NBC REPORT

U.S. Army Nuclear and Chemical Agency

Fall / Winter 2004

A Milestone Issue - Farewell to Dr. Davidson

Interview With Dr. Dale Klein, (ATSD (NCB))

10th Anniversary Perspectives on the Nuclear and NBC Defense Environment

Fifty Odd Years of EMP

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We appreciate comments and suggestions concerning the contents and appearance of *NBC Report* as well as observations related to NBC matters. We reserve the right to edit all letters and make final determination on publication. Letters should include your name, organization, address, telephone number, and e-mail address.

Article Submission

We welcome articles from all DoD personnel involved with NBC matters. All articles are reviewed and must be approved by the *NBC Report* Editorial Board prior to publication. We accept articles in many forms - fax, ASCII, E-mail, typed copy, etc., but are delighted to receive PC/Macintosh diskettes with MS Word or WordPerfect articles. ***Graphics*** in CorelDraw (*.CDR), Adobe Illustrator (*.AI), Adobe PhotoShop (*.PSD), Windows Metafile (*.wmf), EPS, TIFF, JPEG, or QuickTime format, ***should be separate files***. Hard copy graphics are also acceptable. Unfortunately, PowerPoint graphics (*.PPT) cannot be used.

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Distribution is to US Army organizations and activities with NBC-related missions, to include all combat and materiel developers and all units with chemical and nuclear surety programs, to each officer assigned to FA52, and to Army attaches.

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In This Issue

Also In This Issue

A Milestone Issue

This issue marks a true milestone in the publication of *NBC Report.* Not only is it a milestone due to the fact that it's the 10th anniversary issue, but it's also a milestone as the readership of *NBC Report*, as well as USANCA and the entire Department of Defense (DoD), bid farewell to Dr. Charles N. Davidson as the Director, United States Army Nuclear and Chemical Agency.

Dr. Davidson was quite simply the impetus for the creation of *NBC Report*. His insistence on the highest standards of writing, graphics, and layout, besides being the bane of all the *NBC Report* Managing Editors, ensured that the semi-annual periodical was a professional publication of interest to all in the NBC community. His efforts were a major factor in the outstanding reputation and growth of *NBC Report* to the professional journal for FA52 officers that it is today.

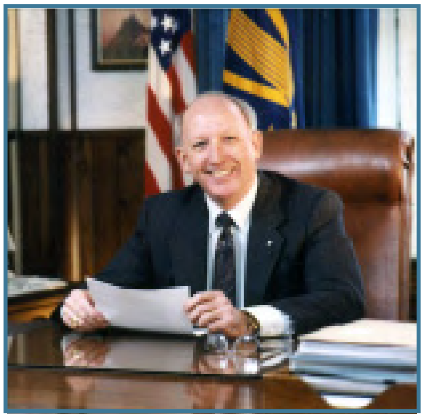
Dr. Davidson's biography following his final "From the Director" article doesn't fully capture the true extent of his contributions to DoD and the Army's preparedness to fight in an NBC environment. While his accomplishments are many, some of the highlights include; the establishment of casualty and troop safety criteria for nuclear weapons targeting; development of the basic underlying principles for what is today's Army Nuclear Survivability Program and the Army Chemical Survivability Program; his by-name selection to chair two interagency assessments of PERSHING missile system vulnerabilities to deliberate and unauthorized launches, the establishment of the Army Reactor Program; his selection by the Army Vice Chief of Staff to lead an assessment of Army nuclear weapons sites for security vulnerabilities and; his chair of the American-British-Canadian-Australian (ABCA) Quadripartite Working Group on NBC Defense that resulted in the completion or promulgation of 37 international standardization agreements. Dr. Davidson received the prestigious ABCA Certificate of Recognition in 2002, the first-ever such award presented to a US citizen.

Equally impressive were the many hours he devoted to community service, particularly in supporting the Boy Scouts of America and as a coach of youth baseball and basketball teams.

Dr. D-we thank you for your more than 42 years of service and wish you the best in your retirement. We look forward to your submission of NBC-related articles as a distinguished nuclear "Graybeard" for publication in future issues of *NBC Report*!

NBC REPORT
U.S. Army Nuclear and Chemical Agency

Ten Years — And Counting



Dr. Charles N. Davidson
Director, USANCA 1993 - 2004

This issue of *NBC Report* marks the tenth anniversary of its publication, and we've succeeded in getting a number of senior people in the nuclear or chemical business, both active and retired, to provide articles that highlight some of the many changes occurring in their areas during this period. Each of these special articles is flagged with a "10th Anniversary Perspective" banner and is generally located in the early part of this issue.

I'd like to be able to say that ten years of this twice-a-year periodical means this is our 20th issue, but I can't! Early on, publication was erratic to say the least as we struggled to institutionalize it among our other jobs and obtain meaningful articles. We were a little unsure of its target audience and had not yet decided which division within USANCA to tag with responsibility for producing it on a regular basis.

Today, we distribute *NBC Report* on an established schedule to a wide variety of mostly Army organizations and individuals that are, or should be, stakeholders in some aspect of nuclear and chemical matters. This includes all combat and materiel developers (the schoolhouses and project managers), units with a nuclear or chemical surety mission, Army nuclear officers, Army attaches, and Defense activities and individuals outside the Army where Army nuclear officers serve. And we've long since pinned the rose on our Operations Division to produce this quality periodical since that division is the one that deals most directly with the "field."

Surveying the past ten years of *NBC Report*, it's clear to me that some things have changed and some haven't since our first Fall-Winter 1994 issue. So what's changed?

My "From the Director" introduction in that first issue referred to *NBC Report* as a "newsletter," probably because we had consolidated USANCA's Surety Information Letter (SIL) and Functional Area 52 (FA52) Newsletter in the publication. We never used that term again. We have since referred to the *NBC Report* variously as a "periodical," "journal," "publication," "issue," or "magazine," but it's much more than a "newsletter."

The first issue had 18 pages excluding covers, and every one of its eight articles was written by a USANCA member. Paper quality was "semi-slick" and, although there were sufficient graphics and line drawings, the only photo was of me! By the Spring-Summer 1999 issue five years later, we had slowly but steadily grown to 28 pages with 11 articles, three of which were written by outside authors. Paper quality was higher, and there were plenty of photos included among the illustrations. In our last four issues, all of which were printed on the highest quality paper, size has varied from about 50 to 75 pages with half to two-thirds of the 13 to 18 articles written by non-USANCAns.

From the very first, we used two-colors (black plus one other) to produce *NBC Report*, realizing that an eye-catching format was necessary to interest readers and attract authors as we were starting out. Over the years, the cost of printing has steadily decreased to the point that, on a per-copy basis, it's actually cheaper now to print in full color than it was ten years ago to print in two colors. As you've probably already noticed, we've made the move to full-color production with this issue.

Press runs have increased over the years, beginning with just over 1,000 to the 4,000 we print now. Although some of this increase has been due to an increased number of addressees, most is due to organizational requests for more copies.

If the points I've just made are things that have changed, what hasn't changed?

Our focus, for one. From time to time, we check informally with some of you to get fresh ideas and make sure we're meeting your needs. Three years ago, we did this in a more organized way by conducting a formal readership survey to see how we were doing. In particular, we wanted to see if you thought our articles were too technical in nature, too tactical in nature, or written with a good balance. We were pleased to learn that almost nine out of ten

(88 percent) of those responding liked the overall balance of our articles. In response to another question, 82 percent of you agreed that *NBC Report* helped keep you current in the latest NBC matters. We've worked hard to maintain this same focus since. And we'll keep checking with you to make sure we don't lose it.

Oh yes, there's one other thing that hasn't changed in the ten-year history of *NBC Report*. My photo, of course!

CHARLES N. DAVIDSON, Ph.D.

Born in Illinois in 1937, Dr. Davidson graduated from The Citadel, the Military College of South Carolina, in 1959 with a B.S. in Chemistry. Upon graduation, he was commissioned in the US Army. He then undertook three years of postgraduate study at Florida State University in Tallahassee and, in 1962, received a Ph.D. in Nuclear Chemistry. During this period, he was the recipient of both Graduate and Postdoctoral Fellowship Awards from the National Science Foundation.

After serving two years active duty as a chemical staff officer with the Army at Fort McClellan, Alabama, he entered government civil service as a physicist. In August 1966, he transferred to the Army Nuclear Agency at Fort Bliss, Texas, as a nuclear physicist, and eighteen months later was named Scientific Advisor to the Commander. In 1973, he graduated from the Army War College in Carlisle Barracks, Pennsylvania, the only Army civilian selected to attend the Army's senior service college during that academic year. He moved to the Nuclear and Chemical Agency at Fort Belvoir in 1977, and two years later was designated the Agency's Technical Director. In 1992, his responsibilities were expanded to include those of Deputy to the Commander. In 1993, he was named Director of the organization, a position he held until his retirement on 15 November 2004. Dr. Davidson was a charter member of the Senior Executive Service.

Dr. Davidson is a member of the American Nuclear Society and the American Chemical Society and frequently represented the United States at meetings of various NATO and Quadripartite working parties. He has authored several technical journal articles and many analytical studies. He is currently listed in a variety of biographical reference works. Active in Rotary and in youth work, he has served as baseball and basketball coach in the Optimist and YMCA athletic programs, as Cubmaster of several Cub Scout packs, as Chairman of two Scout Districts, as Vice President of the Yucca Council, Boy Scouts of America, as President of two Rotary Clubs, and as a member of the Boards of Directors of the Southwestern Sun Carnival Association, the El Paso Girls' Clubs, and the National Capital Area Council of the Boy Scouts of America. His many awards include Scouting's Silver Beaver, Rotary's Paul Harris Fellow, and the Meritorious Executive Presidential Rank.

Surveying the past ten years of NBC Report, it's clear to me that some things have changed and some haven't since our first Fall-Winter 1994 issue

Dr. Dale Klein, Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs

LTC Thomas Moore
United States Army Nuclear and Chemical Agency

I was fortunate enough to gain an hour on Dr. Dale Klein's, (Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs (ATSD (NCB)) busy calendar to gain his perspective on the significant changes in the nuclear, chemical, and biological environments and programs. I went armed with many questions, some perhaps too political for a senior Defense Department official to address. My expectation, that he would graciously avoid some of the more thought-provoking questions, was surprisingly proven wrong. He pressed through all the questions with the same confidence he used to explain the vast collection of change he acquired in his "acronym bowl" that sits in the center of his office conference table. Dr. Klein's answer to my second question will shed some light on the "acronym bowl." I hope you appreciate the following insights into current nuclear, chemical, and biological programs, significant events of the past decade that shaped the WMD focus of the Department of Defense (DoD), and the direction that Dr. Klein will lead the DoD in addressing the critical nuclear, chemical, and biological issues facing our nation.

Q. "What is the biggest contribution your office has made to the DoD since your appointment as the ATSD (NCB)?"

A. "I think there are probably two. The first was getting the office filled. As you might know, the office was vacant for three and a half years. I did not have the opportunity to walk into a position that was already up and running, instead it took a while to staff it and get organized, so finally, the biggest contribution was getting the office filled and functioning. Beyond that, I think the biggest contribution is thinking long term. A lot of the people in DoD, including me, get involved so much in the day-to-day activities. The long-term vision sometimes suffers. I think the contribution that I have specifically brought was a look beyond the immediate crisis, the crisis of the day or the week, to look out five, ten, or fifteen years."

Q. "What has been your greatest frustration or obstacle?"

A. "Probably the greatest frustration is not having enough time. I am a geographic bachelor, my wife is still in Texas, and so I am able to put in extended hours. I usually come in early, stay late, and will come in on a Saturday or a Sunday or both. The volume of material is high and so not having enough time to go through the material in the way that I would like is frustrating. Probably the other frustration is the extensive use of acronyms. People often times don't talk in words, they talk in acronyms and those that have not spent decades in the military will be in a conversation that doesn't mean much because they do not understand the acronyms."

Q. "In 1994, it was unrealistic to think that the United States (US) would focus all elements of national power on preventing a terrorist from detonating a nuclear device within our borders. Ten years later, President Bush stated that the proliferation of nuclear weapons in the hands of terrorists is the biggest threat to US national security. Over the last decade, what were the significant factors that contributed to this increase in nuclear proliferation, specifically the likelihood of a small terrorist group gaining access to a nuclear device or to special nuclear material?"

A. "There are a couple of things that occurred. One is that after the Cold War ended we sort of gave a sigh of relief and thought that we had won and the Soviet Union lost…peace forever kind of feeling. That kind of thinking may have given the US a false sense of security. I even heard a talk by Jim Schlesinger right after the crumbling of the Soviet Union where he had made an observation that terrorism is going to increase. He said that we demonstrated in DESERT STORM such a superior military accomplishment both by our men and women in uniform and our equipment that no one could touch us, especially militarily. He had made the assessment that shortly after the crumbling of the Soviet Union that terrorism was going to rise. He had great insight because that's in fact what has happened. I think in terms of the nuclear side, the cause for challenge was because of a man named A.Q. Khan. In the past our enrichment technology had been closely held. A.Q. Khan really popped the genie out of the bottle. Not only did he proliferate the knowledge, he developed the black market network that delivered products. This is the first time that I have ever seen an individual profit from selling state secrets personally, and suffer almost no consequences. The threat for nuclear explosions has just mushroomed, if you excuse the term, by A.Q. Kahn providing that technology and the systems to deliver it. That has done more harm to our friends and allies and our security than any other event I can think of in the nuclear world."

Q. "What is the DoD currently doing to counter the actions taken by A.Q. Khan?"

A. "One of the things that I am actively engaged in is what is called the Policy Coordinating Committee (PCC). That is very important to me. It is an interagency group to look at how we detect radiation and prevent either an improvised nuclear device from getting smuggled in or an actual weapon. All Departments are concerned about this such as DoD, Department of Energy (DOE), Department of Homeland Security (DHS) and the intelligence community. We are trying to look at a layered approach at how we protect the nation in the area of nuclear smuggling. Technically, this is a difficult issue. Picking up highly-enriched uranium (HEU) when it is shielded is just technically difficult. Prior to the formation of the PCC, the Defense Threat Reduction Agency (DTRA) conducted a series of workshops to look at the state of the art on detecting radioactive materials and what could we do in the future to detect that material. We have had three workshops and we have one more coming in January [2005] where we will look at alternatives and the state of the art, what can we do now, what can we do in the future. I think what we should do is invest on the research and development (R&D) side...what are the new innovative techniques? Just because I have been involved in radiation detection for so long, I know how easy it is to shield a block of HEU. It would be very difficult to pick that up. But, I am optimistic that we will come up with new innovative techniques. An example I use is magnetic resonance imaging (MRI). Who would have thought when it was developed, the medical implications that it would have today? I think that those of us involved in radiation detection have not stepped out of our comfort zone and looked at really unique ways to a great extent, because we never have really had the challenge of having to find HEU or plutonium (Pu). We've always looked at setting detectors in the laboratories that are research tools and we looked at real accurate neutron activation analysis techniques to help our understanding of science. We haven't really focused on a large program to look at finding any HEU and Pu that might be smuggled in. I keep hoping that we will have a new and innovative technique to let us identify that material whether its radio frequency driven or some kind of technique like the MRI that we can put containers, luggage, and things like this through. I believe to really make the world as safe as we would like it to be, we are going to have to come up with new innovative techniques."

Q. "The Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) was recently assigned primary responsibility for implementing National Security Presidential Directive 28 (NSPD-28), involving US nuclear weapons command and control, safety, and security. What are the biggest challenges that you will have to overcome to enhance US nuclear security?"

A. "The good news is that we now have a clear responsibility in [USD] AT&L for nuclear physical security. We now have people that are responsible to make that happen. It does not mean that [USD] AT&L will do it alone. We have involvement from NII (Assistant Secretary of Defense for Networks & Information Integration), the intelligence community, and a lot of others. The good news for the NSPD-28 implementation is now the direction of who owns it is clear, but it will involve a lot of people. I think what is really seen on nuclear physical security is a threat. During the Cold War, we had our scenarios of how we thought people might try to steal one of our nuclear assets and we had a recapture and recovery program. Now with the threat of terrorism, the program has shifted. Our objective now is not to let anyone get their hands on the assets. So that means we will make critical changes to where we store nuclear assets. We have also looked at increasing the numbers of potential adversaries. I think what we have to watch out for is that we do not fall into the trap of just picking a number of individuals that we assume are armed to a high degree, that have a lot of inside knowledge, have a lot of new technology, and have to defend against an unreasonable scenario. We need reasonable scenarios that we will defend against and we will increase technological advantages to make our jobs easier to protect these assets. I think that the area of nuclear physical security is one that we have to couple with the intelligence community. As an example, if I have to protect all of our nuclear sites against a heavily armed group of 50 individuals, that's going to cost a lot of money, it is going to take a lot of people, and the question then is, how much money do I have to invest in the intelligence community to knock those numbers down. So rather than have to spend so much time and effort against a very high number of well-armed adversaries, we need to look at how we can better analyze the threat to get a better handle on it."

Q. "What new methods and/or programs will you implement to enhance the security of US nuclear reactors, weapons, and facilities?"

A. "We are doing some work at our missile silos that involves additional concrete that makes it more difficult for anyone to approach the silos. We need to do things like adding cameras so when an alarm goes off we can get a better indication of what it is. Some of these things from technology are non-lethal forms of deterrence. They will make people very uncomfortable if they try to get in certain facilities."

Q. "What synergies can be gained and applied to chemical and biological security/surety programs?"

A. "There are obviously a lot of synergies. One of the things that happens on the nuclear side of the business as opposed to the chemical and biological side is that the nuclear program has a long history of compliance, regulations, requirements, and discipline. Things nuclear have always been handled in a different way. For example, you do not just go to a supply catalog and order radioactive material without having a licensed approval process to do so. The chemical/biological world is a different world as it applies to addressing or using chemical/biological as a weapon of mass destruction. Chemists and biologists have always used innovation, developed new compounds, sent them to their friends, created other strains, and had their colleagues take a look at them. The good side of that is science and understanding progresses in a nice fashion. The bad news is that those who want to go on the dark side can use this information in destructive ways. The science community will have to somehow strike a balance between freedom of information, increasing the science, and at the same time having responsibility to prevent the misuse of that knowledge. That will be a challenge in that community."

Q. "Over the last decade, there has been increased debate over the necessity to conduct a nuclear test to assure the reliability of the US nuclear stockpile. If the US were directed to conduct an underground nuclear test today, what concerns would you have reference technical expertise, nuclear test infrastructure, and international/domestic reactions?"

A. "Well first I want to say, that being an experimentalist, I believe that experiments compliment our science and analytical aspects and although our current stockpile stewardship is good, we need real experiments to go along with them. That does not mean doing a 100 megaton test. There are a lot of low-yield experiments that would give us very valuable information for our understanding of how nuclear weapons perform. If we were to conduct a test today, we must acknowledge that those individuals involved in an actual test are getting smaller in number, and most of them have gray hair. There is an aging talent pool to draw from…the talent pool is diminishing. If we were to conduct a nuclear test today, a challenge would be identifying the mechanics. What would we have to do, to do the test? In other words, the specialized equipment is not on the shelf, it was specially developed and designed and special cables are required, there is a lot of instrumentation that is not readily available. Then you would need to have people who understand how to conduct a test. I think we would have people that would not know how safe 'safe enough' is. So there would be a lot of confusion as to the talent pool, some people who have never been involved, as compared to many years ago. It has been several years since we have conducted a test so we lost synergism; Step 1, Step 2, Step 3, and the things that lead up to a test. We would like to reinvent that process simply because there is not a trained cadre of people doing this, so it would be a challenge. In addition, there would probably be hundreds of lawsuits filed. So there are technical issues and there would be bureaucratic delays."

Q. "Concerning the question on international reactions, would an underground test serve to deter adversaries that are building nuclear weapons programs?"

A. "Deterrence is a challenge in the terms of what is it that would deter an adversary. Nuclear weapons, I believe, do a good job deterring state and state-sponsored activities. It's less clear what role nuclear plays in deterring terrorists. There are several scenarios that we have looked at…that as things escalate…we never want to use a nuclear weapon, but if we had that as an option, that if a state or state-sponsored activity crosses a certain line, whatever that line is and threatens the use of nuclear weapons, then that is a deterrent. If you ever have to use a nuclear weapon, it has lost its deterrent value."

Q. "What initiatives are there to preserve nuclear expertise for our nation's nuclear weapons designers and nuclear testing infrastructure personnel?"

A. "There have been a lot of studies before I came to the DoD. The DOE has taken a look at this and there have been studies in DoD and the contractor world on where do you get the pipeline, where do you get the next generation of people. The military does a pretty good job because they get young people in and train them and so they have a different kind of pipeline than the national laboratories and contractor base. The contractor base will often times draw on the military's expertise as they leave the Service. So the military often is a source of trained individuals. The Center for Strategic and International Studies is also doing a study on where we get the next generation of nuclear-trained personnel. There are several initiatives underway, I think people recognize the problem. I don't know that a solution has been implemented, but people are aware and taking steps to reconcile the problem."

Q. "The DoD is well trained and prepared for CBRN passive defense. What are your thoughts on our capability to perform other combating WMD missions such as consequence management (CM), WMD elimination or disposal?"

A. "We spend a lot of time on CM...what happens if it is a dirty bomb, an improvised nuclear device, or an actual weapon. We also look at getting slimed, what happens if we get chemical or biological contamination. We spend a lot of time and effort looking at CM as well as the DHS and how they handle a civilian attack of some kind. We always need better decontaminants and we need to make sure we understand the conduct of operations and how we actually implement CM. So that is an area I think the military does very well; training, exercising, and demonstrating the capabilities of CM. We always need better devices, better materials, and better procedures. One of the challenges on CM both for the civilians and the military is how clean is clean. If we have a WMD attack, what are the clean-up standards? We saw that in the Senate Hart building where we didn't have a good bit of time for anthrax decontamination. The real issue for anthrax is on a different form of anthrax or a different strain. There is no standard for how clean is clean for a lot of reasons. Historically, we develop standards for what we can measure rather than what the health impact is. As our equipment gets better and better, our standards get more and more restrictive as to what is acceptable. As a nation we need to have a better understanding of our requirements for how clean is clean; science-based rather than what we can measure. In terms of WMD elimination, I believe that IRAQI FREEDOM demonstrated our capabilities pretty well; COL Mickey Freeland headed up the Nuclear Disablement Team (NDT) that went into Iraq. DTRA had their WMD elimination team, a program, a plan, the people, and the capability to eliminate weapons if they were found. We are obviously working in Libya at eliminating their weapons and WMD. Once we find the materials, I believe DoD has a lot of strengths in eliminating them. We have greater strengths at eliminating WMD than finding it."

Q. "What changes does the DoD need to make to effectively organize for WMD elimination missions?"

A. "I think terrorism and WMD are going to be with us for a very long time. We need to focus, in the DoD, on WMD. Obviously, my portfolio is almost like "WMDs R US" in terms of the chemical, nuclear, and biological defense programs and with DTRA being a Combat Support Agency, we have a fairly centralized focus in terms of how we deal with WMD issues. We have to be prepared on what the future might bring. What will advances in anthrax throw at us and how do we stay ahead of the terrorist threat? We have to have capabilities, both offensive and defensive, to counter the use of WMD. If you look at terrorism in the past, it was typically a few guns, a few high explosives, the consequences were manageable. But if you look at getting some of the dangerous materials in the hands of dangerous individuals and groups, the impact is much different. Having an improvised nuclear device, having anthrax for example, having other biological and chemical agents, makes the consequences much more severe than the kind of terrorism that we have faced in the past. The terrorism threat is much different today than it was in the past simply because of the terrorists' ability to get their hands on WMD."

Q. "Based upon your experience, what value do FA52 officers bring to the Joint Force?"

A. "The [FA] 52s are unique. One of my concerns is that we don't lose this capability. As we look at the Services, we tend to think of the Air Force and Navy for all things nuclear because they are the Services that have the nuclear assets. However, if we step back and look at who is going to put boots on the ground, if there is ever a nuclear device used, it will be the [FA] 52s that go in. The [FA] 52s are effective. I talked to former Acting Secretary [of the Army] Les Brownlee about my concerns about the [FA] 52s, that we properly recruit, train, and promote highly competent individuals so we maintain this asset. When we went into Iraq, the [FA] 52s were leading the way with the NDT and so this is a skill set that we absolutely have to maintain. And it's one when you first think about it you do not think about the role the [FA] 52s play until you look at an event, when an event occurs, even in assessing and predicting an event, the [FA] 52s play a big role."

Q. "How do we effectively influence the Services, as they manage requirements for force structure, when the Joint CBRN centrally manages chemical/biological defense expenditures?"

A. "Usually within the Services there are different opinions of how funds are allocated. For example, if you look at the people that are on the ground, they will always want current supplies, current equipment, and current state of the art. If you look at the people who are looking in the out-years and what the future holds, they will always want more R&D dollars. Even within a Service you will have a push and a pull, you have those who want things, supplies, and current technologies and you have those who are looking out into the future to try and predict what we might need. The best way that we will do that is to guide, direct, and encourage making sure that we have the right people, the right equipment, the right training, and the right investments to get ahead of the WMD. One of the issues that I often consider when making a decision is to not look at what is best for a particular Service, or what is best for the Office of the Secretary of Defense, we should look at what is best for DoD. We are a Department of Defense and we need to look at that collective department to protect the US and our allies. We need to make decisions in a broad perspective."

Q. "What are your thoughts on how well our nuclear stockpile serves/does not serve as a deterrent in our current strategic environment, specifically, would a nuclear "bunker-buster" or other nuclear system, that could effectively hold hard and deeply buried targets at risk, increase the deterrent value of the stockpile?"

A. "I think that on the nuclear side what we need to do in the DoD is provide the President with options. Our job is to have capabilities that can let the decision makers choose what is best for our nation. The current stockpile has protected us through the Cold War and we need to assess what we think we will need in 2030. What is our future nuclear deterrent and what structure will let us maintain the freedoms that we enjoy today? I believe that we should have low-yield options for our nuclear assets. We should have the ability to have a device that can take out hard and deeply buried targets and minimize the consequences of such a device. Those who are opposed to nuclear weapons often say that a low yield weapon or a robust nuclear earth-penetrating weapon will be more usable. I strongly disagree with that. Nuclear weapons are intended to be a deterrent. They will only be used as a last resort, and they will only be used if they provide a capability that we cannot get any other way. They will always be the last resort. One of the things we should do in the DoD is provide the President with those options to choose from. Whether or not they will be used will depend on either stopping something that you can not do any other way or to prevent further use of WMD."

Q. **"During your tenure, what is the most successful thing (program, initiative, ACTD, policy decision, etc.) that you have seen in the CBRNE environment?"**

A. "I think the biggest change we have made cuts across all the programs with our restructuring of the Chemical Biological Defense Program (CBDP). What we had when I came was a series of committees that advised committees. What we did with the CBDP is restructure it around the people and made the people responsible. For example, we have a Joint Requirements Office, a [Joint Program Executive Office] JPEO and DTRA is setting up a science and technology office as a part of this. My deputy is now responsible for the overall guidance and direction of the CBDP. If I now have a specific question or a specific issue I know the person responsible and accountable for that activity. I think that cuts across all of the activities in the Department concerning WMD. We need to give people the training and authority to make the decisions, and then to be accountable and responsible. So probably within my program, that reorganization has had the most impact."

Q. "Were there any lessons taken from this experience and applied to other programs?"

A. "Certainly one that has carried across already was assigning [USD] AT&L the responsibility of nuclear physical security. That is another follow-on or the same concept. I think we need to do the same as we look at the role the [FA] 52s play, we need to have a structure for responsibility and accountability and a program that keeps the [FA] 52s viable as well as all of our other chemical and biological programs."

Q. "What are your thoughts for the strategic direction of the DoD over the next decade in relation to CBRN defense and/or the changes in the nuclear environment?"

A. "Well, unfortunately on the chemical, biological, nuclear, and radiological defense arena…that is going to be with us for a very long time. The terrorism threat and the devices that may be used against the US and its allies is something that is a long-term issue. I think what we need to do from this office is ensure that we have a long-term plan that protects the US and our allies to the greatest extent possible. That means staying ahead of the terrorists at all levels of force protection, that we have the right people we are recruiting, we have the right training for those individuals, and we

have the right equipment so that they can fight and win in a contaminated environment. We have the ability to conduct CM if an event occurs and at the same time, we need to invest in our R&D because as the Secretary of Defense said, "We don't know what we don't know." So we always have to push the horizon so we are not getting complacent and sitting stationary. As an example, microelectronic manufacturers soon learned that if they did not keep pushing the envelope other countries would soon be more competitive. The same thing is true for our CBRNE defense. We cannot remain stationary or people will have capabilities that surpass our defensive technological capabilities. We need to invest with our people, our training, our equipment, and our R&D."

Q. "Are there specific aspects of the military's "transformation" that complement your vision?"

A. "We need to look at the transformation the Secretary of Defense is trying to accomplish, changing from the Cold War active battle to what we believe is likely to be seen in the future where we will have more smaller conflicts. What that means is that we need to be more agile, quicker, smarter, more technically trained, and we just need to continue down that path. Its very likely that the difference in our society...[dealing with] WMD...while there will be battles that are smaller than what we saw for example in World War II, the difference that we have now is that adversaries may be small but potent. It may be a small adversary but they may have devices that require our men and women in uniform to fight in a contaminated environment whether it is chemical, biological, or radiological. This is the transformation that we will continue to push in my area of interest. While our adversaries may not be so large in numbers, they can pose a challenge to our men and women in uniform. One of the things that I have learned in this appointment is that failure by the DoD is not an option. We cannot fail to protect the US and our allies. In order not to fail, we have to invest in the people, the training, equipment, and the R&D to accomplish that mission so we do not fail."

Q. "With reference to CBRNE, what lessons can we learn from our allies?"

A. "We have several agreements with our allies in the chemical and biological and nuclear arena, and we are now in a world of cooperation. We will not go it alone in any conflict; certainly in World War II we did not go it alone. There are a lot of areas where we can leverage our investment and knowledge from our allies so that the US and DoD do not have to carry the full burden. We have a lot of cooperative programs in chemical, nuclear, and biological defense that we will learn here with our allies. It is an excellent program and I expect it to expand as time goes on."

