 2004 Nuclear Weapons Budgets for LANL and Sandia" is http://www.nukewatch.org/facts/nwd/FY04DOEWB.pdf.

[3] Description of legal origins of the Stockpile Stewardship Program in Presidential Decision Directive 15 and the FY 1994 National Defense Authorization Act (PL 103-160) can be found at a Federation of American Scientists web site http://www.fas.org/irp/offdocs/pdd_steward.htm.

[4] The Air Force-led 1992 concept study of a Precision Low Yield Weapon Design, resulted in a Congressional ban on similar research as part of the FY 1994 Defense Authorization Act (Sec 3136 of Public Law 103-160).

[5] Description of SWPP comes from conversations with various NNSA officials that were involved in the program and items presented at NNSA technical meetings attended by the author during his NNSA tour Oct 2001 to Oct 2004.

[6] Description of the New Triad comes from http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm. Description and quote regarding the ACI can be found in the Congressional Research Services document written by Dr Jonathan Medalia, RL32130, *Nuclear Weapon Initiatives: Low-Yield R&D, Advanced Concepts, Earth Penetrators, Test Readiness*, updated Mar 8, 2004, page CR-25. The report is available at http://www.fas.org/spp/starwars/crs/RL32130.pdf

[7] Public Law 108-136, Section 3116.

[8] An objective examination of the issues from both pronuclear and anti-nuclear perspectives can be found in the CRS report RL32130, cited above.

[9] In the interest of brevity, the author did not delve into detail about congressional actions concerning nuclear warhead R&D, to include the Robust Nuclear Earth Penetrator, in the 2002-2005 sessions. There has been a lot of activity, but the results are as stated. If readers want more detail, the CRS work cited above (RL32130) by Dr Medalia provides some additional detail, but the actual words exchanged between congress members can be found in the Congressional Record.

[10] Prepared statement from Commander, USSTRATCOM, Gen James E. Cartwright, to accompany his testimony before the Strategic Forces Subcommittee of the Senate Armed Services Committee on Mar 16, 2005.

An Overview of Maritime Cargo Security Initiatives

MAJ Jennifer Jacobs
United States Army Nuclear and Chemical Agency

Fifteen million cargo containers entered the United States (US) by commercial ship in 2004. These containers are inspected by various means, but the large majority of them do not undergo more than a computerized analysis of the data reported on their paperwork—where did the carrier pick it up, where is it going, and what type of cargo is it? Less than 5% of the cargo is given some sort of non-intrusive physical inspection, such as x-raying the container. Even fewer containers, of course, are actually opened. This low level of significant inspections is understandable; the time required to thoroughly inspect all, or even a large percentage of the containers, would bring trade to a standstill.

This low probability that any given container will face much scrutiny has given rise to substantial concern that a weapon of mass destruction (WMD) could be smuggled into the US simply by shipping it in a cargo container. The maritime transportation system could be used simply as a delivery system, with the intended target somewhere within the country, or the commercial maritime system itself could be the target. A WMD deployed within the maritime shipping system, if done properly, could bring global shipping to a near standstill. Given the world economy's dependence on maritime shipping (responsible for 95% of US imports and exports by weight), halting such a system could clearly cause not only massive disruption and panic, but depending on the duration and severity of the disruption, one could argue that a significant number of deaths could result as well.

There are numerous aspects to this problem, and if one considers the vast scale of shipping, it quickly becomes clear that there will be no simple answers or silver bullets. Although chemical, biological, nuclear, and radiological devices tend to be lumped together under the generic term WMD, the methods by which one can search for each are vastly different, especially if we choose to rely upon technology for assistance. US efforts to address the issues, then, have resulted in a confusing array of programs and initiatives, each tasked with a unique piece of the problem, but nearly always with many overlapping areas of interest. This article will outline the basic missions and challenges of some of the major programs addressing this threat, and convey some of the issues regarding the current approach to maritime security.

Container Security Initiative

The Container Security Initiative (CSI), under Customs and Border Patrol, is an attempt to perform screening similar to that which is performed when cargo arrives on US shores, but to do this screening at the foreign port—before the cargo departs for the US. This is frequently described as "pushing out our borders." US Customs officers are stationed in these foreign ports, and work in collaboration with their foreign counterparts at that port. The presence of the US Customs officers is by the port's invitation, and the US officers have no actual investigatory authority. Instead, they review the paperwork of containers destined for the US, select those in which they are interested, and request that the foreign customs officers perform additional inspection on those particular containers. The number of containers the US may request inspected, and the degree to which the US Customs officers participate in the inspection, varies by country. An interesting aspect of the CSI is that it is a reciprocal program. When a country agrees to receive US Customs officers in their seaport, they then receive the right to station their customs officers in a relevant US seaport. Each country pays the cost to support their own forward-deployed officers, however, so understandably few countries (to date only Japan and Canada) have actually taken the US up on this reciprocity offer. CSI is currently operational in 37 ports worldwide, within the following 19 countries: Canada, Netherlands, Germany, Belgium, France, Sweden, Italy, United Kingdom, Greece, Spain, Singapore, Japan, Hong Kong, South Korea, Ma-

Containers Being Off Loaded at the Port of Halifax. (U.S. Customs Photograph)

laysia, Thailand, United Arab Emirates, China, and South Africa.

Customs-Trade Partnership Against Terrorism

The Customs-Trade Partnership Against Terrorism (C-TPAT) is another program administered by US Customs and Border Patrol. Unlike CSI, C-TPAT approaches the problem from a preventative approach, rather than a search/scan approach. As the name implies, C-TPAT works to partner with industry in order to have industry working for security, rather than having it imposed on them. Security and efficiency have long been considered opposing forces in the business world. C-TPAT is countering this balance by offering efficiency incentives to businesses for increasing their security. The speed with which cargo moves through the US Customs clearance process (or any country's clearance process) often significantly impacts a business's bottom line for that shipment, particularly with just-in-time shipments. Therefore, US Customs has a huge carrot to offer, in terms of "green-lane" entryways into the US. Similar to the E-Z Pass lane at a toll booth, green-lanes allow cargo to enter the country with little or no holdup for inspection. This is a great advantage to the shipper, but obviously poses a security risk for Customs (and the country). In order to counter this risk, Customs requires each industry that is certified with C-TPAT to follow certain security procedures at their facilities. Theoretically, these security procedures are verified By the US upon the company's enrollment in the program, and occasionally re-inspected either on a random or scheduled basis. In reality, so many businesses signed up so fast for the C-TPAT program that Customs has had a difficult time keeping up with the inspection process. A concern within the security industry is that a business fronting for terrorists could sign up for C-TPAT, follow all the security procedures, be certified, and then have green-lane access to the US for their cargo. Customs is aware of this concern and attempting to make such activity as difficult as possible through their screening and inspection process.

Megaports Initiative

The Megaports Initiative (MPI) is administered by the Department of Energy's National Nuclear Security Administration (NNSA). MPI is a portion of a larger NNSA border security program called Second Line of Defense. MPI installs radiation detection portal monitors (drive-thru) at international seaports; it does not install any monitors domestically. The MPI has the particular challenge of convincing foreign seaport officials to actually run the equipment, and analyze and respond to the results. Although US personnel invest considerable time and energy working with each port to design a system installation, install and set-up the equipment, and train host nation personnel, no US personnel are permanently stationed with the equipment once a test, operation, and evaluation (TO&E) phase is complete. In addition, because each container must be driven through a radiation monitor in order for the container to be checked, containers being transshipped at a port (i.e., the container arrives on one ship, is removed from that ship, placed in the shipyard, then transferred to a second ship) are rarely easy to monitor for radioactive contents. The logistics of efficient shipyard movements do not usually allow for each container to be driven through a specific gate-type location. As a result, the large seaports that feed the most containers to the US are not necessarily the most effective locations for radiation portal monitors. MPI has therefore had to look at smaller ports, where much of the traffic of concern might be driving through the gate, rather than transferring ships. Portal monitors are particularly suited to scanning gate traffic, as this is a chokepoint already indigenous to the system. The list of ports being considered for MPI equip-

ment installation is not publicly available, but as one might expect from the above discussion, it does not mirror the CSI list of ports exactly.

Proliferation Security Initiative

The Proliferation Security Initiative (PSI) is administered by the US Department of State. This initiative is quite different from those so far discussed in that the countries involved look not to broadly scan or screen as much cargo as possible, but instead rely on actionable intelligence to intercept a particular shipment in transit. So far most actions have occurred at sea, but recent exercises have focused on ground and air trafficking activities. The PSI agreement itself is in fact very general—countries agree to undertake cooperative action to stop the proliferation of WMD, their delivery systems, and related materials. PSI provides the operational platform for international enforcement of nonproliferation treaties and controls against proliferators undertaking activities that violate those agreements.

Operation Safe Commerce

Operation Safe Commerce (OSC) is a Transportation Security Administration program. OSC looks at the entire supply chain for goods ultimately destined for the US. Typically, these supply chains involve an initial movement by truck to a seaport, with a possible rail connection in between. The maritime leg of the trip may include one or more transfers between ships and/or stops at intermediate ports without transferring the cargo between ships. Upon arrival to the US, cargo is removed from the ship and moved by rail or truck, and less frequently by air, to its final destination within the country. Due to increasing port congestion on the US coasts, some cargo is ending its maritime journey in Canada or Mexico and entering the country by land. Clearly there are many nodes along these paths that present varying levels of vulnerability to the integrity of the container and its contents. OSC traced several specific supply chains from beginning to end, with the cooperation of the industries involved along the route, to determine which sections are the most vulnerable. Once that determination had been made, the program then proceeded to evaluate possible technologies that could decrease each given vulnerability. Testing and evaluation of these technologies is underway. In some cases, OSC may determine that no technology delivers any particular benefit for a particular vulnerability.

Safe and Secure Tradelanes

Safe and Secure Tradelanes (SST) developed from the Total Asset Visibility project developed for the Department of Defense. The concept behind SST is to use radiofrequency identification (RFID) tags on cargo and containers in conjunction with RFID tag readers at seaports in order to keep track of where cargo is, when, and in what condition. Some RF tags can record information relayed by other sensors on the container, theoretically providing information such as whether the door has been opened. However, in spite of this potential security aspect, SST is largely a logistical management tool, rather than a security tool. From a security standpoint, a number of significant issues still need to be considered before SST can be usefully applied. Many of the sensors that might monitor a container's security and/or cargo hazard level are not nearing a deployable status. If these sensors were deployable, the cost of maintaining a global network to receive, evaluate and respond to alarms would then need to be considered, as well as the impact on the shipping system from these alarm evaluation and response requirements. For example, current commercial cargo radiation monitoring systems tend to receive on average 1-5% nuisance alarms, i.e., alarming due to cargo that contains naturally occurring radioactive materials. Applied to the 20,000 containers that arrive in the US daily, we would expect to see 200-1,000 alarms every day, just from radiation sensors, if they were able to be placed within containers headed to the US. If we had container-deployable sensors for chemical and biological threats, high explosives, and stowaways (generally carbon dioxide sensors), the same nuisance alarm rate would result in 1,000-5,000 alarms daily—not including equipment maintenance and malfunction alarms. Responding to this level of alarm rate while maintaining an efficient flow of cargo is not feasible.

Clearly there is much work being done in the field of maritime cargo security, by many different agencies, contractors, and organizations. Due to the immense volumes involved, technology must be used as part of the inspection and evaluation process. However, technology is not a cure-all, and it is a mistake to expect miracles in the form of a sensor. In addition, even if there were deployable and dependable technologies available for all security concerns, the costs of installing and maintaining systems must be carefully evaluated. Finally, we should keep in mind that, although most of the programs described above are focused on container shipping, there are many other methods of maritime cargo transport, to include bulk (grain, oil), break-bulk (pallets, scrap metal), roll-on, roll-off (car ferry-type ships), general cargo, and privately owned small ships. Some of these shipping methods could completely circumvent all the gadgets, screenings, checks, and personnel, possibly allowing cargo to enter the country completely unevaluated, much less inspected. Containerized cargo evaluation and inspection is a good place to start our secure cargo system design, but we should not lose sight of the fact that it should not be the end.

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Estimating the Concentration of Radioactive Material in Air During Emergency Responses

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Over the past several years, several publications, and Department of Defense (DoD) consultation letters have been written giving erroneous guidelines with respect to airborne radiation exposure during radiological emergency responses. The errors in the publications result from two sources: 1) Incorrect determination of airborne activity,[1,2,3,4,5,6] and 2) Incorrect guidelines on when respiratory protection is needed.[5,7,8] This paper will deal with the first of these two errors and outline correct methods for estimating the concentration of radioactive material in air, using the primary instruments in the Army and Air Force inventory (See Figures 1, 2 (page 22), and 4 (page 24)).

Background

The Air Force, due to its mission and history of nuclear weapons accidents, has ensured that it has Bioenvironmental Engineers and Technicians trained in nuclear weapons response at every base. Additionally, Health Physicists have been stationed at selected locations, and others have been assigned to emergency response teams designated to deal with radiological emergencies. Part of the training of all Air Force Bioenvironmental Engineers and Bioenvironmental Engineering technicians is in how to determine airborne concentrations of radioactive material.[5,6,8]

Although the Army does not possess nuclear weapons, the probability that Army assets would respond to a radiological terrorist event or a nuclear weapons accident is high, and the possibility that Army units will some day need to operate near an area where a nuclear detonation has occurred is always present. The Army assigns Nuclear Medical Science Officers (NMSOs) and Health Physics NCOs to selective staff positions that may provide technical assistance for radiological emergency response missions. This paper should be of interest to those NMSOs with a response mission; to National Guard Civil Support Teams; and to a degree, to Preventive Medicine Detachments with AN/PDR-77 capabilities (See Figure 1).

Accurately determining the concentration of radioactive material in the air, while in the field, is most often not possible.[9] Accurate determination of airborne concentrations can only be made by collecting material on air filters, then having the filters analyzed in a radioanalytical laboratory. This process is, however, much too slow to be of any practical use to emergency responders who need to know what level of respiratory protection is needed during a response. Methods for estimating the airborne concentration of radioactive material while in the field have been developed. See for example, Chapter 4, Appendix 3 of the *Nuclear Weapons Accident Response Procedures* (NARP DoD 3150.8-M).[7,10]

Figure 1. An AN/PDR-77 With a DT-669/PDR-77 Probe. This is the Primary Instrument Used by the Army to Measure Alpha Radiation.

Various editions of the NARP have been published. The various versions of the NARP have included the correct equations for using air samplers and RADIACs to determine airborne radioactive material concentrations in the field. Likewise, the 1983 version of the Air Force Broken Arrow Checklist (BAC 83) contains the correct equations for estimating airborne concentration levels.[1] Unfortunately, a draft version of the NARP written in 2002 contained a significant error with respect to the estimation of airborne radiological contamination. The draft incorrectly considered the *4π* efficiency of the detector to be twice that of the *2π* efficiency (it should have been ½). This error was found and corrected, before going to publication, but not before the incorrect results were distributed throughout the Air Force. The incorrect results from this 2002 draft have been taught to students at the Defense Nuclear Weapons School (DNWS) over a period of several years.

In December of 1996 the Armstrong Laboratory Occupational and Environmental Health (AL/OE) Newsletter, Volume 20 No. 3 published a correction to the correct equations used in the NARP and BAC 83.[3] The equations presented in the AL/OE Newsletter contain significant errors, which resulted in incorrect air concentrations being calculated. One of the errors found in the AL/OE newsletter was discovered, and corrected in their April 1997 newsletter[4] and later in a consultative letter from the Air Force Institute for Operational Health (AFIOH).[2]

In February of 2000, a Bioenvironmental Engineering Environmental Field Manual Volume 2, Pocket Reference Guide was written.[6] At first glance the equations presented in the field manual appear to be the same as those used in the 1996 AL/OE Newsletter. There is, however, one significant difference. The field manual does not specify if it uses detector *2π* or *4π* efficiency, whereas, the AL/OE Newsletter uses a *2π* efficiency. If a *4π* efficiency were used, the equation would be correct, however in the example presented a *2π* efficiency is used. The Bioenvironmental Engineering Environmental Field Manual is still used in training Air Force Bioenvironmental Engineers, and is used as a reference throughout the Air Force. This same error occurred in the AF Broken Arrow Guide for Bioenvironmental Engineers.[3]

In addition to the above mentioned errors, all of these references, except the NARP, make another significant error. They use the active detection area of the radiation probes, rather than the actual area covered by the probe when determining air concentration. This error will be discussed in detail later in this paper. [note: Although the equations in the NARP are correct, the results of calculations presented in the 2004 and 2005 editions make this same error in the results presented for the ADM-300 with an AP-100 probe.]

Figure 2. STAPLEX Air Sampler, Used by the Army and Air Force.

Discussion

The concentration *(C)* of radioactive material in air can be estimated using the following equation:

$$C = \frac{2RA_f}{VF_{ab}E_fE_cA_c}$$

Where
R = Count rate measured on air filter
A_f = Area of the filter used to collect material
V = Volume of air sampled
F_{ab} = Alpha or beta absorption factor for filter used
E_f = Collection efficiency of filter used
E_c = *2π* Efficiency of counting instrument
A_c = Area of filter actually counted by the instrument

For a specific instrument, a given air sampler and filter, and a specific isotope, many of the factors in the above equation can be combined into one constant *(k)*, sometimes referred to as a conversion factor, where

$$k = \frac{2\left(35.3\frac{ft^3}{m^3}\right)A_f}{F_{ab}E_fE_cA_c}$$

The *35.3* ft^3/m^3 term allows the volume of air sampled to be input in ft^3 and the resulting concentration calculated to be in dpm/m^3.