The Honorable Dale E. Klein was sworn in as the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs (ATSD(NCB)) on November 15, 2001. In this position, he is the principal staff assistant and advisor to the Secretary of Defense and Deputy Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) for all matters concerning the formulation of policy and plans for nuclear, chemical, and biological weapons. The ATSD(NCB) also is directly responsible to the Secretary and Deputy Secretary of Defense for matters associated with nuclear weapons safety and security, chemical weapons demilitarization, chemical and biological defense programs, and smoke and obscurants. Prior to his appointment by President Bush, Dr. Klein was a professor in the Department of Mechanical Engineering (Nuclear Program) at The University of Texas at Austin. He was the Vice-Chancellor for Special Engineering Programs at the University of Texas System from 1995 until November 2001. Dr. Klein also served as the Chairman and Executive Director of the Amarillo National Research Center (ANRC), during which time he oversaw over $45 million of funding concerning plutonium research and nuclear weapon dismantlement issues. He has been honored with the distinction of Fellow of the American Society of Mechanical Engineers and the American Nuclear Society. Dr. Klein has also received many awards, including the Joe J. King Professional Engineering Achievement Award by the University of Texas at Austin and Engineer of the Year for the State of Texas by the Texas Society of Professional Engineers. Having received his Ph.D. in Nuclear Engineering from the University of Missouri-Columbia, Dr. Klein has been honored with the University of Missouri Faculty-Alumni Award and the University of Missouri Honor Award for Distinguished Service in Engineering.

Defense Threat Reduction Agency: Reducing the Threat of Weapons of Mass Destruction

Major General Trudy H. Clark
Acting Director, Defense Threat Reduction Agency

The Defense Threat Reduction Agency (DTRA) has been in business with its current name and mission since 1998, but its roots date back to the Manhattan Project that developed the atomic bomb during World War II. Today, DTRA's mission is to reduce the threat from weapons of mass destruction – chemical, biological, radiological, nuclear, and conventional and high explosives (CBRNE).

Much of DTRA's specialized knowledge, gained from nuclear weapons effects work, proved to be applicable in combating the full spectrum of weapons of mass destruction (WMD). Expertise on the intricacies of blast and dispersal effects came out of the nuclear weapons program, but it is also at the heart of understanding all other types of WMD.

DTRA is home to nearly 2000 civilian and military personnel, with the uniformed military making up 41 percent of that total. With the war on terrorism, and increased prospects of asymmetric threats for years to come, DTRA increasingly is called upon for its WMD expertise.

DTRA has matured into a full-fledged combat support agency. DTRA personnel had a role in Operation ENDURING FREEDOM and Operation IRAQI FREEDOM, including rapid development of thermobaric weapons used in Afghanistan and Iraq, and WMD elimination in Iraq.

DTRA research has produced cutting edge technologies. For example, a Small-Business Innovation Research initiative in DTRA's Chemical and Biological Defense Science and Technology Program was responsible for the Agentase Nerve Agent Sensor developed with Pittsburgh-based Agentase, LLC. The "colorimetric" sensor is a small area quick check indicator to locate the presence of a nerve agent. This two-inch tall, lightweight, hand held device is swiped over a surface and within a very short time a color indicates what agent, if any, has been detected on that area. Now deployed in a number of overseas locations, the US Army Research, Development and Engineering Command recently named it as one of the Ten Greatest Army Inventions of 2003.

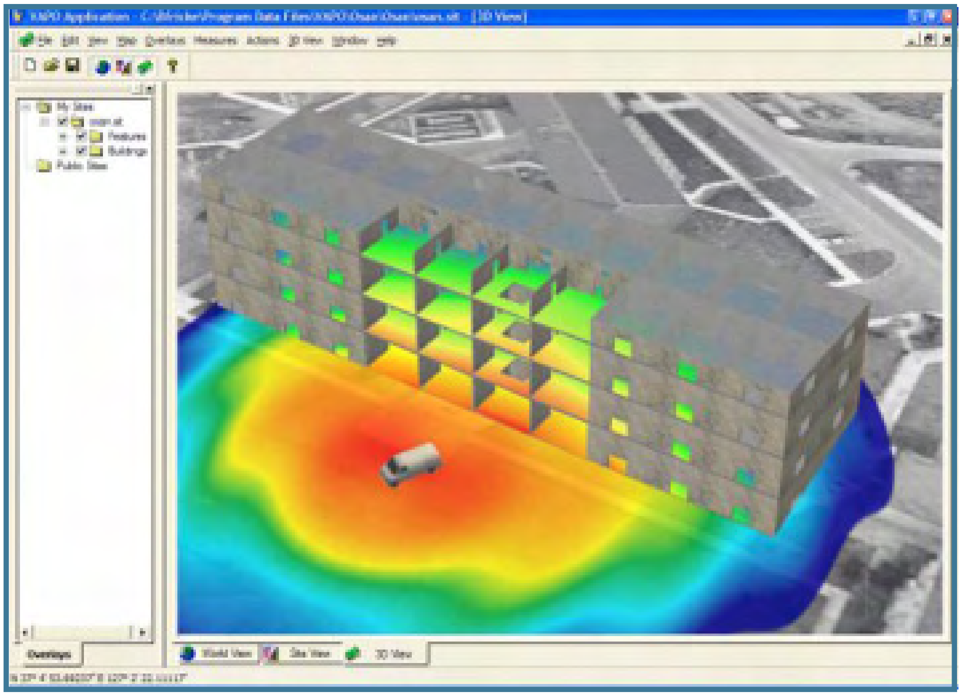
When the Pentagon was attacked on September 11, 2001, the section of the building that was hit had just been renovated using innovative materials and engineering practices recommended by DTRA. Those renovations contributed to fewer casualties that day.

DTRA's products and services support the pillars of the National Strategy to Combat WMD: nonproliferation, counterproliferation and consequence management. Some products and services fit neatly into only one of those categories, while others serve across the full mission spectrum. DTRA personnel are deployed around the world, from San Francisco to Japan to Germany. Literally, the sun never sets on DTRA.

Nonproliferation

DTRA has a major role in nonproliferation efforts, serving as the US government focal point for implementing US arms control inspection, escort, and monitoring activities. DTRA conducts on-site inspections and aerial monitoring abroad, escorts, foreign inspectors in the US, gathers information on the accuracy of treaty-related declarations and weapons systems reductions, and works to build confidence among treaty members.

DTRA helps to secure, transport, and dismantle WMD and associated infrastructure in the Former Soviet



Vulnerability Analysis Modeling.

Cutting up Aircraft as Part of Nonproliferation Work.

Union through the Cooperative Threat Reduction Program (CTR). Through these CTR efforts, DTRA has assisted in deactivating 6,462 strategic nuclear warheads, destroying 549 intercontinental ballistic missiles, eliminating 134 bombers, destroying 27 nuclear submarines, and sealing 194 nuclear test tunnels and holes, among other nonproliferation activities. Due in large part to these efforts, Ukraine, Kazakhstan, and Belarus are now nuclear free.

When the US Army Nuclear and Chemical Agency (USANCA) *NBC Report* began publication in 1994, what is now DTRA's CTR chemical weapons elimination program was already under way. Over the past ten years, there have been a number of achievements in this area, including projects in the Russian Federation and Uzbekistan. The capstone of the program is assisting the Russian Federation to destroy or demilitarize nerve agent production facilities in Western Siberia. The US portion of that effort, to be completed in 2008, includes design and construction of one of two main destruction buildings as well as an industrial area designed to house more than one hundred structures.

DTRA's Biological Weapons Proliferation Prevention Program (BWPP) started in the late 1990's. The program engaged Former Soviet Union biological weapons scientists in biodefense research and improved security and biosafety at institutes that house especially dangerous pathogens.

When possible, former Soviet bioweapons production and testing facilities were also eliminated. Beginning with the Russian Federation, these efforts were later expanded to include Kazakhstan and Uzbekistan. Today, the program still conducts cooperative biological research, improves biosafety and security, and eliminates Soviet-era bioweapons production and testing facilities.

The BWPP is involved in creating a bioweapons threat agent early detection and response system in Kazakhstan, Uzbekistan, and Georgia. When fully operational, each nation will have the ability to detect and respond to natural and man-made disease outbreaks associated with especially dangerous biological pathogens. This program will provide for consolidating all such pathogens into one central specifically configured research facility in each nation.

After the fall of the Soviet Union, it was obvious that issues of nuclear materials transportation and storage would have to be addressed. These materials came from consolidating weapons removed from republics of the Former Soviet Union. The problem was viewed as a chain of custody matter of providing safety and security for warheads and fissile material during all phases of movement, storage, and processing.

DTRA's historic expertise and knowledge of nuclear weapons was brought to bear to improve the safety and security of nuclear weapons and fissile materials in the countries of the Former Soviet Union. The results are impressive. The Russian Ministry of Defense now has laboratories to assess the material condition of critical nuclear weapons safety support and handling systems, and will soon have a modern inventory control system at the national level to ensure materials accountability.

Removal of Mortar Rounds in Iraq.

Emergency response forces now have modern radiation detection and survey, access, and mitigation equipment aboard all-terrain vehicles pre-staged throughout the country to aid on-scene commanders, reducing response times from days or weeks to a matter of hours. Work is also under way to upgrade security at nuclear weapons storage sites and provide increased transportation security for warheads being deactivated.

Detection technology has moved from a focus on non-intrusive technologies for verifying formal arms control treaties such as Strategic Arms Reduction Treaty (START) and the anti-landmine convention, to an emphasis on detecting actual nuclear, biological, and chemical material in improvised or clandestine munitions found in operational environments. CBRNE materials detection, using nuclear/radiological or other technologies, nuclear/radiological materials protection, and US force protection equipment are now central to DTRA efforts.

Counterproliferation

The counterproliferation pillar of the National Strategy to Combat WMD encompasses responses to nations or groups that intend to deploy or use weapons of mass destruction. DTRA has a number of products and services that serve counterproliferation goals.

Task Force DTRA, established in April 2003 to conduct WMD disablement and elimination in support of Operation IRAQI FREEDOM, completed its mission in late June 2004. Task force members were subject matter experts from DTRA and USANCA, among other organizations. For more than 15 months, under the operational control of the 75th Exploitation Task Force and the Iraq Survey Group, the task force conducted assessments of suspected WMD-related threats.

Ultimately, working with Department of Energy specialists from Oak Ridge National Laboratory and with support from Multinational Corps – Iraq and Air Mobility Command, Task Force DTRA removed 1.77 metric tons of low-enriched uranium and more than 1,000 of the most highly radioactive sources, thus, eliminating significant nuclear and radiological materials from potential terrorist use.

DTRA's support for training, exercises, vulnerability assessments, and war plans are important elements in counterproliferation. DTRA takes part in exercises to be sure that everyone who might be involved in dealing with an accident, incident or attack is familiar with the best practices and procedures to be used.

Throughout its 40-year history, the Defense Nuclear Weapons School (DNWS) has provided training advice and services in the field of nuclear weapons. In 1998, the DNWS expanded its mission to include radiological accident response and proliferation training for DoD and other federal and state organizations. The DNWS provides training on US nuclear weapons; WMD; CBRNE; proliferation issues; nuclear accident/incident/emergency response; and radiological and health environmental issues.

Stockpile support to the field has improved with the development of a next-generation consolidated nuclear weapons stockpile tracking/management information system called DIAMONDS (Defense Integration and Management of Nuclear Data Services), available at all continental US Air Force nuclear custodial sites, and now being installed at overseas locations. DIAMONDS supports the nuclear stockpile, which is an element of deterrence and defense under the counterproliferation pillar of the National Strategy to Combat WMD.

DTRA works with Combatant Commands and Service laboratories to develop niche weapons to attack hard targets including tunnels and deep bunkers. In cooperation with the Services, products developed to date include: the advanced unitary penetrator; the Massive Ordnance Air Blast weapon; and, the thermobaric Hellfire missile.

Another niche product developed on short turnaround, was a disposable robot that is used to identify and destroy Improvised Explosive Devices (IED). There are now hundreds of these robots deployed in Iraq and Afghanistan, destroying IEDs while keeping military personnel safe.

In less than two years DTRA developed and deployed more than 22 new technologies in support of US Central Command (USCENTCOM), and US Special Operations Command (USSOCOM) warfighting needs.

DTRA supports the International Counterproliferation Program (ICP). The goal of the program is to support participating countries in development of appropriate government institutions to deter, detect, investigate, and respond to WMD-related crimes. In addition, the program trains and equips participating nations to respond rapidly to WMD incidents within their own borders and their own regions

As part of DTRA's ICP support we have provided WMD detection and interdiction training and/or equipment to 18 nations since the program's inception in 1995. These training and equipment packages are carefully tailored to meet specific organizational needs, including such items as chemical and nuclear identification and analysis equipment.

For fiscal year 2004, the program provided $10.4 million in training and equipment to member nations.

Counterproliferation Training in Moldova.

There have been several examples of successful interdiction. For example, in April 2000, Uzbek ICP-trained customs officials seized ten radioactive containers, and in April of 2001, Kazakh border guards who had been trained and equipped with radiation pagers, found two containers emitting considerable radiation at a rail checkpoint on a train bound for China.

Going a step further, the WMD Proliferation Prevention Initiative is undertaking large-scale projects in Azerbaijan, Uzbekistan, and Ukraine to assist those countries in improving their capabilities to detect and interdict smuggling of WMD-related materials over land and maritime borders. Expectations are that this program will continue to grow.

Still in operational testing, the Unconventional Nuclear Warfare Defense (UNWD) program is expected to employ an array of passive sensors to detect and respond to an unconventional nuclear attack. Equipment lists and procedures developed will be transferable to the Services and shared with other federal, state and local agencies, as well as private organizations for their use.

Consequence Management

One definition of consequence management is the ways and means to alleviate the short- and long-term effects of chemical, biological or nuclear attacks. DTRA traditionally dealt with combat environments and is now applying its expertise to homeland defense coordination responsibilities in which the definition of consequence management emphasizes urban, suburban, rural, residential, industrial, and commercial locations.

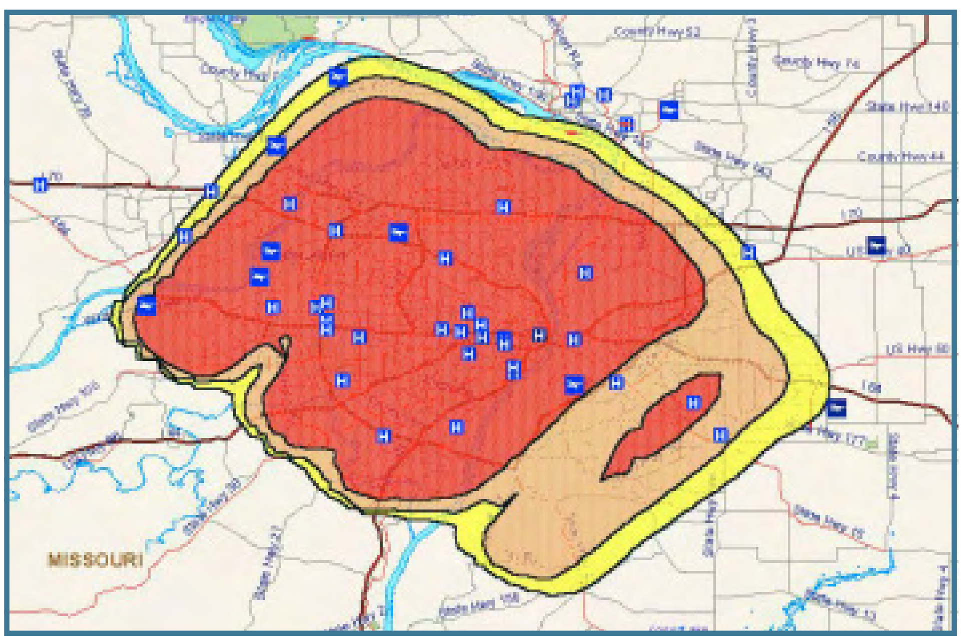
Some consequence management strategies and technologies also support counterproliferation. Computer modeling tools, such as DTRA's Hazard Prediction Assessment Capability (HPAC) software, are used for counterproliferation as command decision aids. They are also part of the consequence management tool kit.

DTRA maintains and provides staffed, equipped, and trained Consequence Management Advisory Teams (CMAT) for world-wide deployment to provide emergency response/consequence management support on matters involving CBRNE accidents or incidents. Most recently, a DTRA CMAT was deployed for the 2004 Summer Olympics. Teams have also supported Operation ENDURING FREEDOM and Operation IRAQI FREEDOM.

DTRA serves as the executive agent for planning and conducting national level nuclear weapons accident response exercises. Since 1979, DTRA has co-sponsored, with the Department of Energy, a variety of joint emergency response exercises, aimed in part at heightening coordination and cooperation between federal, state, and local first responders. Emergency preparedness exercises are part of the Nuclear Weapons Accident (NUWAX) exercise program.

Seaports are essential to US power projection, but they are also vulnerable to attacks with chemical and biological agents. To reduce this vulnerability and quickly restore operations, DTRA, working with USCENTCOM, co-sponsored the Contamination Avoidance at SeaPorts of Debarkation, a five year Advanced Concept Technology Demonstration (ACTD) program to improve warning, protection, and decontamination technologies for military operations in the USCENTCOM area of responsibility.

A preliminary demonstration took place at Charleston Naval Station, South Carolina, during August and early September 2003. A final demonstration was completed in Beaumont, Texas, in mid-September 2004. Decontamination systems and warfighter training during these demonstration projects will be followed by a two-year refinement and evaluation period.



Hazard Prediction Assessment Capability (HPAC) Modeling.

"How clean is clean" is another question that recurs in consequence management. The Agent Fate Program is a multi-year DTRA effort to collect data on the short- and long-term chemical and physical phenomena involved when chemical or biological agents end up on surfaces of equipment at military facilities.

To establish a data base, the program will collect available information, assess its usefulness, and conduct experiments to fill in data gaps or reconcile inconsistencies. Of particular interest is the natural "aging" and evaporation of chemical agents over extended periods of exposure at airfields during combat operations.

A number of other DTRA efforts are aimed at chemical and biological attack prevention and mitigation. For example, Restoration of Operations (RestOps) was an ACTD that prepared fixed tactical sites for defense against and response to chemical and biological attacks. In addition to updates in existing concepts of operations; regulations and publications; tactics, techniques and procedures, training support packages have been developed that will be transferable to appropriate Joint and Service programs.

Summary

These are just a few examples of the challenging work going on in DTRA today. We continue to develop and respond with technologies and operational capabilities developed over decades of support for changing military and homeland defense needs.

DTRA does nothing alone. Our strength is in collaboration with the Combatant Commands, the Services, other Agencies, industry, and our international partners. We look forward to continued collaboration and successes.

Major General Clark is the Acting Director of the Defense Threat Reduction Agency. She has a B.A. in Sociology from the University of Maryland, a M.S. in Guidance and Counseling from Troy State University and has completed studies at the Air Command and Staff College, Armed Forces Staff College, and Air War College. She has completed the National Security Leadership Course, the National Security Decision-Making Seminar, and the US-Russia Executive Security Program at Harvard University.

When the Pentagon was attacked on September 11, 2001, the section of the building that was hit had just been renovated using innovative materials and engineering practices recommended by DTRA. Those renovations contributed to fewer casualties that day.

US Air Force Goals: Survive, Operate, Sustain

Maj Gen Roger W. Burg, USAF
Director of Strategic Security, Office of the Deputy Chief of Staff for Air and Space Operations, Headquarters, United States Air Force

The 10th anniversary of the *NBC Report* is an opportune time to reflect on changes in the NBC defense environment, review United States Air Force (USAF) responses to those changes, and assess future prospects. To put the topic into perspective, it is important to recognize that NBC threats are a subset of the challenges posed by a dynamic international security environment and that the steps the USAF takes to improve its ability to counter chemical, biological, radiological, nuclear, and high-yield explosives (CBRNE), are inherently components of joint and combined operations. In order to properly characterize the USAF's counter-CBRNE (C-CBRNE) operations, we must recall the changing international security challenges the United States (US) has continued to face since the end of the Cold War, then describe USAF initiatives to transform capabilities to survive and sustain operations under CBRNE attacks, and conclude with comments about developments and trends that are shaping future threats.

The Changing Security Environment

As CBRNE weapons technologies and delivery systems became more widely available to regional adversaries following the Cold War, forward bases began to face new challenges. Action was needed to prevent potential adversaries from attempting to deny air access to a region or unacceptably reducing the in-theater tempo of air operations. Operation DESERT STORM posed the first major post-Cold War challenge to coalition forces by a CBRNE-capable adversary. The Operation DESERT STORM lessons learned were significant, reminding us about the importance of finding and destroying mobile missiles, missile defense, target intelligence, CBRNE counterforce attack operations, mission planning, hazard assessment capabilities, and timely tactical warning. This warfighting experience demonstrated the urgency of improving capabilities to counter CBRNE weapons.

In the aftermath of the Cold War and Operation DESERT STORM, President Bill Clinton issued Presidential Decision Directive 18 (PDD 18) on counterproliferation. In response to PDD 18, Secretary of Defense Les Aspin launched the Defense Counterproliferation (CP) Initiative. Based on the requirements in PDD 18, Secretary Aspin's CP Initiative called for improvements in deterrence, counterforce capabilities, active defense measures, and passive defense programs. These four areas, coupled with consequence management, have evolved to form the foundation for the USAF's C-CBRNE end-to-end strategy to integrate capabilities across the full spectrum of offensive and defensive mission areas, ensuring each contributes to overall success. Figure 1 illustrates this five-pillar strategy.[1]

To answer the call of the President and Secretary of Defense, the USAF first surveyed its CBRNE defense capabilities, identified opportunities for improvements, and then embarked on a Service-wide effort aimed at enhancing the ability to sustain operations in contaminated environments. Studies and surveys during the mid-to-late 1990's highlighted three areas that the USAF needed to address. First, more detailed technical and scientific knowledge was necessary to understand agent dispersion, behavior and effects on air base operations, particularly with regard to how chemical agents interact with asphalt, concrete, and other materials and surfaces that are prevalent on air bases. Second, the USAF required better abilities to quickly survey air bases following an attack and identify areas where contamination levels would not forestall operations. Third, commanders needed a concept of operations (CONOPS) and decision aids that would enable them to manage installation resources and personnel in an integrated, base-wide effort to sustain operations in contaminated environments.

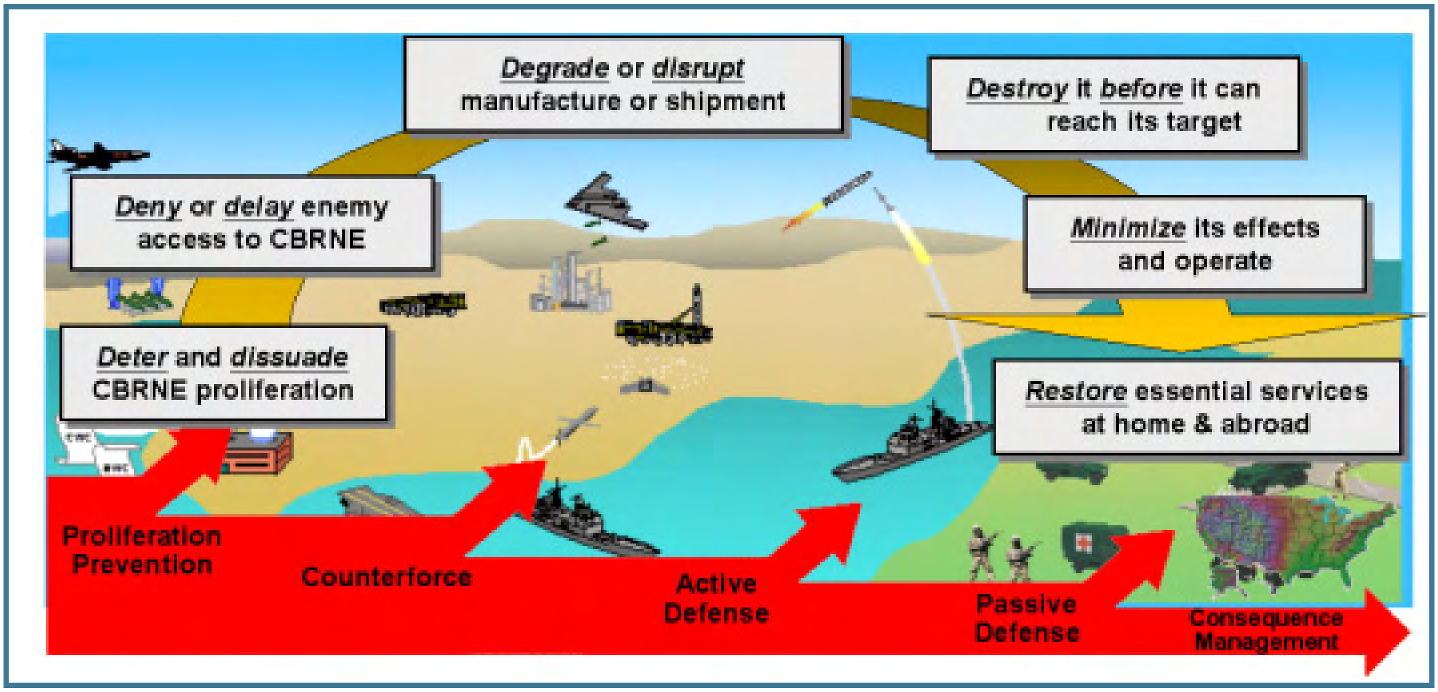


Figure 1. USAF Counter-CBRNE Strategy.

Transforming Capabilities

Direction and guidance to make these types of changes came from the top. In 1997, the Air Force Chief of Staff issued a Service-wide Counterproliferation Master Plan that set out objectives and called for initiatives to improve USAF counterproliferation capabilities. For example, in the area of passive defense, the Master Plan called for a continuing process of scientific research, operational analysis and capability improvements with the following objectives:

- Improve technical and scientific knowledge of chemical/biological agent behavior.
- Identify and assess the operational implications of CBRNE attacks with enough precision to understand and quantify their effects on operations.
- Develop and implement USAF policy, doctrine and guidance governing actions to counter the effects of CBRNE attacks.

USAF air and space assets play important roles in all mission areas, with particular core competencies in counterforce and active defense. In the area of CBRNE defense, the USAF focused early attention on improving the abilities of air bases in forward areas to protect such assets and survive chemical attacks in order to sustain combat operations. As a first priority, the USAF undertook an initiative to define and address the challenges posed by chemical weapons attacks on air bases. When that work had progressed sufficiently to validate the overall approach, a parallel effort was launched to address biological weapons attacks. More recently, the USAF has begun to address the characteristics of and responses to radiological attacks.

Chemical Warfare

In the past, USAF procedures for coping with chemical warfare attacks on forward air bases were shaped by the view that adversary air, missile, and special operations attacks would create extensive (base-wide), persistent, hazardous environments, and severely inhibit operations. As a result of this worst-case assumption, the USAF expected that all base personnel would have to operate under mission-oriented protective posture level 4 (MOPP 4) conditions for an extended period of time until hazardous areas were located, cordoned off, and - as operationally necessary - expeditiously decontaminated. If decontamination was not feasible or possible, it was estimated that hazards would persist for days or weeks. These constraints severely limited an air base's ability to generate sorties and process airlift deliveries. Based on these assumptions, the 1997 Quadrennial Defense Review estimated that missile attacks employing chemical munitions on a forward air base could potentially reduce the base's ability to generate combat sorties by up to 40 percent. In addition, again using these constraints, joint war games and analyses showed that chemical attacks on forward air bases would seriously impact the strategic airlift throughput.

In order to overcome these limitations, the USAF undertook a counter-chemical warfare (C-CW) initiative. From the outset, emphasis was placed on gaining more precise scientific and technical knowledge of chemical agent dispersion and interactions with air base materials. It was vital to achieve detailed and precise understandings of topics ranging from dispersal patterns of agents released from missile warheads to agent behaviors and adsorption on concrete, asphalt, painted metal, and other surfaces common to an air base. Tests and studies sponsored by the Defense Threat Reduction Agency (DTRA), the Missile Defense Agency (MDA), and the USAF showed that adversary ballistic missile attacks were not likely to contaminate an entire air base, and that agent interactions with air base surfaces resulted in significantly shorter periods of liquid contact hazards than previously anticipated. Additional tests of agent behavior on air base surfaces and materials by the West Desert Test Center's Dugway Proving Ground and the Naval Surface Warfare Center's Dahlgren Laboratory developed considerable data about agent adsorption rates. Test results were subsequently used to refine calculations of the likely extent and duration of chemical hazards within the air base environment.

Armed with more complete knowledge of agent characteristics and behaviors, the USAF began to analyze air base operations at high-threat locations. These analyses identified how improvements in capabilities and procedures for battle management, contamination avoidance, and personnel protection would affect an installation's ability to sustain operations and accomplish mission-essential actions following a chemical attack. Teams were dispatched to numerous bases worldwide to collect data from training events and exercises. The teams interviewed and observed personnel at all levels, from flight line maintenance technicians to wing commanders. In addition, information was gathered on all functional activities including medical, logistics, civil engineering, maintenance, force protection, emergency services, and flight operations. All of this data was used for modeling and simulation to analyze and quantify the operational benefits of tailoring post-attack responses to varying levels of contamination in different air base areas. The USAF then selected two forward air bases as test beds where improved procedures were refined, validated, and incorporated into a revised C-CW CONOPS.

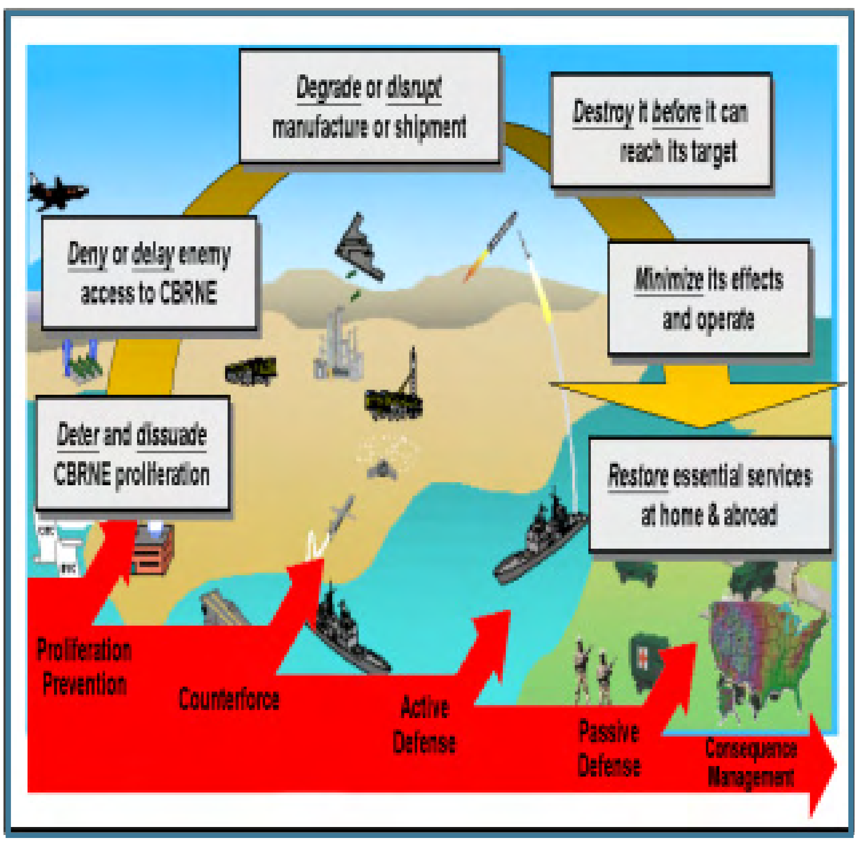


Figure 2. MDA Test Simulates Chemical Dispersal from a Ballistic Missile.

Osan Air Base in the Republic of Korea was one of the forward bases involved in the C-CW CONOPS development and validation. Osan was also chosen as the field site for the Restoration of Operations Advanced Concept Technology Demonstration (RestOps ACTD) sponsored by DTRA and US Pacific Command (USPACOM). One of the goals of the RestOps ACTD was to provide the commander information to mitigate the impact of a chemical or biological attack on a fixed site, minimize the impact on operations, and rapidly restore the site's ability to support war plans. Based on the experience gained at Osan and other Pacific air bases, Pacific Air Forces (PACAF) developed and issued a revised C-CW CONOPS for the command. In 2002, the Chief of Staff of the Air Force directed that PACAF's C-CW CONOPS be adapted and implemented Service-

Figure 3. Airmen at Osan Air Base, Korea Take Shelter.

wide by the end of 2003. In addition, the US Marine Corps adopted core elements of the USAF C-CW CONOPS for use at its airfields in the Pacific.[2]

The USAF C-CW CONOPS is designed to enable commanders to leverage information so that they can make timely, informed risk management decisions. Contamination avoidance and rapid attack assessment are key components of the CONOPS. When information is sparse, as it is at the onset of an attack, worst-case assumptions will continue to guide responses (don MOPP 4 and seek cover). As more information is gathered, the improved situational awareness is used to take advantage of opportunities to regain and sustain combat capability. When post-attack assessments identify portions of the air base that are not contaminated, the wing commander may choose to authorize personnel in those areas to operate at a lower level of protection than MOPP 4, as illustrated in Figure 5, page 22.

As areas are restored and hazard levels diminish over time, commanders can adjust to the changing degrees of risk and take measures to resume vital operations. Figure 5 outlines procedures for making decisions concerning split-MOPP operations.

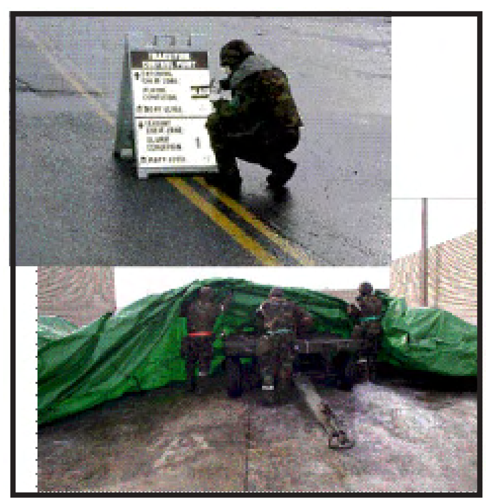


Figure 4. Zoned Contamination Management and Expedient Contamination Avoidance Procedures Manage Hazards and Enable Mission Continuity.

Operations in a split-MOPP environment require robust command, control, and communications, plus a well trained and fully equipped base populace. While the USAF has long had highly-proficient medical and emergency response specialists, the greater scope of the revised C-CW CONOPS requires that all USAF personnel on the base receive tailored training so that the entire base population performs C-CW actions as a team. Therefore, implementing the CONOPS Service-wide has necessitated revisions to doctrine, tactics, techniques, and procedures (TTPs), education, training, and exercises.

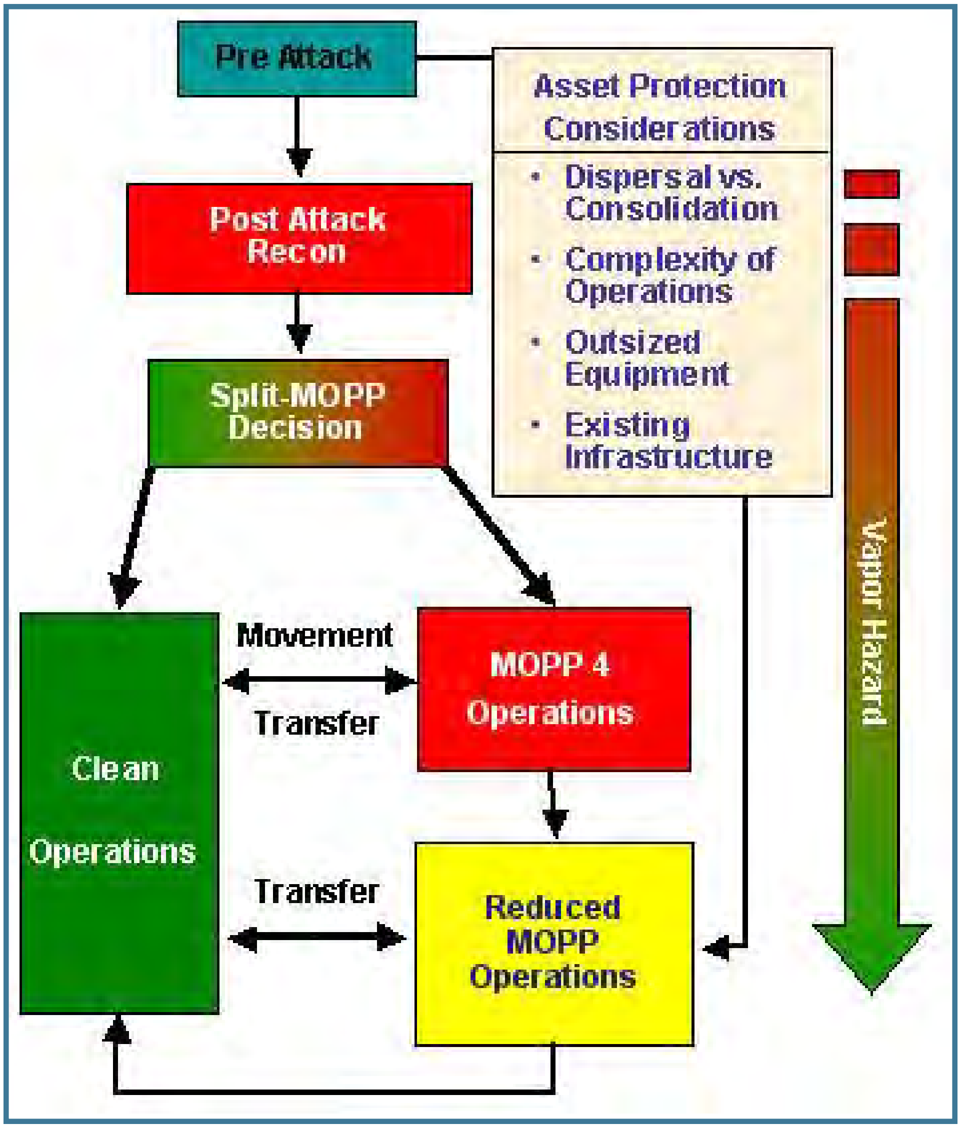


Figure 5. Split-MOPP Operations following a Chemical Attack.

Further, each air base must adapt the CONOPS to its specific mission, threat, and environment. To assist in this process, operational effectiveness assistance (OEA) teams conducted visits to help specific air bases tailor the CONOPS to their locations and requirements. OEA teams modeled the base's operations, helped to identify and prioritize opportunities to overcome chemical attacks, and measured the resulting gains in combat capabilities.

Implementing the USAF C-CW CONOPS has been an extensive, integrated effort involving experts from each functional area across the Total Force of Active, Guard, and Reserves. Although the initial focus was on forward air bases, it became increasingly apparent that the international security threat required plans and preparations be expanded to encompass contingency bases and CONUS installations. Improved C-CBRNE capabilities at CONUS air bases prepared the USAF to cope with attacks in the homeland while continuing to provide forces to the Combatant Commanders. In addition, emphasis was placed on keeping USAF procedures aligned with the other Services, as well as those of joint and combined forces.

As units become proficient in applying the C-CW CONOPS, the USAF has registered significant advances in its ability to survive chemical attacks, operate in chemical hazard environments, and sustain operations over time. By the 2001 Quadrennial Defense Review, air base capabilities to operate under a chemical attack were rated 30 percent higher than in 1997.[3] Measurable improvements are also being registered in readiness and training reports, operational readiness inspections and combat effectiveness readiness exercises. The RestOps ACTD provided further experience in CONOPS implementation and documented increases in operational effectiveness. These results are grounds for some satisfaction, but not for complacency. Continuing efforts are underway to maintain proficiencies and make additional improvements, because the threat will not remain static and the operating environment is certain to become more challenging. But as a work-in-progress, the C-CW effort has improved USAF capabilities while serving as a process guide for a companion initiative to further develop counter-biological warfare (C-BW) procedures.

Biological Warfare

As with the C-CW initiative, efforts to improve the USAF's ability to counter biological weapon attacks are focused on sustaining mission-essential activities at an air base. Surveys and studies conducted between 1996 and 2000 to assess air base C-CW capabilities also examined biological defense issues. In 2001, additional analyses and a Joint Service Integration Group survey of doctrine and TTPs identified shortfalls and opportunities to improve the USAF's biological defenses.

Concern over the potential impact of a biological attack on USAF personnel and facilities increased dramatically following the 9/11 terrorist attacks on the World Trade Center and the Pentagon and the subsequent anthrax letter attacks in September and October 2001. The Air Force responded by producing and fielding Commander's Guidelines as an interim measure to assist commanders in managing biological attacks on their installations, until a C-BW CONOPS could be developed. The lack of existing policy, guidance, procedures and risk management tools uncovered by this initial effort led the Air Force Chief of Staff to charter a Bio-Defense Task Force in July 2002.

The task force, comprised of functional area experts from HQ Air Force staff, academic and research institutes, major commands and field operating agencies, was convened to review and improve USAF operational capabilities to counter biological attacks. To execute its charter, the Bio-Defense Task Force considered the threat, examined relevant scientific and technical knowledge, and conducted additional surveys to fill in data gaps, assess operational capabilities, and identify opportunities for improvements in C-BW capability. A working group at Tyndall Air Force Base, Florida analyzed the information gathered and used it to develop the USAF Interim Base Bio-Defense Plan. This interim plan was immediately made available to USAF installations and operational wings in preparation for Operation IRAQI FREEDOM.[4] In March 2003, the task force published a status report that included the interim plan, identified gaps in USAF biological defense capabilities, and called for actions in the following areas: (1) doctrine and guidance; (2) organization; (3) education, training, and exercises; (4) funding and resources; (5) USAF issues relevant to DoD policy and doctrine for joint operations; and (6) operational capabilities.

In July 2003, exercises at Andersen Air Force Base, Guam, and Ramstein Air Base, Germany revealed a need for additional work to improve capabilities for mission sustainment and recovery in biologically contaminated environments. The task force published another

Figure 6. Biological Defense Training at Tallil Air Base, Iraq.

status report in September 2003 that summarized its findings and recommended specific improvements to USAF biological defense capabilities. The Air Force Chief of Staff subsequently approved the report and issued an action plan that assigns responsibilities for accomplishing 59 specific tasks. The task list includes steps to advance scientific and technological understanding of biological warfare, embed C-BW knowledge and skills in USAF education, training and exercise programs, and improve operational capabilities for biological defense. Vaccination programs received particular emphasis in this plan.

One major initiative to improve operational capabilities is the Kunsan Focused Effort, a year-long series of analyses and exercises that started in May 2004 at Kunsan Air Base, Republic of Korea. Located in a high-threat area on Korea's west coast, Kunsan's environment and operational requirements pose a complex set of potential biological defense challenges. Work is underway to analyze the effects of biological attacks on the base's ability to operate, and to develop, test, and validate TTPs to mitigate those effects. The Kunsan Focused Effort is a significant step toward achieving the long-term goal of developing and strengthening the C-BW element of C-CBRNE CONOPS.

Radiological Warfare

Improving the USAF's ability to counter radiological warfare attacks is a recent C-CBRNE effort. In 2004, the USAF completed an operationally-focused, science-based study of effects of radiological warfare on operational capabilities. As with previous C-CBRNE initiatives, the objective of this effort is to keep mission-essential elements functioning effectively during radiological attacks and regain combat capabilities as quickly as possible. The initial analysis of radiological-contaminated operating environments is complete and the USAF is currently moving forward to assess existing counter-radiological warfare (C-RW) capabilities, identify shortfalls, and develop means of managing radiological effects on operational capabilities. As with the C-CW and C-BW initiatives, the USAF will likely use a cross-functional task force as the preferred mechanism for assessing capabilities, identifying shortfalls, and recommending improvements.

Nuclear Warfare and High-Yield Explosives

Unlike the chemical, biological and radiological efforts, the USAF has a longstanding counterproliferation history in the areas of nuclear weapons and high-yield explosives. With more than 50 years of experience to draw from, the policies and procedures relating to the counter-nuclear mission are well established. We work continually with other elements of the DoD, as well as national-level agencies, to prevent potential adversaries from obtaining or employing nuclear weapons. This effort is among our highest national security priorities. In addition, the USAF maintains a robust nuclear safety program, to include accident and incident response.

Similarly, throughout its history the USAF has been fully engaged in countering the use of high-yield explosives across the full spectrum of C-CBRNE offensive and defensive mission areas. High-yield explosives are the current weapons of choice for our adversaries, who continue to find new and innovative ways to employ them. The use of improvised explosive devices in Iraq is a prime example. USAF C-CBRNE efforts must continue to adapt to the evolving threat posed by the proliferation and use of these types of weapons.

Institutionalizing Improved Capabilities

In carrying out its responsibilities to organize, train, and equip forces, the USAF has undertaken extensive measures to institutionalize C-CBRNE improvements and integrate them into operational capabilities. The institutionalization measures summarized below include changes to plans and programming, organization, policy and guidance, and education, training and exercises.

Organize

Institutionalizing C-CBRNE changes required the implementation of an organizational structure to support burgeoning C-CBRNE requirements, defining key functional area roles and responsibilities within the new organization, and the development or revision of supporting doctrine, policy, and guidance. One early step was to publish Air Force Doctrine Document (AFDD) 2-1.8 to provide doctrine for counter-NBC operations. As a result of AFDD 2-1.8, the Joint Staff designated the USAF as the Lead Agent to draft Joint Publication 3-40, *Joint Doctrine for Combating Weapons of Mass Destruction*. USAF also made updates to its policy directives, instructions, manuals and other guidance documents ranging from basic doctrine to field guides.[5]

The USAF's C-CBRNE Master Plan was revised in June 2004 to incorporate current National Security guidance and mesh requirements, programming and resource processes with joint and OSD capabilities-based assessments and planning mechanisms.[6] Under the Master Plan framework, the USAF aligns resources with requirements by building and implementing programmatic roadmaps for the areas of proliferation prevention, counterforce, active defense, passive defense, and consequence management. Implementation of the Master Plan is overseen at Headquarters, Air Force by a cross-functional C-CBRNE Council comprised of directors of operational and functional elements of the Air Staff and the Office of the Secretary of the Air Force. The Chief of the Air Staff's Counterproliferation Division serves as the Council's Secretary.

Throughout the past decade, the USAF has maintained C-CBRNE functional centers of excellence at several field-operating agencies. The Air Force Civil Engineer Support Agency (AFCESA) headquartered at Tyndall Air Force Base, Florida, provides contingency operations technical support to USAF installations worldwide. AFCESA's Full Spectrum Threat Response (FSTR) Integration Division integrates guidance, training, equipment and exercises for the FSTR program. The Air Force Medical Operations Agency (AFMOA) provides medical planning and execution support, and the Air Force Medical Support Agency (AFMSA) oversees execution of USAF surgeon general programs and policies. Another organization, the Air Force Nuclear Weapons Counterproliferation Agency (AFNWCA), was established in 1998 to provide scientific and technical expertise on nuclear weapons and counterforce agent defeat technology programs. In 2003 AFNWCA activated a C-CBRNE Division to perform technical analyses, assess operational impacts of CBRNE attacks, and develop advanced concepts and mitigation strategies. Other avenues for innovation opened in 1997 when the USAF established a network of operationally-focused battlelabs to generate ideas on how to best use weapon systems. The Air Warfare, Force Protection, and Air Mobility Battlelabs, among others, offer opportunities to develop and test improved C-CBRNE capabilities.

Another important aspect of the effort to organize for countering CBRNE is establishing, measuring and reporting relevant standards of operational readiness. Guidance for the USAF Status of Readiness and Training System (SORTS) was revised in 2003 to increase detailed reporting on NBC defense readiness.[7] Since readiness ratings are important indicators of combat capability, NBC defense capabilities have become an area of interest for USAF inspector general inspections and evaluations.

As combat wings implement these new procedures, there is increasing reliance on concepts such as Integrated Base Defense (IBD). This emerging concept integrates the application of offensive and defensive actions, both active and passive, to eliminate functional stovepipes and focus the efforts of all air base personnel and resources toward mission-sustaining actions. IBD, as a subset of Force Protection, requires all Airmen to be proficient in those actions that will deter, detect, preempt, mitigate or negate threats to USAF air and space operations and assets. This includes being able to perform these actions in a C-CBRNE role, and continue defending the base in a CBRNE environment should an incident occur.[8]

<u>Train</u>

Considerable training is necessary to achieve and maintain force-wide proficiencies to counter CBRNE attacks. Ten years ago, the USAF NBC defense training was focused largely on medical, emergency response and readiness specialists. For the rest of the USAF, training to use individual protective equipment (IPE) was provided only when individuals were placed on mobility status or as they deployed to high-threat areas. Since then, a life-cycle C-CBRNE education, training and exercises initiative has been undertaken to institutionalize C-CBRNE proficiencies into the USAF culture. Now each Airman is familiarized with NBC defense and the use of IPE during basic military training. Refresher courses are taught during the individual's Air Expeditionary Force training cycle. Unit training and exercises have been modified to emphasize more realistic and demanding scenarios and requirements. To increase awareness of C-CBRNE issues and enhance professional military education and commanders' courses, the USAF Counterproliferation Center was established at the Air University at Maxwell Air Force Base, Alabama in 1998.[9]

<u>Equip</u>

Along with the rest of the Armed Forces, the USAF has realized considerable capability improvements over the past 10 years from the new generation of equipment developed under DoD's Chemical-Biological Defense Program. The USAF is well into the process of fielding the Joint Service Lightweight Integrated Suit Technology (JS LIST), the Joint Service Aircrew Mask, and M291 skin decontamination kits. The Improved Chemical Agent Monitor (ICAM) and M22 Automatic Chemical Agent Detector and Alarm (ACADA) are also in the field. For radiological threats, the USAF replaced earlier detection devices with the ADM 300. Also, over the next 5 years the JPM Guardian Installation Protection Program will enhance installation protection at 200 DoD installations (64 USAF installations) by fielding and training CBRNE detection and response capabilities, including a mix of government and commercial off-the-shelf products, tailored to installation threats and vulnerabilities.

Future Challenges

While weapons technology advanced during the past decade, the means of weapons delivery and the set of potential adversaries have grown significantly. Delivery modes now encompass threats ranging from small, long-range unmanned aerial vehicles (UAVs) to a letter in the mail. Adversaries today include larger numbers of capable and dedicated terrorists eager to attack US forces, citizens, and critical infrastructure overseas and at home. Technology has also advanced and proliferated to make CBRNE weapons more readily attainable, including new generations of chemical and biological agents. Table 1 summarizes some of the changes that have taken place.

The trend toward more diverse and challenging threats is certain to continue and the pace of technological change is likely to accelerate further in areas such as biological sciences, advanced energy sources, information and nanoscale technologies. While these technologies offer many productive and positive prospects, they also create the potential for highly disruptive and destructive uses. In the biological arena, genetic engineering could result in new pathogens that are more toxic, more resistant to vaccines or treatment, easier to deliver, or more persistent once disseminated. Advances in releasing energy from chemical bonds or by working at the atomic level—such as certain energy states of nuclear isomers—could provide increased destructive potential for new forms of explosives. In the hands of a hostile regime, any of these potential capabilities are reasons for alarming concern. In addition, the threat is compounded as highly-destructive weapons become increasingly available to non-state actors such as terrorist groups and extremists. To maintain the security of the United States and succeed in the Global War on Terrorism, military forces must be trained, equipped, and prepared to engage an increasingly diverse range of threats. To meet these challenges, it is vital that the USAF continues providing Combatant Commanders with forces able to sustain combat operations and prevail at all levels of conflict and in all environments.

As Director of Strategic Security at USAF Headquarters, Major General Burg is responsible for providing policy, guidance, expertise and oversight to the USAF nuclear, space, force protection and homeland defense programs. Prior to assuming duties at the Air Staff in August 2004, he served on the National Security Council as Director for Nuclear Policy and Arms Control. He holds a B.S. from the U.S. Air Force Academy, a M.S. from Columbia University, New York, and a M A. from the Naval War College at Newport, Rhode Island.

Table 1. Security and NBC Defense Environments: 1994—2004.

	Then - 1994	**Now - 2004**
Description	**NBC**	**CBRNE**
Proliferators	State-to-State Transfers, Nukes From the FSU, Scientists for Hire	Same, Plus Failed States, Terrorists, Black Marketers
Threat of the Day	Chemical Attacks on Deployed Forces During a Regional Conflict	Bio Attacks That Target Forces Plus Homeland Population, Infrastructure, Agriculture
National Strategy	Deter, Defend, Retaliate	Same, Plus Preempt if All Other Means Fail
USAF Canonical Scenario	Ballistic Missile & SOF Chemical Attacks on a Forward Airfield	Same, Plus Bio, UAVs, and SOF Terrorist Attack in CONUS

ENDNOTES

[1] The integrated strategy is further elaborated in *National Strategy to Combat Weapons of Mass Destruction*, December 2002 (http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf); Joint Publication 3-40, *Joint Doctrine for Combating Weapons of Mass Destruction*, 8 July 2004 (http://www.dtic.mil/doctrine/jel/new_pubs/jp3_40.pdf); and Air Force Doctrine Document 2-1.8, *Counter-NBC Operations*, 16 August 2000 (https://www.doctrine.af.mil/Main.asp).

[2] Burgess, Glenn F. (Col, USMC, Ret.), "Counter Chemical Warfare: Now …Survive and Operate," Marine Corps Gazette, December 2002, (86:12), p. 47.

[3] QDR CIWG, 2001

[4] In addition, a ChemBio website was established to provide commanders and unit personnel with guides and current information. The site is at https://www.xo.hq.af.mil/xos/xosf/xosfc/index.shtml.

[5] See Air Force Policy Directive (AFPD) 10-26, C*ounter-NBC Operational Preparedness*, 6 Feb 2001; AFPD 10-25, *Full-Spectrum Threat Response*, 18 July 2002; and Air Force Manual 10-2602, *Nuclear, Biological, Chemical, and Conventional Defense Operations and Standards*, 29 May 2003. All are available at http://www.e-publishing.af.mil/pubs/.

[6] *USAF C-CBRNE Master Plan*, June 2004. Available at https://www.xo.hq.af.mil/xos/xosf/xosfc/index.shtml.

[7] Air Force Instruction 10-201, Status of Readiness and Training System, 12 December 2003. See Appendix D. Available at http://www.e-publishing.af.mil/pubs/.

[8] See Air Force Doctrine Document 2-4.1, *Force Protection*, at http://www.e-publishing.af.mil/pubs/.

[9] Air Force Counterproliferation Center programs and publications are available at http://www.au.af.mil/au/awc/awcgate/awc-cps.htm.

PHOTO CREDITS

Figure 3. Hanging out with the 'Hawg.' OSAN AIR BASE, South Korea — (Left to right) Senior Airman Edward Connell, Staff Sgt. Adrian Sanders, Senior Airman Dusty Surber and Master Sgt. Shayne Murphy take shelter in a hangar during a chemical exercise here. The Airmen are assigned to the 51st Aircraft Maintenance Squadron. http://www.af.mil/media/photodb/photos/040323-F-3963C-055.jpg (U.S. Air Force photo by Staff Sgt. Bradley C. Church)

Figure 6. Checking for NBC. http://www.af.mil/media/photodb/photos/040301-F-6229O-014.jpg

The Evolution of Chemical, Biological, Radiological, and Nuclear Defense and the Contributions of Army Research and Development

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This article represents the opinions of the authors and does not represent the official views or position of the Army or Department of Defense.

During the past decade, first as Director, Joint Program Office for Biological Defense and then as Commanding General of the Soldier and Biological Chemical Command (SBCCOM) – recently reorganized and activated as the US Army Research Development and Engineering Command (RDECOM), I was fortunate to witness and participate first hand in what I believe is the most significant evolution in our approach to CBRN defense since the aftermath of the battle of Ypres in 1915. The advent of the Global War on Terrorism (GWOT) and the realities and implications of the use of weapons of mass destruction (WMD) certainly played a major role, but there were other underlying and interrelated factors that all came together during this time to truly change our focus throughout all the components of CBRN defense.

In my view there are four "functional components" or aspects of CBRN defense, that also apply to other types of operations. They are: 1) Material Issues – The things required to conduct the mission, 2) Technology – The capability and functions required, 3) Force Development – The operational capability needed, and 4) Doctrine – The operational methods employed. The threat and our level of acceptable risk determine the requirements for these components. However, in terms of CBRN defense, the threat and our corresponding approach uniquely must apply not only across the full warfighting spectrum, but also in conjunction with domestic activities. This article will review my perspective of the changing landscape of CBRN defense, examine some of the unique technological and operational contributions of RDECOM and its predecessors, and how I view the road map for the future.

Changing Threat…or Full Recognition of the Threat?

Our approach to the threat of CBRN weapons or materials use is significantly different than before the 1990's. Despite the fact that industrial accidents such as the release of Methyl Isocyanate in Bhopal, India, nuclear plant disasters at Three-Mile Island, PA and Chernobyl in the Ukraine, as well "asymmetric" use (1978 Bulgarian dissident assassination using ricin) involving actual conventional CBRN materials/hazards or equally toxic and hazardous materials, our approach was centered on the traditional Air-Land battlefield. This is a reflection of how we viewed the threat – and the functional components of CBRN defense.

Quite simply, our past approach to the nuclear weapons and radiological threat was that while possible, their limited use in battle was constrained by the socio-political ramifications and of course widespread use would mean "Armageddon." Our detection, survey, and dosimetry capabilities were little changed from the 1960s and designed for essentially grossly contaminated areas. The Department of Defense (DoD) had little specialized operational capability other than a few select organizations and units with direct responsibility for nuclear weapons. Despite best attempts, Army Chemical Corps units responsible for radiological decontamination and survey missions rarely, if at all, had the time, resources and expertise to deal with a nuclear scenario, nor did our Army as a whole. Nuclear training for Army units was limited and extremely unrealistic. There was little concern for radiologically contaminated areas where expected exposures were less than militarily significant. While the threat from nuclear weapons and our approach to dealing with its effects have not changed a great deal, today we recognize that the use of radiological materials in weapons and the hazards of commercially used radioactive material pose significant challenges. Depleted uranium from expended munitions, products from nuclear processing (e.g. "yellow cake", spent fuel rods), and medical radiological diagnostics (Co-60, Cs-137) can pose substantial hazards on the battlefield and in the homeland. A radiological dispersion device (RDD) is perhaps one of the most troubling threats to our civilian populace. Although the effects of a RDD are relatively insignificant when compared to an actual nuclear device – the public's very real fear of "radioactivity" places both on the same level. Coupled with a national sense of risk-intolerance to the population in general, and to our Soldiers in particular, means we now have to not only know the specific isotope, but where and how it is distributed and to extremely low-levels.

Despite the well-known hazards of the world's industrial chemical industry, our approach to chemical threats in the early 1990s was centered on classical chemical warfare material and its large-scale use in battle. Chemical weapons use in the 1980's Iran-Iraq war and the earlier revelations of advances in Soviet technology and operational doctrine served to reinforce the notion that the next conflict could see their broad use against United States (US) and allied forces. Indeed, the overwhelming concern for the first Gulf War was large scale Iraqi use of chemical weapons. While our forces were better prepared to deal with the chemical threat – our approach still centered on deterrence and if required, dealing with militarily significant hazards and effects. Our protection and detection technologies were designed to operate in areas with large-scale use. Although low levels of nerve agents can be fatal, our operating premise was that enemy use would be unambiguous, resulting in trade-offs in detection levels, sensitivities, and agent specificity of our material solutions. What was essential at the time was a capability that could be mass fielded with enough capability to protect the force. This lead to the use of cheap colorimetric wet-chemistry detectors (M8, M9, M256) and supplemented by more expensive ion-mobility detectors Chemical Agent Monitor (M8, CAM) at the user level. More advanced and expensive technology such as Gas Chromatography/Mass Spectrometry (GC-MS) was introduced with the Fox reconnaissance vehicle, but only in limited quantities for specific uses. Our individual protection ensemble capabilities were certainly sufficient, but logistically difficult to sustain given our material stockpiles at the time. The Army would have had great challenges in this regard had chemical weapons use actually occurred.

Today, the term "chemical" means not only chemical warfare agents, but also all hazardous and toxic chemicals. Environmental exposures to low-levels of hazardous materials can potentially cause systemic long-term disorders. Agent Orange and Gulf War Syndrome are two military-related examples. Although there is no clear evidence, some in the civilian community believe that Gulf War Syndrome is related to low-level chemical agent exposure. Contaminants in the production of the herbicide mix "Agent Orange" were definitively linked to a wide variety of health problems in veterans of the Vietnam War. In concert with the public's concern for safeguarding the environment, the DoD is now held to intense public scrutiny and expectations of compliance with Occupational Safety and Health Agency (OSHA) and Environmental Protection Agency guidance rather than just military significant levels. This is not only warranted, but is also extremely challenging to implement. War is not environmentally friendly and the current technology required to achieve low-level sensitivity and selectivity of the full range of hazardous chemicals and to package it for fielding on a large scale is complex and expensive. However, we must get there. Each of the Services faced unique operational demands in the event of use of chemical agents, yet only the Army had dedicated full time assets for decontamination, survey, and related tasks. While each Service implemented plans for emergency actions to sustain operations, the Army was intended to provide the bulk of the specialty forces to deal with chemical agents. Unfortunately, in the early 1990's, again, very few specialized units existed to deal with chemical agents and although the Chemical Corps had substantial decontamination assets in the Army Reserve and active force, they were equipped with 1950's technology, lacked Joint force interoperability, and had little capability or experience to operate in support of a civil incident. The Army's Technical Escort Unit was the only unit with extensive experience handling and recovering chemical agent material and munitions. This small unit stationed at Aberdeen Proving Ground has over 65 years of practical experience in this regard and today is serving as a focus for our Army's enhanced CBRN operational response capabilities.