Using this equation, concentration then becomes:

$$C = \frac{Rk}{V}$$

As dust is collected on the filter of an air sampler the flow rate through the filter will decrease. If the decrease in flow rate is assumed to be linear (an acceptable assumption in most emergency response situations) then the volume *(V)* can be calculated as

$$V = \left(\frac{F_o + F_f}{2}\right)t$$

Where
F_o = Initial flow rate
F_f = Final flow rate (flow rate just before air flow is stopped)
t = Amount of time air is run through the filter

The flow rate through an air filter is most often determined using a rotameter (see Figure 3). The observed flow rate, using a rotameter will differ from the true flow rate if the temperature *(T)* and air pressure *(P)* at the time of use are different than the temperature and air pressure

Figure 3. Rotameters on a STAPLEX Air Sampler.

used to calibrate the instrument. Differences in temperature and air pressure can be accounted for by using the following equation:

$$F_{true} = F_{observed}\sqrt{\frac{P_{calibrated}}{P_{true}} \times \frac{T_{true}}{T_{calabrated}}}$$

While there are numerous publications that explain the correct way to make these corrections,[11,12,13,14,15,16,17,18] there is also a significant publication that gives an incorrect equation and instructions. NUREG-1400 was written to assist those performing air sampling at nuclear powerplants to meet regulatory guides. The equation and instructions for correcting rotameter readings for temperature and pressure presented in NUREG-1400 should not be followed, as they are not correct.[19]

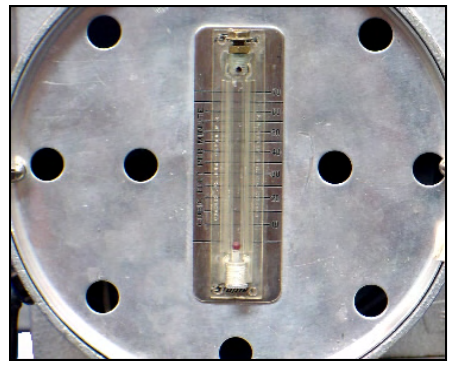
The significance of correcting for the true flow rate will depend on how different the actual and calibrated temperature and air pressure are. Most often if the instrument is being used at the same altitude as it was calibrated at, there is no need to correct for pressure differences. Temperature differences are often large enough to require corrections to be made.

Several assumptions are made when estimating the concentration of radioactive material in air. One of the most significant of these is the size of particles being collected on the filter. The size of the particles will vary by location as a result of meteorological conditions and as a result of the origin of the particles (e.g. dust from the ground, smoke from a fire, etc.). Additionally, particle size cannot be expected to be uniform during any response scenario. Both the filter's collection efficiency (E_f) and its absorption factor (F_{ab}) will be affected by particle size. Unless more accurate site specific information is available, a constant particle size of *1.0 µm* is normally assumed.

A filter's collection efficiency (E_f) can only be determined through carefully controlled laboratory measurements. A filter's efficiency (E_f) as a function of particle size can most often be obtained from a filter's manufacturer.

A filter's absorption factor (F_{ab}) depends not only on the type of filter being used, but also on the type of radiation being measured and the energy of these particles. In addition, this factor must include not only absorption by the filter, but also absorption by particles collected on the filter. As with the collection efficiency (E_f), absorption factors (F_{ab}) can only be accurately determined under carefully controlled laboratory conditions. Obtaining accurate absorption factors (F_{ab}) is often not easy, and not something that filter manufacturers routinely determine for all filters and isotopes of interest. The Air Force's Broken Arrow Guide for Bioenvironmental Engineers[5] and their Broken Arrow Checklist[1] recommend absorption factors (F_{ab}) for alpha particles generated from the decay of plutonium (Pu) and collected on various types of filters. No information as to how these numbers were determined is presented, however. The determination of absorption factor's (E_f) is likely the single most important area related to estimating the concentration of radioactive material in air, where additional research is needed.

The Broken Arrow Guide for Bioenvironmental Engineers[5] recommends that only glass fiber filters be used for collecting beta producing materials, and cellulose fiber filters be used when testing for alpha particles. If the alpha absorption factors presented in the guide are correct, then this is good advice, however, it should be noted that both types of filter will work for alpha or beta producing particles.[11] Often during an emergency response what isotopes will be present is not known ahead of time. Having only one type of paper for all responses simplifies life and decreases the chances of errors being made in the field.



Rear View of Rotameters on a STAPLEX Air Sampler.

In several of the references referred to in this paper, rather than use the actual area counted (A_c), an active detection area of the instrument was used.[2,3,4,5,6,8] In actuality, what detection area is used is not important, as long as the value used is the same that was used in the determination of the instrument efficiency. In the case of the AP-100 probe, used in some of the above mentioned references, the number used in the instrument efficiency studies was *123 cm²*. This then is the value that must be used for A_c, not the active detection area of *92 cm²* as was quoted in these references.[6,8]

It should be noted that 123 *cm²* is not the actual probe area measured by the authors, but it is the area that must be used in the calculations, as long as it is the area used in the efficiency calculations.

When using air samplers to estimate the concentration of radionuclides in air during an emergency response, it is necessary to subtract the results obtained from a background air sampler from those obtained from an air sampler in the area being tested. One factor that must not be overlooked is the importance of

choosing a good background location. All too often, during emergency responses, the area chosen to make background measurements is not representative of the survey area. Among other factors, the count rate measured on the filter paper will depend on the amount of dust collected on the filter. If one air sampler is set up in a parking lot, and another in a dusty area, comparison of the results will be meaningless. The conditions under which the background air sampler is used must be as close to those of the survey samplers as possible.

The Broken Arrow Checklist recommends that when reading filter paper with RADIAC instruments two readings be taken at diagonal locations on the paper, and that these readings be averaged to obtain the gross counts per minute *(cpm)* for the filter[1]. The Defense Nuclear Weapons School has traditionally taught that two readings be made, then the highest of the two be used. The authors of this paper recommend that an average be taken, as suggested in the Broken Arrow Checklist. If a more conservative approach is desired, then the lowest background reading should be used, and the highest survey area measurement.

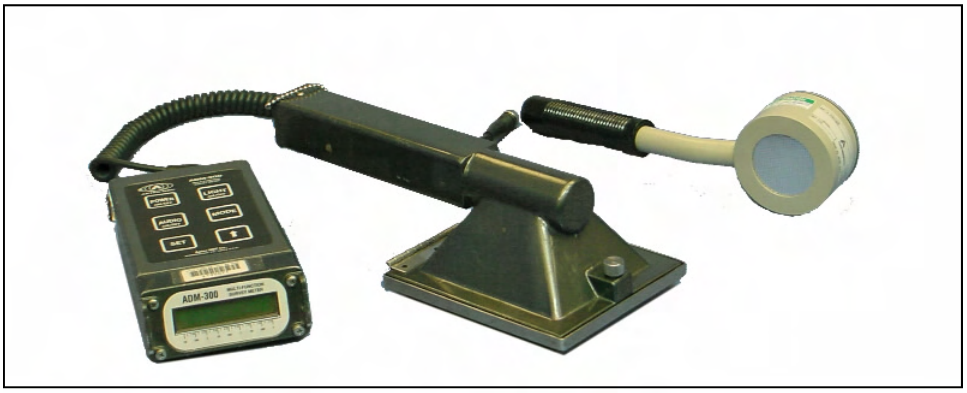


Figure 4. Photo of an ADM-300, AP-100 Alpha Probe and BP-100 Beta Probe. This is the Primary Radiation Measuring Equipment Used by the Air Force.

Results

The primary instrument used by the Air Force for response to radiological incidents is the ADM-300 (See Figure 4). Most often, when being used in conjunction with an air sampler to estimate the airborne concentration of radionuclides, an AP-100 alpha probe is used. Using the best available data, the conversion factor *k* is calculated to be *2000* $\frac{ft^3 \bullet dpm}{m^3 \bullet cpm}$ for this configuration. This assumes $A_f = 406\ cm^2$ [2,5], F_{ab} = 0.55 (from *Broken Arrow Guide for Bioenvironmental Engineers*[5] and *Bioenvironmental Engineering Environmental Field Manual vol. 2*, source of number is not specified), $E_f = .7$ [13], $E_c = 0.3$ cpm/dpm (for Pu)[12] and $A_c = 123\ cm^2$.[12] E_f was obtained from a study performed in 1963 and is likely overly conservative.

The Army's DT-669/PDR-77 can be used to estimate airborne radiation, the same way as can the Air Forces ADM-300 with an AP-100 attached. There is a slight difference in the efficiency of the Air Force and Army instruments. This results in a slightly different conversion factor being calculated. A study performed at Kirtland AFB involving 80 measurements made with both sets of instruments showed that the average efficiency of the PDR-77 was *10%* greater than that of the ADM-300 for measuring Thorium 232. It should be noted that this study was performed using only one ADM-300 and one PDR-77. Both had recently been calibrated, but the possibility that other instruments would have responded differently does exist. This is the best data currently available, and as a result we have used this to calculate the conversion factor for the DT-669/PDR-77. The result is a conversion constant (*k*) of *1800* $\frac{ft^3 \bullet dpm}{m^3 \bullet cpm}$.

Conclusions

Several publications dealing with estimating the concentration of radioactive material in air have contained significant errors. The correct equations for determining these values are contained in the current (Feb 2005) Nuclear Weapon Accident Response Procedures (NARP)[7], although the conversion constant in this reference that was calculated using these equations is not correct. Conversion constants (*k*) have been calculated for the Air Forces ADM-300 connected to an AP-100 probe, and the Army's DT-669/PDR-77. These numbers are

2000 and $\frac{ft^3 \bullet dpm}{m^3 \bullet cpm}$,

1 8 0 0 $\frac{ft^3 \bullet dpm}{m^3 \bullet cpm}$, respectively.

One of the greatest potentials for error when estimating the concentration of radioactive material in air results from the fact that accurate values for the alpha and beta absorption factors for filters are not known. These factors are particle and energy dependant and will vary between isotopes. Further research to determine these factors is needed in order to determine the optimum respiratory protection needed during radiological emergency responses.

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Pentagon Shield
Urban Atmospheric Boundary Layer Study
Washington, DC
19 April – 15 May 2004

Donald P. Storwold Jr.
Dugway Proving Ground

The Pentagon Shield field campaign was designed to improve our understanding of the microscale properties of the atmospheric boundary layer over an urban area to better prepare for airborne threats from terrorism and/or industrial accidents. In particular, knowledge gained from the experiment is aiding in the development and installation of an automated airborne hazard detection and response system for the Pentagon or other strategically significant locations. In the event of a chemical incident, the system will automatically track and project the hazard areas outside and within the building.

The Special Programs Office of the Defense Advanced Research Project Agency (DARPA) funded the Pentagon Shield field study. The experiment was conducted in and around the Pentagon in Arlington, VA during April and May 2004. The Research Applications laboratory of the National Center for Atmospheric Research (NCAR) is responsible for the overall program management of Pentagon Shield.

Participation

Table 1 lists the organizations that participated in the campaign, which included researchers from the United States Department of Defense (DoD), the National Oceanic and Atmospheric Administration (NOAA), University of Colorado (CU), other government agencies, and several government contractors.

Table 1. Pentagon Shield Participants.

Aerospace Corporation
Coherent Technologies, Incorporated (CTI)
Cooperative Institute for Research in the Environmental Sciences, University of Colorado at Boulder (CU)
Defense Advanced Research Projects Agency (DARPA)
National Center for Atmospheric Research (NCAR)
National Oceanic and Atmospheric Administration Air Resources Laboratory Field Research Division (ARLFRD)
Northrop Grumman
Pentagon Force Protection Agency (PFPA)
United States Army Dugway Proving Ground West Desert Test Center

The Dugway Proving Ground (DPG) Meteorology Division was tasked with providing ground-level and building-top meteorological data, upper-atmospheric measurements, and wind profile information. Dugway fielded fifteen Portable Weather Information Display Systems (PWIDS), ten SuperPWIDS, a Sound Detection and Ranging (miniSODAR) Doppler acoustic sounder, an actinometer system (to measure net solar radiation), and a 32 meter tower for temperature and wind profiles. In addition to instrumentation, DPG also provided upper-air support with radiosonde balloon launches and forecast support at the Command Post. Appendix A provides photos of instrumentation supporting the Pentagon Shield project.

DPG personnel providing onsite support of Pentagon Shield included Ed Argenta, Bryan Aronian, Roland Barbero, Paul Broderick, and Donny Storwold, the DPG test director. Additional offsite support came from Susan Gross, Scott Halvorson, and John White.

Dugway provided the majority of the meteorology instrumentation used during Pentagon Shield, but other organizations also contributed. Table 2 provides a complete list of the experiment's instrumentation and their contributing organizations.

Experiment Conduct

Five Intensive Operating Periods (IOP) were conducted for Pentagon Shield, with multiple tracer gas disseminations and sampling occurring throughout each IOP. During the IOP's, sulfur hexafluoride (SF_6), a safe, inert tracer gas, was released

Table 2. Pentagon Shield Instrumentation and Organizations.

Instrumentation	Organization
Fourier Transform Infrared (FTIR) Spectrometer	Aerospace Corp.
Programmable Integrating Gas Sampler (PIGS)	ARLFRD
Tracer Gas Analyzer (TGA)	ARLFRD
CLR Photonics, Inc. coherent Doppler lidar (WindTracer)	CTI
21-m^3 tethered lifting system (TLS) blimp	CU
32-m wind profile	DPG
32-m temperature profile	DPG
Actinometer (net solar radiation)	DPG
MiniSODAR	DPG
PWIDS	DPG
Radiosonde balloon launches	DPG
SuperPWIDS	DPG
Raman-shifted Eye-safe Aerosol lidar (REAL)	NCAR
Mobile Chemical Agent Detector (MCAD)	Northrop Grumman

for short periods of time. Numerous portable tracer samplers were placed throughout the Pentagon area to collect outdoor and indoor air samples for several hours after the SF_6 was released in order to track the movement of the tracer gas. At the end of each experiment the tracer samples were collected for post-experiment analysis. All IOP's were conducted during the nighttime hours for three reasons; reduced traffic within the Pentagon made it easier to place instrumentation, the HVAC system could not be adjusted during regular business hours, and balloon and blimp launches were only permitted after the Reagan National Airport terminated flight operations each day (approximately 10:00 p.m.).

Figure 1. Wind Tunnel Experimentation of Pentagon Model.

A question that often arises about gaseous tracer studies is the safety of the tracer materials. Government and private organizations in the United States and Europe have safely and successfully used these tracer gases for many years in both indoor and outdoor studies. SF_6 is commonly used as a gaseous insulator in high voltage electrical equipment, in foam insulation, gas-filled athletic shoes, tennis balls, loudspeakers, shock absorbers, sound-insulating windows, in the semiconductor industry and in many other applications.

Future Plans

Figure 1. illustrates some of the wind tunnel research being conducted to develop the Pentagon Shield airborne hazard detection and response system. The second phase of Pentagon Shield field experiment was conducted from 7-23 November 2005. This experiment verified and validated the outdoor and indoor transport and dispersion models and a new Raman-Shifted Eye-safe Aerosol Lidar manufactured by ITT Industries.

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TRINITY – Secrets & Security (Part II)

Mr. Martin W. Moakler, Jr.
United States Army Nuclear and Chemical Agency

In Part I of this article (published in the Spring / Summer 2005 issue of *NBC Report*), I described the Manhattan Engineer District organization and several prominent project facilities. In this part of the story, I will discuss Presidential involvement in the Manhattan Project.

The Race with Germany: The FDR Years

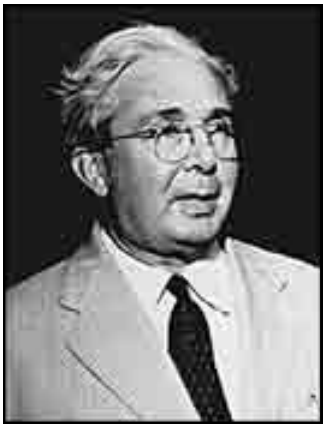
In the years between World War (WW) I and WWII, the scientific community initially experienced a period of unparalleled freedom and exchange of scientific discovery. The field of theoretical nuclear physics was advancing by leaps and bounds as the mysteries of the atom and nucleus unfolded (Atomic Archive, 2005). Numerous centers of theoretic physics emerged throughout Europe and research discoveries were freely expressed in the open academic community. That all changed in 1933 when Adolf Hitler became the Chancellor of Germany.

Chancellor Adolf Hitler Salutes his Followers at a Nazi Party Rally. (February 1933).

Student members of the Nazi "Brown Shirts" harassed and terrorized Jewish and half-Jewish undergraduates who had come from Poland or Hungary to study in Germany (Atomic Archive, 2005). In the spring of 1933, the University of Gottingen, the seat of brilliant achievement in years past, became the focal point of Hitler's anti-Jewish policies (Atomic Archive, 2005). Student demonstrations proclaiming the coming of the "new order" became an every-day occurrence. Respected scholars were brutally expelled. Some of the world's foremost physicists such as Max Born, James Franck, Eugene Wigner, Leo Szilard, Edward Teller, and John von Neumann were forced to flee (Atomic Archive, 2005). With the aid of philanthropic organizations such as the Rockefeller Institute, many of these refugee scientist emigrated to England and the United States (US) (Atomic Archive, 2005).

Only a few years later they would become the most ardent champions of the construction of the atom bomb. The alarm which they felt at the possibility that Hitler might be the first to possess so terrifying a weapon can only be understood when one realizes what abuse and persecution they had to endure from the Nazis in 1932 and 1933 (Atomic Archive, 2005).

Leo Szilard, sacrificing many years of his career and having no permanent post for himself, worked tirelessly to find suitable positions for many of the fleeing scientists. He was responsible for numerous colleagues being offered academic positions. He organized several groups and worked with the Academic Assistance Council, a London-based group, headed by Ernest Rutherford, that acted as a clearinghouse for information (Atomic Archive, 2005).



Leo Szilard – Group Leader, University of Chicago Metallurgical Laboratory.

At about this same time, groups were forming in America to assist with the "rescue" of noted scientists. At Columbia University, a Faculty Fellowship Fund was established and the US government became involved through its formation of the Emergency Committee in Aid of Displaced German Scholars (Atomic Archive,

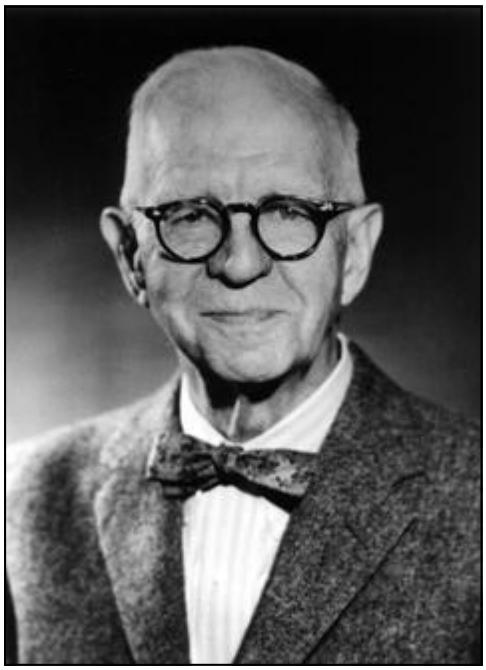
2005). Thirty scientists and scholars arrived in the US in 1933, thirty-two in 1934, only fifteen in 1935; but forty-three came in 1938, ninety-seven in 1939, fifty-nine in 1940, and fifty in 1941. Of these, approximately 100 were physicists (Rhodes, 1986).