The threat of biological warfare did not end with the signing of the Biological Weapons Convention of 1972. Indeed, events involving clandestine use, suspected incidents such as the 1979 anthrax outbreak in Sverdlovsk (later confirmed in 1992 by President Yeltsin as the result of banned production activities), the ease of conversion of dual use technology, and advances in genetic engineering combined to keep biowarfare as a top threat. The specter of Iraqi use of biological agents in the first Gulf War was as much, or arguably even more so, as great a threat as Iraq's vast chemical stockpile. While our capabilities for dealing with the chemical battlefield in the early 1990's were sufficient, this was not the case for biological agents. Our doctrinal approach relied upon prophylaxis (where possible), environmental monitoring, and medical surveillance to detect exposures. The downside of this "post-exposure" methodology is that it relies on direct evidence (e.g., finding a crop duster with biological materials) or the ability to diagnose and treat the disease before it progresses to a clinically untreatable stage. Preventative treatment (vaccines), advanced warning or even "detect-to-treat" capability is desired. Early field detection technology brought to the Gulf in 1991 consisted of only agent specific, antigen based "smart tickets" and rudimentary air sampling/analysis.

Today, we recognize that the CBRN threat comes not only from traditional nation states and terrorist organizations, but also from individual or groups of criminals (Aum Shinrikyo), poor safety practices (industrial accidents) and even Mother Nature (natural disasters). Of course, this was also true in the past but our CBRN defense focus was primarily on the conventional battlefield. Unfortunately, although the signs were there well beforehand, it would take a number of events in the US and abroad to change national policy and DoD's approach to CBRN defense.

Change in National Policy

While the conventional "Cold-War" military threat in Europe effectively ceased with the fall of the Berlin Wall, numerous adversaries in the rest of the world still existed, many with known offensive chemical or biological capabilities and "Cold-War" approach. Our strategic posture for CBRN defense relied on three key principles 1) Strategic Deterrence - the threat of escalation and overwhelming response if CBRN weapons/material were used against US or allied forces, 2) Forces prepared to "fight [dirty] and win" on the NBC battlefield, and 3) Support to non-proliferation initiatives.

There was little question of the effectiveness of our strategic deterrence capabilities. The potential and will to remove or eliminate Saddam Hussein through the use of non-conventional capabilities (nuclear) is often referred to as a reason why chemical weapons were not employed by Iraq during the first Gulf War, despite Iraq's capable arsenal and experience. The worldwide political cost and outright personal implications were presumably too great. It is important to note that Iran did not posses a similar deterrent nuclear capability, nor was world opinion as demonstrative, during the Iran-Iraq war of the 1980s.

The increased incidents of terrorism in the US and abroad, to include the use of CBRN materials, rendered our policy approach much less effective. As a result, significant policy changes were enacted to counter the changing threat resulting in the development of new force capability and doctrine both in DoD and in the civilian sector. While the 1993 World Trade Center bomb incident brought foreign terrorism to the homeland, the early 1995 Tokyo sarin subway attack and Murrah Federal Building bombing in Oklahoma City can be viewed as the watershed events that galvanized our approach to terrorism in general, and CBRN hazards in particular. Indeed, during the 1990's key statutes such as the Stafford Act and WMD (Nunn-Lugar-Domenici) Acts were amended or enacted, and Presidential Decision Directives (PDD) 39, US Counter-Terrorism Policy, PDD 62, Combating Terrorism, and PDD 63, Critical Infrastructure Protection were issued. The impact of these and other key policy and plans lead to such broad based efforts such as: providing training and support to state and local governments to deal with CBRN incidents; establishment of a national series of exercises dealing with consequence management (TOPOFF, Determined Promise, Unified Defense); establishing new response organizations within DoD such as Joint Task Force for Civil Support, the Chemical-Biological Rapid Response Team (CB-RRT), the Chemical Biological Incident Response Force, and Civil Support Teams (WMD-CSTs). Additionally, we saw a dramatic increase in the CBRN capabilities of first responders at the state and local level and establishment of federal capabilities such as the FBI's Hazardous Materials Response Unit. While one may view these changes as simply an increase in resources to meet a need, as discussed previously the demands of dealing with CBRN hazards, formerly viewed and resourced as a warfighting problem, is now full spectrum, with resultant technology needs that did not exist in the conventional DoD framework.

The advent of the Global War on Terrorism further defined and broadened the scope of our policy approach to CBRN defense. The ap-

Support to Current Operations Through the Cooperative Defense Initiative.

proach to CBRN operations both in Afghanistan and Iraq centered not only on the protection of our forces, but also called for the systematic investigation, recovery, destruction, and dismantling of an adversary's CBRN stockpile and infrastructure. This approach is necessitated by the urgency of effecting non-proliferation of CBRN material. While we could have successfully achieved all these objectives in Iraq or anywhere else for that matter, the fact is that we were forced to put together an ad hoc capability, develop doctrine, develop tactics, techniques, and procedures (TTPs) and plans on the fly, and execute with whatever equipment we could find. A great task that was much debated was how to actually do "CBRN sensitive site exploitation." We have gained much experience over the past two years and new emerging doctrine is taking shape. I think that had we actually discovered large stockpiles of CBRN materials, we would have run a tremendous risk with learning some lessons the hard way. We have very few personnel with actual, bona fide experience handling CBRN weapons. The matter of establishing a "battlefield" CBRN stockpile recovery and demilitarization operations would have been an enormous and expensive undertaking. The World War I and II techniques of loading materials on barges and dumping at sea are no longer viable options.

Evolution of CBRN Defense

Despite our vastly changing threat and our changing approach to dealing with that threat, our Army and scientific and technology community have made tremendous gains to meet mission requirements. I will briefly review some of the significant changes we have made (Material, Technology, Doctrine, Forces) in this regard and specifically the role of the RDECOM and its predecessors in effecting these changes.

Technology and Material Issues

These two components of CBRN defense are the primary tools required to overcome user requirements to accomplish the mission. Technology leads to a material solution, however, maturity of the technology plays a direct role on how quickly solutions can be developed. When we look at our chemical detection capabilities, our needs have grown from a relatively focused class of compounds to requirements for broad range, more selective and sensitive capabilities. Our primary chemical detector technology of the 1990s was ion-mobility, which was not suitable for this enhanced role. The original M93 Fox reconnaissance vehicle was the first platform fielded with Gas Chromatography (GC)-mass spectroscopy capability, but cost and complexity limited broad use. Today, several types of detectors, such as the HAPSITE, are in use for specialized purposes with developing technology to miniaturize and reduce cost for wider use. While GC-mass spectroscopy provides an enhanced capability, it must be employed by specialists and must be optimized to the class of hazard investigated. The ability to detect agent clouds resulted in the development of passive infrared (IR) standoff devices such as the M-21 RSCAAL, however, its primary utility is against a conventionally delivered chemical attack – not for low level detection in an urban environment.

Our biological agent detection capability before 1990 was essentially observation for symptoms and prophylactic immunization for selected diseases. We had to rush development and fielding of immature, emerging technology to provide a measure of post-attack detection capability. Subsequently, rapid determination of organism viability or strain is difficult to do in the field and can only be reliably done by culturing. This takes precious time in our approach to treatment or protective measures. Future efforts are focused in this area to provide more responsive analytical capability as far forward as possible. However, development and fielding of Hand Held Assays (HHA), the Joint Biological Point Detection System (JBPDS), and using commercial off the shelf, field ruggedized PCR and ELISA-based analysis systems such as the RAPID, have greatly increased our abilities to determine potential biological agent hazards. The result of the discovery of Iraq's weaponized anthrax capability, the Soviet's admission of violating the Biological Warfare Convention, and the impact of biological agents in general lead to significant changes in our approach to biological defense and R&D. In 1992 the Army formally established a program manager for Biological Defense and later the Joint Program Office for Biological Defense. These offices served to coordinate and manage the development of several key defense systems now in place such as the Biological Integrated Detection System (BIDS) and JBPDS and advanced HHA. These offices also managed the development of vaccine programs such as the anthrax vaccine program. As a result, our Soldiers are protected against the most widespread and easily used biological agents.

Personal protective equipment has also changed significantly. The replacement of the Chemical Protective Overgarment with the Battledress Overgarment and finally the Joint Service Lightweight Integrated Suit Technology (JSLIST) Overgarment represent a continuing evolution in reduction of heat stress, increase in protection factors, and integration among various mission needs (such as aircrew protection). Next generation technology development is underway to not only reduce heat stress and increase protection, but to integrate decontamination capabilities as part of a single uniform fabric. The M17 and M24/25 series masks were replaced by the M40 series to provide a common mask system to reduce logistics while providing superior protection. The next generation Joint Service Mask will provide a DoD standard mask, increasing interoperability and protection capabilities as part of an integrated protective ensemble for the Soldier. RDECOM's Natick Soldier Center is leading the way to develop integrated civil-military protective ensembles through its National Protection Center (NPC). The NPC is a Joint Agency Center of Expertise sponsoring and conducting research, development, test, and evaluation, and promoting commercialization of advanced/multi-threat protective clothing and equipment for military and civilians in high-risk occupations or conducting missions in extreme environments. These included fire fighting and HAZMAT response. By taking a holistic, Soldier-centered approach, a variety of human and environmental factors can be simultaneously addressed. Already, advanced prototypes of next generation protective gear have been developed to improve soldier protection while reducing mission degradation.

Integrated Suit and Helmet.

A somewhat overlooked aspect is the role of technology in the development of non-lethal capabilities. The end of the Cold War and focus on limited regional conflict, Stability and Security Operations, and the Global War on Terrorism present our forces with life-threatening situations where non-lethal military capabilities have many great advantages. Urban warfare and civil disturbance op-

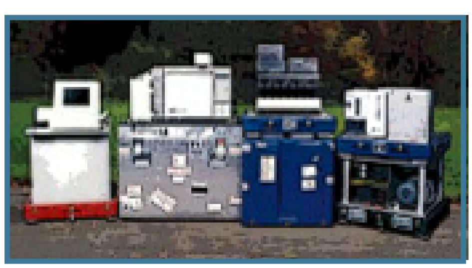
Joint Service Lightweight Integrated Suit Technology (JSLIST).

erations are two examples. Chemistry and biology are the basis for a great deal of the underlying technology of non-lethal approaches. RDECOM's Edgewood Chemical and Biological Center (ECBC) is the nation's leading laboratory in this area. While the use of non-lethal technology presents operational and policy challenges, their utility is well established. Sensory irritant development and use can be traced back to World War I and incapacitant development soon after World War II. Edgewood is home to many other novel non-lethal technologies – examples include anti-personnel acoustics (dating back to 1943), counter-traction technologies (dating back to the Korean War), and the Army's first non-penetrating projectile for riot control use (the Ring Airfoil Grenade, type classified in the early 1970's). In short, the scientists and engineers at ECBC have a long and successful history with all aspects of non-lethal technology research and capability development dating back many years before this area of study became fashionable in the late 1980s and early 1990s. The potential applications of non-lethal technology are readily apparent and I believe will play a significant role in our future force capability.

A final area where we have made much progress is the area of decontamination. Aqueous foam decontaminates were developed as alternatives to effective, yet hazardous and logistically troublesome, Decontamination Solution #2 and Super Tropical Bleach. Much work remains to reduce the logistics and effectiveness of decontamination. The ultimate answer is self-decontaminating applications in order to reduce manpower requirements and operational impact. Today, ECBC is conducting extensive basic research in this area to meet this challenge.

Evolution on CBRN Defense – Forces

Previously I highlighted some of the changes in our national CBRNE operational response capabilities. RDECOM (then SBCCOM) was a key contributor to several of these efforts. Our Forensics Analytical Center (FAC), part of the ECBC, is a world recognized center of expertise regarding analysis of chemical warfare agents. Considered the US 'gold-standard' for chemical agent analysis, it is certified for conducting analysis under the Chemical Warfare Convention Treaty. The FAC developed and operates a mobile flyaway laboratory for chemical analysis for the federal law enforcement and intelligence communities. The lab participates in every US mission when suspected chemical material is found. The Homeland Defense Business Unit (HDBU), also part of ECBC, was the original program office responsible for organizing, developing, and conducting training for first responders under the Domestic Preparedness Program before it transitioned to the Department of Justice. Today the HDBU provides specialized teams in support of DoD worldwide that support installation infrastructure improvements, exercises, and training to prepare against a CBRN attack. While our research efforts achieved significant accomplishments for our nation, one of SBCCOM's most significant visible impacts was the development and transition of several unique and key CBRN response units into the Army force structure.



Mobile Laboratory.

An additional outgrowth of the Nunn-Lugar-Domenici Act was the requirement for DoD to organize to coordinate and manage DoD chemical and biological (CB) defense support to civil authorities in response to a WMD incident. The Department of the Army directed the SBCCOM to address this issue and subsequently established the CB-RRT in late 1997. Since then, the CB-RRT matured into a functional organization that leverages partnerships with key CBRN defense organizations and employs unique, sophisticated communications equipment and integrated information management systems to provide single source CBRN defense expertise to the supported Lead Federal Agency or Joint Task Force commander. It is presently being transferred to FORSCOM as part of the Army's new 20th Support Command (CBRNE) that was activated on 15 October 2004. The CB-RRT is being renamed the CBRNE Technical Augmentation Team (CBRNE-TAC). It operates in direct support of Joint Task Force for Civil Support and other agencies as required to provide technical CBRN expertise and specialized operational support, participating in support of each major consequence management Joint Task Force operation and exercise as well as selected National Special Security Events. Its Operations Center can bring together, physically and virtually, some of the nation's leading CBRNE technical experts without the need for the experts to be deployed to an incident site.

Technical elements partnered with the CBRNE-TAC include the US Army Technical Escort Unit (TEU); ECBC and the ECBC Forensic Analytical Center (FAC), the US Army Reserve Unit for Consequence Management (ARU-CM), US Army MEDCOM Special Medical Augmentation Response Teams (SMART) and Regional Medical Commands

(RMC), US Army Medical Research Institute of Chemical Defense (USAMRICD); US Army Medical Research Institute for Infectious Diseases (USAMRIID), US Army Center for Health Promotion and Preventative Medicine (CHPPM), US Navy Medical Research Center (NMRC),US Navy Environmental Health Center (NEHC), US Navy Environmental and Preventive Medicine Units (NEPMU) and the US Naval Research Laboratory (NRL). The CB-RRT program is one of our many great success stories of transitioning an initial concept and research plan into an operational capability for the nation.

Another success story is our development and formation of the Army Reserve Unit – Consequence Management (ARU-CM). Leveraging our requirements under the CB-RRT program and recognizing that a large number of technical specialists were also in the Army Reserve, we devised a concept to establish a specialized Army Reserve unit dedicated to CBRNE consequence management. The objective was to create a subject matter expert and operational support pool that could be quickly recalled in times of crises to augment our core active duty team, both deployed and in the rear, as well as support the various missions of the command. The ARU-CM was formally established in November 2001 under SBCCOM with a number of highly skilled CBRNE and medical personnel, including some highly recognized scientists and physicians. The timing of the activation of the ARU-CM was quite fortuitous given the demand for our operational capabilities during the Global War on Terrorism. The ARU-CM was fully mobilized in the spring of 2003, with about 20 percent of the unit continuing to serve on active duty today. The ARU-CM was transferred to the new 20th Support Command on 16 October 2004.

A cornerstone of the Army's CBRNE response capability was the TEU, now designated the 22nd Chemical Battalion (TE). Originally designed to deal with transport and movement of chemical weapons, and leveraging over 60 continuous years of experience dealing with actual chemical and biological materials and munitions, it has evolved into the nation's premier response unit. It has deployed worldwide conducting sensitive missions in support of DoD, civil authorities, the United Nations and others. TEU served as the model for development and design of the FBI's Hazardous Materials Response Unit and the National Guard's Civil Support Teams. The TEU has been on the front line of the fight against terrorism, having had a continuous presence in the USCENTCOM area of responsibility, supporting multiple operations at home as part of Operation NOBLE EAGLE, and providing support to protecting our national leadership. The demand for TEU's capability lead to our successful efforts to not only convince the Army leadership to expand TEU's size, but also realize our vision to establish an overarching operational command to manage CBNRE operations.

The demands of the war on terror for our specialized operational capabilities and scientists plus our responsibilities to secure the nation's eight chemical weapons stockpile sites lead to our establishment of a Homeland Operations division in SBCCOM lead by BG Craig Peterson. The synergy of bringing together the broad range of operational capability and mission experience in the CB-RRT, TEU, and the ARU-CM in one headquarters was immediately apparent and gave us the idea to explore a method to provide the Army a means to overcome existing capability gaps. This was the genesis of the "Guardian Brigade" concept, wherein we conducted an extensive threat and mission analysis of the new CB response requirements – the ability to simultaneously support both the homeland and two Combatant Commands – and designed a flexible, modular organization to meet those needs. This concept received much interest from the senior Army leadership as a way to address complex mission requirements such as that given to the 75th Exploitation Task Force in Iraq. The Army not only approved our concept plan, but also expanded the proposed mission set to include not only specialized CBRN response, but also conventional explosives ordnance disposal. This redesigned effort, initially labeled CBRNE Command, is intended as the Army's single source organization for CBRNE and EOD operations and was formally approved by the Army G3 and stood-up under FORSCOM on 15 October 2004. The new 20th Support Command (CBRNE) will initially consist of the former CB-RRT, the 22d Chemical Battalion (formerly TEU), the 52d Ordnance Group (EOD) and ARU-CM. Approved future force structure consists of a second Chemical Battalion (TEU), a Chemical Brigade headquarters, an Analytical and Remediation Directorate (battalion equivalent), a second EOD Group, three additional EOD Battalions, and other CBRNE-related Army organizations, such as the Asymmetric Warfare Regiment.

Evolution on CBRN Defense – Doctrine

There were a number of shifts in our overall doctrinal approach to CBRN defense during the past decade as a result of our changing view of the threat landscape. These changes also impacted the four components of NBC defense discussed earlier. The first change was in our "definitions." Definitions change over time to reflect the thinking of the day. The terminology of choice a decade ago to categorize nuclear, biological, and chemical weapons was "Weapons of Mass Destruction." WMD is still defined in Joint Pub 1.02 as:

Weapons that are capable of a high order of destruction and/or of being used in such a manner as to destroy large numbers of people. Can be nuclear, chemical, biological, and radiological weapons, but excludes the means of transporting or propelling the weapon where such means is a separable and divisible part of the weapon.

The term "WMD" is a convenient sound bite as opposed to NBC (either the weapons, the broadcast network, or the typical epithet applied to NBC training). However, It also represents our battlefield approach and mindset and did not encompass the full range of the evolving threat. The current Joint definition in Joint Publication 3-11, *Joint Doctrine for Chemical Warfare* is:

All aspects of military operations involving the employment of lethal and incapacitating munitions/agents and the warning and protective measures associated with such offensive operations. Since riot control agents and herbicides are not considered to be chemical warfare agents, those two items will be referred to separately or under the broader term "chemical," which will be used to include all types of chemical munitions/agents collectively.

The term Toxic Industrial Chemicals and Toxic Industrial Materials (TICs and TIMs) began to show-up as we recognized the battlefield and homeland implications of these materials – also because chemical defense equipment and protective gear is neither designed nor capable of the level of protection needed. Within the last several years our doctrinal definition of "chemical" is now changing to encompass all toxic and hazardous materials. While our equipment and protective gear are generally the same as before, this doctrinal shift will now drive the development of next generation technology and materials to provide this capability. Likewise, the realization of radiation threats besides that from detonation of a nuclear weapon gave rise (or in a sense a rebirth) to the "radiological" threat. Thus we have today's more appropriate terminology of CBRN for "Chemical, Biological, Radiological, and Nuclear" defense being integrated into our doctrinal language. Our formal publications will reflect this in the future, which should end confusion.

There were three significant operational changes in our doctrine as well. First, our approach to NBC defense changed from a "Fight and Win" in an NBC environment mindset, where concepts such as sustained fighting under NBC conditions were required, to an emphasis on avoiding engagement in NBC operations if at all possible. Our emphasis on mobility and quick, decisive warfare precludes sustained NBC operations. Secondly, our approach to nations with WMD capabilities is that we will now engage to systematically seek out, eliminate, and disable adversarial capabilities to prevent proliferation. While perhaps this always been an objective to some degree, the proliferation of WMD technology now makes it an operational imperative. Lastly, we have finally recognized that our CBRN defense operations must translate into and comply with the civil support needs and regulations which are much more stringent and demanding. These changes will serve to continue the process of restructuring our training base to include OSHA and related training, especially for chemical Soldiers, but also drive the technology development of required equipment.

Change in R&D and Acquisition Approach

Our approach to research, development and acquisition significantly evolved to better meet changing needs and also to synchronize efforts for the future. During the early 1990s the Chemical and Biological Defense Agency/Command was formed that codified traditional chemical R&D with various NBC program and product management elements and the chemical stockpile program. Later, integration of Natick Soldier System Center lead to the formation of the Soldier and Biological Chemical Command, allowing leveraging of Natick's soldier systems approach and protection technology development to further promote development of NBC protective equipment. Subsequently, our acquisition community centrally organized the Program Executive Offices under a central hierarchy while keeping a link to the various R&D centers. Another key shift was the consolidation of NBC requirements management at the Joint level in the NBC Joint Requirements Office. This development recognizes the truly Joint aspect of NBC defense and has already proven efficient at developing Joint versus Service specific solutions. Despite these efforts we have made relatively slower progress in viewing NBC defense as an integral systemic capability, rather it is generally looked at as a separate type of operation. To overcome this mindset requires a holistic, integrated approach to research and development. The formation of RDECOM is a key step to achieve this endstate. RDECOM now brings together under one command all of the Army's Research, Development and Engineering Centers with a workforce of over 12,500 scientists and engineers across all functional areas and disciplines. Material solutions are no longer stove-piped in individual organizations by function;

rather the full range of science and engineering is now available for focus on a particular problem. The result is elegantly reflected in RDECOM's motto: "Technology to the Warfighter Quicker." RDECOM's ability to quickly respond to warfighter requirements and provide material solutions was proven early during Operation IRAQI FREEDOM. Today, our liaison teams are located in theater and interfacing with Soldiers and units to facilitate this process.

Evolving Technology and Road to Future

The road to the future in warfighting capability, and specifically in NBC defense, is centered in the development of five key technology areas: Nanotechnology, Biotechnology, Advanced Computing, Robotics, and Power and Energy. The Army is a leader in development in these technologies, but what is important is that we understand not what they can do for us, but rather what are the implications? For example, the Army developed the first "computer," ENIAC, which was designed to produce fire control solutions. Our mistake was that we continued to develop this technology for better fire control systems rather than understanding what this new technology is and what we want to do with it. As a result, we are users of IT technology and must change based on the latest technology rather than having the foresight to drive it; being evolutionary instead of revolutionary. Nanotechnology is not just about making things smaller, but there is tremendous potential in areas such as self decontaminating fabrics, advanced medical support, and information systems. Biotechnology is not just about making better vaccines or drugs, but also things such as the development of electronic storage capability, production of biopolymers, or even bio-fuel cells that we "feed" instead of fuel. The role of robotics is clear as enablers, reducing human exposure to highly dangerous missions such as rendering safe an IED; however, eventually we may also extend technology to completely automate logistics delivery, decontamination and other labor-intensive tasks. Advanced computing can not only solve complex engineering questions, but also provide the Soldier on the ground with the ability to process visual and sensory data. Key to many of these revolutionary technologies is resolving the power and energy requirements. We must be able to store sufficient energy to generate the power required. Here again we will require the Army's full breadth of science and engineering. RDECOM stands to be the centerpiece of this endeavor.

Summary

The conventional and asymmetric threats and hazards of a CBRN event are not new, yet our focus and approach to them arguably changed dramatically over the past decade. A more holistic approach to the CBRN threat and corresponding evolution in doctrine, policy, and response capability dictated urgent advanced technology requirements. This need required fundamentally changing the way the Army managed its research and development efforts in order to quickly get technology in the hands of the warfighter. The Army and nation can be viewed as successful in adapting to the changing CBRN defense environment, yet significant shortfalls still exist. Fortunately Army transformation of research and development is bridging that gap today while setting the conditions for developing next generation, integrated technology solutions to overcome these shortfalls.

Major General (MG) Doesburg is the Commanding General of the United States Army Research Development and Engineering Command. He has a B.S. in Chemistry from the University of Oklahoma and a M.S. in Military Science from the US Army Command and General Staff College. MG Doesburg is the former Commander of the US Army Soldier and Biological Chemical Command, Aberdeen Proving Ground, Maryland. He was also the Director, Joint Program Office for Biological Defense and the Chief, Chemical and NBC Defense Division, Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans.

Lieutenant Colonel (LTC) Steiger is MG Doesburg's Executive Officer. He has a B.S. in Chemistry from Syracuse University, and a M.S. and Ph.D. in Chemistry from Georgia Institute of Technology. LTC Steiger was the G-3, US Army Guardian Brigade. He is also a former Commander of the Chemical-Biological Rapid Response Team.

Robotics.

Changes in the Nuclear and NBC Defense Environment and United States Army Chemical School's Corresponding Contributions

BG Stan Lillie
United States Army Chemical School, Commandant

Several key events over the last fifteen to twenty years have not only shaped our world and Nation, but are the drivers for how the Army and the Chemical Corps presently conduct business. The educational process, in several cases, has come at great expense, but the lessons learned will help shape our actions for the future.

Until March 20, 1995, when members of the Aum Shinrikyo cult entered the Tokyo subway system and released the deadly nerve agent sarin, most would not have thought homeland security was a necessity. However, this attack killed 12 people and injured thousands and, coupled with other deadly events, such as the 3,800 people killed from a Methyl Isocyanate leak in Bhopal, India in December 1984, brought security and consequence management into focus.

Consider the collapse and breakup of the former Soviet Union in December 1995, terrorist attacks on the United States (US) on September 11, 2001, and the anthrax attacks that followed in September and October of 2001. The thought of a chemical, biological, radiological or nuclear attack has become an unfortunate reality.

What other tragedies from history could revisit our future at home or on the battlefield? On April 25, 1986 the world's worst nuclear power accident occurred at Chernobyl resulting in radiation being spread across Northern Europe. This awakened the world to the possibilities and realities of nuclear fallout. The sudden acute respiratory syndrome epidemic, first reported in February 2003, spread rapidly throughout an increasingly globalized and interconnected world. It is also possible to imagine terrorists targeting a military chemical munitions storage activity or an industrial chemical production facility (industrial or military).

CBRN Reconnaissance

With a growing Soviet threat, the Chemical Corps in the 1980s, realized the need for an NBC reconnaissaince platform that could potentially eliminate a unit's unwarned encounter with contaminated terrain. In support of Operation DESERT STORM, we fielded the XM93 "Fox," a German produced, highly mobile armored carrier, equipped with nuclear and chemical detection as well as warning and sampling equipment. The Fox continues to be our work horse, but with the Army's transformation, technological advances, and operational needs, we are upgrading our nuclear biological and chemical (NBC) reconaissance capability.

The Army is currently developing the Stryker Nuclear, Biological, Chemical, Reconnaissance, Vehicle (NBCRV). For the first time, US forces will have a true NBC detection capability on one platform with three NBCRVs in each Stryker Brigade. The NBCRV will provide chemical vapor point and standoff detection and chemical identification capability while stationary or on the move. It will also have a stationary point biological detection and identification capability and a nuclear/radiological detection capability. The NBCRV will also be C-130 transportable, which the current M93A1 Fox is not.

Biological Detection

At the time of DESERT STORM, available biological detection capabilities were very limited; however, over the last several years we have fielded several new biological detection capabilities. Chief among those are the Biological Integrated Detection Systems (BIDS). The BIDS, first fielded in 1996, provided the world's first battlefield integrated biological detection capability. We are now fielding our third generation BIDS, the Joint Biological Point Detection System (JBPDS). The JBPDS provides a more automated biological agent point-detection, collection, and identification capability for both fixed-site and mobile operations.

This system automatically detects, alerts, collects, and identifies agents simultaneously in less than 20 minutes. Additionally, we have fielded the Joint Portal Shield network sensor system, which provides the same capabilities as the BIDS for fixed sites. These systems provide presumptive analysis of suspect aerosolized biological warfare agents (BWA).

An urgent need for lower echelon units (i.e., Battalion or Brigade) to have BWA detection capabilities has led to the recent fielding of a smaller, more simple BWA collection system, the Dry Filter Unit (DFU). This system continuously collects aerosolized particles and requires operators to manually prepare a sample to be tested with the Hand Held Assay for presence and identification of suspected BWA contamination. Although the system is not automatic, the DFU is more versatile than the BIDS, being able to collect a sample inside buildings as well as outside. An added benefit is the DFU does not require specialized training, although operators do need training to ensure proper technique is used to eliminate contamination of the sample.

Although these systems are a great advancement for the Chemical Corps in its mission to protect warfighters from the emerging BWA threat, technology has limited us to "detect-to-treat" capabilities. In comparison with the immediate effects of chemical warfare agents, most BWAs have an incubation period that affords the infected warfighter and medical personnel hours, days, or weeks to begin treatment. Our ultimate goal is to field a biological detection system with "detect-to-warn" capabilities to provide the time necessary to effectively treat exposed personnel.

The widespread nature of today's battlefields, from fields and mountains to caves and cities, is shifting our detection requirements from large BWA aerosol releases to smaller point releases that would most likely be used in urban environments. This requires a system that is light, small, mobile, and simple to operate. This protection will help ensure a decisive win regardless of where we fight.

Doctrine

Chemical defense doctrine continues to evolve to meet evolving chemical, biological, radiological, and nuclear (CBRN) threats, in particular the CBRN threats faced in the war on terrorism.

We currently have published or are writing four new field manuals (FMs) that deal with the response and management of CBRN events. FM 3-11.21, *NBC Aspects of Consequence Management*, and FM 3-11.22, *CBRN Response in Support to Incident Management* were published in 2001 and 2003 respectively. FM 3-11.23, *CBRN Responder Operations Handbook* and FM 3-11.XX, *CBRN Incident Control Handbook* are currently being written.