Szilard is normally credited with the concept of a nuclear chain reaction (Atomic Archive, 2005). Szilard was known to ponder, “if only we could get two neutrons out of an atom per collision, then we could get a chain reaction (Atomic Archive, 2005).” Early in 1939, research results were just finding this out, with theoretical predictions being validated through research, engineering, and materials. Academic research and published findings were very open, as scientists freely exchanged ideas and results. The issue of secrecy also emerged in 1939. Szilard and others felt that any further dissemination of information should be curtailed to prevent Nazi Germany from gaining insights into American scientific atomic breakthroughs (Atomic Archive, 2005). Also, efforts needed to be consolidated to beat the Nazis and that would take the support of the US government.

The "Hungarian Conspiracy," scientists who lived under the tyranny of Nazi controlled Hungry, decided to take action (Atomic Archive, 2005). Leo Szilard, Edward Teller, and Eugene Wigner, perhaps more than anyone, understood the enormous threat that Nazi Germany posed for the world if they should happen to be the first to develop a nuclear weapon (Atomic Archive, 2005). Their concerns were that the US would have access to a supply of uranium and that the project needed government funds and control to expedite weapon development (Atomic Archive, 2005).

They solicited the support of Albert Einstein to take this message to President Franklin D. Roosevelt (FDR) (Atomic Archive, 2005). In July 1939 Edward Teller drove Leo Szilard to visit Albert Einstein at his Long Island, NY home to meet with the "Master" himself (Atomic Archive, 2005). Szilard drafted the Einstein letter, Einstein signed it and sent it to President Roosevelt via Alexander Sachs, a personal friend of the President. The Einstein letter was written to express a sense of urgency to the President. It was read to President Roosevelt on October 11, 1939 (Atomic Archive, 2005). Roosevelt established the Uranium Committee in October 1939 under the direction of Lyman Briggs (NAP, n.d.).

Einstein and Szilard Recreate the Drafting of the Letter After the War.



Lyman Briggs, Chair of the Uranium Committee.

Briggs was appointed the Director of the Bureau of Standards in 1933. In 1939, FDR called on Briggs, by then aged 65, to head "The Uranium Committee," a secret project to investigate the atomic fission of uranium (Atomic Archive, 2005). The committee, including both civilian and military representation, was to look into the current state of research on uranium to recommend an appropriate role for the federal government (Atomic Archive, 2005). In early 1940, the Uranium Committee recommended that the government fund limited research on isotope separation as well as Fermi's and Szilard's work on chain reactions. The Uranium Committee had concluded that enriched samples of uranium-235 were necessary for further research and that the isotope might serve as a more efficient fuel source for an explosive device (Atomic Archive, 2005). Thus, finding the most effective method of isotope separation was a high priority. Several complicated techniques of physical isotope separation, were considered for further investigation (Atomic Archive, 2005). The techniques considered were electromagnetic, gaseous diffusion, centrifuge, and liquid thermal diffusion.

Equally important to the recommendations of the Uranium Committee to the beginning of the Manhattan Project was a report from the United Kingdom by the MAUD Committee (MPHPA, n.d.). A group of United Kingdom scientists was established by the British in the spring of 1940 to study the possibility of developing a nuclear weapon (Atomic Archive, 2005). They were codenamed the MAUD Committee. The July 1941 MAUD Report maintained that a sufficiently purified critical mass of uranium-235 could fission even with fast neutrons (Atomic Archive, 2005). The MAUD Report estimated that a critical mass of ten kilograms would be large enough to produce an enormous explosion. They estimated that a bomb this size could be ready in about two years and loaded on existing aircraft (Atomic Archive, 2005).

The Uranium Committee reports had set the stage, but the MAUD report helped the American atomic bomb effort turn the corner. The MAUD report contained specific plans for producing a bomb that were produced by a distinguished group of scientists with a high level of credibility (Atomic Archive, 2005). The MAUD report dismissed plutonium production in favor of uranium. It also dissuaded using thermal diffusion, electromagnetic, and centrifuge methods in favor of the gaseous diffusion method to produce uranium-235 on a massive scale. The British believed that uranium research would lead to the production of a bomb in time to affect the outcome of the war.

While the MAUD report provided encouragement to Americans advocating a more extensive uranium research program, it also served as a sobering reminder that fission had been discovered in Nazi Germany almost three years earlier and that, since the spring of 1940, a large part of the Kaiser Wilhelm Institute in Berlin had been set aside for uranium research (Atomic Archive, 2005).

December 7, 1941 saw the Japanese attack at Pearl Harbor and the US was thrown into WWII. Based on Einstein's letter and concepts of scientists working in Britain, FDR set up a joint Anglo-American effort to produce atomic bombs for potential use during the war (FDR Library, n.d.). The result was the creation of the Manhattan Project to create the atomic weapon. Colonel James C. Marshall received the assignment of directing a Laboratory for the Development of Substitute Metals, or DSM, during the summer of 1942 (Atomic Archives, 2005). Marshall immediately moved from Syracuse to New York City, where he set up the Manhattan Engineer District, established by general order on August 13 (Atomic Archives, 2005). Marshall was thought to move too cautiously and was quickly replaced. On September 17, the Army appointed Colonel Leslie R. Groves (promoted to Brigadier General six days later) to head the effort (Atomic Archives, 2005).

Groves was an engineer with impressive credentials, including the building of the Pentagon, and, most importantly, had strong administrative abilities (Atomic Archives, 2005). Groves moved the Manhattan Engineer District headquarters from New York to Washington. President Franklin D. Roosevelt (FDR) approved the establishment of what ultimately became a government investment in excess of $2 billion, the Manhattan Project, on December 28, 1942 (Atomic Archives, 2005). By the beginning of 1943 the Manhattan Project had the complete support of FDR and the military leadership, the services of some of the nation's most distinguished scientists, and a sense of urgency driven by fear that Germany would beat the US to the bomb.

At the Quebec Conference, in August 1943 FDR and Churchill signed a secret agreement governing collaboration between the two countries on the development of the atomic bomb. (FDR Library, n.d.). FDR also foresaw that atomic weapons would become the basis for post-war military and diplomatic policy, and on September 18, 1944 he and Churchill signed the Hyde Park Aide-Memoire committing the two powers to a monopoly on atomic information in the hopes of keeping the peace in a post-war world (FDR Library, n.d.). Ironically, FDR did not live to see Trinity. During a vacation at Warm Springs, Georgia, FDR died on April 12, 1945 (FDR Library, n.d.).

The Buck Stops Here: The Truman Years

Within twenty-four hours of President Roosevelt's death, the new President, Harry Truman, was informed about the Manhattan Project by Secretary of War Stimson (Truman Library, n.d.). Ironically, in March 1941, Senator Truman had chaired a special committee called the Truman Commission to investigate the millions of dollars being wasted in the National Defense Program.

Senator Truman and his commission focused on the extravagant expenditures of the Manhattan Project and demanded information defending this highly classified project (Truman Library, n.d.). Secretary of War Stimson personally requested that Senator Truman withdraw the Congressional watchdogs and vouched for the Manhattan Project. Truman complied with Stimson's request. It took Stimson 12 days to send a memo to President Truman to brief the new President on the greatest classified project of the War Department (Truman Library, n.d.). Based upon the advice of Stimson, the Interim Committee was formed with the approval of the President to establish war-time controls of the Manhattan Project, determine follow-on publicity, make recommendations on post-war research, development, and controls (Truman Library, n.d.). A draft press report was prepared by this group for the President to present after a successful test of the atomic bomb.

President Truman faced a very short time-line. Just 26 days after taking office from FDR (May 8, 1945), Nazi Germany surrendered. The focus of the US turned towards Japan. Truman established the Targeting Committee to make recommendations on targets for the atomic bomb (Truman Library, n.d.). Since Germany had dropped out of the war, only Japanese targets were considered. Sixty-five days after assuming

White House Central Files
Confidential Files

SECRET

WAR DEPARTMENT
WASHINGTON

b.f. War

25 file

April 24, 1945.

Dear 4-25-45

Dear Mr. President:

I think it is very important that I should have a talk with you as soon as possible on a highly secret matter.

I mentioned it to you shortly after you took office but have not urged it since on account of the pressue you have been under. It, however, has such a bearing on our present foreign relations and has such an important effect upon all my thinking in this field that I think you ought to know about it without much further delay. x386

Faithfully yours,

Henry L. Stimson

Secretary of War. x25

The President,
The White House.

Talk Patton list tomorrow, Wed. 25, HA.

HARRY S. TRUMAN LIBRARY "NATIONAL ARCHIVES AND RECORDS ADMIN." U.S. GOVERNMENT

DECLASSIFIED
E. O. 11652, Sec. 3(E) and 3(D) or (E)
OSD letter, April 12, 1974
By NLT-HC, NARS Date 2-2-76

SECRET

Stimson Memorandum to President Truman after Assuming Office.

the Office of the President, while at the Potsdam Conference with Churchill and Stalin, the Trinity bomb was detonated (Rhodes, 1986).

Intermission – the Story Continues

This ends the second part of this article. Part three will be continued in the next issue of *NBC Report* and will cover the preparation for the Trinity shot and eye witness accounts of the event.

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

Franklin D. Roosevelt Library

Page 1 of Einstein's Letter to President Franklin D. Roosevelt.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an inofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action giving particular attention to the problem of securing a supply of uranium ore for the United States;

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

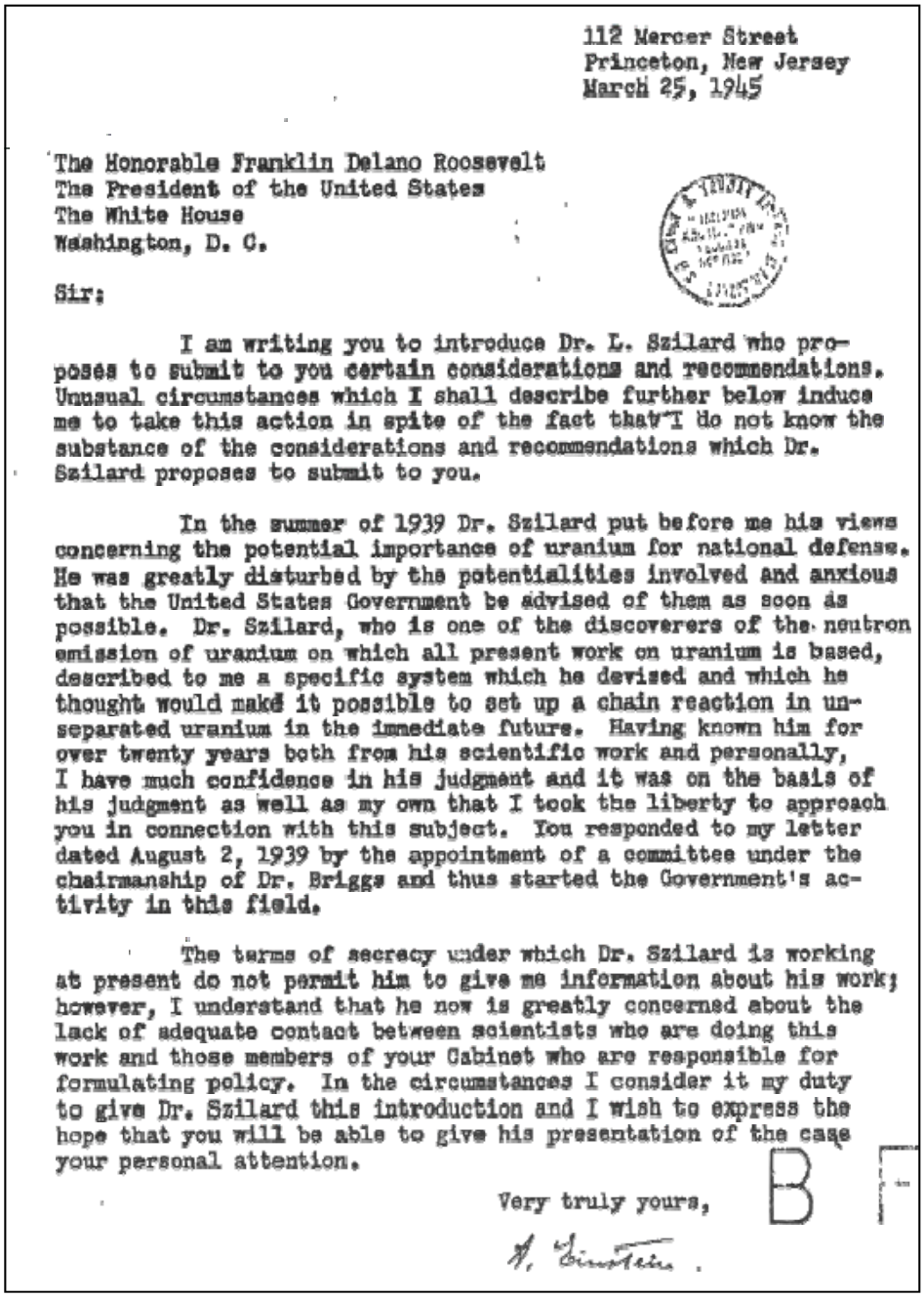
Yours very truly,

A. Einstein

(Albert Einstein)

Franklin D. Roosevelt Library

Page 2 of Einstein's Letter to President Franklin D. Roosevelt.



112 Mercer Street
Princeton, New Jersey
March 25, 1945

The Honorable Franklin Delano Roosevelt
The President of the United States
The White House
Washington, D. C.

Sir:

I am writing you to introduce Dr. L. Szilard who proposes to submit to you certain considerations and recommendations. Unusual circumstances which I shall describe further below induce me to take this action in spite of the fact that I do not know the substance of the considerations and recommendations which Dr. Szilard proposes to submit to you.

In the summer of 1939 Dr. Szilard put before me his views concerning the potential importance of uranium for national defense. He was greatly disturbed by the potentialities involved and anxious that the United States Government be advised of them as soon as possible. Dr. Szilard, who is one of the discoverers of the neutron emission of uranium on which all present work on uranium is based, described to me a specific system which he devised and which he thought would make it possible to set up a chain reaction in unseparated uranium in the immediate future. Having known him for over twenty years both from his scientific work and personally, I have much confidence in his judgment and it was on the basis of his judgment as well as my own that I took the liberty to approach you in connection with this subject. You responded to my letter dated August 2, 1939 by the appointment of a committee under the chairmanship of Dr. Briggs and thus started the Government's activity in this field.

The terms of secrecy under which Dr. Szilard is working at present do not permit him to give me information about his work; however, I understand that he now is greatly concerned about the lack of adequate contact between scientists who are doing this work and those members of your Cabinet who are responsible for formulating policy. In the circumstances I consider it my duty to give Dr. Szilard this introduction and I wish to express the hope that you will be able to give his presentation of the case your personal attention.

Very truly yours,

A. Einstein.

Albert Einstein to Franklin D. Roosevelt, March 25, 1945.

Mr. Martin Moakler is a retired Army FA52 Colonel and is currently working as a physical scientist in the Nuclear Division at USANCA. His previous assignment was as Chief of the Nuclear Division at USANCA. He earned a M.S. in Nuclear Engineering and Computer Science from Rensselaer Polytechnic Institute, a M.S. in Engineering Management from the University of Missouri-Rolla, a M.S. in Education from Old Dominion University, and is a graduate of the US Army War College. His email address is moakler@usanca-smtp.army.mil.

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Exceeding the Sum of its Parts: Closer Collaboration between FA52s and the Army Research Laboratory

MAJ Steven L. Creighton
United States Military Academy

When the Cold War was in full swing, it made sense to keep Functional Area 52s (US Army's Nuclear and Counterproliferation officers or FA52s) exclusively "Nuclear", and the Army Research Laboratory (ARL) exclusively "Build the Next Weapon System." But when updating our perspective to address the threats and constraints of today, the "keep it separate" approach mandates scrutiny. This article proclaims that a much enhanced national capability can be achieved should FA52 officers closely couple with the United States (US) ARL's research and development efforts as they pertain to chemical, biological, radiological, and nuclear (CBRN) weapons effects, detection capabilities, and strategic materials availability.

Having FA52 officers assigned to ARL research sites or providing FA52 Liaison Officers to these sites would:

1) Enhance development efforts at the sites by providing more technical expertise (i.e. many FA52s are Ph.D.s, physicists, chemists, and engineers).
2) Provide the Army with FA52 officers that are more aware of the latest technology in fields critical to threat reduction.
3) Ensure that military expenditures and development efforts are optimized for war fighting requirements.

To underscore how FA52 – ARL collaboration is mutually enhancing, five ARL research endeavors pertaining to weapons of mass destruction (WMD) are examined below. Clearly, they are of vital interest to the FA52 community.

Enhanced Prediction of Dispersion Areas

Figure 1 shows a computer simulated prediction of contaminated areas resulting from a chemical, biological, or radiological attack on the downtown area of a major US city.