Additionally, FM 3-11.14, *NBC Vulnerability Analysis*, was recently revised to assist in CBRN defense analysis during the Intelligence Preparation of the Battlefield process. Highlighted in the revised manual are chemical warfare agents, toxic industrial material, and release other than attack – issues which can quickly degrade the warfighters' combat effectiveness.

Decontamination

Our decontamination doctrine and systems are outdated, relying upon the same aqueous-based technology introduced over four decades ago. This decontamination process is very time and resource intensive.

We must capitalize on current and future technologies in order to rapidly move forward toward decontamination agents that reduce the logistical burden, react rapidly and more effectively to neutralize and remove contamination, and reduce the risks to our Soldiers, equipment, and environment. Our programs are doing just that.

Over the past five years we have made significant strides in improving our decontamination capabilities and the next five years will see even more significant improvements. We have fielded the M100 Sorbent Decon System across the entire Army, eliminating the logistics burden of both the M11 and M13. For Operation IRAQI FREEDOM, we fielded the Karcher Multi-Purpose Decontamination System (MPDS) in order to fill large shortfalls in the availability of the M17 Light Decon System (LDS). The MPDS provides the Warfighter with an expanded capability that is more reliable and easier to use than the M17. We are actively engaged in future decontamination system development through the Joint Service Personnel/Skin Decontamination System (JSPDS), the Joint Portable Decontamination System (JPDS), the Joint Service Transportable Decontamination System (JSTDS), the Joint Service Sensitive Equipment Decontamination System (JSSED), and the Joint Service Platform Decontamination System (JPID). The JSPDS, JPDS, and JSTDS programs will provide the Army with improved capabilities to conduct skin decontamination; immediate, operational, and thorough decontamination missions. The JSTDS, JSSED, and JPID programs will provide us with new capabilities to effectively conduct fixed site, terrain, interior and sensitive equipment decontamination operations.

We are also developing a robotic decontamination demonstration at the Chemical School to determine if robotics will improve the effectiveness and efficiency of decontamination operations while simultaneously reducing the inherent risks to the Soldier. We are making great strides, along with the other Services, to improve decontamination, and we will continue to make even bigger strides in the future.

Obscuration

Obscurant use, as a means of protecting Soldiers from harm and screening friendly actions from the enemy, is as old as warfare itself. As a joint force multiplier, visual obscuration has been employed extensively since World War II using fuel-driven smoke generators for large area obscuration. During recent combat operations, the individual Soldier relied on self-employed obscuration methods, such as smoke grenades and vehicle-launched obscuration systems. Their current use across the full spectrum of conflict clearly illustrates that obscurants remain a relevant combat multiplier in the 21st Century.

The value of obscuration is not limited to ground forces. Maritime forces can use obscuration to conceal over-the-shore operations as well as conceal their ships to deny anti-ship missile acquisitions. Airfields (through the use of obscuration at both actual and deception areas) remain under a blanket of obscurants to shield rearming operations.

Obscuration is a non-lethal option able to achieve effects otherwise unavailable to the friendly force commander. For example, obscurants could safeguard a ground unit moving through a city. By defeating threat target acquisition efforts, obscurants could deny effective, observed fire from a sensitive area without inflicting excessive collateral damage. Kinetic effects present a less viable option to the commander in an environment congested with non-combatants. Obscuration could provide the suppression effect the commander required without the destruction of lethal fires. In this case, obscuration may be far more efficient than high explosives.

Counter sensor operations will be of immeasurable value to the Future Force. The Chemical Corps' ability to provide full-spectrum obscuration to the Unit of Action (UA) and Unit of Employment (UEy) through both the integrated obscuration capability on the Future Combat System and through obscurant unit augmentation at the UEy level, is limitless. Future obscuration payloads on manned and robotic systems will be quickly exchangeable with other payloads, providing surge capability and maximizing the utility of assets on the ground should obscuration be needed. In our Future Force, the user identifies the target and effect desired as automation provides the optimal solutions based upon terrain, weather, and time. The key to effective obscuration operations will be balancing obscuration with other signature reduction means to achieve full dominance of the electro magnetic (EM) spectrum.

Obscurants remain a key combat multiplier in the future. On demand and on target, obscuration remains relevant to the Future Force. Obscuration provides an invaluable advantage against enemies attempting to leverage an asymmetrical advantage through an aggressive control of the EM spectrum and the denial of enemy target acquisition process.

Individual Protection

The near term future fielding of enhanced individual protection equipment (IPE) will provide our warfighters with improved protection and flexibility in a CBRN environment. Our warfighters will obtain increased tactility, dexterity, and comfort that will also help sustain the fight in a CBRN environment with reduced logistical requirements.

Capturing maturing IPE technologies, the green vinyl overgloves will be replaced with the Joint Block 2 Glove Upgrade (JB2GU). The JB2GU will provide the wearer with enhanced dexterity and tactility, a 30-day wear time, and 24 hours of protection in a contaminated environment. The Alternative Footwear Solutions (AFS) will replace the black vinyl overboots. The AFS will provide the wearer with a 45-day wear time and 24 hours of protection in a contaminated environment.

The Joint Service General Protective Mask (JSGPM) will replace the M40/42 Protective Mask series. The JSGPM will provide the wearer with enhanced respiratory protection against emerging new CWA threats. Additional capabilities are enhanced visual field-of-view; communications (audible face to face up to 3 feet); lower breathing resistance; and the ability to change out filters in a contaminated area.

The Nuclear, Biological, Chemical Environment Personal Hydration System (NEPHS) will replace the two quart canteen warfighters are currently using. The NEPHS will provide the capability to draw water from untreated sources and the water purification unit attached to the CBRN hardened liquid reservoir will filter specified CWA. The NEPHS will also provide the ability to hydrate virtually hands free while on the move in either a contaminated or uncontaminated environment. The

NEPHS is currently undergoing research and development.

Personnel

To facilitate reaching our goal of a 21st Century Chemical Warrior, our initial entry recruitment strategy for officers has changed dramatically. We are now targeting our recruitment program towards skill sets that we can build on and continue to shape throughout an officer's career.

Previously we recruited officers from the total pool of available Reserve Officer Training Corps (ROTC) cadets. This provided us an opportunity to access lieutenants who were well rounded in academics, physical fitness, and leadership abilities, but not necessarily from the science, math, and engineering majors. We have recently changed our recruitment goals to target ROTC cadets who are not only physically fit and display sound leadership skills, but also those cadets who have the technological degrees we desire.

The new emphasis on science, math, and engineering majors is a direct result of the modernization and technical nature of the Chemical Corps mission. Officer Candidate School graduates and cadets who are branched into the Chemical Corps can expect to be exposed to scientific and mathematical disciplines once they have reported to the Chemical Officer Basic Course. Once these officers start their Chemical Corps career, they will have ample opportunities to draw on their technical backgrounds and apply that knowledge in operational assignments.

The Chemical Corps will continue to revise the skill sets for enlisted Soldiers. The skills that were taught for the "Cold War" mission are not relevant for the 21st Century Dragon Soldier. Our plan is to migrate as many of those specialized skills as possible from our technical courses (i.e. Technical Escort, Chemical/Biological/ Radiological/Nuclear Response) to the Initial Entry Training for our enlisted Soldiers. This will help to facilitate a 21st Century Chemical Warrior trained and experienced in all aspects of CBRN defense.

Training

New, state-of-the-art training facilities were planned, constructed, and opened for business when the Chemical School moved to Fort Leonard Wood in 1999. New training at Fort Leonard Wood included second-generation Fox and the Preplanned Product Improvement M31A1 Biological Integrated Detection System in custom-built simulator training areas. Decontamination training began in the new Alan A. Nord Hall that allowed power-driven training indoors during inclement weather. The Maxwell Thurman Hall contained purpose-built conventional, small group, and digital classrooms capable of sending and receiving computer-based and televideo instruction. A new Chemical Defense Training Facility and a Chemical Corps addition to the Fort Leonard Wood Museum rounded out the major facilities.

Mid-1990s Chemical School training provided the field with chemical Soldiers, noncommissioned officers and officers ready to fight in full-scale NBC warfighting environment. There was limited training for non-traditional warfighting missions such as the Chemical Weapons Inspections or the Chemical & Biological Countermeasures course that was available for civilian fire-rescue and law enforcement personnel.

Officer training has been greatly influenced by experiments to improve the educational experience. Efforts to combine field and command post exercises with the Engineer and Military Police Schools have had success. The Captains Career Courses currently combine for a computer-driven simulation. Other experiments combine Captains and Lieutenants together for field training exercises.

Evolving Missions - Homeland Security

In 1999, the Department of Defense began standing up National Guard Weapons of Mass Destruction Civil Support Teams (WMD-CSTs). These teams have a mission to:

- ■ assess a suspected nuclear, biological, chemical, or radiological event in support of the local incident commander,
- ■ advise civilian responders regarding appropriate actions, and;
- ■ facilitate requests for assistance to expedite arrival of additional state and federal assets to help save lives, prevent human suffering, and mitigate great property damage.

The Chemical School now has the mission to train the WMD-CSTs. The Chemical School conducts the qualification training for these teams in the new Civil Support Skills Course. The course is an integral part of the CST-WMD team requirements for validation of mission capability. This training has expanded to provide instruction consistent with National Fire Protection Association 472 Standards and 29 Code of Federal Regulation 1910.120. Additionally, we are continuing to integrate this training into all of our professional courses to provide chemical Soldiers with the skills necessary to properly respond to the full range of CBRN hazards, which include the CBR warfare agents and industrial hazards.

Our challenge in developing a plan for Installation Force Protection is to protect our Soldiers, their families, and our civilian partners working at our facilities. In protecting an installation and all of its resources from the devastation of a CBRNE incident, we have a clear objective; stop a CBRNE incident before it occurs. We also must respond quickly and efficiently in the event an attack occurs. We do not have a "cookie cutter" solution for our installations. Innovations in our planning, doctrine, and training will give our commanders the best tools to protect our power projection platforms and facilities.

In March 2005 we will begin construction of the Department of Defense CBRN Responder Training Facility at Fort Leonard Wood. This facility will provide state of the art training for domestic CBRN response operations and will include training for interagency responders. Some of these responders include Installation Support Teams, National Guard WMD-CSTs, and other chemical assets from the active and reserve components that have a mission of protecting our facilities and the homeland. The new facility will provide an additional 42,000 square feet giving us seating for 150 students, a 70+ seat after action review auditorium, administrative space for the staff, and a maintenance area. The highlight will be training ranges with cameras to oversee the students, record actions, and provide operational control as would be seen in response events. The facility will also provide opportunities for reconnaissance, survey, sampling, and decontamination both in buildings and outdoors. We will partner with our firefighters to use and improve existing confined space training areas and take advantage of already developed training programs.

Transformation

The Army is in the process of transforming from a division-based organization into modular, combined arms, Brigade Combat Team (BCT) based force. Two years ago the Chemical Corps initiated a restructuring initiative to become a modular, multi-functional, and full-spectrum combat enabler. Single function platoons provide CBRN reconnaissance and surveillance, decontamination, and multi-spectral obscuration. Companies integrate the platoon capabilities to provide CBRN support from the BCT through the ports of debarkation. Battalions continue to integrate chemical companies supporting the UEx and UEy in the battlespace.

Looking back on our accomplishments, I am astounded! The Chemical Corps has made great strides toward becoming a true combat multiplier for the Combatant Commander and an integral part of the defense of the Homeland. The capability of our detection and protective equipment has greatly increased and our chemical Soldiers are much more technically competent than they were only a few short years ago. I am sure that we will continue to make great strides thanks to the dedication and hard work of so many Chemical Corps Soldiers, noncommissioned officers, officers, DA civilians, and contractors. I expect future achievements by the men and women of the Chemical Corps will equally amaze me.

Brigadier General Lillie is the Chief of Chemical and the Commandant of the United States Army Chemical School. He has a B.S. in Biology from Middle Tennessee State University and a M.S. in National Resources Strategy from the National Defense University. He is also a graduate of the Industrial College of the Armed Forces.

Over the past five years we have made significant strides in improving our decontamination capabilities and the next five years will see even more significant improvements.

Personal Perceptions of Current Nuclear Issues

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This article represents the opinion of the author and does not represent the official views or position of the Army or Department of Defense.

For the United States Army Nuclear and Chemical Agency's (USANCA) 10th anniversary issue of *NBC Report*, I am giving my perceptions of current Department of Defense (DoD) attitudes toward the use of nuclear weapons and the survivability of our Armed Forces against nuclear threats. Though these are only my perceptions, prejudiced by 50 years of experience in this business, it is important to recognize that perceptions, in our nation's capital, can be as important as facts and just as damning.

I would like to first review some of the historical background and then address the changes that I have seen, and continue to see, since the end of the Cold War. I must caution the reader that I am not privy to all that is going on in this field at the present time, but there are some indicators that I find encouraging and others that are worrisome, all of which warrant careful consideration.

Background

Since Operation TRINITY in 1945 until 1992, the United States Atomic Energy Commission (AEC), now called the National Nuclear Security Agency (NNSA), conducted nuclear tests to validate the designs and safety aspects of nuclear weapons.

In 1946, the Manhattan Engineering Division began experiments to investigate the effects of nuclear weapons, both from an offensive and defensive viewpoint. In January 1947 the Armed Forces Special Weapons Project (AFSWP) became the agency of the United States (US) DoD that coordinated all of the DoD nuclear weapon effects testing. Early work emphasized blast and thermal effects on civilian and military structures, ships and military weapon systems, as well as nuclear radiation effects on biological systems. In the investigation of these effects at the Nevada Test Site (NTS) and the Pacific Proving Ground (PPG), the relative importance of other nuclear weapon-produced phenomena came to light. Among these were;

- Enhancement of the earth's Van Allen Radiation Belts by high altitude detonations,
- Ionization effects of X-rays (Thermo-mechanical and Systems Generated Electromagnetic Pulse (SGEMP)),
- Radio propagation disturbances,
- Electromagnetic Pulse (EMP), and
- Transient Radiation Effects on Electronics (TREE).

After the signing of the Atmospheric Test Ban Treaty in 1963, the study of some of these phenomena was reduced to using simulators, all of which were very useful but with some compromise in fidelity. One such simulator was the underground nuclear test (UGT). The UGT was viewed as a simulator since the nuclear device detonated was not an operational weapon and the confined real estate was not representative of a true tactical nuclear environment. However, this form of test had value in studying the effects of high energy coupling to mechanical systems and in assessing the response of military electronic pieceparts, components, and systems to nuclear radiation. It did provide a mixed environment of X-rays, gamma rays, and neutrons.

Other forms of simulation were provided by the use of conventional high explosives, thermal radiators, radio frequency (RF) radiators, and nuclear radiation sources such as linear accelerators, pulsed nuclear reactors, and flash X-ray (FXR) machines. The former Defense Nuclear Agency (DNA) (a descendent of the AFSWP and now an element of the Defense Threat Reduction Agency (DTRA)) was the pioneer agency in developing some of these simulators and placing them in Service laboratories and in the industrial laboratories where some of them were designed. Much of this work built on early work by the Plasma Physics Division of the Naval Research Laboratory.

One FXR machine, AURORA, was designed to provide the equivalent of high gamma radiation fluence over a large area for the testing of military electronic sub-systems. It was situated at the U.S. Army Harry Diamond Laboratories (HDL) at White Oak, MD. Another FXR machine, CASINO, was placed at the Naval Surface Weapon Center (the former Naval Ordnance Laboratory), also at White Oak, to examine the effects of X-radiation on space systems. Pulsed nuclear reactors were situated in many laboratories, including the former Harry Diamond Laboratories, the White Sands Test Facility, and Aberdeen Proving Ground.

EMP simulators existed at the HDL Woodbridge Virginia EMP research facility, the White Sands Test Facility, the former Air Force Weapons Laboratory (now the Air Force Research Laboratory) in Albuquerque, New Mexico, the Naval Surface Weapon Center laboratories in Dahlgren, Virginia, and Solomon's Island, Maryland.

The former DNA and its current successor, DTRA, acted as the DoD center of excellence for nuclear weapon effects (NWE) and the "conscience" that would "sound the alarm" when nuclear survivability was given insufficient attention by a Service Systems Project Office (SPO). It was an agency that anticipated the needs of the Services long before they recognized the need themselves, and conducted the research and development (R&D) to have the necessary technology in place when it became required. The DNA was the close confidant of the Office of the Secretary of Defense (OSD), the former Strategic Air Command (SAC), the Joint Strategic Target Planning Staff (JSTPS), and all of the unified commands.

Much of the strength of this agency was derived from the collegial relationship it maintained with the Service laboratories that were engaged in NWE R&D. These laboratories were called upon to provide chairmen and members of working groups to advise the DNA project officers on their research programs. The simulators built by DNA were placed at Service laboratories to encourage the sharing of data among the different Services. Many individuals who were "trained on the bench" came to DNA to fill positions on the staff.

A Global Change in National Security

At the close of the Cold War in 1991, the population of the US was elated over the lessening of the threat of annihilation in a nuclear exchange with the Soviet Union. Congressional representatives, in response to their constituency, sought to exploit the "Peace Dividend" by moving away from R&D associated with nuclear offense and defense and diverting the support to other fields.

The Services saw a lessening of the need for new strategic nuclear weapon systems after 1991 and their stated requirement for nuclear survivability slowly declined, along with that for new offensive weapons. This reduction of both offensive and defensive nuclear emphasis in the US Armed Forces initiated a major decline in qualified military and civilian personnel, since work in this area is no longer considered career enhancing. It is even becoming impractical for the few specialists who choose to remain in the field since the reduced level of funding does not allow a sufficient level of the new R&D required to assure the survivability of military systems.

The R&D investment in nuclear survivability and lethality has been decimated despite the continuing need for design and assessment of:

- New semiconductor integrated circuits,
- Upgrades to existing weapon systems,
- New sensitive optical and solar energy components and advanced signal processing circuits for satellites.

There is also a serious need for strong efforts to improve the understanding of nuclear phenomenology, particularly in the area of high altitude nuclear effects. Codes that are used to predict the enhancement of the electron belts have large uncertainties in their outputs and these uncertainties require unnecessarily large safety margins in the design of space systems.

Today, the United States Strategic Command (USSTRATCOM) and other commands have shifted from DTRA to the NNSA laboratories for NWE advice. In fiscal year (FY) 1983 the DNA budget for NWE was more than $250M: the DTRA NWE budget for FY 2004 is around $62M in 1983 dollars, of which approximately 50 percent is for hardened electronics. I realize that DTRA must address many more threats than the nuclear threat, but I seriously question the apportionment of the funding within the nuclear area.

Almost all of the nationally recognized NWE experts have left the DTRA and efforts to recruit new trainable scientists and engineers are almost non-existent. The Service laboratories are no longer a source of experienced recruits since the NWE programs at the laboratories have also atrophied to almost nothing.

I am not privileged to see the DoD agenda that produced this decline in the NWE programs at DTRA, but it is totally clear to me that it could not have happened accidentally.

In 1992, the United States entered a nuclear testing moratorium that remains in effect at this time.

There are attempts to compensate for the lack of an UGT program by the use of constrained design, above ground laboratory radiation facilities and computer analyses. However, contemporary integrated circuit design is moving to ever-decreasing architecture size which makes an accurate analysis of radiation response very difficult. I believe that a proper program in this area should exploit three important areas; hardened circuit technology, laboratory testing, and advanced computing techniques. They should be regarded as a coordinated package in which each of the three could be used as a check against the others.

Newly Emerging Threats

The Cold War threat is long over, but there are now nuclear threats from much less predictable adversaries than those that existed in the past. At this time there are eight declared nuclear weapon states, three suspected states and 12 states formerly possessing or pursuing nuclear weapons. Some of these nations could potentially pose a threat to the US, either directly or by selling weapons to another nation or terrorist group.

There is concern that a relatively small "dirty" weapon could be detonated in a densely populated area as a terrorist attack with serious consequences. This radiation threat, although beyond the experience of the average American citizen, can be visualized, at least by those who are familiar with the Three Mile Island or Chernobyl incidents. Other contemporary nuclear threats are more subtle, far-reaching, and more difficult for the general public to comprehend.

A hostile adversary could use a nuclear weapon to blackmail the US or "to level the playing field" when threatened by the US or our allies. An EMP attack on an expeditionary force could burn out unhardened military electronic equipment and place it at a strong disadvantage from loss of communication and battlefield situational awareness. Moreover, the same high altitude burst could destroy low earth orbit (LEO) satellites either by direct irradiation or by enhancement of the earth's radiation belts. If the adversary is not technologically advanced or he is prepared to temporarily exist in such an environment, he could fire the weapon over his own territory and claim that it was only a nuclear test. The selection of an appropriate retaliatory response from the United States would not be an easy task.

The congressionally chartered *Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack* concluded that the US power grid, telecommunications system, banking system, and fuel delivery systems are at risk. A concomitant investigation of collateral damage to satellite systems from such an attack, or even from EMP attacks of foreign powers on each other, showed that all satellites in LEO could be at risk.

One atmospheric nuclear test, STARFISH PRIME, clearly demonstrated the threat. When the US detonated the 1.4-megaton device on 9 July 1962 at 400 km altitude, a total of 21 satellites were in orbit or were launched in the following weeks. Eight suffered radiation damage that compromised or terminated their missions. Neither US intelligence services nor the Soviet Union released information for the remaining 13 satellites, so information on their fate is not available.

In many respects, satellites of the 1960s were relatively robust against nuclear effects. Their bulk and comparatively low-speed operation tended to make the electronics of the era substantially less vulnerable to radiation upset and damage than modern electronics at comparable exposure levels.

STARFISH PRIME also burned out electrical streetlights in Hawaii from the EMP effect. Recent disclosures by the Russian government indicate that there was damage to power transmission lines from their high altitude nuclear tests as well.

Mitigating the New Nuclear Threats

<u>Proposed Redesign of the Nuclear Arsenal</u>

The population of the US is under the mistaken impression that our nuclear arsenal is far greater than what is necessary to deter any hostile threat. In fact, we are self-deterred since the large weapons in the US arsenal were designed for the old Mutually Assured Destruction (MAD) concept of the Cold War. The current US policy is to not design or test nuclear weapons in spite of the fact that other nations have taken a much more liberal interpretation of "zero yield" in their compliance with the test moratorium.

There is discussion, within some circles, of the redesign of our nuclear arsenal to include smaller more useful weapons, such as "bunker busters," but this is a highly controversial issue. There are those who believe that any initiative to reactivate our nuclear weapon production infrastructure would serve as a justification for other existing or "would be" proliferents to produce and test nuclear weapons. At this time, there are at least ten countries that have built and tested nuclear weapons regardless of the US position and some will be no more deterred from using nuclear weapons than they are deterred from beheading or blowing up innocent civilians.

A recent study of blast-producing weapons concluded that some modern conventional weapons, with precision guidance and enhanced energy release, could easily replace some nuclear weapons. This is certainly true, but nuclear weapons are "political weapons" and they are intended more for deterrence than preemptive attack. In my opinion, the United States nuclear arsenal cannot deter contemporary threats since our nuclear weapons are too large and less sophisticated than they should be.

In assessing the current unstable security situation throughout the world, it becomes very difficult to find an appropriate deterrence to every hostile act. This is patently obvious for the Middle East and possibly for any other region. Restraint on the part of the US does not guarantee restraint by all of our adversaries. Terrorists enjoy the ability to hide within many countries, including our own, and targeting them carries the risk of collateral damage to the innocent.

I see a tendency on the part of American politicians to equate nuclear survivability with the possession of a nuclear arsenal. I believe that it is flawed logic to assume that a lack of nuclear survivability will encourage nuclear disarmament.

<u>Deterrence through Survivability</u>

The issue of nuclear survivability has always been a "side issue" in discussions of a nuclear test ban. Verification of the safety and reliability of nuclear weapons was the major argument in favor of nuclear testing since our nuclear weapon stockpile was considered our deterrence. Insufficient consideration was given to the premise that survivability is also a form of deterrence that should be demonstrated in a nuclear test. The MAD policy was to be able to respond with a massive retaliation after surviving a nuclear attack and this was based upon the clandestine nature of our strategic assets such as the submarine launched ballistic missile (SLBM) force. Since MAD is no longer credible as a deterrence strategy, the importance of having credible nuclear survivable systems increases significantly.

The modern ground force makes high use of modern electronic technology that is, indeed, a force multiplier. However, one should ask if the warfighter is prepared to continue the campaign if his electronic systems suddenly disappear. Certainly, cost-effective survivability measures should be employed to the maximum extent, but ground forces should be constantly exercised without their electronic systems to foreclose surprise and chaos in the event that the systems are lost.

For want of appropriate deterrence against contemporary nuclear threats, we should place more emphasis on survivability. If hardening our high priority assets, be they military or civilian appears too costly, the decision to harden should be made after careful consideration of both the probability of attack vs. the regrets. Survivability of a system is derived from many factors: hardening, shielding, prudent design, and tactics. The important issue is, that for systems considered crucial to our civilian or military infrastructure, the builder (e.g., SPO) should be required to implement the necessary steps and demonstrate how the survivability will be assured.

There are some signs of an awakening to the changing contemporary nuclear threats faced by the United States. The report of the congressionally sponsored EMP Commission is receiving wide exposure. The Air Force is reexamining the role of its satellites and is formulating a plan to redress the vulnerability of these systems wherever appropriate.

Conclusions

There are many threats other than nuclear that must be addressed, and the defense budget must be spread over many operational and R&D items. My only concern is that important threats may be ignored due to a false sense of security, a lack of appreciation of the threat, and a flawed set of priorities.

Dr. Conrad received his Bachelors degree from the University of California (Berkeley) and his Doctorate from the University of Maryland. He is a Fellow of the Institute of Electrical and Electronics Engineers, Inc. and has been awarded the DoD Distinguished Civilian Service Medal, the DNA Outstanding Service Medal, the DTRA Lifetime Achievement Award and the Peter H. Haas Award.

He entered the nuclear weapons effects field in 1956 providing and analyzing test samples of electronic materials that were exposed in several atmospheric nuclear test series and in innumerable underground nuclear tests. He was the Technical Director of the DoD nuclear PIN STRIPE event. As a Solid-State Physicist and Nuclear Engineer, he has performed research in the area of ionization effects in dielectric materials. He was an Associate Technical Director of the former US Army Harry Diamond Laboratories and Deputy Director (Science and Technology) of the former Defense Nuclear Agency. He was a Vice President of Kaman Sciences Corporation for 10 years after retirement from government service.

He is the Domain Coordinator for Ionizing and Electromagnetic Radiation Effects within the DTRA Weapons Effects Test Information (WETI) data archival program. Throughout *his career he has served as an adviser on nuclear survivability and lethality to numerous military commands, weapon system developers, DoD agencies, Deputy Secretaries of Defense, and Congressional staff members.*

Dr. Conrad is currently assisting the Institute for Defense Analyses in recommending a survivable and secure national space satellite architecture. He recently completed a paper for a congressionally sponsored commission to examine the concomitant nuclear radiation effects on satellites that can occur as a result of an EMP attack.

There is concern that a relatively small "dirty" weapon could be detonated in a densely populated area as a terrorist attack with serious consequences.

Fifty Odd Years of EMP

Dr. Conrad L. Longmire

This article represents the opinion of the author and does not represent the official views or position of the Army or Department of Defense.

The invitation to write a paper for this 10th anniversary issue of *NBC Report* came to me at an opportune time. I have received a copy of the Executive Report of the Electromagnetic Pulse (EMP) Commission, and I want to do what I can to support the goals established by the Commission. In this paper, I present a short history of the observations of the phenomenon of EMP, of our efforts to understand and predict it, and of some attempts to design electrical and electronic systems that would not be damaged by it. Based on my personal experiences, mostly in developing the physical theory of EMP and "calculational" techniques for predicting it, I make some recommendations for further work in these areas, which have been neglected for the last decade. I also comment on changes needed in the governmental management structure for EMP in order to preserve and revitalize EMP science.

The Early Years, 1945 to 1960

After I arrived in Los Alamos in August 1949, I worked mostly on weapon design for approximately the first five years, and then on the plasma physics associated with the controlled fusion (Sherwood) program. While this work provided a good background for all of the weapon effects studies that began about 1960, I did not become familiar with the subject of EMP phenomena until that time. The pre-1960 EMP experiences of J-Division, the Los Alamos test division, were related to me by John Malik, the experimental physicist who made most of the measurements of gamma rays from nuclear tests.

From the very first test (in July 1945) on, EMP effects were always a threat for experimenters trying to record weapon performance data electronically. With bunkered and electrically shielded apparatus, data could be recorded successfully, but the power supplies used to convert alternating current (AC) to direct current for the vacuum tubes would be burned out after the event. This problem was avoided by eliminating the AC power lines running into the bunkers and using local batteries instead. Another problem was that miles of coaxial cable running from the bunkers to control stations farther away were invariably not reusable due to multiple punctures of the insulation.

Malik also showed me the results of many measurements of the EMP signal radiated to distant observers by the surface or near-surface bursts of that era. The waveforms observed were similar to those that would be radiated by the damped oscillations of a suddenly imposed charge on the outside of a conducting sphere, the radius of which was comparable with what one could estimate for the region of highly ionized air near the explosion. Because the gamma dose from larger device yields would ionize larger regions, the period of the oscillations could be used empirically to get a rough estimate of the yield. Disappointingly for the experimenters, the rising part of the waveforms contained no apparent evidence of an exponential rise similar to that of the fission reaction.

In a test during Operation PLUMBBOB in Nevada in 1957, Peter Haas of the Diamond Ordnance Fuse Laboratory attempted to measure currents induced in wires buried in the ground in the close-in region, i. e., under the ionized air sphere. EMP disrupted most of the measurements, but he did record peak wire currents at several distances from the burst. This was the only data on EMP in the close-in region that was available in 1960.

EMP and Minuteman

In 1960, questions were raised about possible damaging effects of EMP on the Minuteman system, which was in development at that time. This system was supposed to be able to launch retaliatory missiles after being subjected to nuclear attack. It was suggested by Peter Haas and by British nuclear scientists that a large nuclear burst in the missile farms could expel the geomagnetic field from a large volume of air and ground, rapidly changing the magnetic flux linking the intersite cable system. This would induce currents in the cables that might be large enough to burn them out, preventing the retaliatory launches.