This model was created by research scientists at the Army's High Performance Computing Research Center (AHPCRC) using state-of-the-art techniques in computational fluid dynamics (CFD). AHPCRC was sponsored by ARL and is co-located with the University of Minnesota in Minneapolis. This model demonstrates ARL's efforts to model wind and weather patterns at ground level and very low altitudes – which, of course, affect the Soldier. This type

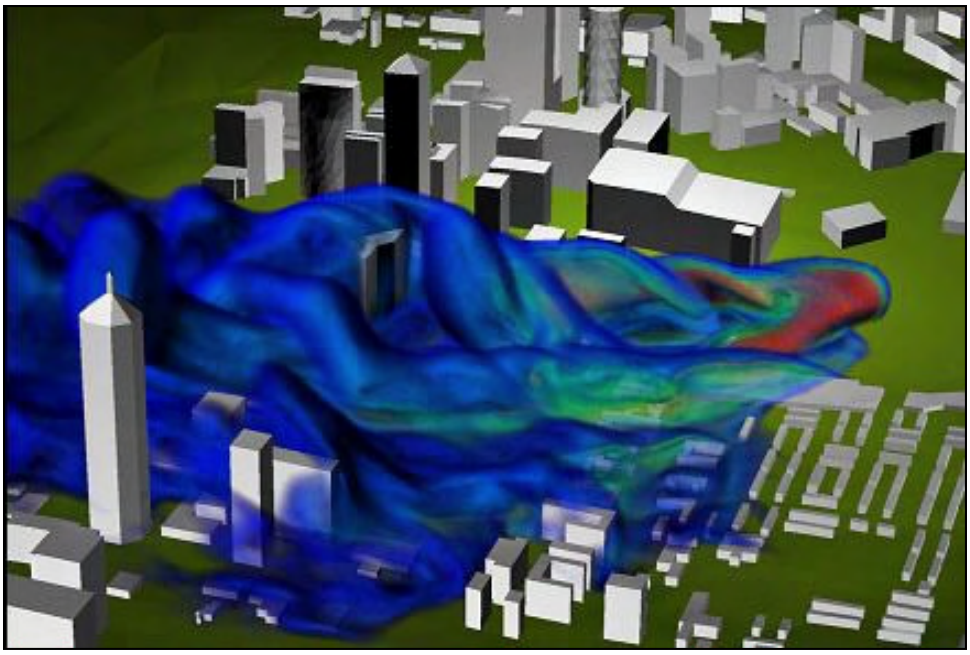

Figure 1. Computer Simulation of a Chemical, Biological, or Radiological Attack on a Simulated US City.

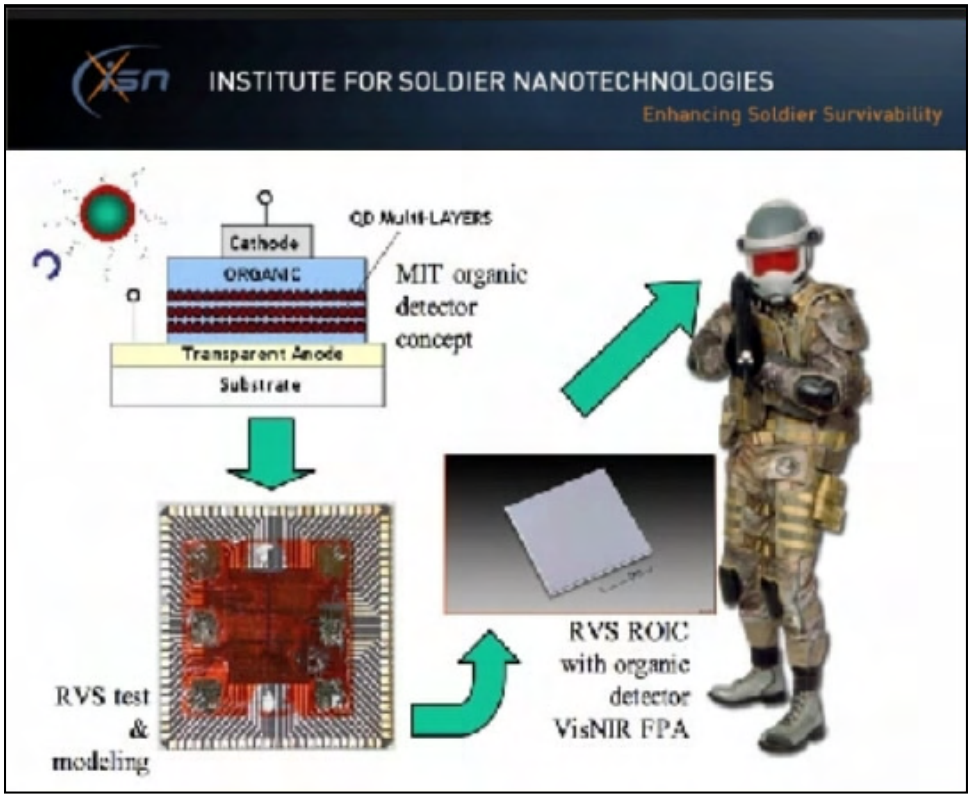

Figure 2. Institute for Soldier Nanotechnologies.

of "local" weather prediction differs significantly in detail and resolution from "global" weather prediction. ARL has a group in Adelphi, Maryland (co-located with its headquarters) that models weather as well.

Development of Faster and More Accurate CBRN Sensing Technology

Figure 2 was copied from a web page created by sensing technology researchers at the Institute for Soldier Nanotechnologies (ISN). The ISN is co-located with the Massachusetts Institute of Technology, is funded $10 million per year by ARL, and employs 45 faculty members from 10 academic departments and over 100 graduates student and post-doctoral researchers.

Team 3 is one of ISN's seven research teams and is dedicated to sensing and counteraction. More specifically, Team 3 is developing measures to detect and respond to chemical and biological threats. This technology will directly assist counter-proliferation efforts in two ways. First, the US Army must be able to detect the presence of WMD in a threat country before we can take action; and second, threat to the Soldier can be reduced by faster response time in the event of an attack on an installation or individual.

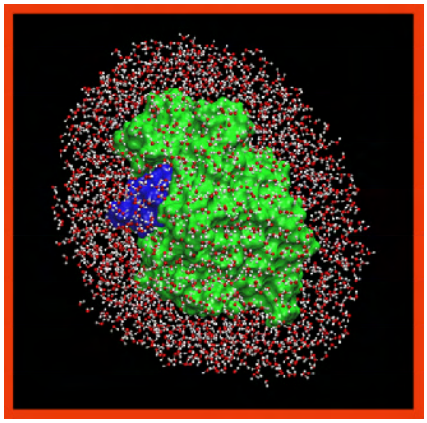

Figure 3. Reaction of Cells and Proteins Exposed to CBRN-Related Substances.

Predicting CBRN Effects on the Human Body

Researchers at Fort Detrick, Maryland are interested in how cells and proteins react when exposed to CBRN-related substances. In the simulation depicted in Figure 3, researchers look for the chemical behavior when protein, ligand and water are all involved. The green area is the protein, the blue is the ligand, and the little speckles around both represent water molecules.

The AHPCRC stations its staff scientists at locations like Fort Detrick to assist researchers with high performance supercomputing. Understanding the effects that CBRN-related substances have on the body will better equip the Army to find antidotes and prioritize which substances pose the greatest threat to Soldiers.

Prediction of Blast Effects and Structure Vulnerability

Figure 4 (page 36) shows a computer simulated prediction of damage incurred to a reinforced concrete building after a truck bomb detonates in close proximity. Performing vulnerability analysis of structures before they are inhabited by Service members will reduce tragedies like the 1996 bombing of Khobar Towers.

The ARL has a number of scientists researching the complex simulation of explosions and blasts with sophisticated modeling algorithms. As these high-fidelity algorithms become more robust and accurate, a question the FA52 community should be asking is: "Can we use this new technology to re-look how we model thermonuclear blasts?" ARL's cutting edge research in both blast modeling and CFD (as seen in Figure 4.) should be raising eyebrows regarding both the reduction of threat to the Soldiers and better models for nuclear weapons effects.

Is it Physics or Engineering?: A Blurred Line

As technology progresses, the fine line delimiting what is physics and what is engineering becomes blurred. High caliber engineers are often no longer satisfied with models that predict results based purely on macro scale equations, sought are models that capture the physics of what is happening at the micro or atomic

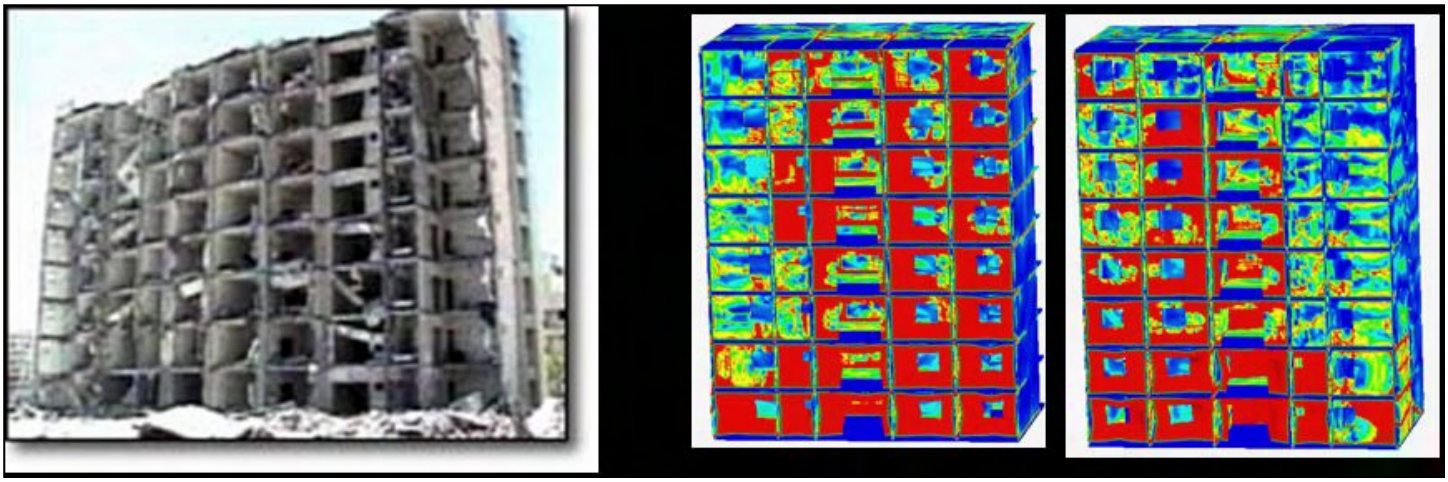

Figure 4. Computer Simulated Damage From a Truck Bomb.

level. Moreover, the engineering of nano-sized building blocks into useful devices has recently gained great attention. To this end, an engineer peering into electron microscope, motivated by a desire to observe behavior at the nano-level, is becoming a more common event.

Multiscale modeling

Multiscale modeling entails the ability to predict the behavior of matter at different length scales. Examples of such scales include the atomic scale (*1x10* $^{-10}$ *meters*), micro scale (*1x10* $^{-6}$ *meters*), and macro scale (*1x10* $^{-0}$ *meters*). At ARL's laboratory in Aberdeen, Maryland, computational multiscale research is being conducted so that events occurring at the macro-scale – such as a bullet penetrating through a protective vest – can be modeled using equations normally associated with the molecular level. Figure 5 is a simulation performed at ARL depicting graphite subjected to a mechanical loading.

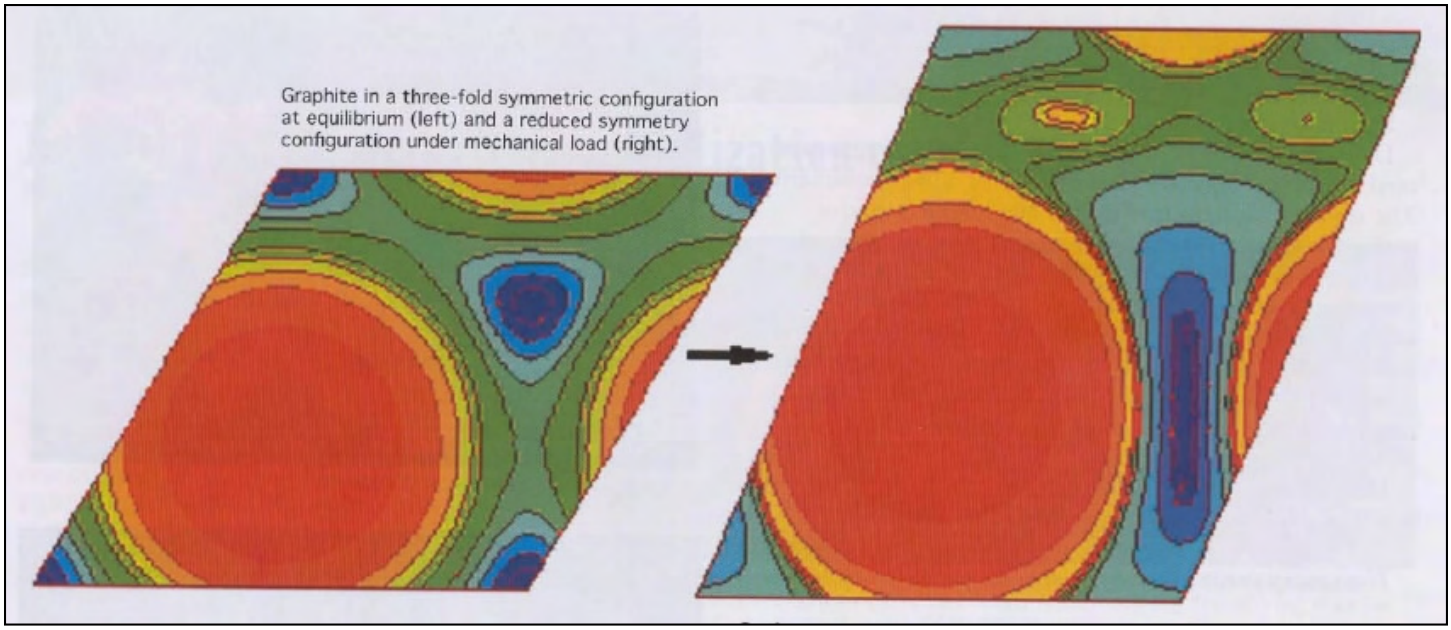

Figure 5. Graphite Subjected to Mechanical Loading.

To further emphasize the growing popularity of multiscale modeling, it should be pointed out that at the 8th US National Conference on Computational Mechanics (July 2005), three of the mini-symposia were dedicated to multiscale modeling. The relevance to the FA52 community lies in the generality of these methods. The variational multiscale method has been called "a paradigm for computational mechanics" [1] by Thomas J.R. Hughes, a well known pioneer in the finite element modeling community. In another article by Hughes, he points out that "these methods may be thought of as methods for dealing with multiscale phenomena which are pervasive in [all types of] physics and engineering." [2] Again, FA52s should be asking, "Can we use these methods to better model a thermo-nuclear detonation where reactions at the atomic level produce enormous heat and pressures at the macro level?

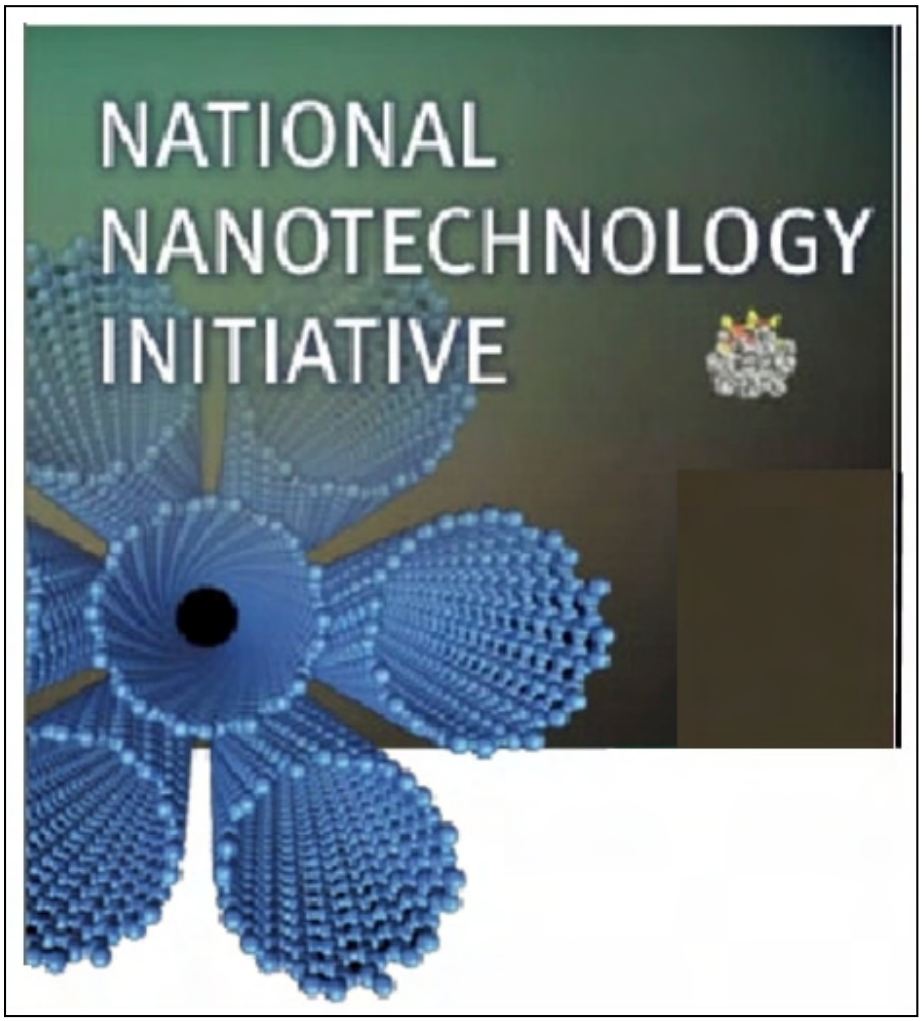

Figure 6. Nanotube Bundle.

Nanotechnology

The word nanotechnology is pervasive today in research laboratories and academic institutions throughout the country. Enormous amounts of time and money have been invested in this promising field in an effort to build new and better devices, mechanisms, and materials. The carbon nanotube in particular has been in the spot light – being used as a building block at the atomic level.

The promise of constructing things made of nanosized building blocks (such as the carbon nanotube) has brought engineers to the atomic level and further erased the border between physics and engineering. Figure 6 was taken from the National Nanotechnology Initiative home page and shows a nanotube bundle.

Conclusion:

We all look on our uniforms and it says "U.S. Army." Why then shouldn't FA52's be assigned to the US Army Research Laboratory to assist researchers and better understand the capabilities and limitations technology provides regarding WMD and counterproliferation? FA52s having assignments of this type would be best for the US military – particularly in these times of great transformation.

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Putting a New Spin on an Old Concept

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With James Chadwick's discovery of the neutron in 1932, a host of experiments to better understand the behavior of the neutron ensued. By 1938 Enrico Fermi was the leading expert in the field of neutron research. After the discovery of nuclear fission by Hahn and Strassmann in 1939, Fermi set forth to create the first sustained nuclear reaction, which he achieved under Chicago stadium in 1942. In a later experiment, Fermi built a thermal neutron disc chopper. The Fermi-chopper, as it was later dubbed, allowed the time-of-flight of the neutron, and thus its energy, to be determined. In his experiment, Fermi used this knowledge to map the absorption cross-section of boron-10 (B^{10}) throughout the thermal neutron region.[1] The bulk of neutron experimentation during the 1930s and 1940s was geared toward the highly classified *Manhattan Project*, which led to the construction of the first atomic bomb at Los Alamos, New Mexico.

Fast-forwarding through six decades, the emphasis on neutron research has shifted 180 degrees. The emphasis no longer lies in the development of nuclear weapons but rather in the prevention of smuggling nuclear weapons or special nuclear material (SNM). This type of prevention is now commonly known as counterproliferation. In my research conducted at the Air Force Institute of Technology (AFIT), I used Fermi's disc chopper concept to characterize a neutron energy spectrum using a new *Forward Edge* neutron time-of-flight spectroscopy technique. In short, the goal of the research was to infer characteristics of a neutron energy spectrum using the Fermi-chopper to see if it would be possible to identify SNM solely from its neutron spectrum.

Application

The science of remotely and quickly differentiating nuclear material such as industrial or medical isotopes from SNM (highly enriched U^{233}, U^{235}, and Pu^{239}) is at the forefront of research and development for several different government agencies. Current requirements for this ability lie in a variety of areas including border security, nuclear treaty verification, and field identification of nuclear materials.

The Department of Homeland Security has the requirement of protecting our nation's borders at a host of border crossing check points and points of cargo debarkation. Inbound cargo at all of these points provides a possible haven for smuggled SNM. The ability to rapidly and accurately differentiate SNM from other legitimate nuclear isotopes is important in terms of both national security and economic interests.

The Defense Threat Reduction Agency (DTRA) serves as the United States (US) government focal point for implementing US arms control inspection, escort and monitoring activities.[2] Critical in this mission is the ability to quickly and accurately account for all inspected Russian nuclear warheads, while maintaining the strict protocol outlined in the governing treaties.

During OPERATION IRAQI FREEDOM commanders sometimes lost both time and momentum awaiting the confirmation of the presence of SNM at various pre-identified sensitive sites. A field portable nuclear identification technique could provide the ability to more rapidly and accurately confirm the presence of suspected SNM. This information would prove critical not only to the safety of the soldier on the ground but also to the momentum of the overall operation.

Myriad techniques exist or are currently being researched whereby SNM may be identified through active or passive interrogation. Passive interrogation implies identification through nothing more than observation. For example, the observation of gamma rays produced through the natural decay of the various transuranic metals used in SNM is one means of determining the presence of, and possibly deducing the type of, SNM. Neutrons also provide a means of passive interrogation through observation of the neutrons emitted during spontaneous fission. Spontaneous fission, another form of natural decay, occurs to a very small extent in all types of SNM. Active interrogation is the use of an external device that scans the material with energy, such as an x-ray machine. One active interrogation technique bombards the SNM with neutrons from an external neutron source. The nuclear reactions that result produce

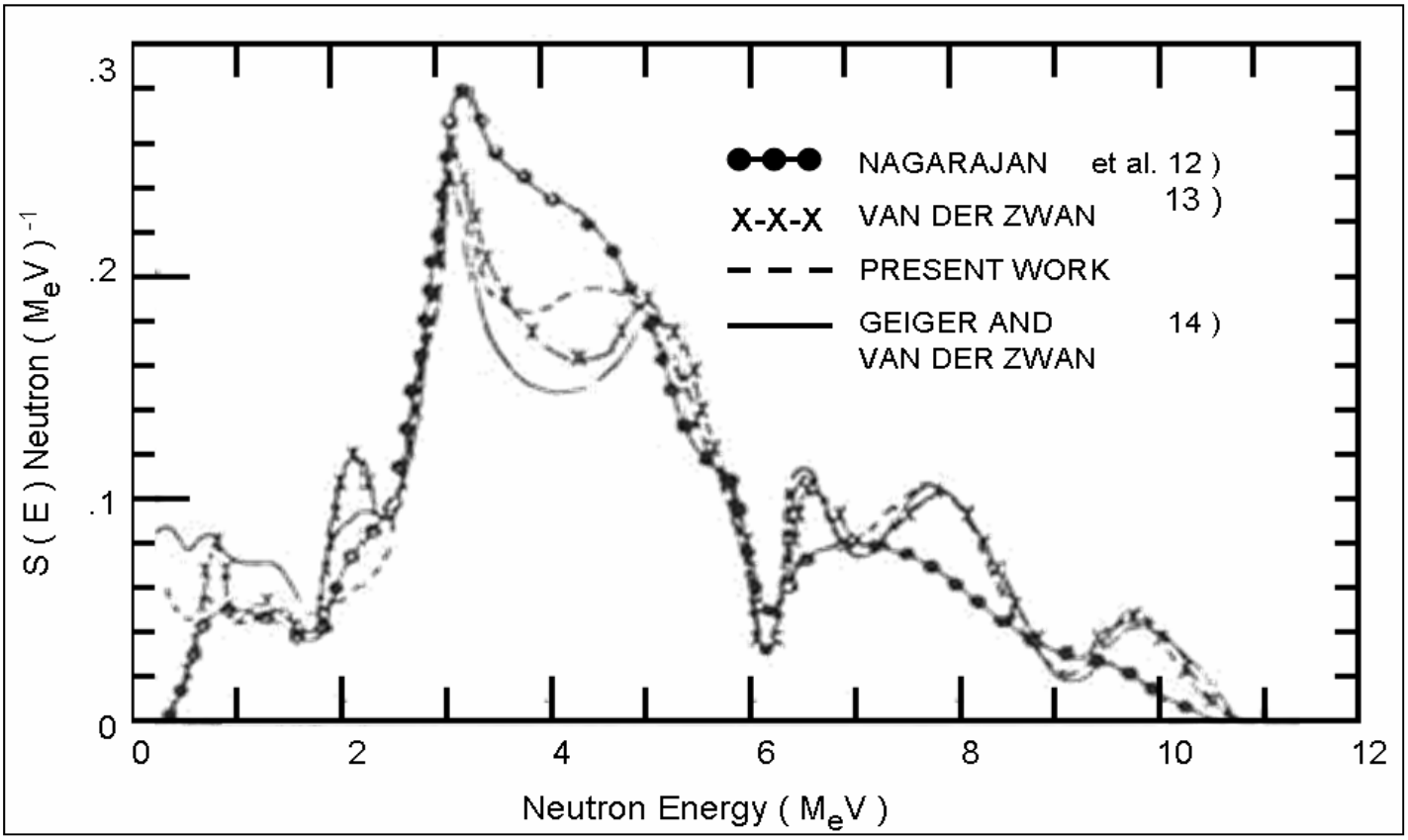

Figure 1. PuBe Neutron Energy Spectrum.

a host of gamma and neutron emissions several orders of magnitude higher than those generated through natural decay, making detection and identification more feasible.

However, the gamma emissions can be masked with the use of a few inches of lead and can be more easily fabricated in order to produce a bogus signature, or spoof. Neutrons, on the other hand, are very difficult to mask due to their lack of columbic interaction with other materials and would require several inches to feet of a hydrogenous material (i.e. paraffin). The fabrication of a neutron emitting source is also much more difficult to achieve.

The idea of using the Fermi-chopper as a means of identifying SNM stems from the fact that different transuranics, as well as different common configurations of weapon pits, have neutron spectra with specific characteristics. The time-of-flight method, in theory, has the potential to determine the energy of a neutron across the entire energy spectrum. However, in practice many obstacles exist in determining the energy of neutrons above the thermal range. These obstacles will be discussed later.

Experimental Design

The experimental setup used in the conduct of this research included seven critical components. A Plutonium-Beryllium (PuBe) source provided the neutron spectrum simulating the neutron emissions from SNM. Paraffin was used to reduce the lower energy portion of the spectrum. A Fermi-chopper was designed and fabricated to produce a neutron pulse and thus a start time for measurements. The Fermi-chopper design incorporated a flight tunnel for the neutrons to traverse a fixed distance before entering the next critical component, the detector.

A Saint-Gobain manufactured organic scintillator was laced with B^{10} in order to achieve maximum efficiency in thermal neutron counts. The signal, which provided the stop time, fed through a variety of ORTEC nuclear instrumentation modules (NIM) that isolated the thermal neutron capture peak of the B^{10} reaction. A fast-trigger LeCroy oscilloscope provided the means to connect the positioning of the neutron chopper to the arrival of thermal neutrons at the detector. Finally, a MATLAB code provided analysis of the oscilloscope data in order to produce the forward edge neutron energy spectrum.

Experimental Work

As seen in Figure 1 the PuBe source creates neutrons across a broad spectrum of energies, from thermal to ~11 MeV. The data shown in Figure 1 was derived in previous work through both experiment and computer modeling.[3] The PuBe spectrum has several characteristic features which include a variety of peaks and valleys along the entire spectrum. The presence of paraffin both attenuates and moderates the neutron spectrum. By inserting ever increasing thicknesses of moderation, the flux of thermal neutrons varies approximately as the features in the PuBe spectrum of Figure 1, starting with the peak at 0.9 MeV and con-

cluding with the last peak at 9.8 MeV.

The first data run observed the unmoderated spectrum of the PuBe source, which had very few thermal neutrons present. The second data run included the presence of a 1.5 cm thick block of paraffin moderator between the PuBe source and the Fermi-chopper. In essence, the presence of the paraffin shifted the PuBe spectrum such that the maximum neutron flux at 3.1 MeV was moderated to thermal energies.

The aluminum Fermi-chopper, as seen in Figure 2, was simply a solid aluminum disc with a hole (neutron gate) bored radially through it. It was designed to function at frequencies up to 20,000 RPM without mechanical failure; however, the mechanical properties had to be balanced with nuclear properties. The disc diameter remained large enough to produce a significant difference in neutron attenuation between the open-gate and closed-gate configurations. The disc, enclosed in an aluminum housing, used cadmium sheets inlaid around the circumference of the disc in order to further attenuate thermal neutrons between the two configurations. A forward-biased photodiode provided a signal when the Fermi-chopper was exactly 90º out of phase with the source-to-detector line of sight (i.e. gate-closed position).

The detector was separated from the source-side of the Fermi-chopper by 45.4 cm. The high concentration of B^{10} in the detector interacts predominantly with thermal neutrons which undergo the reaction $B^{10} + n \rightarrow Li^{7} + \alpha$. These resultant heavy charged particles deposit nearly 3 MeV in energy into the organic scintillation material. This signal is processed through a series of ORTEC NIMs to include a preamplifier, delay amplifier, timing single-channel analyzer, and a linear gate and stretcher. This system of NIMs isolated the energy associated with the thermal neutron capture from all other energy neutron events occurring in the detector (i.e. proton recoil).

The gated thermal neutron capture signal fed into the LeCroy oscilloscope where it was compared to a second signal generated by the photo-diode. The photo-diode signal provided the means of determining the position of the Fermi-chopper at any given instant. The oscilloscope created a data file on every triggering of the photodiode. These files were later imported into MATLAB and processed through the two developed codes to produce the spectra shown in Figure 3.

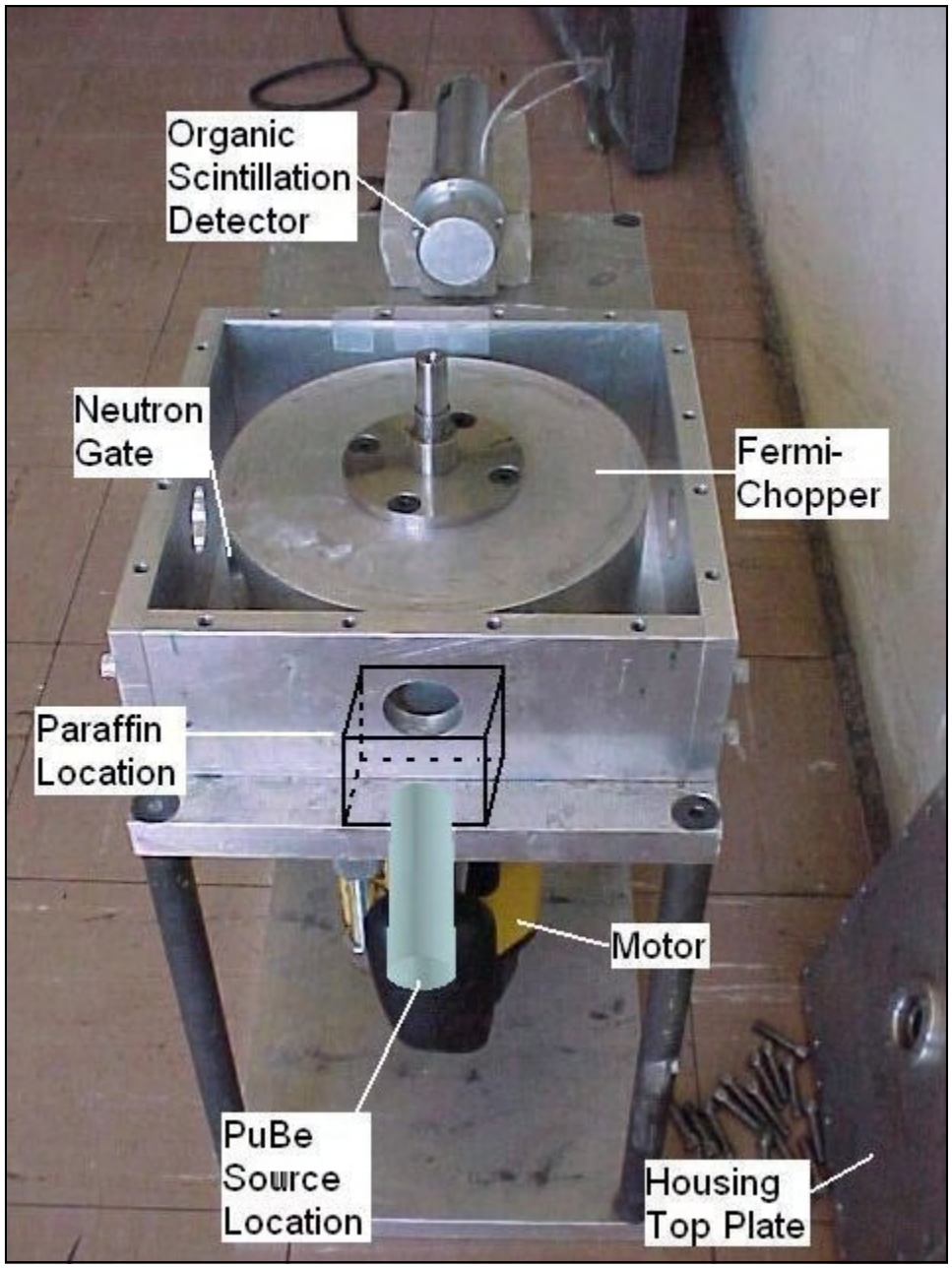

Figure 2. Fermi-Chopper and Housing.

Figure 3 is a comparison of the forward edge spectra of the two data runs, unmoderated and moderated. Beginning with the initial opening of the neutron window ~1250 µs after the photo-diode trigger, both spectra increase as the thermal neutron capture events are summed over time. Point A refers to the point at which a true thermal neutron, one that originated from the source, could make it to the detector (i.e. previous counts are either high-energy neutrons slowed to thermal energies in the detector or surrounding material, such as housing or shielding moderation).

Region B indicates the time in which the amount of detector exposed to the source increases with the increasing overlap of the circular

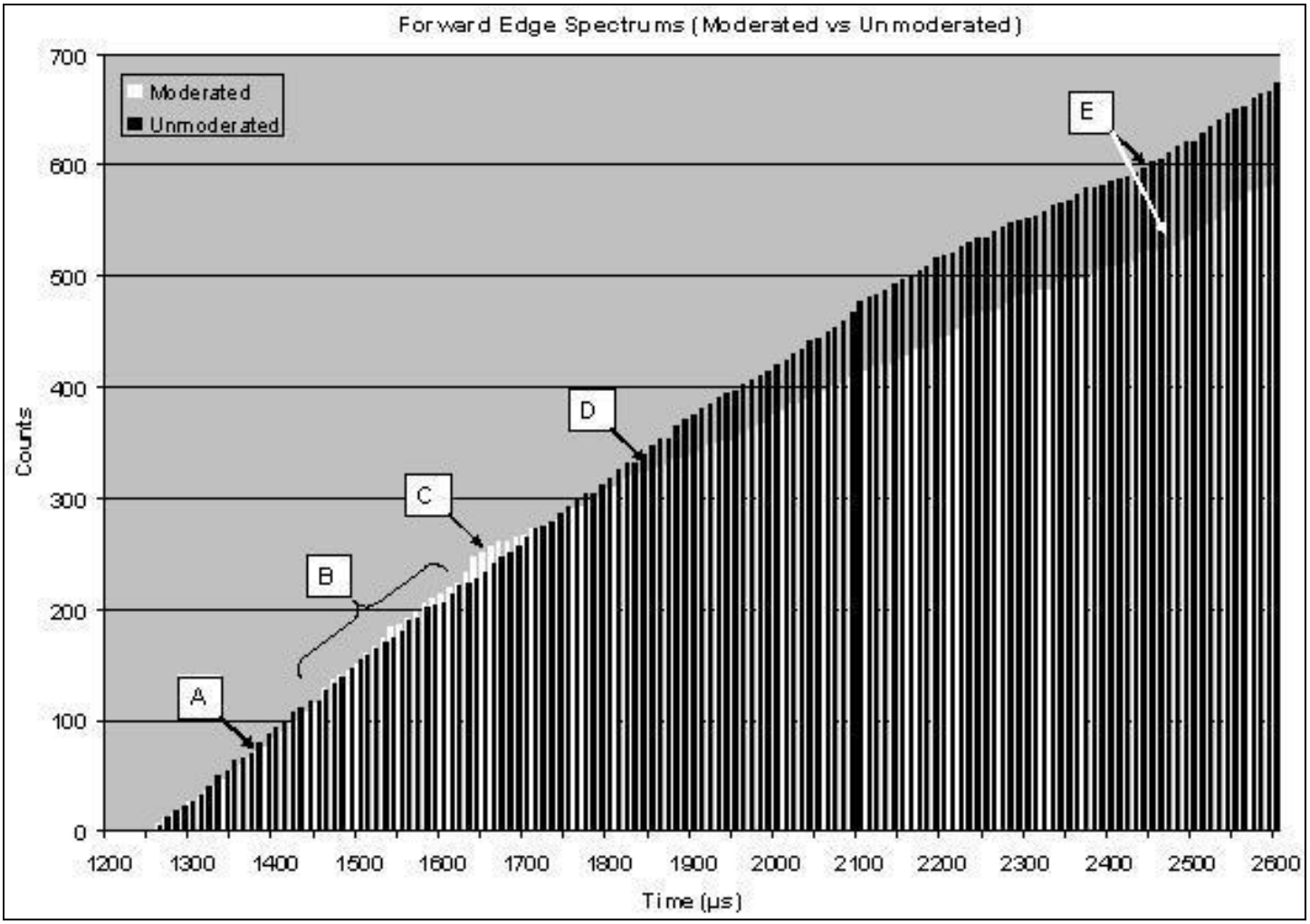

Figure 3. Comparison of Forward Edge Spectrums (Unmoderated Data Run and Moderated Data Run).

neutron gate to the source (e.g. imagine the process of two eclipsing circles). This increase permits a larger number of thermal neutrons to reach the detector. During this period, the moderated slope clearly increases more quickly than the unmoderated slope.