To look into this possibility, the system contractor formed a committee, of which Benjamin Sussholz was the secretary. Its membership included a general, several colonels, corporation vice presidents, many engineers, and some experimental physicists, all very practical and responsible people who could fix the system if they knew what the threat to it was. There were also three theoretical physicists—Richard Latter and William Karzas of the Rand Corporation's Physics Group, and myself. Practical is not an adjective often applied to theoretical physicists, who may not be able to make any real apparatus work. But we knew enough atomic physics to estimate the currents and electrical conductivity that would be induced in the air by the gamma rays from a nuclear burst, and we knew how to solve Maxwell's equations for the electric and magnetic fields that would be generated. Latter and Karzas, working together at Rand, and I at Los Alamos, came to the same conclusion: an outward flux of Compton recoil electrons driven by gamma rays from the burst would indeed tend to push the geomagnetic field out, but the electrical conductivity resulting from intense ionization of the air would oppose and greatly reduce the movement of the geomagnetic field. Widespread burnout of the inter-site cables should not occur. However, there would be some leakage of signals through the cable shields to the inner wires, which could cause damage or upset to sensitive circuitry, a problem the system's electrical engineers should be able to handle.

In this connection, the peak-current data obtained by Haas in PLUMBBOB was useful. I presented an analysis of this data based on the assumption that the current was driven by the radial electric field generated by the Compton current, rather than by geomagnetic field changes. From this model it followed that the peak current was approximately proportional to the square root of the gamma-ray dose. This result was in agreement with the experimental data, and provided a rule for scaling to higher yields.

Thereafter, hardening to EMP became a major task for the Minuteman system developers, and work on it continued for many years. Latter, Karzas and I attended several meetings, including some at Minuteman sites, where tests using large electric pulsers were being performed. Whether the system was ever actually made hard is not known with certainty. But a believable hardening program could not have been formulated without the input provided by three theoretical physicists.

The High-Altitude Tests

In 1962, the US carried out several nuclear tests at high altitude over Johnston Island. The agency sponsoring the tests was the Defense Atomic Support Agency (DASA), the forerunner of the Defense Nuclear Agency (DNA) and the Defense Threat Reduction Agency (DTRA). The purpose was to investigate the blackout of radar and communications that was expected to result from such events, which might be used by an attacker to help his missiles penetrate an anti-ballistic missile system. The rationale for the tests was provided mostly by members of the Physics Group at Rand, which also included theoretical physicists Albert Latter and Robert Lelevier. They formed the core of an active advisory group for DASA, with representatives from Los Alamos, Lawrence Livermore, and Sandia National Laboratories.

I was the representative from Los Alamos. My group performed calculations predicting the x-ray outputs for the events, and also the residual kinetic energy and ionization state of the device debris. It had been expected that the debris ions and electrons would recombine to form neutral atoms. Our calculations showed that the debris expanded too rapidly to allow total recombination to occur, leaving one or two electrons off of most atoms.

This result caused a major change in the phenomena expected to be observed in the STARFISH event, a megaton device exploded at 400 kilometers (km) altitude. Whereas neutral atoms can travel unimpeded for hundreds of km in the thin air at that altitude, the debris plasma (ions and electrons), interacts with the geomagnetic field in much shorter distances (the gyro radii). The result is that the geomagnetic field limits the expansion of the debris in directions perpendicular to the ambient field, but not in the parallel direction. Much of the debris energy then flows along the field lines, both northward and southward, until it is deposited in the much denser air at altitudes near 150 km. For STARFISH, the two resulting debris patches were at 900 km north and 4500 km south of Johnston Island. Fortunately, we conveyed our revised expectations to the experimenters in time for them to move some of their photographic gear to these locations.

The high altitude tests were spectacular experiments in plasma physics. Light emitted by air atoms excited by atomic or electronic impacts clearly showed the effects of the geomagnetic field, and many photographs were taken. Several experimenters recorded the variations in the geomagnetic field that reached sea level at widespread geographical locations. This is the magnetohydrodynamic (MHD EMP) discussed below in this paper. Others recorded the gamma-induced EMP, which turned out to be much larger than had been thought likely, although no specific predictive calculations had been made.

The Gamma-Induced EMP from High Altitude Bursts

From a burst at high altitude, the gamma rays emitted in generally downward directions produce most of their Compton recoil electrons in the layer of air between altitudes of 20 and 40 km. The horizontal extent of the layer exposed to gammas is hundreds of km, depending on the burst altitude. Because of the different travel times for signals to reach an observer from different regions of the layer, one might expect the pulse length observed to be as long as several milliseconds, and the amplitude to be correspondingly low.

In 1963, while I was giving a series of lectures on EMP theory at the Air Force Weapons Laboratory (AFWL), Malik showed me experimental data from the high altitude tests. For STARFISH (the first event) the signal received overdrove the recording equipment, so that neither the amplitude nor true waveform could be determined. For the later events KINGFISH and BLUEGILL fairly good recordings were made, although somewhat lacking in rise rate. They showed pulses of a single sign with duration of the order of a microsecond; the following negative phase (necessary for a radiated signal) was too long and too low in amplitude to be read well.

The puzzle presented by this data came with its own clue: the duration of the pulses was comparable with the gyro-period of Compton electrons in the geomagnetic field. Within a few hours, I knew the answer. The magnetic deflection of the initially radial flux of Compton electrons would produce a current transverse to the radial direction. This current (unlike the radial current) could generate a signal propagating in the radial direction. Since such signals generated at various radial distances would all travel at the same speed as the gammas, they would all add in phase, creating a pulse with larger amplitude but the same duration.

I gave two lectures on this subject at AFWL, the first on the general concept and the second on a numerical evaluation of the physics for a specific case. Richard Latter and Karzas were present for the second lecture. Not having heard the description of the concept, they objected strongly to the idea that the gammas could produce such a short pulse. However, after thinking about it overnight, they agreed that my explanation was correct. They later worked out the physics themselves, using the integral or potential formulation of electromagnetic theory, whereas I had used Maxwell's differential equations directly. This brief episode was the only serious disagreement that we ever had.

Together we defended the theory from attacks by others, usually individuals who had some knowledge of electromagnetics but not enough mathematical skill to reach correct conclusions. If the individual entertained suspicions that the EMP "mafia" was exploiting the phenomenon for its own advantage, and if he happened to be employed by a prestigious institution, the attack could be serious. Latter and Karzas, who worked for DNA in advisory roles, bore the main brunt of these attacks. Both of them are now deceased, and they are missed.

MHD EMP

The phenomena in MHD EMP are complex and vary with the height of burst. What follows is a brief description for the STARFISH event.

Most of the gammas and x-rays are emitted in times less than a microsecond, when the debris has moved only a few meters. Gammas contain about 0.1 percent of the total energy released and x-rays about 75 percent. Downward-going x-rays are absorbed mostly by air between altitudes of 80 and 150 km, forming an x-ray patch, which extends horizontally out to about 2000 km. Air in the patch is ionized and therefore electrically conducting, making a good electromagnetic shield for several seconds, until the ionization recombines.

The expanding debris drives a shock wave involving the geomagnetic field and ionized air around the burst point. This hydromagnetic shock wave travels at speeds of the order of 1000 km/sec, but it cannot immediately pass through the x-ray patch, where conductivity links it to the much greater inertia of neutral atoms and molecules. Instead, the first signal to reach the ground travels outwards as an Alfven wave at high altitudes to the edge of the x-ray patch, then down through the ionosphere to the earth-ionosphere cavity, where it becomes an ordinary EM signal that travels at the speed of light (halfway round the world in 0.067 second). This first signal, called the propagated blast wave, arrived at both Johnston Island and Hawaii about 2 seconds after the burst. At both places the signal caused an increase (compression) in the geomagnetic intensity, by about 3 milligauss (mG) at Hawaii and 1.4 mG at Johnston Island.

After about 10 seconds, the direct signal began to diffuse (skin effect) through the x-ray patch over Johnston Island. This signal, called the diffused blast wave, was observed at Johnston Island but was not apparent at Hawaii. It also caused an increase in geomagnetic intensity, by about 2.7 mG, and peaked at about 30 seconds after the burst. This peak was immediately followed by a larger signal that caused a decrease (rarefaction) in the geomagnetic intensity by as much as 7.3 mG. This signal was caused by the upward expansion of the air that had been strongly heated by the shock wave, and is called the heave signal. It peaked at about 70 seconds, and lasted for a few hundred seconds as the field slowly returned to its ambient condition. It also was not observed at Hawaii, a consequence of the fact that the fields outside a localized current distribution must fall off with distance, in the quasi-static phase, at least as fast as those of a magnetic dipole ($1/r^3$).

If STARFISH had been fired over land, an electric field of about 5 volts/km would have been induced in the ground. This field is comparable to those generated in geomagnetic storms, which have been known to cause problems in long power lines and communication cables. Without the shielding provided by the x-ray patch, fields in the ground would have been much larger.

Computer Codes

By using mathematical analysis, it was possible to find approximate analytical solutions describing various phases of EMP phenomena. This effort was vital for establishing and verifying understanding of the phenomena. However, for making predictions for many cases, it was more practical to construct and use computer codes. The codes usually could be checked against the analytical solutions.

The gamma-induced EMP is characterized as a very fast-rising pulse, in times on the order of a nanosecond, which moves outward in radius at the speed of light. For a finite-difference solution of Maxwell's equations, one therefore needs to use time steps less than a nanosecond and a radial mesh with spacing on the order of 10 cm. One needs to calculate to times and radii of a microsecond and 1000 km at high altitude, and to 100 microseconds and 10 km at low altitude. Clearly the computer storage requirement and running time were excessive for the computers available in the 60's and 70's.

This problem could be greatly eased by replacing the time and radius variables t and r by the retarded time $T = t - r/c$ and $r' = r$. The beginning of the gamma pulse and of the EMP is at $T = 0$ at all r. With these variables, small time steps are needed only for small T, and a fine mesh for r is not needed at all. The surface burst code LEMP was constructed on this basis at Los Alamos in the 60's, and improved at Mission Research Corporation with DNA's support in the 70's. It turned out that, with the new variables and straightforward differencing of Maxwell's equations, the code was unconditionally unstable, i.e., unstable for any time step, no matter how small. However, Robert Richtmyer, an applied mathematician, showed how to stabilize it by using implicit differencing. The CHAP code for calculating the gamma-induced EMP from high-altitude bursts, developed in the 70's under support from DNA, also uses the retarded time.

At present, there is no adequate code for calculating the MHD EMP from high-altitude bursts. This is a problem requiring three space dimensions and time, involving hydrodynamics of at least two fluids (ions and neutral atoms and molecules) and electromagnetic fields. Thus far, only crude models of reduced dimensionality and simplified physics have been calculated. These calculations, done in the late 80's and early 90's under support from DNA and DTRA, helped to establish our understanding of the exceedingly complex phenomena. At about the time in the mid 90's when work could have begun on constructing a code with the full physics and dimensionality of the problem, DTRA's EMP czar terminated all work on EMP codes, opting instead to promulgate an EMP Standard to define EMP for all Department of Defense programs. While our knowledge of gamma-driven EMP environments was fairly sound at that time, for MHD EMP we had only the limited data from the 1962 tests plus the results of our crude calculations.

DTRA carried on a small and perfunctory program in EMP environments from 1994 to 2003. Reportedly, that program has now been terminated.

The Future

Fortunately, both Los Alamos and Lawrence Livermore National Laboratories have the capabilities for running and maintaining the LEMP and CHAP codes, which probably ought to be recoded for modern computers if they have not been already. I believe they can also preserve and improve the theoretical and analytical assets of EMP science. They have staff with adequate technical backgrounds, and a tradition for doing excellent science. Except for some concern that these fortunate conditions could cease to exist as a result of some unwise steps in security management, I do not worry about the future for gamma-driven EMP.

For the MHD EMP there are two possibilities. First, DTRA owns under contract some computer codes that were originally constructed to calculate all of the phenomena that follow a high-altitude burst except for the EM fields produced at points less than 60 km in altitude. At present, these codes are being applied to geomagnetic storm phenomena as part of a space weather program. They could be modified to calculate the fields down to and into the ground, thus providing MHD EMP predictions. For DTRA to manage such a program effectively, it might have to employ a theoretical physicist in a position with decision-making authority. Dr. Gordon Soper, a member of the EMP Commission, formerly held such a position in DNA. It would be ideal if he, or someone of comparable stature, could be persuaded to act as an advisor with the authority of technical director.

The other possibility is that Los Alamos and/or Lawrence Livermore National Laboratories also take over the responsibility for providing information on MHD EMP. It is logical to regard the interaction of nuclear weapon outputs with the natural environment as falling within the purview of the weapon laboratories, and their computing facilities best match the demands of the problem. In the long run, this would probably be the best solution. One would hope that they could find a way to start from where DTRA is now, in order to reach the final goal as soon as possible.

Further Reading

Additional discussion of EMP physics by the present author and references to papers by other authors can be found in:

1. IEEE Transactions on Antennas and Propagation, Vol. AP-26, No. 1, p. 3, (Jan., 1978);

2. Handbook of Atmospheric Electrodynamics, Vol. II, HansVolland, Ed., CRC Press, 1995, pp. 135—153.

Conrad Longmire received a B.S. degree in Engineering Physics from the University of Illinois and a Ph.D. degree in Theoretical Physics from the University of Rochester. He worked on radar at the MIT Radiation Laboratory during the Second World War. He has taught physics at Columbia, Rochester, and Cornell universities. He worked on nuclear weapons and their effects at the Los Alamos Scientific Laboratory from 1949 to 1969, and later at Mission Research Corporation, where he was a founder and chairman of the board of directors until 1994, when he retired. He and his wife Theresa live in Santa Barbara. Their proudest achievement was to rear and educate seven children, all of whom became self-supporting.

EMP Articles That Shaped the Army HEMP Program

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The first indication that large electromagnetic (EM) field strengths would be generated from a nuclear detonation in the earth's atmosphere occurred at Trinity Site, White Sands Missile Range, NM in July 1945. When scientists prepared for the world's first successful atomic bomb detonation, they deliberately shielded important electronics from anticipated large amplitude EM signals. No mention was made to the public about the potential problem to electronics, nor was the public notified of the magnitude of the signal strengths measured during that tower shot. In fact, virtually nothing appeared in the open literature on nuclear-induced EM phenomena until the next decade. This article summarizes the findings of some of the most important, unclassified but Army-relevant articles of the mid-1950's through the 1970's.

Articles in the 1950's-1960's

Early journal articles correctly described the electromagnetic phenomena we now call high-altitude electromagnetic pulse (HEMP) as a secondary effect resulting from a nuclear detonation in the upper atmosphere. No reference was made to experimental data: most articles detailed the phenomena as we describe them today, i.e., in terms of Maxwell's equations and air chemistry equations. The phenomena had several names, e.g., radio emission, radio pulse, radio signal, electromagnetic signal, radioflash, etc. Apparently HEMP was more interesting than EMP from a detonation on or near the earth's surface, perhaps because of the widespread coverage on the earth or because it was easier to describe mathematically (or both).

It turns out many of the early journal articles were written by Soviet scientists. One of the first translated into English was by a Soviet author named A. S. Kompaneets. In his article he described the effect he called radio emission and how it is created in the upper atmosphere from an atomic explosion. Specifically, he discussed the concept that prompt gammas have sufficient mean energy (about 1 million electron volts) to cause the Compton effect, and are therefore the origin of the Compton electrons that create HEMP. The discussion also included some air chemistry calculations. In addition, he referenced an even earlier Soviet article by Ia. L. Al'pert that discussed the general characteristics of the entire radiated radio pulse spectrum.

Two of the most prolific US writers of early EMP articles were William Karzas and Richard Latter of the Rand Corporation. They first explored the use of radio signals to detect nuclear explosions as far as halfway around the world (Figure 1). They later calculated the magnitude of the EMP signal and realized its potential threat to electronics.

Gilinsky and Peebles, also from the Rand Corporation, wrote several articles that described the radio signal as a dipole field.

Once the community saw the potential offensive uses of EMP, the publication of unclassified reports and articles rapidly decreased. Thus, few articles on EMP appeared in the open literature between the mid-1960's and the late-1970's.

Perhaps the most famous exception is the 30 October 1967 article in Electronic News, entitled "US Seeks Answers to A-Blast Oddity." The article said during the high-altitude nuclear tests in the Pacific in the early 1960s that "hundreds of burglar alarms" in Honolulu began ringing, and "circuit breakers on the power lines started blowing like popcorn." Later articles attributed less dramatic effects to EMP; nevertheless, this article was cited for years as the justification for addressing EMP survivability.

Articles of the 1970's

Some of the most interesting early EMP articles are by Conrad Longmire. Working for Los Alamos Scientific Laboratory in the 1960s, he wrote many articles articulating the important physics and air chemistry that occurs when a nuclear device is detonated in the upper atmosphere. While many of these early reports and briefings were not available to the community in general, in the 1970's he wrote an excellent early history of EMP in the US and listed many of the major contributors. He also wrote an unclassified article that estimated the theoretical limit of the prompt gamma-induced EMP by assuming the instantaneous generation of prompt gammas and simplifying several air chemistry assumptions. Dr. Longmire has summarized his EMP experiences in an article in this *NBC Report*, entitled "Fifty Odd Years of EMP."

Wunsch and Bell wrote another classic article. They developed a thermal model and a semi-empirical formula to explain the thermal damage mechanism for discreet semiconductor devices subjected to an electromagnetic pulse-induced signal. Simply stated, their model shows that for very short pulse widths (about 0.01 microseconds or less (a microsecond is 10^{-6} seconds), semiconductor damage appears to be energy dependent. That is, damage is due to the total energy deposited on the device before the device can dissipate this energy. For pulse widths between 0.01 and 100 microseconds, damage is due to the energy deposition rate, i.e., power. The Wunsch-Bell thermal model and formula were fundamental to virtually every Army EMP vulnerability assessment in the 1970s. A typical damage plot for several transistor junction areas is shown in Figure 2 on page 54. It plots the power per unit area (P/A) as a function of pulse width (in seconds) necessary to make the device go into second breakdown, a point beyond which the device can no longer recover from the runaway thermal current.

Mathematically, this figure can be expressed as the sum of several terms:

$$P/A = AT^{-1} + BT^{-1/2} + CT^{0} ,$$

where A, B, and C are constant functions of time, and T is the pulse width. Note that, for EMP pulse widths, the failure curve for pulse widths typically less than 0.01 microseconds goes as 1/T. Greater than 0.01 microseconds, the curve goes as $T^{-1/2}$ until approximately 100 microseconds, above which the failure is related to the device's continuous dissipation rating. This relationship is illustrated in Figure 3 on page 54.

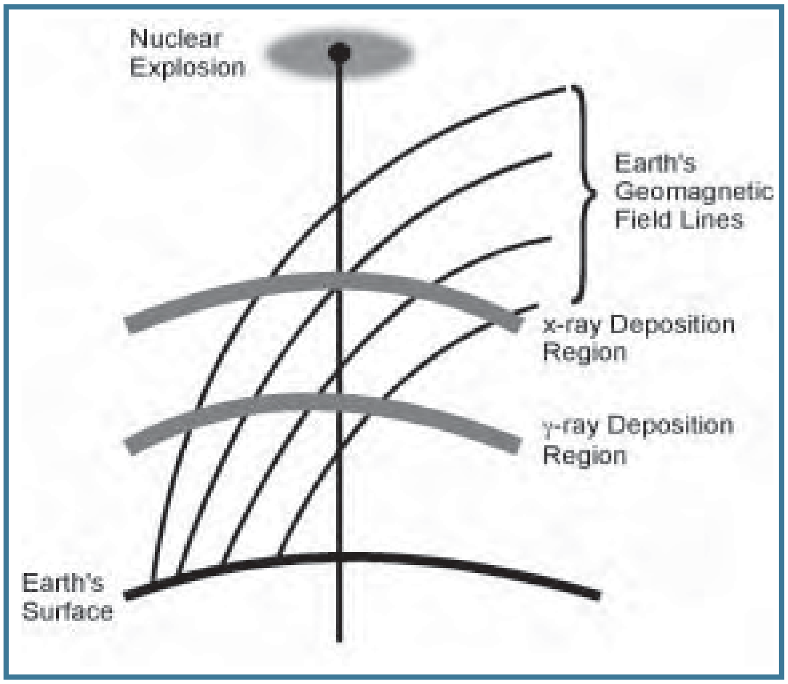

Figure 1. Nuclear Explosion Above the Earth.

Summary

Although mathematical arguments were used instead of test data to explain the presence of EMP, early HEMP articles are surprisingly easy to follow. It is worth the time to review them, as these arguments continue to be used today to explain the basic physics mechanisms of EMP generation. Of particular note are those by Kompaneets and by Karzas and Latter.

The articles by Longmire (considered by many to be the "Father of US EMP") provide an excellent unclassified discussion on HEMP. These articles, plus those by Wunsch and Bell, provide the basis for present day Army HEMP hardening programs.

Further Reading

Spring/Summer 2002 *NBC Report*, A Brief History of the Army Electromagnetic Pulse Program. This article is Part I of a history of the Army EMP program.

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Gilinsky, Victor and Peebles, Glenn, The Development of a Radio Signal from a Nuclear Explosion in the Atmosphere, *Journal of Geophysical Research*, volume 73, 405-414 (January 1, 1965).

US Seeks Answers to A-Blast Oddity, *Electronic News*, (October 30, 1967).

Longmire, Conrad, On the Electromagnetic Pulse Produced by Nuclear Explosion, IEEE Transactions on Antennas and Propagation, volume AP 26, No. 1, 3-13 (January 1978). *Fifty Odd Years of EMP, NBC Report*, Fall/Winter 2004.

Wunsch, D.C. and Bell, R.R., Determination of Threshold Failure Levels of Semiconductor Diodes and Transistors Due to Pulse Voltages, IEEE Transactions on Nuclear Science, NS-15, No. 6, 244-259 (December 1968).

Mr. Robert A. Pfeffer is a Physical Scientist at the United States Army Nuclear and Chemical Agency in Springfield, VA, working on nuclear weapons effects. He has B.S. in Physics from Trinity University and a M.S. in Physics from The Johns Hopkins University. Previous government experience includes Chief of the Harry Diamond Laboratories (HDL) Electromagnetics Laboratory and Chief of the HDL Woodbridge Research Facility, both in Woodbridge, Virginia.

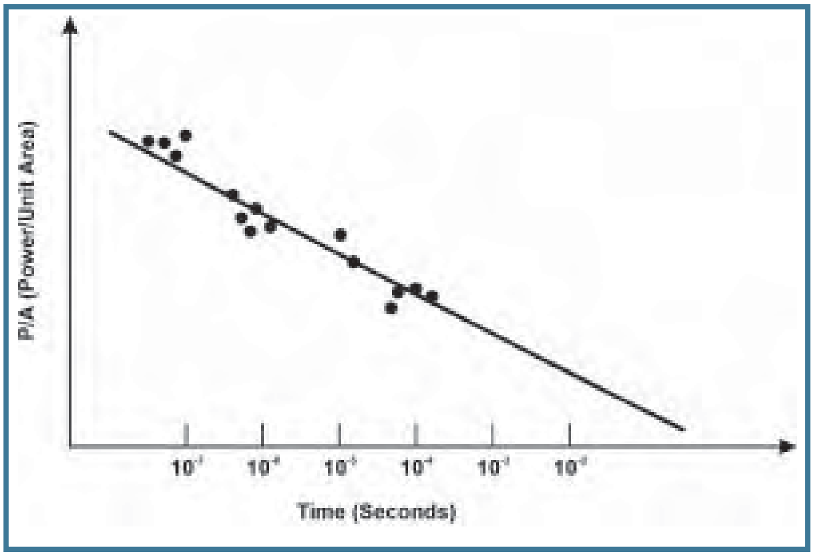

Figure 2. Typical Transistor Junction Failure Plot for a Narrow Range of Pulsewidth.

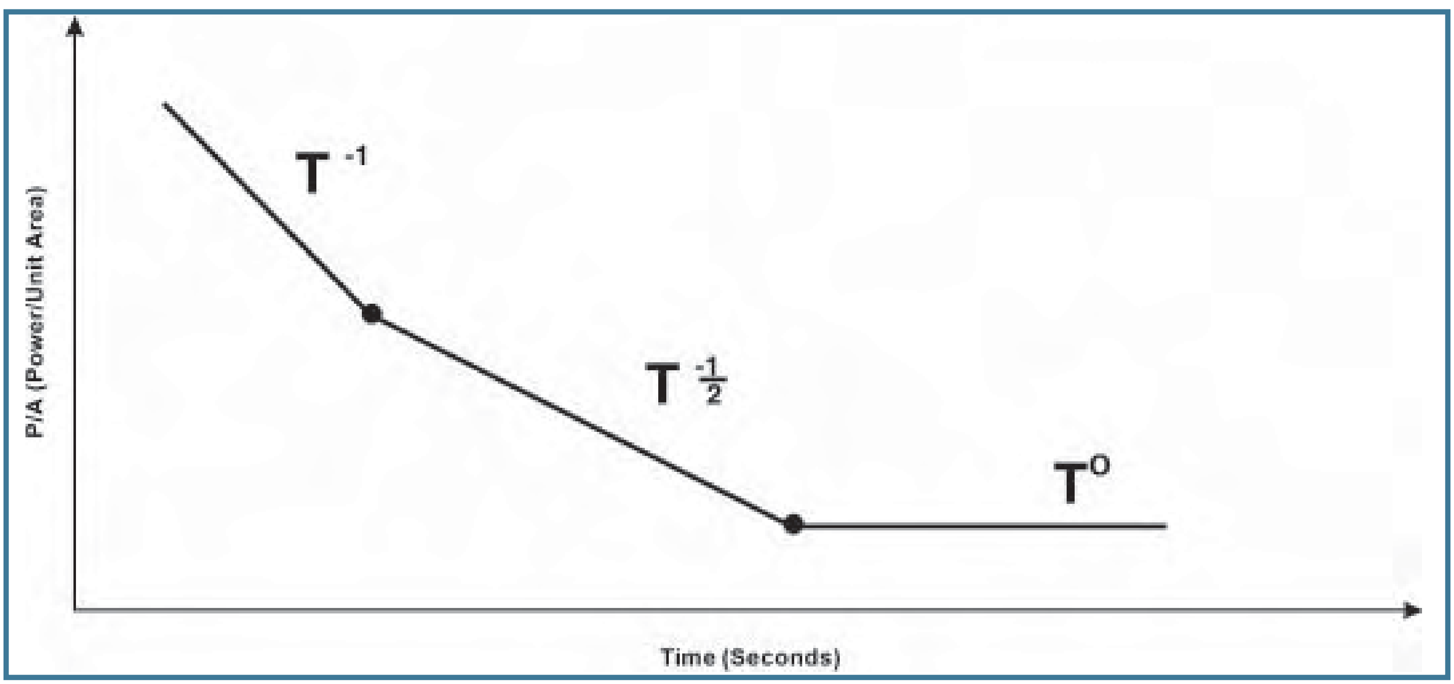

Figure 3. Typical Transistor Junction Failure Plot for a Narrow Range of Pulsewidth.

Assessing the Effectiveness of Nuclear Material Smuggling Deterrents

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A number of organizations around the world are involved in the effort to prevent nuclear material smuggling. These groups use a variety of technological and procedural methods to accomplish this common goal. However, there is generally no yardstick by which to assess the effectiveness of the various methods. As a result, our efforts as a global community are most likely not as focused and cost effective as they could be. This paper outlines a method to evaluate the cost effectiveness of nuclear material smuggling detection systems, thus providing decision makers with a tool that gives some degree of clarity to this critical effort.

In order to evaluate the effectiveness of a system, one must have some level of understanding of whom or what is to be detected. In this case, we need to understand who is attempting to smuggle nuclear materials and what routes and methods they are using. We need to understand how the smuggler acquired his nuclear material, since this helps to evaluate his characteristics and abilities. We need to characterize their abilities, resources, motivations, and level of access to critical facilities. We must anticipate the likely decisions made by the smuggler at the point at which he will interact with this system. Once we understand these aspects of the nuclear smuggler, we can then assess the attributes of our given detection system in comparison to the smuggler that the system will face.

In examining the known nuclear smuggling cases reported by the Illicit Trafficking Database (ITDB) of the International Atomic Energy Agency (IAEA), and open journal articles, it is apparent that the most commonly apprehended nuclear smuggler might be called the "opportunist"—an inexperienced smuggler who saw what he believed to be an opportunity for a financial windfall. Also evident in this case data, however, are a sizeable number of criminal groups involved in nuclear smuggling. Finally, we must assume that some number of government officials may be taking advantage of their positions to traffic in nuclear materials, although the available case data do not appear to indicate any apprehensions in this category. Each of these three broad categories (opportunist, criminal group, and government official) will be discussed in the upcoming sections. Their characteristics, abilities, and tendencies will be examined, as these are the critical attributes involved in assessing the impact of any possible detection system. It is important to remember, however, that the categories simply define representative types of adversaries with graduated levels of abilities. An adversary may not be a government official, but if he has the capabilities of one, he will fit into the "government official" category. The varying abilities of these categories are used to model the varying probabilities of success in nuclear smuggling versus a given system.

In addition to understanding the varying capabilities of the adversary categories, it is important to understand the proportional representation of a threat that a given detection system will face in the different adversary categories. For example, a particular system may have a high probability of effectiveness against the inexperienced opportunist, but may have a negligible effect on the government official. If so, an evaluation of the system's overall effectiveness must clearly consider the percentage of adversaries interacting with the system who are inexperienced opportunists and the percentage who are government officials.

Nuclear Smuggler Categories

1. Opportunists. These individuals are engaged in what is for them essentially a once-in-a-lifetime activity. They are likely to be employees at a nuclear facility, although they could range in position from the nuclear scientist to the security guard or custodian. Although both the nuclear scientist and the custodian are unlikely to have significant, if any, experience in smuggling contraband, there is a key distinction between the two in that the nuclear scientist will clearly have a better understanding of what he is handling

and how it can be shielded from detectors. For the same reason, he is also much less likely to injure himself by attempting to transport a strong source without adequate shielding. Regardless of nuclear knowledge, however, the opportunist is not used to criminal activity, and certainly not used to smuggling contraband. Therefore, he will prefer legal, common routes, rather than routes that he does not know and is not supposed to be using. At border crossings, this individual will follow directions and will attempt to blend in with other travelers. He will be very unlikely to use back roads, to attempt to enter unauthorized locations, to have forged passes or documentation, or to use elaborate ruses. He will try to act exactly as he would if he did not have illegal nuclear materials in his possession.

Because the opportunist has acquired an item that he considers his ticket to a financial windfall, he will be extremely reluctant to relinquish possession of the material. He will make every effort to transport the material while it is in his own possession to a location where he believes he will find a buyer. Case data shows this pattern occurring frequently. In the early 1990s, there was a widespread belief that buyers of nuclear material were easily found in Western Europe. As a result, many opportunists were arrested in Germany attempting to sell smuggled nuclear materials to undercover policemen. Most recently the trend has indicated that smugglers believe their market is in states such as the Ukraine, Turkey, Bulgaria, and the Czech Republic.

If the opportunist feels that he has a low chance of successfully transporting his material, while maintaining physical possession, he may decide to risk shipping the material. This shipment method may be by air, land, or sea. The opportunist will most likely choose that method which he either understands the best or feels is the safest. Regardless of the shipping method, the opportunist will almost surely try to have the material transported in the most direct manner possible and will attempt to meet it on the other end.

Case histories indicate that these inexperienced opportunists account for approximately three-quarters of nuclear smugglers. Most often there are several individuals involved, all similarly inexperienced in criminal activity. Generally, shielding is clumsy, if it is attempted at all, suggesting that those with a significant understanding of radioactive material properties are not the most frequent smugglers.

2. Criminal Groups. These organizations obviously have experience in illegal activities and most likely in smuggling. They may have acquired their material through collaboration with a nuclear facility employee, purchase from a middleman, or by direct theft. The criminal group may have regular smuggling routes and methods and is likely to use these in moving the nuclear material. These routes may avoid legal border crossings, but in many cases, the smuggling routes will actually use legal border crossings. There is no reason for criminal groups to go out of their way to avoid a legal border crossing if they feel that they can be successful in moving their contraband through it. Legal crossings are almost always cheaper, quicker, more convenient, and easier than illegal crossings. The criminal group may be familiar enough with the border crossing facility procedures to feel confident that their contraband will not be discovered, or the group may have an insider at the facility that will assist them with their crossing.

The criminal group will prefer not to give up possession of their nuclear material. However, due to their familiarity with smuggling contraband, they may be willing to turn over the material to a shipping network under some circumstances. These circumstances would primarily involve the strong belief by the criminal group that they will indeed regain control of their material at the other end. Using a shipper or shipping route that the group uses regularly for either legitimate or illegitimate business could achieve this comfort level. As with the inexperienced opportunist, the criminal group may choose to ship via air, land, or sea and will attempt to meet their material on the other end of the transit. However, due to their greater resources, the criminal group will have less difficulty accomplishing this task; the group only has to find any one trustworthy member who can travel to the endpoint. In the case of larger criminal organizations, the group may already have members in the destination country, on the other end of a regular smuggling route. These larger criminal organizations may have even penetrated the shipping industry in their regions of activity to the point that they are able to watch and possibly control their shipment enroute. If this is the case, such a group would be less hesitant to use the commercial shipping system, as they are not actually losing control of their material by shipping it.

Most smuggled nuclear material to date has originated in the former Soviet Union, particularly Russia. An examination of Russian organized criminal groups shows that some appear to be at least dabbling in nuclear materials smuggling. However, it is important to note that, to date, the level of activity seems to be rather minimal. When one considers the objectives of organized crime and the means at their disposal for realizing those objectives, this minimal level of nuclear smuggling activity is not surprising. Generally, organized crime exists to make money and to propagate the means to make money. Currently, Russian organized crime sees great profits in controlling Russian businesses, both public and private, and in extracting “protection” fees from those that they do not control. Other organized criminal organizations make substantial, sustainable profits from trafficking in drugs, guns, women, illegal aliens, and various highly taxed legal commodities such as cigarettes and alcohol. Currently, the market in nuclear materials is primarily seller-driven, with a dearth of buyers. This does not provide a strong incentive for the financially savvy black marketeer to abandon or curtail his efforts in a successful revenue stream to explore the possibly non-existent market in nuclear materials. That said, a changing buyer demand could significantly affect this assessment from the point of view of the organized criminal group.

Case histories suggest that criminal groups probably account for about 20 percent of nuclear smuggling activity. A good argument can be made that case history is not an accurate indicator of actual criminal involvement, since this more experienced group is less likely to be apprehended, and therefore less likely to be documented, than the inexperienced opportunist. However, it is also logical that the amount of nuclear smuggling activity by criminal groups is not wildly out of proportion to the level indicated by case histories because, as outlined above, criminal groups will not find nuclear smuggling profitable in the current market. The cost-benefit evaluation of nuclear material smuggling is likely to demonstrate to savvy organized crime syndicates that financial and personal longevity is not well served by moving significant quantities of nuclear materials, especially when money can be easily made on ventures that are more or less accepted by many governments. Therefore, it does not make good business sense for financially oriented criminal groups to attempt to be active in nuclear materials trafficking. The 20 percent value suggested by case histories is not out-of-line with this reasoning.

3. Government Officials. The case histories of nuclear smuggling apprehensions do not show any clearly documented incidents of smuggling by government officials. However, it would be naïve to simply assume that there are none. Anecdotal reports, an understanding of the bureaucratic climate within the states of the former Soviet Union, and knowledge of human nature leads us to the conclusion that there will be corruption in government officials entrusted with the care of nuclear materials. It is important that we include this category of nuclear material smuggler because they are clearly the group most difficult to impact with nuclear material smuggling detection systems. Ignoring this group entirely will lead us to an overly optimistic assessment of effectiveness.

The government official who smuggles nuclear material will most likely have the ability to bypass or negate most, if not all, checkpoints and inspections staffed by personnel. Inspections performed automatically by technological devices will be more likely to successfully detect smuggling by the government official. However, if an alarm by an automatic inspection device can be overridden by simple direction to a guard or other response personnel, this increased detection probability may be negated. The government official may not transport the material personally; instead, he may simply authorize its shipment within the scope of his normal duties. This could involve hiding the nuclear material within a legal shipment of non-nuclear materials, or simply understating or misstating the amount of nuclear material that is being legally shipped. Although the latter situation has occurred, it appears in most cases that the goal was to avoid paying customs duties, rather than smuggle nuclear materials for sale to a group that wanted the material for nefarious uses. The government official may also work in collaboration with a criminal group. In this case, the government official would most likely act in the role of facilitator, signing paperwork, authorizing access, and otherwise paving the way for the criminal group, who would do the actual work of moving the material.

Terrorist Groups

Terrorist groups are not specifically addressed in the discussion above regarding the various types of nuclear smugglers. This is because terrorist groups vary greatly in their abilities, resources, motivations, goals, and determination. The category definitions in the previous section are broken down based on the capabilities of each group, such that terrorists cannot be properly placed in any single group. Instead, it is appropriate to evaluate the specific capabilities of particular terrorist groups or individuals and place them in one of the categories accordingly. For instance, a lone actor who has a statement to make, but who has no real smuggling skills, would fit the definition of the inexperienced opportunist. A fairly organized terrorist group with international connections or a high level of insider knowledge would fit the mold of the criminal group. A very highly sophisticated or state-sponsored terrorist organization, although it may not have the same authorities of a government official, could be placed into that category, since it represents the adversary with the highest probability of successfully smuggling nuclear materials or weapons.

Probability of System Success

Once we have defined the adversary, we must then define our probability of success against him. The probability of success will of course be dependent on the characteristics of the deterrence system being considered. A system that consists primarily of a technological device, such as a radiation detector, must be evaluated based on parameters such as its level of sensitivity, reliability, number of false alarms, and the likelihood that the operator will be able to, and choose to, operate it properly. Procedural systems must be evaluated based on factors such as whether or not personnel will adhere to the rules under all conditions for all individuals, and if not, when and why personnel will violate the procedures.

The probability of success for a given system will most likely be different for each of the adversary categories. Most systems will have their greatest impact on the lowest level threat, the inexperienced opportunist. These systems will generally have lower probabilities of success against higher-level adversary groups. For instance, if a particular device is estimated to be 90 percent effective against the inexperienced opportunist, depending on the specific attributes of the device, it may be only 70 percent effective against criminal groups, and possibly only 30 percent effective against government officials. These probabilities would be best determined by objective testing of the system's effectiveness. However, in many situations such testing will be difficult, if not impossible. In this case, a subjective evaluation by experts in the relevant fields can be used. Although the resulting values will not be as accurate as objective testing, they will give reasonable probabilities of effectiveness that can be used to determine useful cost-effectiveness information, as described in the next section.

Cost Effectiveness Evaluation

The probability of the system's success against each adversary category (P_d—probability of detection), the probability that the given adversary category will use the route in question (P_u—probability of usage), the proportion of the threat that is expected to come from each of *n* adversary categories (P_a—probability of adversary category), and the cost for the proposed detection system at the given location can be combined as shown in the equation below to determine cost effectiveness in terms of percentage points of security improvement at a given location per dollar spent (ppsi/$). Because adversaries can be expected to find ways through or around a detection system, the effectiveness of a system will decrease over time. At the time of initial installation, the cost effectiveness of the solution will be its greatest. However, depending on the type of detectors used, the effectiveness will exponentially decrease by a factor we call the security effectiveness decay constant (${}_s$). The value of this constant depends on the adversary knowledge and the system deployed. Utilization of this constant is critical not only in evaluating the system's effectiveness over time, but also in making an initial installation decision. The resultant Cost Effectiveness Equation (CEE) is shown in Figure 1.

It may be that the decision to install one deterrent system (S_1) over another (S_2) based on an initial (t=0) cost effectiveness is not the best decision. For example, if the cost effectiveness of S_1 is initially 0.1 ppsi/$, but only 0.001 ppsi/$ after one month, while S_2 has a relatively constant cost effectiveness of 0.05 ppsi/$, the better decision may be to install S_2. The CEE evaluates the probability of successfully interrupting the adversary both at the time of installation of the upgrade and after installation, giving a cost per percentage point of improved probability of success. The probability of a successful interdiction following this interruption is not included in this equation.

The results for a number of locations under consideration, for t=0, can be graphed to give a better understanding of the cost-benefit associated with each location being evaluated. This graph will typically take the shape of that shown in Figure 2.

With information such as that graphically depicted in Figure 2, the decision-maker can more clearly evaluate the initial cost effectiveness of installing deterrence systems at various locations. If a number of locations are under consideration, and funding is limited, this method will assist the decision maker in determining the most cost-effective locations for a given nuclear smuggling detection system. An assumption in the CEE is that the threat will select a route with the same frequency af-

$$Cost\ effectiveness = \frac{\sum_{a=1}^{n}\left[(P_d)_{after} - (P_d)_{before}\right]_a P_{u_a} P_a}{Cost\ to\ upgrade\ location} * e^{-\lambda_s t}$$

Figure 1. Cost Effectiveness Equation.

ter an upgrade as before the upgrade. For certain threat groups this assumption loses some validity as a government insider could be expected to know that systems were fielded at a particular crossing. As a result, he would not use that route. Even inexperienced opportunists may eventually learn methods to circumvent given detection systems. To account for these realities, the security effectiveness decay constant is incorporated. Therefore, as discussed in the example above, the initial cost effectiveness should be paired with the security effectiveness decay constant to make final installation decisions.

Clearly, these cost-effectiveness values will be estimates. However, these estimates provide a method for quantification of the assumptions involved in the decision-making process. Because a number of assumptions must be made in this process, it is difficult to understand their cumulative impact without a means by which to combine them. Several locations are separated by only very small differences in their cost effectiveness, while others have great differences, as shown in Figure 2. The decision-maker must understand that the results of the CEE are based entirely on the assumptions that go into the equation and, therefore, should not interpret these numerical results as absolute values, but simply as the quantification of the given assumptions. The CEE is a tool to identify the conclusions to which given assumptions lead. The CEE can also be used to evaluate the sensitivity of the assumptions by altering the assumptions and analyzing the effect on the results of the CEE. Since the single point estimates required in the CEE are usually based on expert judgment, uncertainty is present in the outcome of the CEE. Probability density functions as ranges on the values used in the CEE are one method for dealing with this uncertainty.

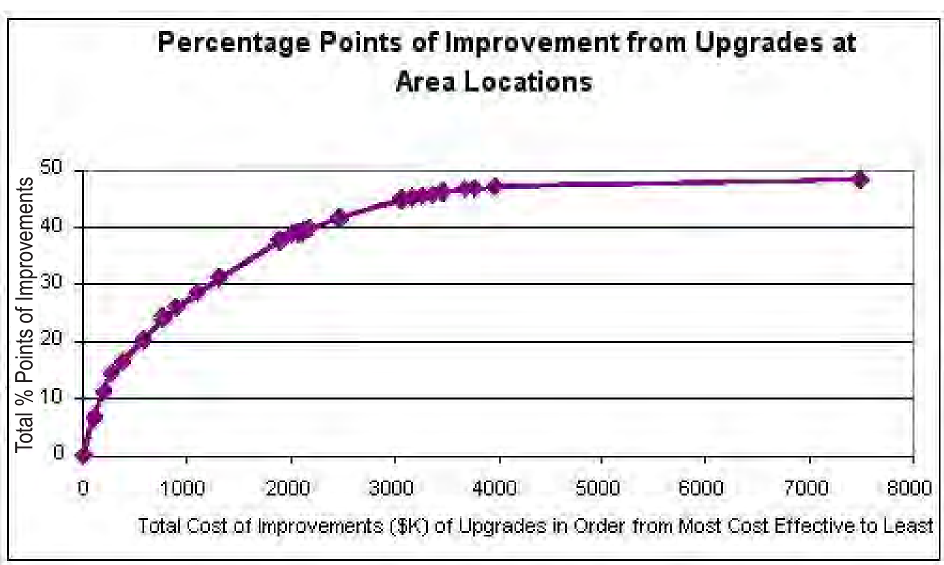

Figure 2. Initial Cost Effectiveness of System Installations at Multiple Locations (t=0).

Conclusion

The method presented here for evaluation of the effectiveness of various nuclear material smuggling detection uses, of necessity, a number of assumptions and estimates. These assumptions and estimates are based on a logical evaluation of the motivations and capabilities of the nuclear smuggler, as well as significant case history data. They should be continually re-evaluated by those analyzing the effectiveness of nuclear smuggling detection systems. However, by making such estimates, one is able to determine cost-benefit values for detection systems in potential locations, giving the decision maker a valuable tool in assessing the most efficient use of available funding.

Combined with intelligence, the CEE provides a more complete and objective information base for the decision-maker. No one tool should ever be used as the sole basis of a decision, given the inherent uncertainties involved in this type of application. However, this evaluation tool has been and will continue to be an important component of evaluating the effectiveness of systems intended to combat nuclear material smuggling.

The authors work at Sandia National Laboratories in International Border and Maritime Security. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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SERPENT: A Counterproliferation-Counterforce Analysis Tool

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The Simulation Environment and Response Program Execution Nesting Tool (SERPENT) is a robust, hazard prediction and damage assessment modeling and simulation tool for counterproliferation and counterforce study applications in the arena of chemical, biological, radiological, nuclear, and high explosives (CBRNE). It combines new physics codes/programs along with established codes in a flexible and highly capable software architecture. A number of technology application codes were developed dealing with counterproliferation scenarios, including, but not limited to; agent release, internal dispersion, agent neutralization, effluent rise, integrated with penetration, blast, and atmospheric transport models to create a comprehensive hazard prediction and damage assessment simulation. The architectural framework for this methodology consists of non-invasive modules linking the input and output of stand-alone applications while providing development tools, graphical analysis, and statistical parameterization. This architecture, along with the suite of physics models is collectively known as SERPENT. This paper provides an overview of the SERPENT tool, its technical background, operational use, and a plan for future development.

Introduction

The expectation that hostile nations or terrorists will use chemical and/or biological (CB) agents against US targets rapidly increases from day to day. In 1994, the US Air Force officially established the need for exploring and identifying technologies responding to this threat. The Air Force Agent Defeat Weapon (ADW) Analysis of Alternatives (AoA) provided a formal assessment that evaluated the efficacy of the current inventory and future weapon options. The ADW AoA study analyzed over 50 air-to-surface weapon concepts proposed by government and commercial organizations that might possibly neutralize, deny access, immobilize, and/or destroy CB agents/weapons during their production, storage, or employment phases. One of the main requirements of the study called for the significant reduction of hazardous materials release and subsequent downwind lethal effects. At the beginning of the study, a suite of models to accomplish the AoA did not exist.

Two of the major operation capability elements (OCEs) within the 2002 Joint Warfighting Science and Technology Plan (JWSTP), Counterproliferation of Weapons of Mass Destruction (WMD) Joint Warfighting Capability Objective (JWCO)[1] are:

- Target defeat with minimal collateral hazards.
- Combat and collateral hazard assessment.

Target Defeat With Minimal Collateral Hazards

Target defeat options vary along several dimensions. Once a nuclear, biological, chemical (NBC) facility has been located and characterized, the challenge is to defeat the facility with appropriate weapons while minimizing the collateral hazards resulting from both the weapon and the facility itself. A conventional munition incorrectly targeted could create a cloud of chemical or biological agent, having far-reaching effects from dispersion into the surrounding environment. This unfortunate consequence drives the requirement to develop and validate new, more effective munitions, enhance existing weapons or modify employment methods.

Combat and Collateral Hazard Assessment

Counterproliferation mission planning and operations takes into account a range of consequences. These include prediction and mitigation of the collateral hazards that might result from:

- Attacks or strikes against NBC targets.
- Enemy use of WMD against US, allies, or coalition forces during a major theater war or other circumstances.
- Accidental or deliberate release of NBC agents from a facility.

A common set of technical capabilities provides the basis for accomplishing these tasks.

- Characterization of sources to develop an understanding of the potential hazards that might be dispersed.
- Atmospheric transport modeling.
- Real-time weather forecasting integrated with atmospheric transport modeling.
- Accurate characterization of any hazards that might be produced.

In 1995, the Air Force Nuclear Weapons and Counterproliferation Agency (AFNWCA) initiated the examination of existing chemical and biological collateral hazard modeling. Figure 1 illustrates the sequence of events that occurs in typical counterproliferation scenarios involving attacks on hardened structures. The physical phenomena include: weapon(s) penetration of the target and the resultant structural response, detonation/fragmentation of the weapon(s), agent release, internal dispersion-neutralization-venting of the agent, and the stabilization of the vented material into the atmosphere.

In the first stage, the weapon(s) penetrates the hardened structure and detonates, possibly causing structural damage, such as partial or full collapse of the ceiling, walls, or floors. The EVA-3D survivability/vulnerability model[2] was selected as the penetration evaluation model for the ADW AoA[3], but has since been replaced with PENCURV+[4]. The BLASTX[5] blast effects mitigation model determines structural wall failure. Additional algorithms were developed within SERPENT to refine multiple weapons, random variations in weapon location, orientation, and velocity effects associated with various guidance packages and fuse definition.

In the second stage, the weapon detonation generates energetic casing fragments as a result of blast effects. Depending on the location of the weapon detonation, and configuration/construction of the agent containers, the propagation of weapon fragments may penetrate containers causing agent release. The Agent Release Model (ARM)[6,7] was developed by ITT for use in the AoA to predict whether or not chemical or biological agent is released from its container, and if so, the quantity, state, and time of release due to conventional blast fragmentation weapon effects. Further research efforts developed CH-ARM[8] (Computational fluid dynamics-quality, High-fidelity, Agent Release Model). CH-ARM provides a high-fidelity aerosol release model for both catastrophically and lightly damaged containers, as well as, models for several concept weapons such as the Passive Attack Weapon (PAW). At present, ARM and CH-ARM remain the only known release source term codes specifically tailored for CB counterproliferation applications.

In the third stage, blast and overpressure from the weapon detonation disperse agent throughout the structure and vent airborne agent and hot weapon gases to the atmosphere through bomb holes, preexisting doors, windows, and ventilation shafts. The Venting of Internal Pressure from Energetic Reactions (VIPER), originally IDV model[9,10], also developed by ITT for use in the AoA, predicts the bunker environments, degree of agent neutralization, and venting from within a closed facility. VIPER computes the thermal and chemical neutralization of wet/dry biological and liquid/dusty chemical agents using Monte-Carlo tracer particle histories processed through the Empirical Lethality Model (ELM)[11] developed by Sandia National Laboratories for AFNWCA. The majority of neutralization from conventional weapons is thermal and characterization of the neutralization is an integral step in estimating the amount of viable agent vented to the atmosphere.

In the fourth stage, the vented agent and hot weapon gases rise to form a cloud in the atmosphere. The Hot Effluent Rise (HER)[10] model developed by ITT for use in the AoA, formats information describing high-velocity hot effluent coming from ground level vents. The model creates a pseudo-stabilized input for a Gaussian puff atmospheric dispersion code of the contaminant cloud when the effluent stops rising.

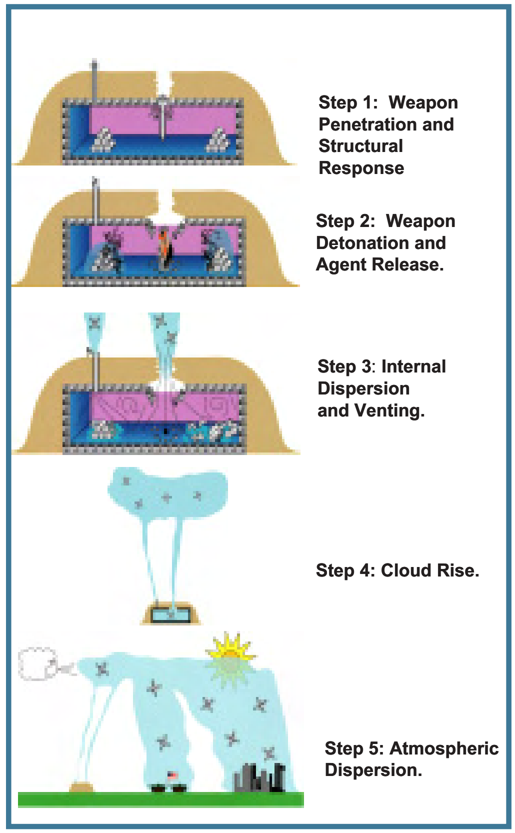

Figure 1. Collateral Hazard Assessment Steps for a Hardened Target Attack.

In the fifth stage, after definition of the source terms, the hazardous agent release cloud is subject to widespread dispersion via wind and atmospheric turbulence. The Hazard Prediction and Assessment Capability (HPAC)/Second-order Closure Integrated Puff (SCIPUFF)[12] dispersion model was used as the atmospheric transport model for the ADW AoA. The HPAC module provides the means to model hazard area ground plots based on the defined source terms, weather forecasts, and particulate transport analyses. Output graphics from HPAC display the hazard ground-level footprint for agent deposition, dose, or concentration.

To down-select weapon concepts for the ADW AoA study, researchers analyzed a minimum of two scenarios (single and multiple weapon attack) for each possible weapon/target pair. Of 16 baseline and 20 conceptual weapons, six were chosen for full analysis. Additionally, 24 facility targets and eight mobile targets were chosen. To identify the number of executions required to complete the analysis, the following was used: the number of possible targets times the number of weapons times two scenarios (one single weapon attack and one multiple weapon attack) times the number of different delivery conditions (usually four). As is evident, this quickly becomes a very large number of analyses. In addition, to accurately capture a set of realistic results given the accuracy of weapon delivery, a stochastic analysis of each scenario was required. Typically, the stochastic simulation consisted of 50 iterations over weapon placement, penetration, fragmentation, and agent release for each weapon/target pair.

To accomplish the large number of simulations required for the AoA study, researchers needed an automated interface. The Simulation Environment and Response Program Execution Nesting Tool (SERPENT)[13] uses a graphical user interface (GUI) along with parametric looping algorithms and data exchange methodology. It was developed to allow an analyst to automatically transfer the output parameters from one model to the input parameters of another model and vary those parameters for bounding studies. The process described in Figure 1 for hardened targets is simplified for open targets, such as open-air ground-mobile targets and soft aboveground storage sheds. The exact sequence of events, and thus the exact sequence of modeling codes required, depends on the weapon and target. As an example, in the case of an open-air ground-mobile target, the analyst may choose to do a stochastic analysis over the weapon placement for the agent release model and then generate the atmospheric dispersion results based on the iteration with the maximum number of containers with holes. The analyst may select a number of maximum, minimum, and closest-to-average parameters with which to produce results. Additional algorithms available to create a Gaussian puff representation of the parabolic cloud of aerosol from the agent release model (CH-ARM) along with 'pool' definitions to feed directly into HPAC/SCIPUFF. Algorithms that generate HPAC/SCIPUFF project files are being replaced with the new Integrated HPAC (IHPAC) interface.

Architecture Overview

The initial goal of SERPENT stated a requirement to support the execution of the AoA by providing a framework for interoperability, stochastic analyses, and multiple parameter variation between counterproliferation and collateral hazard analysis tools. The essential technical approach for the design of the SERPENT architecture encapsulated each analysis model in a generic object common to the software interface for maximum flexibility and modeling capability ("plug-and-play"). Each member code remains unaltered ensuring modularity, version control/code upgrades, and reliability. The SERPENT architecture manages the input and output of data/files, including geometry and parameter conversions between analysis models, and performs simple statistical analysis where appropriate. The core of SERPENT is written in Java, cross-platform portability is only limited by the ability to encapsulate the individual analysis models.

To provide maximum modeling capability, SERPENT also allows nested executions of some or all of the analysis models. Typically, a large number of input variables and variations require a stochastic analysis. Figure 2 illustrates the primary models, methodology and functions of SERPENT. All intelligence, target, and weapon input data gets processed and stored in a SERPENT database. The core analysis models get represented within the SERPENT structure. Common outputs from SERPENT include: single shot probability of kill (SSPK), the number of weapons to defeat a target, and the collateral effects (area or population affected by a WMD release). SERPENT currently uses four basic types of analyses, determined by the types of models executed. The following explain these analyses:

Weapon Effectiveness (SSPK)

The analysis process for calculating the stochastic average (or SSPK) involves looping over a penetration code to randomly place a weapon within a defined Circular Error Probable (CEP) and averaging the number of damaged containers over the random variations (each with a single detonation) on the aimpoint(s). PENCURV+ determines the weapon's penetration and

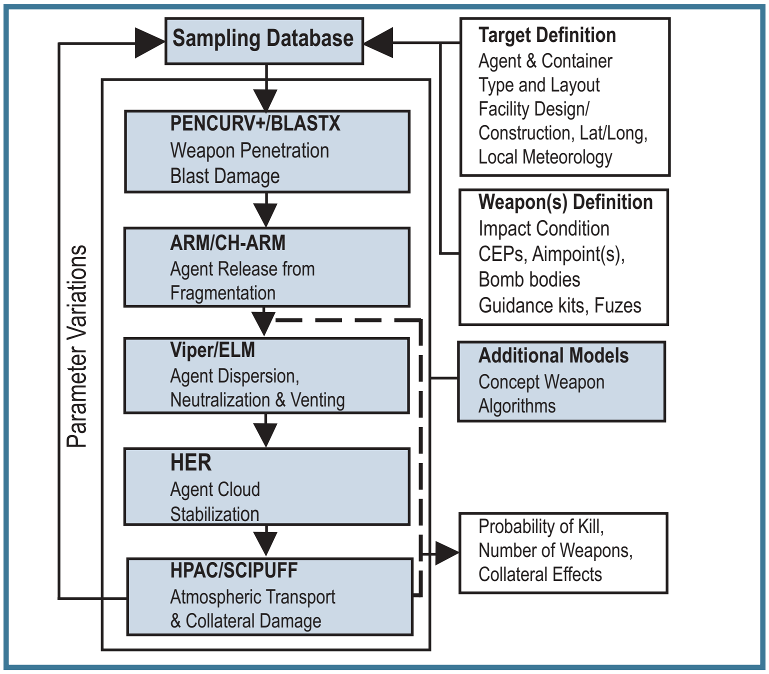

Figure 2. SERPENT Architecture/Methodology.

final position prior to detonation and the bunker response. CH-ARM then detonates the weapon and calculates the agent container damage response based on the fragmentation results. The number of damaged containers then gets reported in the summary results. (If a container receives one of more holes, this constitutes damage). The number of damaged containers gets derived from using the average number over a series of trials. The recommended number of trials is 50 or more in order to obtain a reasonable standard deviation and a reasonable run time. Dividing the number of damaged containers by the actual number of containers then gives the raw SSPK.

Number of Weapons for Target Defeat

This study involved determining the expected number of weapons required to achieve a desired kill criterion (e.g., structural kill, container damage, agent neutralization, etc...) with a defined confidence level. It involves the same process as the SSPK calculations in that the analysis loops over the penetration code to randomly place a weapon within defined CEPs and averages the number of damaged containers calculated from the random variations. To maximize the effectiveness of the weapons, the aimpoints must have geometric uniformity throughout the facility for small CEPs or in the center of the facility for large CEPs. The user/analyst iteratively adds weapons, whether geometrically or centered, until the results meet a particular kill criteria.

Collateral Hazard/Agent Release

The analysis process for calculating the amount of threat agent released to the atmosphere involves placing a weapon(s) at the average detonation location (geometric for tight CEPs or the center of the facility for large CEPs) and averaging the aerosol and leakage over a number of detonations at this location(s). The main difference between this study and the previous two remains that the penetration code only executes once to place the weapon(s), or the weapon gets placed manually. Iterations over the agent release code obtain an average release. For hardened targets, an internal dispersion code and effluent rise model may give further insight into determining the vented amount and cloud height.

Hazard Area

The analysis for calculating a hazard area involves a collateral hazard analysis coupled with an atmospheric transport model. Weather conditions and geographical positions, paired with the collateral hazard source term provide input into a downwind transport model such as SCIPUFF (HPAC) or MESO. HPAC then produces hazard plots based on the suspected release.

Physics Codes

The heart of SERPENT revolves around the modeling capability represented by the physics codes. These codes are the best available (fast-running) codes for their specific portion of the problem. A short introduction to these codes follows in the paragraphs below.

PENCURV+/PENCRV3D

PENCRV3D is a three-dimensional (3D) projectile penetration code that calculates the penetration of a rigid, axisymmetric projectile into a target with curvilinear material layers. Features include: a choice of three normal stress forms (PENCO-hard and PENCO-soft, ISAAC2, and FORRESTAL), a jointed rock algorithm, interface and free surface effects, wake separation and reattachment, a weapon failure algorithm, and impact-induced projectile rotation. PENCRV3D, bundled with a suite of new programs, collectively defines PENCURV+, to provide the analyst both quick rigid body and more detailed deformable body predictions.