Point C illustrates the point of maximum exposed source-to-detector area, hence the number of thermal neutrons arriving at the detector spikes in the moderated data run. From this point forward, the amount of source-to-detector area begins to decrease and correspondingly the number of thermal neutrons also decreases in the moderated spectrum.

Point D represents the time at which the last true thermal neutron can arrive at the detector. From point D onward the number of thermal neutrons arriving at the detector belongs to those high-energy neutrons downscattered in energy by the surrounding material. Point E, an unanticipated decrease in flux, is potentially due to a combination of events. The decrease in flux may be attributed to a series of events that occur from the geometry of the disc and the diminishing presence of low-energy neutrons that does not occur at any other time during the rotation of the disc chopper. As the neutron gate begins to close, the depth of aluminum as seen by a neutron in flight from the source to the detector begins to increase; however, it is not yet thick enough to present much attenuation. Thus, the only neutrons present are the low-energy neutrons (i.e. below thermal) which are still in route from the disc to the detector. This number is diminishing as the area of the detector exposed to the source is diminishing.

Conclusions

Figure 3 provides an indication that through carefully selected and positioned moderation, the rudimentary characteristics of a neutron energy spectrum may be inferred from the forward edge technique; however, as mentioned earlier, several obstacles exist to more exact measurement.

First, it must be understood that the presence of moderation does not cleanly attenuate, or cut off, the lower energy neutrons and it does not uniformly moderate all targeted neutrons down to a specific thermal energy. Rather, the process is statistical and some low-energy neutrons make it through the moderation without being attenuated and some high-energy neutrons will pass through unmoderated, thus the forward edge spectrum produces a muddled picture at best.

Another downfall of this application in identifying SNM is the extreme counting inefficiency. Each of the spectrum produced in Figure 3 required 3,550 separate files (i.e. photodiode triggers), which required nearly one hour of total operating time to produce. Additionally, the flux of this PuBe source is several orders of magnitude greater than that of the typical SNM of interest for passive interrogation. Since current treaty verification prohibits active interrogation, this exorbitant amount of time for this type of passive interrogation would be prohibitive.

Finally, a significant amount of moderation in the form of shielding was required in order to cut down on the amount of background neutron events (i.e. sky shine). The bulk of so much hydrogenous material would ultimately limit portability in any future designs.

In terms of the considered applications, both field identification and treaty verification have potential future use for the proposed technique. Due to the less stringent requirement for counting time, the Fermi-chopper may someday prove useful in the area of field identification. Even with this latitude in counting time, the inability to provide an accurate portrayal of the true neutron spectrum due to the smearing effect of the moderation would yield rudimentary results at best. Additionally, the bulk of the required shielding would prevent the development of a man-portable device.

In terms of treaty verification, the Fermi-chopper may eventually prove useful as well. The ability of the Fermi-chopper to identify a weapon's pit-specific neutron signature may prove useful. Comparing a weapon pit's spectrum from previously recorded inspections would identify the shuffling of warheads to cover up any losses due to theft or intentional proliferation. Because of the Fermi-chopper's poor counting efficiency, this potential application will remain impractical unless treaties are amended to include active interrogation techniques.

Although portability does not prevent the use of the Fermi-chopper in aiding border security, the counting inefficiency does. The amount of time available to interrogate, passively or actively, a shipping container from ship, train, or truck will never accommodate this technique. The economic impact of delaying the off-loading of each cargo container even a few minutes equates to several billion dollars lost in yearly revenue for the shipping industry.

Overall, this research effort proved ideal in mastering a wide variety of physical concepts from Newtonian to nuclear physics. While the concept certainly has merit in terms of laboratory experimentation as part of an academic curriculum, the Fermi-chopper, with its present technology, would prove of little use to current government requirements.

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[3] Kumar, A. and Nagarajan, P. S. "Neutron Spectra of 239Pu-Be Neutron Sources," Nuclear Instruments and Methods, Vol 140, 1977.

The idea of using the Fermi-chopper as a means of identifying SNM stems from the fact that different transuranics, as well as different common configurations of weapon pits, have neutron spectra with specific characteristics.

The time-of-flight method, in theory, has the potential to determine the energy of a neutron across the entire energy spectrum.

Dying to Win: The Strategic Logic of Suicide Terrorism

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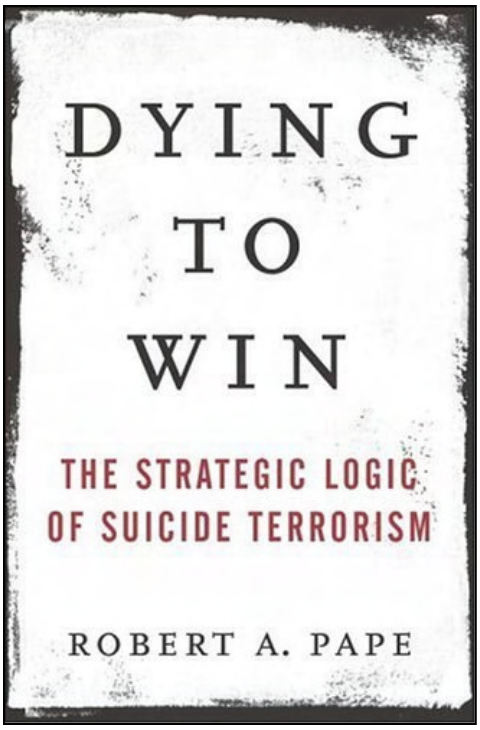
The Judge Advocate General's Legal Center and School

To win the war on terrorism, we must have a new conception of victory. The key to lasting security lies not only in rooting out today's generation of terrorists who are actively planning to kill Americans, but also in preventing the next, potentially larger generation from rising up. America's overarching purpose must be to achieve the first goal without failing at the second. To achieve that purpose, it is essential that we understand the strategic, social, and individual logic of suicide terrorism. Our enemies have been studying suicide terrorism for over twenty years. Now is the time to level the playing field. [1]

The tragic events of September 11, 2001, are vividly burned into the collective memory of the citizens of the United States (US) and continue to serve as stark reminders that there are people across the globe who will take extreme measures to cause harm to America and her citizens. In response to these attacks, the US has undertaken a strategy to take the fight to the enemy by seeking regime change in countries that support or harbor terrorists. This policy is based, in part, upon the belief that Islamic fundamentalism is the driving force behind the terrorists' attacks against American interests around the world.[2] This was also the view held by the author of *Dying to Win: The Strategic Logic of Suicide Terrorism*, shortly after the suicide terrorist attacks of September 11, 2001.[3] However, in his quest to better understand the motives of the terrorists, Professor Robert A. Pape ultimately concluded that suicide terrorism is not based on religion, but on a common strategic objective.[4]

In this book, Pape suggests that "what nearly all suicide terrorist attacks have in common is a specific secular and strategic goal: to compel modern democracies to withdraw military forces from territory that the terrorists consider to be their homeland."[5] After deeper analysis, Pape refines this proposition by offering the following hypothesis: the "taproot of suicide terrorism is nationalism." [6] To support these assertions, Pape relies on a comprehensive database he created that contains the details of every suicide terrorist attack that occurred between 1980 and 2003.[7] This database contains information detailing whether a specific attack was part of a campaign; the name, nationality, and ideology of most suicide terrorists; and the date, location, and circumstances of the attack.[8] After providing helpful background information that explains the historic origins of suicide terrorism, Pape organizes his argument by examining the strategic, social, and individual logic of suicide terrorism.[9]



Although Pape is currently recognized as an expert in the field of suicide terrorist knowledge, it has not always been the focus of his work. Pape currently serves as an associate professor of political science at the University of Chicago, and until the suicide terrorist attacks of September 11, 2001, his focus had primarily been on military air power.[10] He was an instructor at the US Air Force School of Advanced Airpower Studies, and completed his doctoral dissertation in 1998 on the topic of coercive air power.[11] It was not until the aftermath of the September 2001 terrorist attacks that Pape immersed himself in documenting and studying suicide terrorism.[12] Because of his comprehensive research in this area, Pape was also appointed as the director of the Chicago Project on Suicide Terrorism, which is partially funded by the Defense Threat Reduction Agency and the University of Chicago.[13]

Before delving into the substance of his argument in *Dying to Win*, Pape provides a brief but wide-ranging history of suicide terrorism, beginning with the Jewish Zealots' suicidal attacks during the period 4 B.C. to 70

A.D. He then moves to the Ismaili Assassins' attacks during the eleventh and twelfth centuries, and concludes with the Japanese kamikazes' onslaughts during World War II.[14] Interestingly, Pape found no recognized instances of suicide terrorism from 1945 through 1980.[15] Suicide terrorism emerged as a widespread "tool of political coercion" following the suicide attack on the US Marine barracks in Beirut in 1983.[16] Although this was not the first suicide terrorist activity to interrupt the thirty-five year respite following World War II, the event energized terrorist organizations throughout the world because it "dominated media headlines for weeks, consumed Western national leaders for months, and encouraged terrorist groups from Hamas to the Tamil Tigers to al-Qaeda to adopt this method of attack." [17]

Against this background, Professor Pape dives into the substance of his argument by discussing the strategic logic of suicide terrorism. According to Pape, suicide terrorist organizations are largely motivated by applying coercive political power.[18] These organizations wish to "compel a target government to change policy" by "punishing" the target countries.[19] Because suicide terrorist organizations do not have the resources to defeat a major power, they rely on suicide attacks to level the playing field by "causing mounting civilian costs to overwhelm the target state's interest in the issue in dispute and so to cause it to concede to the terrorists' political demands." [20]

This argument represents the heart of Pape's theory that suicide terrorist organizations seek to compel democracies to withdraw military troops from territories that the terrorist organization considers its homeland. To refute the argument that suicide terrorism is the product of Islamic fundamentalism, Pape provides a comprehensive table tying the timing of the suspension of suicide terrorist campaigns to the full or partial concession of a target government.[21] He also notes that suicide terrorism is most effective against democracies because the target government is accountable to the civilian populace.[22]

Pape next tackles the social logic of suicide terrorism and the role religion plays. As previously stated, Pape contends that the "taproot of suicide terrorism is nationalism – the belief among members of a community that they share a distinct set of ethnic, linguistic, and historical characteristics and are entitled to govern their national homeland without interference from foreigners." [23] When the citizens of a nation feel that they are occupied by a foreign power, they may come to believe that the community has "lost the ability to protect the political, economic, and social interests of its members," and the "future trajectory of the nation is no longer determined by the members of the community." [24] In these situations, citizens of the occupied nation "come to feel intense loathing toward the nation occupying their homeland and may develop a heroic sense of duty to inflict terrible punishment on the enemy society in order to compel it to leave." [25]

Pape notes that most al-Qaeda suicide terrorists are citizens of nations allied with the US, and the governments of these nations invite American troops into their countries, often against the wishes of the host nations' citizens.[26] Suicide terrorist organizations capitalize on American presence among their citizenry, emphasizing this discrepancy in ideology between the target state's government and its citizens. Religious differences play a large part in this concept by offering suicide terrorist organizations an opportunity to "demonize" the foreign power's differing religious theories, and "gain legitimacy for martyrdom from the local community." [27]

This process allows suicide terrorist organizations to overcome the strong social prohibitions against suicide and gain support for their cause, despite the fact that suicide rates are lowest in Muslim countries.[28] Religion allows demonization, which encourages suicide terrorists to sacrifice their lives while killing others.[29]

Finally, Pape analyzes the logic of individual suicide terrorism, discussing the different forms of suicide and the theory of "altruistic martyrdom." [30] He begins by differentiating the three categories of suicide. Egoistic suicide "occurs when an individual . . . chooses voluntary death as a means to escape [a] painful existence," and fatalistic suicide occurs "when individuals are confined under conditions of such excessive regulation, oppressive discipline, and seclusion from society, that they can be made to carry out extreme acts through . . .brainwashing." [31] Pape focuses mainly on altruistic suicide, which "occurs when high levels of social integration and respect for community values cause otherwise normal individuals to commit suicide out of a sense of duty." [32] In short, these suicide terrorists are willing to give their lives for the cause of their community.[33]

The concept of "altruistic martyrdom" requires give and take from the individual and the community.[34] "Altruistic martyrdom" implies that an individual commits a suicide terrorist attack in an effort to advance what he has come to believe is a community interest or goal. The community sanctions and supports these actions because it has been manipulated into believing that the community goal is worthy of a suicide attack.[35] Suicide terrorist organizations are able to manipulate the community by "using elaborate ceremonies and other means to identify the death of a suicide attacker with the good of the community – such as high-profile funerals, "martyr videos," and murals and graffiti." [36]

Based upon his extensive documentation of suicide terrorist attacks from 1980-2003, Pape provides a detailed demographic profile of suicide terrorists. He comes to the conclusion that "suicide attackers are rarely socially isolated, clinically insane, or economically destitute individuals, but are most often educated, socially integrated, and highly capable people who could be expected to have a good future." [37] This finding is counterintuitive to the popular belief that only mentally unbalanced individuals would carry out such attacks.

Pape concludes that the US' current strategy for dealing with suicide terrorism has actually produced results directly contrary to those sought.[38] Although American forces have done a great job of defeating the enemy on the battlefield, this is a limited success because it serves as a "stimulus to the rise" of the next generation of suicide terrorists.[39] This can be seen in Iraq today, where American and coalition forces routed Iraqi government forces on the battlefield, only to struggle against insurgents and suicide terrorists. Consequently, Pape proposes the return to the strategy of "off-shore balancing" to deal with the current situation in the Middle East.[40] Recognizing that oil is a strategic US interest, this strategy calls for the withdrawal of American military personnel from the Arabian Peninsula, "while working with Iraq, Saudi Arabia, and other Persian Gulf states to ensure that they maintain the critical infrastructure for a rapid return of US forces should that prove necessary." [41] While all of Pape's arguments are persuasive, two criticisms weaken his theory.

Pape assumes that suicide terrorist attacks on American military forces will cause the American public to pressure its government to withdraw from the region. However, this assumption fails to consider that suicide terrorists have been attacking their own citizens, especially in Iraq. If a suicide terrorist organization's primary motivation is the removal of an occupying force from its homeland, it can be expected to attack the occupying power's forces, civilians, or other assets. However, Pape makes no connection between the suicide terrorist organizations' goal of coercing a target government and attacks on the citizens of the occupied territory. In the case of Iraq, the American public has not pressured the government to remove forces because of the deaths of Iraqi civilians. Conceivably, Pape would argue that attacks against Iraqi citizens are an attempt to compel the new Iraqi government, an ally of the US, to force the withdrawal of US troops from Iraqi soil, but Pape does not directly address this issue.

The second issue relates to Pape's suggested return to the strategy of "off-shore balancing." [42] While this may have been a sound strategy that has protected and served American interests in the past, it is not currently viable. The US cannot afford to create the impression that it is conceding to the demands of suicide terrorists. If the US withdrew its forces from Iraq, it would only encourage future attacks. Pape himself addresses this issue when he discusses the US withdrawal from Lebanon following the suicide terrorist attack against the Marine barracks in 1983.[43]

Dying to Win is objective, well-researched, and a must-read for military officers. Pape's hypothesis is ultimately sound and directly addresses one of the pivotal issues of the Global War on Terrorism, but his theory undermines the basis on which the current strategy of the US is founded. Though it may not provide all the answers, Pape's book should be mandatory reading for senior lawmakers and Department of Defense officials who are struggling to come to terms with this scourge of suicide terrorism. The Global War on Terror is far from over, and now is the time to gain a full understanding of our enemy so that we can defeat him on tomorrow's battlefield.

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[4] Id.
[5] Pape, supra note 1, at 4.
[6] *See id.* at 79.
[7] *See id.* at 3.
[8] *See id.* at 201-02.
[9] *See id.* at 21.
[10] *See* Murphy, supra note 5.
[11] *See id.*
[12] *See id.*
[13] *See id*.
[14] *See* Pape, supra note 1, at 11-13.
[15] *See id.* at 13.
[16] *See id.* at 14 (noting that the Hezbollah suicide bombing killed 241 Marines).
[17] *Id*. at 14-15.
[18] *See id.* at 27.
[19] *See id.* at 27-29 (offering that a terrorist's willingness to die will coerce a target government because "suicide attacks are generally more destructive than other terrorist attacks," because "suicide attacks are an especially convincing way to signal the likelihood of more pain to come," and because "suicide terrorist organizations are better positioned than other terrorist groups to heighten expectations of escalating future costs by deliberately violating norms in the use of violence").
[20] *Id*. at 30.
[21] *See id.* at 40.
[22] *See id.* at 44 (noting that suicide terrorists are more likely to attack democratic governments because they are perceived as weaker than authoritarian governments, thus are more susceptible to the application of political coercion through suicide attacks).
[23] *Id*. at 79
[24] *Id*. at 84.
[25] *Id* at 84, 85.
[26] *See id.* at 114, 116 (discussing the fact that 79% of "al-Qaeda's transnational suicide terrorists – those not associated with American military presence – are from four Muslim countries, all of which have regimes that are close allies of the United States and all of whose suicide terrorists are associated with the cause of national liberation in their own countries").
[27] *See id.* at 80, 90-91.
[28] *See id*. at 80-83, 181.
[29] *See id*. at 90.
[30] *See id.* at 172, 187.
[31] *Id* at 172-73.
[32] *Id*. at 172.
[33] *See id.* at 185 (discussing the fact that many suicide terrorist attacks are conducted by teams, an indication that the terrorists are working together toward a common goal).
[34] *See id.* at 187-188.
[35] *See id.* at 187-188.
[36] *Id* at 82.
[37] *Id*. at 200.
[38] *See id.* at 237-250.

The Strategy of Nuclear Deterrence
Why MAD Was Sane

MAJ Andrew Pache
Defense Threat Reduction Agency

The energy that binds together atoms is the most destructive force ever harnessed by mankind. Nuclear weapons not only drove military strategy for over 50 years, their existence and the threat of their use shaped the geopolitics of the second half of the 20th Century. The concept of Mutual Assured Destruction, or MAD as it became known, maintained the nuclear peace during some of the tensest moments of the Cold War and was the only logical strategic path to follow for the opposing sides in that conflict.

When the first atomic weapons were detonated over Hiroshima and Nagasaki in August of 1945, the strategic implications were not readily apparent. Although the destructiveness of these weapons was orders of magnitude above anything ever used, the United States (US) had few in its inventory and limited means of delivery against a defended target. In the years immediately following the war nuclear weapons were not seen as an integral part of any US strategic plan. Many were clearly horrified at the devastation caused by these new bombs and little effort was put into the program in the years after World War II. Communism was quickly replacing fascism as the ideological opponent of the Western democracies, and the Berlin crisis of 1948 was the start of the incorporation of nuclear weapons into US defense policy.

The second factor driving nuclear weapons to the forefront was the actual and perceived conventional military superiority of the Soviet Union. Both the US and the Soviet Union began a massive rearmament process in the early 1950's. The economic strain of these programs was tremendous and the conservative Eisenhower administration saw nuclear weapons as a relatively cheap way to maintain military parity with the USSR. This was validated in 1953 at the armistice talks to end the hostilities in Korea. Truman had kept the threat of nuclear weapons off the table for much of that conflict, but when the talks bogged down and it was hinted that the US might raise these restrictions, the peace talks began to progress. Nuclear weapons were now seen as a powerful diplomatic tool. The West began to formulate policy around these weapons and in 1954 the strategy of "Massive Retaliation" was born. This policy relied on the threat that any aggression would result in the complete destruction of the enemy's economic and political centers. However, this first attempt at using nuclear weapons as a deterrent to Soviet aggression had mixed results. First, the Pentagon was not convinced that timely authority to release atomic bombs in the event of an attack would be received. Thus, they continued to build up conventional forces, negating the theoretical cost savings in the defense budget. Diplomatically, "massive retaliation" was untenable as well; as most other nations did not believe the US would launch a nuclear attack in response to any small-scale conflict such as Korea or Indochina. Strategic theorists of the time recognized this as well and published reports calling for a more flexible policy that allowed for the appropriate levels of force to be used in different situations. It became obvious that modifications to the current policies would have to be made.

In August of 1945, Robert Oppenheimer warned then Secretary of War Henry Stimson that the US would not forever maintain hegemony over nuclear weapons. While the policy debates were taking place in the US, the Soviet nuclear program was maturing and the Soviets began working to address the strategic shortcomings of its nuclear forces. It detonated its first fission weapon in August of 1949 and its first hydrogen bomb in 1953. However, like the US after the war, Stalin placed minimal importance on nuclear weapons in relation to defense policy, so it was not until after his death that nuclear development began in earnest. During the 1950's the Soviets made rapid development in ballistic and cruise missile technology, jet engines, satellites and guidance systems. On the policy side, the Soviets were wrestling with the same issues as the Americans. Can a "limited" nuclear war be fought? Do tactical nuclear weapons have a place on the battlefield and if so, how should they be used? How could conflicts escalate into all out nuclear exchange? On both sides, a vast amount of intellectual effort was expended on squaring strategy and pol-

icy with the realities of this awesome new weapon.

Technology would ultimately drive the focus of nuclear policy on both sides of the Atlantic. As the US and the Soviets began to reach parity with their nuclear forces in the early 1960's, there was a shift toward using ballistic missiles as the delivery means of choice. Missiles were easy to hide and their mobility made improvements in enemy missile accuracy a moot point. Ballistic missile submarines presented an even more elusive target. This resulted in a situation where a first strike launched by either side would not be able to destroy enough of the enemy's missiles to prevent a devastating counter-attack. It became apparent that neither side could use a nuclear war as, in Lenin's words "a continuation of politics by means of armed force." A first strike would result in national suicide.

Defense Secretary Robert McNamara entered the term "Mutual Assured Destruction," or MAD for short, into the strategic lexicon in 1964 and defined it as "the ability to deter a deliberate nuclear attack on the United States or its allies by maintaining at all times a clear and unmistakable ability to inflict an unacceptable degree of damage upon any aggressor, or combination of aggressors – even after absorbing a surprise first attack." The term and its definition correctly summarized the state of affairs that existed between the two nuclear superpowers. If a first strike would not result in the sufficient destruction of the enemy's retaliatory capability, and that retaliation would mean the devastation of the industrial, political and population base of your own country, then it made no sense to launch that first strike.

The technology that enabled this equilibrium posed the first and only threat. Because of the move to intercontinental ballistic missiles, development began on anti-ballistic missiles (ABMs) that were designed to intercept the weapons during various stages of flight. This was (and is) a potentially destabilizing technology because if an aggressor felt he could adequately protect his national assets, it followed he would be more likely to launch a first strike. The problem of killing a supersonic missile while in flight is an extremely difficult one to solve and it's doubtful that any of the systems being developed would have been effective. The introduction of multiple independently targeted re-entry vehicles made the problem infinitely harder by putting several warheads on a single missile. At a certain point in its ballistic phase, these warheads would separate and head towards their individual targets, making effective interception close to impossible. The Soviets recognized that the problem was beyond the current level of technology and shelved their program in 1968. This fact was unknown to the US at the time and they continued work until the Strategic Arms Limitation Treaty of 1972 put strict curbs on ABM deployment and development. No effective ABM system was ever fielded.

The ABM question would arise periodically over the next 20 years, notably with the "Star Wars" initiative put forth by Ronald Reagan in 1983. The fact remained that neither side saw ABMs as a real factor that could affect the realities of a nuclear exchange. No one was willing to bet their nation on the unproven defensive technology and the primacy of MAD remained in effect for the remainder of the Cold War.

We stood face to face with the Soviets for half a century, with the threat of nuclear war and the destruction of our nations keeping the overall peace. For all the ideological differences, there was cold logic at work that enabled the leaders of the two sides to see that a nuclear exchange just was not worth any perceived gain. Today, the threat of a nuclear exchange between superpowers has receded, but the threat from "rogue" nuclear programs and from terrorists obtaining a complete weapon is very real. The nuclear genie is out of the bottle, and shifting global situations added to the proliferation of technology across borders will make it extremely difficult to get it back under control. Wishing and looking the other way will not make it disappear.

Major Andrew Pache is a Nuclear Design Officer at USANCA. He has a B.S. in Environmental Engineering Technology from Norwich University. He was previously assigned as the USSOCOM/USCENTCOM Weapons of Mass Destruction (WMD) Plans officer for the Combating WMD branch of the Defense Threat Reduction Agency (DTRA) in Alexandria, VA. His email address is andrew.pache@us.army.mil.

ENDNOTES

[1] Freedman, Lawrence "The First Two Generations of Nuclear Strategists," Essay in "Makers of Modern Strategy. From Machiavelli to the Nuclear Age" Edited by Peter Paret, Princeton NJ, Princeton University Press 1986, p737

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[4] Sublette, Carey "Nuclear Weapons Frequently Asked Questions, Section 10.0, Chronology for the Origin of Nuclear Weapons" [Online] Available http://nuclearweaponarchive.org/Nwfaq/Nwfaq10.html 15 May, 1997

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[8] Freedman p761

"Blue to FA52" Two Success Stories and Counting

MAJ Eugene Sheely and CPT Todd Hathaway
Defense Threat Reduction Agency

By capitalizing on the manning reductions of the Air Force (AF) and Navy, Operation Blue to Green offers opportunities to AF, Navy, and even Coast Guard officers, who may have otherwise sought civilian employment, to become Army officers. The program allows these officers to maintain their current rank and enjoy all the benefits of active duty service. The Army benefits by gaining the valuable knowledge, skills, and abilities (KSA) they developed prior to this transition.

Navy officers who serve as Nuclear Propulsion Officers, Nuclear Power School Instructors, and Naval Reactors Engineers are highly desirable for selection into the Army's Functional Area (FA) 52 (Nuclear and Counterproliferation Officer) career field. Their training is unparalleled in the civilian industry and is not available through the regular Army. The Navy requires these officers to complete an initial four to five year contract, after which they can seamlessly transition into the Army FA52 career field via the FA52 "single-track" option. AF officers with a nuclear background are also sought after by the FA52 career field. Due to the AF's efforts to downsize, time on station and AF active duty commitments may be wavered. Officers in the grades of O-1 to O-3 can apply at any time for a Blue to Green interservice transfer, though time in rank is one criteria used when selecting officers for a specific branch or career field. Officers in grades of O-4 and above may also transition to the Army, but the process is slightly different and is no longer referred to as Blue to Green.

With continued geopolitical instability precipitating greater demands on Army branches, it is difficult for many branch managers to justify releasing officers to the FA52 career field while their manning levels remain below 90%. Interservice transfer officers from the Navy and AF can fill many of the gapped FA52 authorizations, while ensuring a steady flow of O-3 and O-4 officers into the FA52 career field.

During the last 12 months, the FA52 Proponent Manager, Mr. Robert Beimler, selected two officers through the interservice transfer process. The first officer was MAJ Eugene Sheely, a former AF Health Physicist with a doctorate in physical chemistry. MAJ Sheely's background is considerably different than

most AF officers, in that he had previously completed Army Officer Candidate School, Infantry Officer Basic Course, and several other Army Courses. MAJ Sheely is currently assigned to the Defense Nuclear Weapons School as the Academic Director. The second officer was CPT Todd Hathaway, a former Navy officer and Army Reservist with a B.S. in Metallurgical Engineering, assigned to DTRA's Combating WMD Directorate, Interagency Coordination Division (CWC). Both officers provide valuable experience and technical knowledge to their commands at a time when the FA52 career field is expanding to accommodate the needs of the Department of Defense.

The FA52 career field strongly promotes advanced educational opportunities for its officers. Both interservice transfer officers are planning to take advantage of the educational opportunities available to FA52 officers. MAJ Sheely is considering a second Ph.D. CPT Hathaway is looking forward to attending the University of Florida's Nuclear Engineering Masters degree program in 2007, in conjunction with research at the Naval Research Laboratory, followed by a three-year Physics/Nuclear Engineering Instructor assignment at

the United States Military Academy (USMA) at West Point, New York. The two and three-year graduate degree programs are sponsored by the USMA Physics Department and the United States Army Nuclear and Chemical Agency.

For more information on the Blue to Green program for prospective FA52 officers, contact CPT Hathaway at 904-226-7228 or todd.hathaway@dtra.mil.

Army Human Resources Command (HRC) personnel are also available to answer specific questions related to the interservice transfer process via email at blue2green@hoffman.army.mil.

For current information on the FA52 career field, go to https://www.hrc.army.mil/site/active/opfamis/52/fa52.htm.

Major Eugene Sheely is the Academics Director of the Defense Nuclear Weapons School in Albuquerque, NM. He has a B.S. in Chemistry from Brigham Young University, a M.S. in Physical Chemistry from the University of Idaho, and a Ph.D. in Theoretical Physical Chemistry, also from the University of Idaho. He was previously assigned as the Chief of Environmental Health Physics and the Chief of Occupational Health Physics at the Air Force Institute for Operational Health. His email address is Eugene.Sheely@abq.dtra.mil.

CPT Todd Hathaway is assigned to the Combating WMD Directorate at the Defense Threat Reduction Agency in Fort Belvoir, VA. He has a B.S. in Metallurgical Engineering from Iowa State University. He was previously assigned as the Officer Programs Officer Department head at Navy Recruiting District Montgomery. His email address is todd.c.hathaway@us.army.mil.

The Origin of the Metric System?

Mr. Robert Pfeffer
United States Army Nuclear and Chemical Agency

For many English-speaking nations, the transition to metric system has been slow and sometimes traumatic. Why must we change our measuring system, developed over these many hundreds of years, to one based on multiples of tens? No more furlongs per fortnight, you say? Rubbish.

Honestly, the metric system has been around for a long time too. You can trace its origin to the decimal, which has been traced back as far as 1585. Around that date, the Belgian Simon Stevin wrote The Tenth, a 36 page booklet that was eventually translated into English in 1608. It was in this booklet that the term "decimal" became part of the English language. Stevin also advocated the use of the "tenth" in specific areas of commerce and science, thus getting away from the often inconsistent and fractionally based foot/pound system of measurements. For example, the yard was officially defined as the measured length of a particular English king's arm. As you can imagine, the foot and the pound had equally interesting origins!

Finally, along came John Napier (inventor of logarithms). He used the decimal point to write amplitudes in metric units.

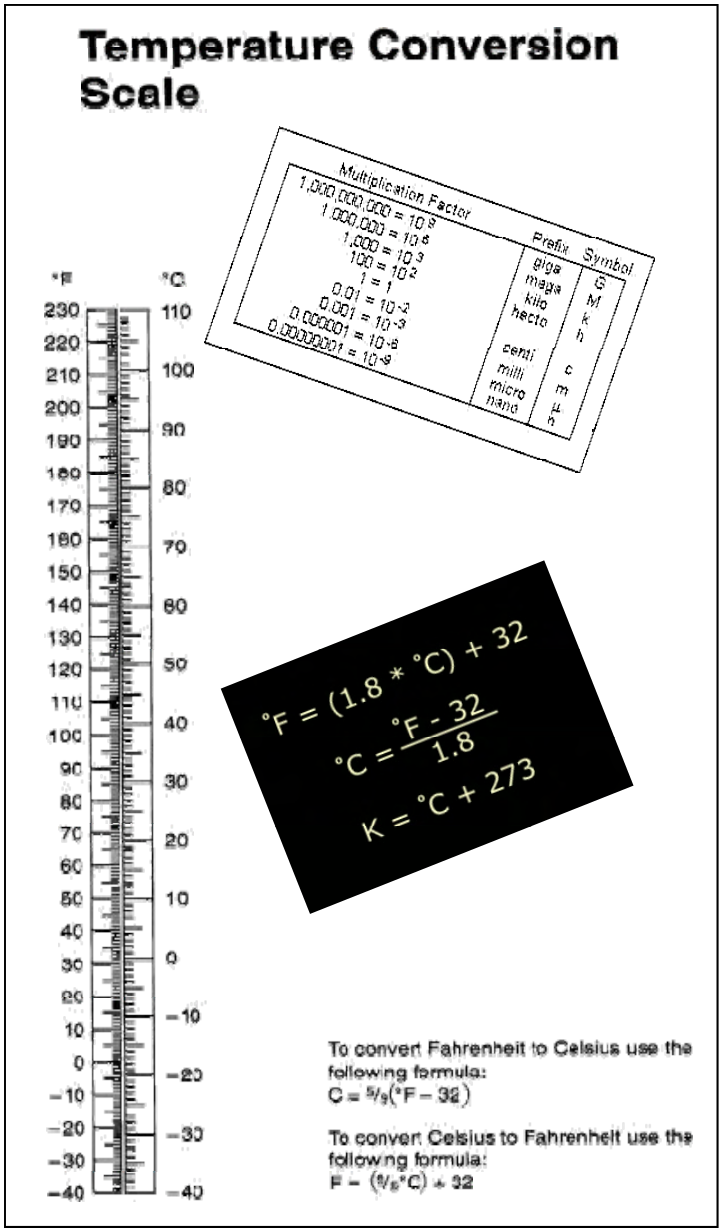
So now you know the origin of the metric system. Oh, yes, do not mix metric and English units (as a NASA contractor did in the 1999 Mars Polar Lander mission with catastrophic results!).

By the way, what is furlong per fortnight in the metric system?

FURTHER READING:

Boorstin, Daniel, The Discoverers, First Vintage Books, 1985.

This article was derived from the article "What's This Point?" in the Washington Laboratories, Ltd T&E Update, Issue 19.



The images were found at the following web sites:
http://www.bgsu.edu/
http://library.thinkquest.org/
http://highered.mcgraw-hill.com/

DTRA Exercises National Response Plan in Two Events

Ms. Cindy McGovern
Defense Threat Reduction Agency

A single-engine aircraft crashes into an explosive handling wharf on the water front at Naval Submarine Base, Kings Bay, Georgia. The resulting fire and explosion kills several and damages the nuclear weapons being loaded onto the submarine. What ensues is a multi-layered response which includes base, local, state, and national responders. This scenario was the basis for Exercise Dingo King 2005 held in late August at Kings Bay. Jeff Danshaw, project manager in the Emergency Response branch of the Combat Support directorate called the exercise "a great success."

"We threw very tough challenges at the responders day and night during Dingo King because we wanted to push the envelope of their leadership abilities, responders' skills, and available resources, "Danshaw said in an interview with a local Jacksonville, Florida television station. "It is extremely important for everyone involved in emergency management to grasp how crucial it is for them to prevent accidents, while simultaneously and regularly practicing together so they can quickly and effectively respond should a real accident occur."

In addition, Danshaw said, "We had a very senior-level of play with credible event scenarios for a low-probability, high-consequence event."

The 1,800 participants hailed from the Departments of Defense (DoD) and Energy, the Federal Bureau of Investigation, the Environmental Protection Agency, the United States Coast Guard, the Centers for Disease Control, the Federal Aviation Administration and the National Transportation Safety Board. Local participants included Florida Department of Emergency Management and the Georgia Emergency Management Agency. It was also the first opportunity to exercise and evaluate the Military-Civilian Task Force for Emergency Response mutual-aid agreement between Kings Bay, Camden County, Kingsland, St. Marys, and Woodbine.

Planning for Dingo King began about a year ago. Since the Defense Threat Reduction Agency (DTRA) is the DoD executive agent for the DoD nuclear weapon accident/incident exercise program, DTRA lead the way. To conduct an exercise of this size, Danshaw and his planning team used a building block approach which began with seminars and table top exercises prior to the August event. The table top series was designed to bring together DoD and federal organizations to discuss the process of responding to such an incident.

Exercise Dingo King Included Extensive Public Affairs Play With DTRA and DoD Public Affairs Personnel Serving as Members of the Media. The Exercise Also Included a Community Meeting. In the Photo Above, Actors Attend the Meeting and Question Navy Officials.

DTRA exercises are also planned to be objective-based and multi-tiered. The key objectives of DINGO KING were to:

- Exercise the National Response Plan
- Define US Northern Command and Department of Homeland Security (DHS) roles in nuclear weapon accident response
- Full weapon recovery to include response, render-safe procedures, packaging and transport.

Danshaw said Dingo King was significant because it included a number of firsts for a DTRA-sponsored nuclear weapons accident exercise. It was the first to exercise the new National Response Plan and its Nuclear and Radiological Incident Annex. It involved DHS and the inter-agencies in this type of exercise. It allowed for the inaugural participation by US Northern Command (NORTHCOM) and real-time deployment of participating response teams.

The National Response Plan establishes an interagency mechanism for federal involvement in and DHS coordination of domestic incident management operations. The plan also specifies that DHS coordinates federal response or incidents of national significance and it introduces the concepts of coordinating and cooperating agencies. Further, the nuclear/radiological incident annex outlines coordinating and cooperating agencies responsibilities; recognizes that coordinating agencies have specific nuclear/radiological technical expertise and assets for responding to the unique characteristics of these types of incidents.

"We expect in the future to be more involved with NORTHCOM in nuclear weapons accident exercises, so it was important for them to see how things work," Danshaw said. "We also expect even more involvement from DHS in the future."

Danshaw said the final portion of the exercise was a site remediation seminar. "It was very successful," he said. "We had the right people with the right technical expertise to discuss remediation issues." Danshaw said the seminar could be a stand-alone course in the future. "We might also hold the site remediation exercise in advance of a future exercise," he added. "I think it would have helped the Navy answer some questions better."

Navy Rear Admiral Mark Kenny, Commander of Submarine Group 10, Briefs During a Simulated Press Conference, While Debbie Monette, Department of Energy Accident Response Group Senior Energy Official Looks on.

From his perspective, Danshaw said the Navy learned a lot as a result of the exercise. "I think they learned some things they never would have discovered otherwise," he said. "They were able to see the big picture and the federal response."

Now that the exercise is over, an exercise assessment will be done and a thorough after action report will be completed and submitted to the participants. Exercise Dingo King was not a graded exercise. "We always do this," explained Danshaw. "It allows us to fine tune our planning for the next exercise."

Utilizing the National Response Plan was a significant aspect of the exercise. The plan's introduction states, "A concerted national effort to prevent terrorist attacks within the US; reduce America's vulnerability to terrorism, major disasters, and other emergencies; and minimize the damage and recover from attacks, major disasters and other emergencies that occur."

"The Nuclear/Radiological Incident Annex of the National Response Plan provides an organized and integrated capability for a timely, coordinated response by Federal agencies to terrorist incidents involving nuclear or radioactive materials (Incidents of National Significance) and accidents or incidents involving such material that may or may not rise to the level of an Incident of National Significance."

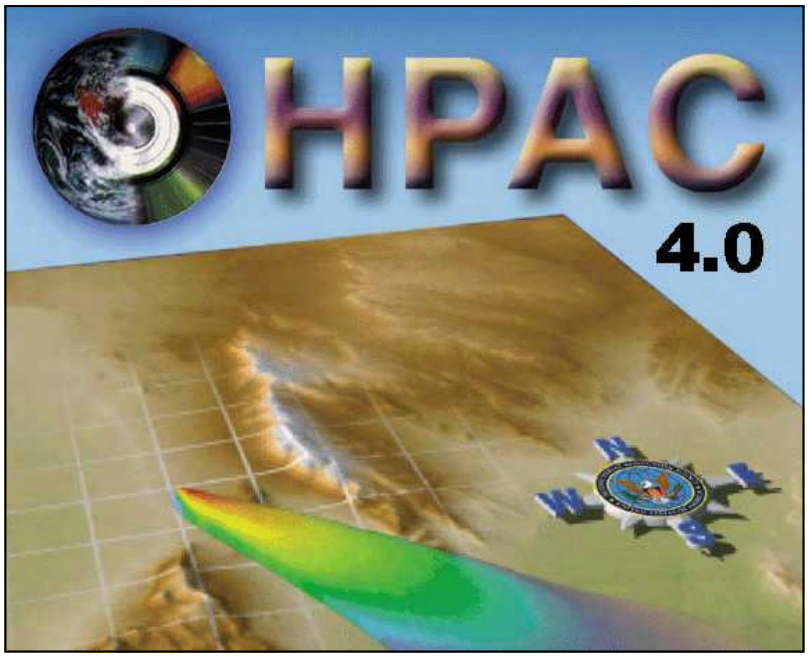
Editor's Note: This article and associated photographs are reprinted with the consent of the author, Ms. Cindy McGovern. The article first appeared in the November 2005 issue of *DTRA Connection*, volume 7 number 10.
Ms Cindy McGovern is the editor of *DTRA Connection*.

Defense Threat Reduction Agency's Consequence Management Advisory Team

LTC John Cuellar
United States Army Nuclear and Chemical Agency

The Department of Defense tasks the Defense Threat Reduction Agency (DTRA) with a range of consequence management (CM) responsibilities and functions in support of the nation's preparation for, and response to, a domestic or foreign CM event. A Consequence Management Advisory Team (CMAT) is DTRA's means of delivering CM advisory expertise to the Combatant Commander or Coordinating Agency in response to a domestic or foreign weapons of mass destruction (WMD) event or incident involving chemical, biological, radiological, nuclear, or high explosives (CBRNE). DTRA's CMAT, an incident- tailored, 2 to 20-person team, is comprised of a core cadre of WMD/CBRNE CM advisors/planners/modelers from the Consequence Management Branch of the Emergency Management Division in the Combat Support Directorate of DTRA, that are augmented by other subject matter experts from DTRA or other agencies as appropriate. The CMAT also provides a conduit for interagency liaison in preparation for WMD response.

The CMAT mission is to deploy subject matter experts, planners and hazard prediction computer modelers and support a Combatant Command (CoCom), Joint Task Force (JTF), or Coordinating Agency in deliberate planning, exercises, and execution of their response to CBRNE accidents or incidents.

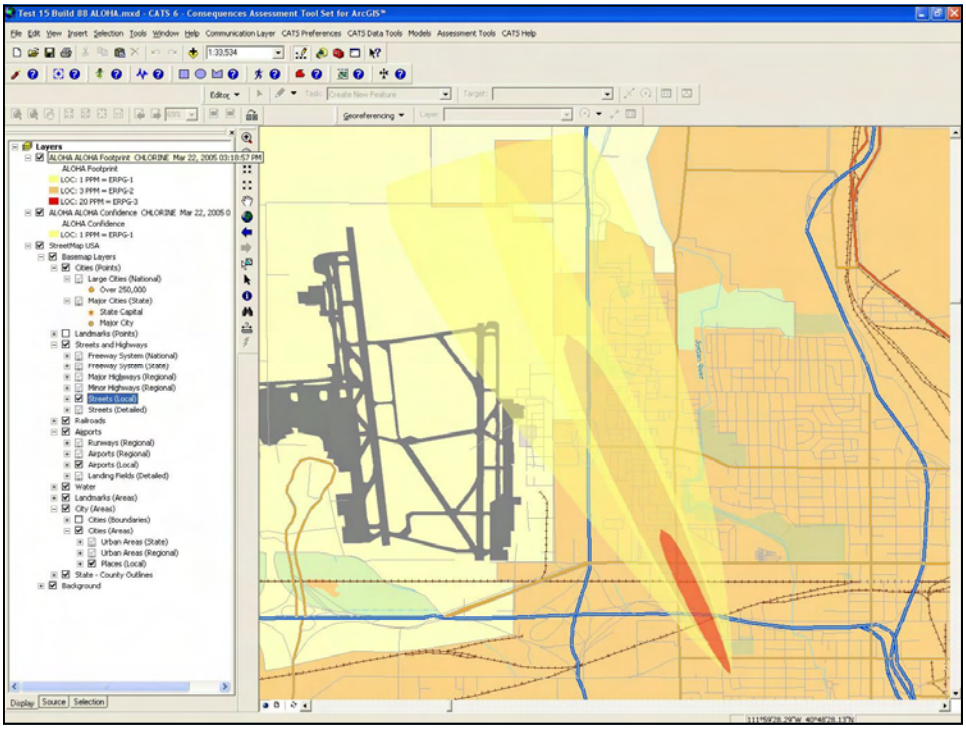


Hazard Prediction and Assessment Capability (HPAC).

In the event of a WMD incident or accident, the DTRA CMAT can support Combatant Commanders by deploying to the Unified Command Headquarters (HQs) or a JTF HQs (JTF-Civil Support/CM) and provide WMD/CBRNE effects modeling, planning, advice, and public affairs/legal subject matter expert support. The CMAT can also deploy to support a Coordinating Agency's (Department of Homeland Security, Federal Bureau of Investigation (FBI), Federal Emergency Management Agency, or Department of State are examples of Coordinating Agencies) response to a domestic or foreign WMD event. In peacetime or in contingency, the CMAT supports the Joint Staff (JS), Office of the Secretary of Defense, or the Services in preparation for, or post-result of, a WMD incident or accident. In accordance with a Memorandum of Agreement (MOA) with the United States Northern Command (USNORTHCOM), the DTRA CMAT supports the USNORTHCOM Joint Technical Augmentation Cell (JTAC) with modelers/planners/advisors for deployments outside the continental United States (OCONUS).

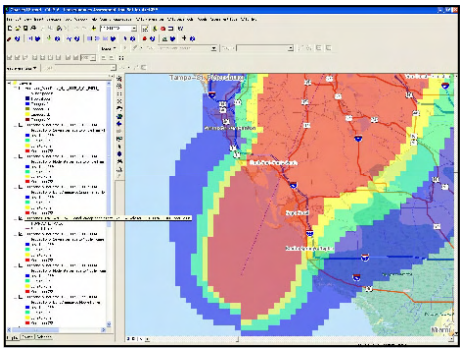
The CMAT's charter is to, upon notification of a WMD/CBRNE event, task organize and prepare to deploy. The team consists of a core of WMD/CBRNE advisors - effects modelers/planners – that are augmented as the situation dictates from other assets in

Consequences Assessment Tool Set (CATS).



CATS Predicts Coverage From Nuclear, Biological, and Chemical Releases.

the agency, such as Public Affairs Specialists, General Counsel/Legal Advisors, and Counter Intelligence/ Physical Security Specialists, as required. DTRA has a standing MOA with the Armed Forces Radiobiology Research Institute for radiation health physicists or radiation physicians if required. The CMAT members are equipped with laptop computers and peripherals; the DTRA Hazard Prediction and Assessment Capability program; the DTRA Consequences Assessment Tool Set program; DTRA high-resolution weather models; urban wind field modeling; and a host of WMD/CBRNE utilities, tools, references, and high-resolution imagery/ infrastructure databases. The CMAT can deploy either CONUS or



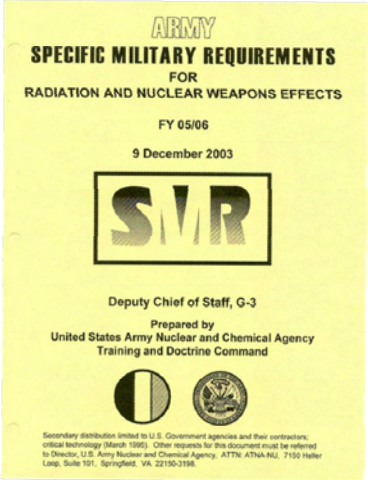
CATS Predicts Hurricane, Tidal Surge, and Earthquake Damage.

OCONUS, and has unclassified and classified voice/data reachback capability to DTRA resources through DTRA's Operations Center. Team personnel have NBC personal protective equipment, field gear for hot or cold worldwide weather environments, official and diplomatic passports, and the full set of worldwide deployment immunizations.

The CMAT routinely participates in JS directed, CM and nuclear weapon accident exercises. CMAT advisors or teams have supported National Special Security Events for the FBI at the 4th of July celebration in Washington D.C., Major League Baseball All Star Game, National Football League Super Bowl, World Economic Forum, Presidential Inauguration, national conventions, and the 2002 Winter Olympics. In addition to current operations, CMAT supported OPERATIONs ENDURING FREEDOM, IRAQI FREEDOM, and DISTINGUISHED GAMES (Athens 2004 Olympics).

Lieutenant Colonel John Cuellar is the Nuclear Medical Science Officer at USANCA at Fort Belvoir, Virginia. He has a B.A. in Physics from the Pitzer College, and a M.E. in Instructional Psychology from the University of Oklahoma. He was previously assigned as a Consequence Management Advisory Team Leader at the Defense Threat Reduction Agency. His email address is : john.cuellar@us.army.mil.

NBC Community News


ARMY
SPECIFIC MILITARY REQUIREMENTS
FOR
RADIATION AND NUCLEAR WEAPONS EFFECTS

FY 05/06

9 December 2003

SMR

Deputy Chief of Staff, G-3

Prepared by
United States Army Nuclear and Chemical Agency
Training and Doctrine Command

Specific Military Requirements (SMR)

The FY 08/09 SMR preparation process will begin with a two-day meeting at USANCA on 18-19 January 2006. Workshops on each of the major topics will follow capability presentations from various organizations. A Coordination Draft will be circulated to the MACOMs for review several months after the meeting, followed by final document distribution later in 2006.

Related 2006 Technical Meetings

24th Hardened Electronics and Radiation Technology (HEART) Conference 6-10 March 2006
2006 DoD E3 Program Review 3-7 April 2006
2006 IEEE Nuclear and Space Radiation Effects Conference (NSREC) 17-21 July 2006
POC is Mr. Robert Pfeffer @ 703-806-7862

HPAC provides the capability to accurately predict the effects of hazardous material releases into the atmosphere and the collateral effects of these releases on civilian and military populations. HPAC employs integrated source terms, high resolution weather and particulate transport algorithms to rapidly model hazard areas and human collateral effects.

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https://acecenter.cnttr.dtra.mil
acecenter@cnttr.dtra.mil

FA52 Courses of Interest

Theater Nuclear Operations Course (TNOC)
27 Feb-3 Mar 06:
TNOC is the only course offered by a Department of Defense (DoD) organization that provides training for staff officers and DoD civilians at Joint, Combatant Command, and Service levels who are required to conduct or support theater nuclear planning. The course teaches students the skills and knowledge necessary for theater nuclear planning, to include the integration of nuclear and conventional fires, weapon system delivery capabilities and limitations, determination of collateral damage effect, determination of force protection and warning measures, and the theater nuclear plan approval and execution process. The course number is DNWS-RO13 (TNOC). Call DNWS at (505) 846-5666 or DSN 246-5666 for quotas and registration information.

Joint Planner's Course for Combating WMD 3-7 Apr 06:
For DoD staff officers with combating WMD responsibilities. POC is LtCol Morales at 703-325-1294.

Nuclear and Counterproliferation Officer Course (NCP52) 10-28 Jul 06:
NCP52 is the Functional Area 52 qualifying course. Initial priority is given to officer TDY enroute to a FA52 assignment or currently serving in a FA52 position. For availability, call the FA52 Proponent Manager at (703) 806-7866.

Quarterly SERPENT Training Now Available.

SERPENT (Simulation Environment & Response Program Execution Nesting Tool) is an end-to-end target planning tool that simulates offensive operations or counterforce attacks on chemical/biological (CB) targets and quantifies target lethality, hazardous material dispersion to the atmosphere, and collateral effects on civilian and military populations.

It provides a high fidelity methodology for estimating the source term characteristics for CB targets, provides the tools for determining "kill criteria" and damage assessment while minimizing collateral hazards, and provides the ability to "bound the problem" and make comparative analyses for targeteering and weapon selection when intelligence information is limited or lacking.

Anyone involved in weapon design, weapon system effectiveness methodologies, and/or the lethality and collateral effects associated with a weapon attack should become familiar with SERPENT. The Basic Course introduces the origin, methodology and fundamentals of consequence modeling with the SERPENT v2.1 toolset while the Advanced Course offers a detailed understanding of target modeling, weaponeering concepts, uncertainty analyses, and output products for CB target defeat.

Upcoming training dates:
March 2006 Huntsville, AL
June 2006 Colorado Springs, CO
August 2006 San Diego, CA

For information on upcoming dates and locations, please contact Ashley McGuirk at ashley.mcguirk@itt.com.

SERPENT is developed for and funded by the Air Force Nuclear Weapons and Counterproliferation Agency

JOINT DoD/DOE USE CONTROL PROJECT OFFICERS GROUP (UCPOG)

"...to assure authorized use and to prevent unauthorized actions..."

The Use Control Project Officers Group (UCPOG) provides a joint DoD/DOE coordination and communication forum for Use Control systems within our current and future nuclear weapon stockpiles

UCPOG Calendar—2006

Date	***Event***	***Location***
17-21 April 2006	**UC Project Officers Meeting (UCPOM) 2006-01**	**HFM&T Plant, Kansas City, MO**
12 October 2006	**Annual UC Brief to the Nuclear Weapons Council, Standing and Safety Committee (NWCSSC)**	**Pentagon, Washington, DC**
16-20 October 2006 (tentative)	**UCPOM 2006-02**	**TBD**

For more information contact:
Patrick Starke, LT/USN, Lead Project Officer
(703)325-4350 or patrick.starke@dtra.mil

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Get it posted here. Send your input to nca@usanca-smtp.army.mil

Note: The editor retains the right to edit and choose which submissions are printed.

U.S. ARMY NUCLEAR AND CHEMICAL AGENCY

Fort Belvoir, Virginia