PENCRV3D uses differential-area force-law (DAFL)[14] code developed by US Army Engineer Waterways Experiment Station (WES) researchers in 1975. The Armament Directorate at Eglin Air Force Base sponsored development of the first, full 3D version for use on the boosted kinetic energy penetrator (BKEP) program. PENCRV3D v2.0 received accreditation from the Joint Technical Coordinating Group for Munitions Effects in August 2001. The latest PENCRV3D upgrade, PENCRV3D v3.0, includes: a jointed rock algorithm for modeling fractured or weathered rock, a generalized ISAAC2 normal stress equation (not restricted to a soil half-space target), a modified impact-induced projectile rotation, improved hard-layer perforation for pointed nose projectiles, programmed limitations on using axial tangential friction stresses, and an improved weapon failure algorithm. PENCRV3D v3.0 needs to still receive accreditation.

BLASTX

Although agent release from containers primarily comes from fragments, air blast can cause facility damage (e.g., wall failure) that will create new exit pathways for agent and increase the amount of structural venting. BLASTX computes the shock wave environment in a room using a semi-empirical, modified ray tracing procedure. The blast originates from spherical or cylindrical explosions (assumed). Walls of the room are treated as perfectly rigid reflecting surfaces that may fail and allow gases to vent into other rooms. Two types of free air source models exist: (1) tabular spherical explosive and cylindrical explosive models based on hydrocode calculations and (2) the empirical wave forms for spheres of TNT or composition C-4. Shock wave reflections from the walls of a room are computed using the procedure of the Low-Altitude, Multiple-Burst (LAMB) model[15,16]. Each reflection from a wall acts as a pulse originating from an image source free-air explosion located behind the wall. The pressure at any point is a non-linear superposition of the direct shock and the contribution from an image source for each of an infinite series of reflections. The pressure waveforms get combined using the LAMB non-linear shock addition rules to produce the total shock wave pulse. The LAMB shock addition rules ensure conservation of mass, momentum, and energy. Except for Mach reflections produced by explosions near a wall, the shock wave model ignores the interaction of shocks before arrival at the target point. The shock wave model is not appropriate for 1-D planar shock propagation in tunnels where Mach reflections from the walls merge into a single shock front. BLASTX has undergone significant validation and is the most widely accepted fast-running blast code for bunker type targets.

CH-ARM

The CFD-quality High fidelity Agent Release Model (CH-ARM) determines the release of liquids and powders from thin-walled cylindrical containers caused by fragments or rods from conventional weapons. CH-ARM, a fast-running engineering code, produces results within a few minutes on a typical personal computer. CH-ARM has four main modules explained in the following sections.

Fragment Generator Module

The fragment generator determines the spray of casing fragments created by conventional weapons, based on curve fits to arena test data. ITT has developed a rigorous statistical module called FragGen, which is a part of the CH-ARM agent release model. FragGen generates statistically correct fragment patterns with respect to mass and polar angle for any conventional cased weapon. Figure 3 shows an example of a polar angle probability density function (PDF).

Fragment Propagator Module

The fragment propagator module has three sub modules:

■ Fragment Tracer: determines which fragments intersect which containers.

■ Fragment Penetration: determines whether an impacting fragment penetrates a container wall. Penetration routines include most container materials (metals, plastic) and shielding materials (concrete, soil, wood).

■ Fragment Energy Deposition: determines the amount of energy a penetrating fragment imparts to the agent due to drag as it travels through the agent medium.

Container Response Module

The Container Response algorithm determines the overall damage

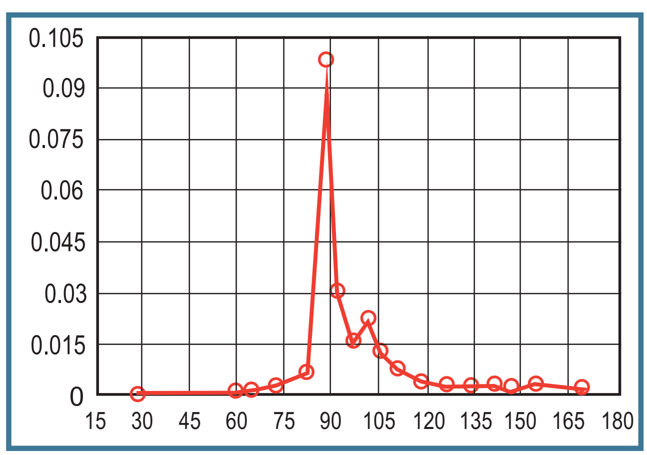

Figure 3. Fragment Polar Angle PDF for Mk-84.

to the container caused by the penetrating fragments. For liquid-filled containers, the cumulative energy deposition from multiple fragments causes the liquid to expand. In the most extreme case, this expansion causes the container to catastrophically burst. This phenomenon is called hydraulic or hydrodynamic ram results.

Agent Release Module

The Agent Release algorithm determines the release of the liquid or powder contents of the container, described in terms of vapor, fine aerosol, coarse aerosol, bulk release, and gradual gravity-driven leakage. CH-ARM determines the initial aerosol size distribution based on the strain rate in the fluid. CH-ARM also includes secondary (aerodynamic) aerosol breakup algorithms to predict the final aerosol size distribution. For each container, ARM computes the number of hits, the number of holes, the energy deposition, ram index, percentage of agent aerosolized, the source height and radius, the percent leakage and the time to 50 - 80% leakage, and type/number of container damage (i.e., reparable, irreparable, and catastrophic). SERPENT can display the containers color-coded to any output parameter from CH-ARM. Figure 4 shows an example of the number of holes per container as predicted by CH-ARM.

For the facility as a whole, CH-ARM quantifies the total container aerosol mass and leaked mass. CH-ARM characterizes the aerosol in terms of a histogram of user specified particle diameter bins for use by VIPER or any consequence analysis code.

CH-ARM has undergone significant software verification, validation, and comparisons to a number of major empirical test series. A comparison to DIPOLE JEWEL 5[17] and the Multiple Burst Test Series[18] validated the fragment generator, container response, and agent release portions of the code. Comparisons with DRIP II, III, and IV[19] validate the rod penetration, dry and liquid agent release algorithms for low energy penetrators.

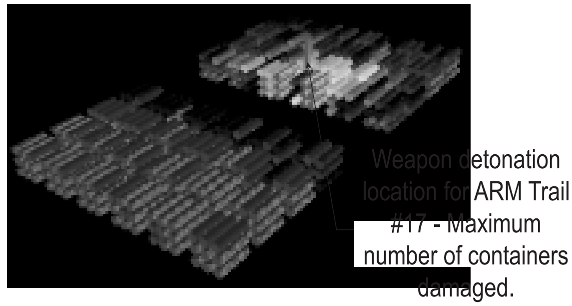

Figure 4. Number of Holes per Container (Example of CH-ARM Output)

VIPER

VIPER computes the thermal and chemical neutralization of wet/dry biological and liquid/dusty chemical agents using Monte-Carlo tracer particle histories processed through the ELM neutralization criteria. The VIPER tracer model works with a variety of neutralization parameters and limits, including: ELM upper and lower temperature limits, minimum time at temperature limits, and different database coefficients within certain temperature or humidity ranges. In the neutralization algorithm, tracers migrate with the flow across zone boundaries, through doors, and out the vents. VIPER has true 3D code with CFD–like and vertical stratification models. VIPER calculations can run in a low-resolution mode, treating each room as a single entity, connected to other rooms and to the outside by nozzle-like openings, or in a high-resolution 2D or 3D mode for maximum fidelity. Figure 5 on page 66 shows the physical phenomena modeled by VIPER. The hot expanding weapon gases from a conventional air-to-surface weapon detonated within a structure can generate sonic flow at many of the doors, generating high speed circulation in rooms far from the weapon. After agent materials get ejected as droplets or powder from munitions or canisters, they can become immediately entrained in the flow. If the gases have sufficient heat, liquid agents can evaporate off the floors or other surfaces on which they have come to rest. Once suspended in the room gases, the flow can transport and disperse the agent materials throughout the structure and vent some fraction of the agent to the atmosphere. The amount of agent ejected into the atmosphere depends on the distance from the weapon to the vent(s) and the amount of time the agent has had to settle, deposit or condense on surfaces. Since chemical agents can react with the hot gases, or condense on walls, correctly predicting the agent/weapon gas concentrations and temperatures throughout the structure remains a paramount importance. Temperature history plays an important part in the prediction of biological agent neutralization.

Short-term bunker blow-down problems have used VIPER, long-term venting due to internal fires[20], and long-term venting driven by diurnal heating and cooling cycles. Recent work for the Passive Attack Weapon (PAW) used VIPER to simulate long-term venting due to solar heating and diurnal temperature variations for above-ground targets as shown in Figure 6 on page 66.

HER

The Hot Effluent Rise (HER) code takes information describing high-velocity hot effluent coming from ground level vents (as obtained from a code such as VIPER), and produces a description of the rising contaminant cloud suitable for input to a Gaussian puff dispersion model (such as HPAC) when the effluent stops rising. After a bomb has detonated in a bunker containing chemical or biological agents, much of the agent becomes airborne, and due to the high temperatures from the explosion within the confined area, agent can vent through either designed bunker vents or the bomb hole(s). The venting of the agent can reach high velocities due to the constriction of the holes. Normally, the agent vented will have both high temperature and velocity during venting. This venting, or jetting, may have velocities reaching up to Mach 2 with respect to the ambient air.

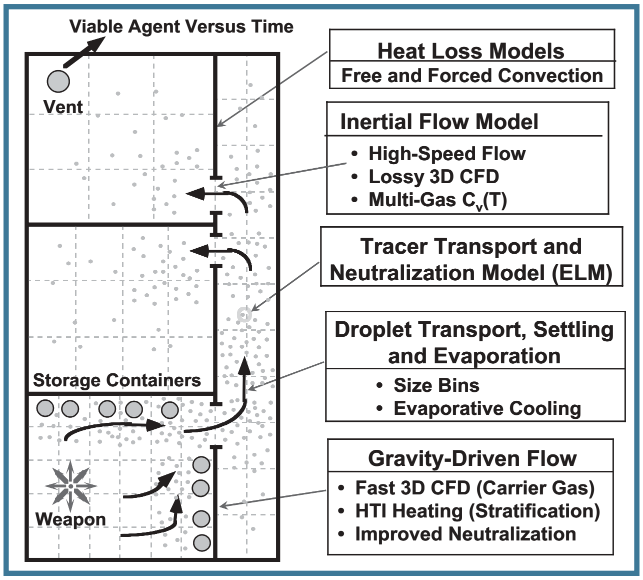

Figure 5. Components of VIPER

The vented agent (effluent), gets modeled as having three phases: (1) the 'jetting dominated' phase, (2) the 'cross-over' phase, and (3) the 'atmospheric transport' phase. The jetting dominated phase is the regime where the dynamics of the high-temperature, high-velocity effluent interacting with the ambient air dominate. The specifics of the atmosphere (such as stability, turbulence, or velocity) have little to no importance. The cross-over phase is that regime where the velocity and temperature of the effluent have reduced to the point that both the dynamics of the effluent with the ambient air and the transport and dispersion due to atmospheric properties do have importance. The atmospheric transport phase is the regime where the velocity and temperature from the jetting process have diminished to the point that they have minimal effect on the agent dispersion dynamics. (HER uses a fixed-time description of the atmosphere). The final atmospheric transport phase uses a code such as HPAC or MESO.

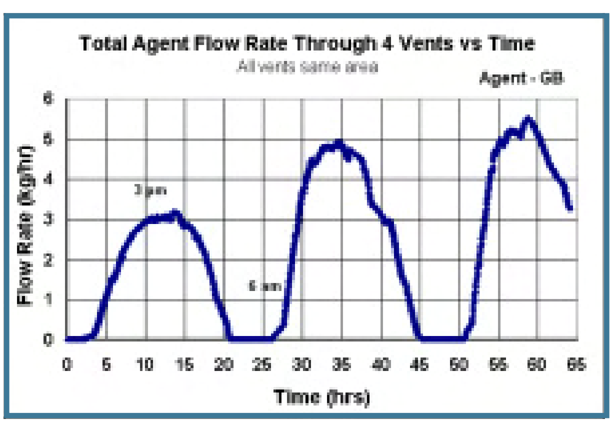

Figure 6. Long-Term Venting Rate (Example of VIPER Output)

The required parameters for a HER calculation include: atmospheric density, viscosity, pressure, temperature, turbulent velocity, thermal conductivity, velocity gradients, wind speed, and wind direction as a function of height. Currently, the structure of the atmosphere varies little in latitude and longitude over the extent of the horizontal spread of the effluent cloud.

HPAC

The Hazard Prediction and Assessment Capability (HPAC) code developed and maintained by the Defense Threat Reduction Agency (DTRA) is a counterproliferation-counterforce collateral assessment tool that provides the means to predict the effects of hazardous material releases into the atmosphere and its human collateral effects on civilian and military populations. It employs integrated source terms, high-resolution weather forecasts, and particulate transport algorithms to model hazard areas and human collateral effects in minutes. HPAC includes a Lagrangian puff dispersion atmospheric transport model called Second-order Closure Integrated Puff (SCIPUFF). SCIPUFF calculates how the released material disperses through the environment. SCIPUFF calculations take into account turbulence and diffusion due to a variety of factors including the weather and terrain.

SERPENT uses only the HPAC 'analytic incident model' allowing the user to specify the exact amount and form of a hazardous material release. The pseudo-stable puff locations get fed directly from HER into a HPAC project file. For open or mobile targets, the agent release clouds and pools get fed from CH-ARM into a HPAC project file. Using the 'analytical incident' provides SERPENT with the ability to place the agent at distinct locations around a target site. SERPENT also creates separate puffs for each aerosol particle size bin.

MESO

MESO is an atmospheric dispersion and transport prediction model that employs the use of a unique random-walk tracer technique to simulate a gradient-transfer diffusion process. The random-walk technique simulates both atmospheric transport and dispersion anywhere from the ground up to and above the tropopause. Tracer particles undergo random-walk excursions to simulate a gradient-transfer diffusion process (Diehl et al., 1982). Easily modeled eddy diffusivities are complex functions of both space and time. This numerical technique substantially increases processing time over the standard particle-in-a-cell or finite difference methods.

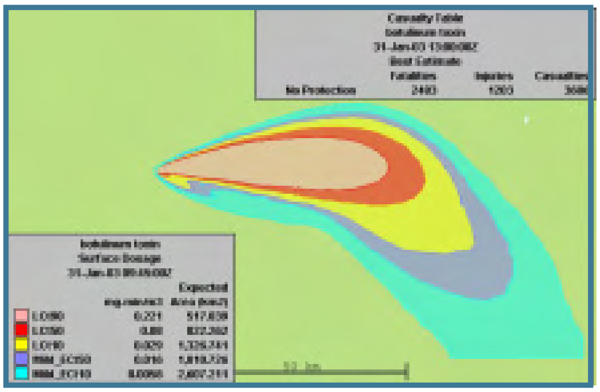

Figure 7. Collateral Hazard Area Predictions (Example of SERPENT/HPAC Output).

MESO is available independently of the SERPENT architecture at this time. Future plans include the integration of the MESO user interface, algorithms, weather downloader, and plot generation tools.

Operational Use

After the completion of Phase 0 ADW AoA in 2001, SERPENT became the leading toolkit for use in counter CB weaponeering and contingency planning. SERPENT became one of AFNWCA's keystone tools, with many other government agencies coming to AFNWCA for analysis of specific problems. SERPENT has supported operations in both a reachback mode (AFNWCA analysis) and as a toolkit. Table 1 shows a partial list of operational applications.

More recently, AF/XO provided direction for the incorporation of SERPENT software into the USAF Targeting Toolbox and the investigation of joint requirements. Based on the use of alpha version, United States Strategic Command endorsed using SERPENT as an element of their Chemical, Biological, Radiological, and Nuclear (CBRN) toolkit. Additionally, SERPENT remains the only targeting/operational-planning tool for the Passive Attack Weapon (PAW).

Table 1. Operational Applications of SERPENT.

Organization	Joint Critical	Joint	Non-Joint
DTRA	2	23	40
DOE	0	2	7
DIA	0	2	0
OSD	0	1	1
JCS	0	1	0
NORTHCOM	0	2	0
STRATCOM	0	9	0
EUCOM	0	3	0
USFK	0	2	0
NATO	0	1	0
AFFRI	0	0	1
CIA	0	0	1
Total	2	46	69

Future Development Plan

SERPENT, CH-ARM, VIPER, and HER development is funded and managed by AFNWCA. The Air Force recognizes the utility of the SERPENT suite and now is investing more resources into its development. Currently, the work focuses on several areas: a) ease-of-use of the interface, b) target construction with a computer-aided design (CAD) package, c) secondary burn modeling with VIPER, and d) code documentation required for software certification. Future plans call for integration with target intelligence databases, translation/importation of pre-existing models, integration of alternate atmospheric transport models, an urban windflow model and nuclear effects, development of a targeteering version, and development of a user forum/data exchange platform. Currently, the beta version of SERPENT has been distributed to the community to include the United Kingdom. More information can be found at the website: https://wwwmil.afnwca.kirtland.af.mil/afnwca/AT/SERPENT/ or contact Staci Stolp (505) 853-1193 to request a copy.

Conclusion

SERPENT provides a unique environment for studying CBRN counterproliferation-counterforce scenarios, the hazards associated with them, and the bounds of the uncertainties. The role of SERPENT provides the best selection of models and tools to the analyst to support the decision-making process with emphasis on fidelity and flexibility. The analyst has the ability to determine the validity of a particular model for a specific scenario, perform comparative studies, and determine sensitivities/uncertainties within the parametric definition of the problem.

This article is the result of the numerous authors from the Air Force Nuclear and Counterproliferation Agency in Albuquerque, New Mexico and ITT Industries Inc. in Colorado Springs, Colorado.

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Quo Vadis: Where Goes the Army Reactor Program?

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Over the past few years there have been considerable changes in the Army Reactor Program. This naturally leads us to ask where is the program heading? To answer this question, I will first summarize some of the changes that have happened at the facilities, and present the current status. From there, I will look ahead to some planned modifications. Finally, I will tell you where I believe this will lead the Army Reactor Program – the regulatory and oversight roles, as well as the management.

Operational Reactors – A New Era

The Army has decided to consolidate nuclear weapons effects testing at the White Sands Missile Range (WSMR). This decision was based on several factors, but the strongest driver was the cost of security. Since the fast burst reactors are manufactured of highly-enriched uranium (HEU), they have the same surety requirements as a nuclear weapon. This means a large-sized security force and its attendant costs.

In September 2004, the special nuclear material fuel from the Army Pulse Radiation Facility (APRF) reactor at Aberdeen Proving Ground, Maryland was shipped off-site, ending the operational era of that facility. Nearly two-thirds of the fuel was returned to the Department of Energy (DOE) facility at Oak Ridge, Tennessee. The remaining one-third was sent to WSMR for indefinite retention until the DOE accepts it for permanent disposal or reuse.

WSMR modified their existing fuel storage vault to support the receipt of the fuel from the APRF. Major John Carter of the Army Reactor Office (ARO) conducted an independent criticality analysis to authenticate the one completed by WSMR.

Two independent criticality analyses are required to ensure the fuel is stored safely and will not become critical.

When the Army G3 approved the consolidation of nuclear effects testing at WSMR, he placed several requirements on the US Army Test and Evaluation Command, the Army major command responsible for the reactor facilities. These requirements included establishing an outdoor testing capability at WSMR to test equipment at long distances, and combined environment testing – using the fast burst reactor in conjunction with a flash x-ray machine. Both of these requirements drive the need for major changes to the WSMR operating permit to ensure safe operations. Once necessary modifications are completed at the facilities, WSMR will be able to perform essentially the same types of testing previously done at the APRF.

Deactivated Reactors – Still Safe, Still Here

The Army had three operational nuclear power reactors in the mid-1970's that have all been deactivated – meaning de-fueled, placed in a safe condition, and awaiting decommissioning. The reactors pose no risk to workers, the public, or the environment. The US Army Corps of Engineers (USACE) maintains a proper level of site and environmental monitoring and has the records to document safe and environmentally responsible stewardship of the facilities. The three facilities are: the SM-1 at Fort Belvoir, Virginia; the SM-1A at Fort Greely, Alaska; and the MH-1A on the *Sturgis*, a barge located with the James River Reserve Fleet near Fort Eustis, Virginia.

Over the past several years, USACE has performed environmental remediation of contaminated soil at Fort Greely (previously reported in the Fall-Winter 1999 *NBC Report*), conducted a shipboard all-hazards assessment on the *Sturgis* barge to support eventual decommissioning planning, and performed the initial on-site work for the SM-1 all-hazards assessment. This is in addition to the "routine" operations and maintenance required for physical security, verifying building and ship integrity, environmental monitoring, supporting tours, and physically maintaining the equipment and facilities.

Ironically, USACE has not received funding to complete the decommissioning of the facilities because they have maintained the facilities in a safe condition. Safe facilities with no risk to the public or environment and relatively low operations and maintenance (O & M) costs, do not have the same priority of programmed funding as that given to unsafe facilities. Despite the fact that decommissioning has been verified as a valid requirement, the priority is not high enough for funding.

The ARO presented a study in 1998 to the Army Deputy Chief of Staff for Operations (G3) that showed the impact of delaying reactor decommissioning. The study concluded that costs would likely increase faster than inflation. The study also identified potentially higher future costs due to regulatory uncertainty associated with decommissioning a nuclear facility – typically radiological disposal regulations can be expected to become more onerous and potentially costly over time, not less. The study also raised questions on where the material would go once facility decommissioning began; obviously, decommissioning would not start without a viable disposal site for the waste! The G3 personally briefed the Vice Chief of Staff of the Army (VCSA) on the study results, and the VCSA directed USACE to move ahead with the required all-hazards study to facilitate cost estimates for decommissioning.

What's Next?

It may be time to revisit the path forward for deactivated facilities. The original National Environmental Policy Act documentation for the reactor decommissioning allowed for a 50-year wait after the de-fueling to allow for radioactive decay. A delay in reactor decommissioning would help to reduce worker radiation dose during decommissioning operations. By waiting, we would not be violating any commitments made to the American public and are in complete compliance with national policies and guidelines. With other priorities in the United States and worldwide, maybe we should formally put decommissioning "on the back burner." The ARO believes this to be a viable course of action.

The APRF is going to be decommissioned in the near-term as part of the Army reactor consolidation plan. The various Army stakeholders are engaged in determining the cleanup criteria, options for future land use, and potential reuse of buildings. The ARO's primary concern is that the decommissioning must allow for the "total release" and unrestricted use of the land and any remaining buildings. Total release – a term not defined by any regulations – means that the public or the Army could use the land and buildings, at any time in the future, without any radiological concerns. Once released, the Army would no longer have liability for any radioactivity or radiological concerns. This is important, since once decommissioning is considered complete, there would be no institutional controls on the buildings or land. Any future use or disposal would need to be completed as if the entire remaining APRF infrastructure and land had never been activated or contaminated.

Finally, WSMR modifications will require regulatory control and oversight to ensure the Army Reactor Program goals, as outlined in Army Regulation 50-7, are met. Proposed modifications include allowing outdoor operations with the attendant radiological risks and additional physical access controls. These were relatively easy at APRF due to its remote location within the controlled area of the Aberdeen Test Center. The reactor at WSMR is close to a road used by the staff and to a lesser degree by the public. This road is among the areas that will require access control. The ARO will be looking closely at access control and other means to ensure that there will be no inadvertent radiation exposure to the workers or to the public. Installing the flash x-ray machine is expected to require major physical modifications to the WSMR reactor facility. The ARO will be looking at structural integrity, radiation shielding, and physical security prior to these modifications, as well as results of post-modification testing.

WSMR now has an up-to-date safety basis, which includes the safety analysis report and supporting documents. The ARO has a priority to ensure the safety basis remains up-to-date during all of these modifications.

Summary

In summary, the Army Reactor Program has reached a point where we are reevaluating our activities. We have successfully raised the standard in ensuring nuclear safety and improved conduct of operations. We are looking at ways to improve oversight of the operational facility at WSMR as well as the deactivated reactor facilities. We want to ensure senior Army leadership remains confident in the direction the program is headed and can give us course corrections to ensure the program is supporting the Army.

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The Mission: Waging War and Keeping Peace

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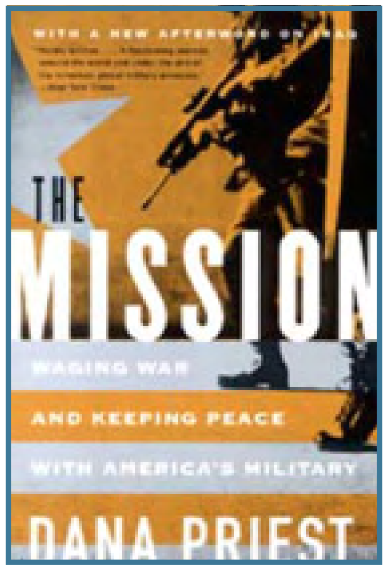
> *[E]ven as the Indonesian economy tumbled and wage and price protests bled into the streets, American special forces were giving lessons to their Indonesian counterparts. At a housing construction site owned by the Lippo Group conglomerate eighteen miles outside Jakarta, twelve U.S. soldiers diagrammed a straightforward mission: find the enemy somewhere in a warren of plywood rooms, blow a hole in the wall, and kill or capture as many as possible while trying not to shoot each other.*[1]



The above statement captures the author's thesis: the American military is a blunt instrument being used to attempt the fine embroidery of foreign policy. To make this point, Dana Priest relates the stories of the Commanders in Chief, or "CinCs" of the various regional Combatant Commands, telling of their immense resources and prestige, while laying out painstaking histories of the development of military power in foreign policy. While critical of the Bush administration, the Defense Department, and most use of military power for purposes other than all-out war, she shows admiration for the military professionals who attempt to accomplish the missions they are assigned. The author seems to repeat a fundamental flaw of reasoning throughout, however, conflating the issues of the appropriate use of military engagement with the lack of State Department involvement in foreign affairs, consistently implying that the use of one somehow must preempt the other. Her claims that Congress inadvertently gave the Services and Combatant Commanders their present power while the State Department somehow withered away from disuse and a lack of funding seem oversimplified by not including in their calculus the change in the security situation across the globe.[2] Throughout the manuscript, which is a fine tale of military engagement and its attendant complexity, the thread of her thesis at times weaves true and at times sadly misses the mark, depending on her example.

She has created a worthy historical primer for the military officer reader. She effectively chronicles the rise of the Special Forces and puts together fairly succinct historical vignettes on the development of both the Defense Department and the regional Combatant Commands. She also takes a significant detour from her thesis, dedicating nearly half of her book to the peace-keeping missions in Bosnia and Kosovo, and providing graphic depictions of the challenges, leadership failures, and crime that bloomed in those lawless and unstable environments. The educational value of this portion of the book alone makes it worth reading for military officers, especially those who could be deployed to such an environment. The book is more disjointed by the inclusion of the peace-keeping section, and I agree with Major General Atkeson, who reviewed this book for *Army Magazine*,[3] who felt that the story of the crime in Kosovo by an American soldier belonged in a separate text.[4] I would go even further. The section on Bosnia and Kosovo, by themselves, could have made a fine book concerning the challenges of peacekeeping operations and the intense leadership necessary to keep them on track. Happily though, the Balkans portion is a welcome respite from Priest's familiar saws about the need for stronger civilian control of the military, and it takes readers into the heart of what really happens in a peace-keeping operation. Alas, the respite does not last, and the last two chapters of the book are devoted to Priest's political soap-box and scathing criticisms of the current administration's policies for engagement with the Third World, including the "abandonment" of the mission in Afghanistan in favor of a pre-emptive war in Iraq.[5]

Historical Primer

In looking at the way the military has been used in foreign policy, Priest has written a strong primer on several areas of military and government history. One area she covers deftly is the development, organization, and uses of the Special Forces. Though filled with backhanded compliments and criticisms of overblown egos and a lack of female representation on the teams, the book does a good job of tracing the relevant contributions of the Special Forces from its inception through present-day operations, with major emphasis on successes and the political obstacles faced by the organization.[6] The most entertaining chapter of the book focuses on the exploits of Special Forces Team 555, the "Triple Nickel," a team with the 5th Special Forces Group from Fort Campbell, Kentucky. Priest colorfully tells the story of their unusual exploits in Afghanistan. From their unlikely meeting of a hulking, flashlight waving CIA operative named "Hal" in their "tactical" Afghan landing zone, to their success in directing allied air power against Taliban targets, the story of the 555 is the stuff movies are made of.[7] The realism of combat also plays an important part in the story, however, and other teams she writes about do not fare as well. They face the fog of war when they mistakenly call in an air strike on their own position or are caught between competing warlords and are forced to use supporting arms against "allies" to extract their teams from danger.[8]

Though less entertaining than the tales of the Special Forces, Priest's portrayal of the history and political development of the Department of Defense (DoD) through the various Congressional acts is incredibly enlightening. The author's purpose in this section is to ostensibly demonstrate how the power of the Combatant Commanders developed. She contends that, "Congress's original intent had been to curb inter-Service [sic] rivalry and competition, not create a separate foreign-policy track,"[9] but her trace of DoD development from post-World War II (the National Security Act of 1947) to the establishment of the unified Combatant Commands, (the Goldwater-Nichols Act) demonstrates how history has affected our transformation into a joint war fighting organization. Of particular note is her description of Defense Secretary William Perry's influence in broadening the role of the military in foreign policy. According to Priest, his "reign as defense secretary proved historic. He was the first to see that the military could be used to shape the world in peace-time, by using military-to-military relations to seduce countries into the US sphere of ideas and geopolitical interests."[10] The resulting Clinton administration National Security Strategy directing the CinCs to "shape, prepare, respond all over the globe" developed into the "peacetime engagement activities" that the author believes were the beginnings of her perceived over use of the military.[11]

Among the historically interesting areas of history in the book is the rise of Al Qaeda, Usama Bin Laden, and the Taliban in Afghanistan. The book lays out the painful truth of the CIA's assistance to Pakistan and the Mujahideen fighters of Afghanistan, which spawned Bin Laden. The resulting pullout after the Soviet departure left a vacuum filled by warring factions. Eventually, the ethnic Pashtun Taliban became a stabilizing force. Priest includes a concise history of the rise of Usama Bin Laden and his original goals to overthrow the corrupt monarchy in Saudi Arabia and eject Americans from Saudi soil. This grew into the 1998 Fatwa "to kill Americans and their allies—both civilian and military."[12]

Some of the most important history in the book is in the large portion focused on the Balkans. Exceedingly relevant for military officers who may see duty in any "stability and support operation" from Europe to the Middle East, the lessons in this manuscript are many. The stories she tells are heart-rending, the issues complex. Each vignette illustrates the need for strong leadership, training, and engagement and supervision at all levels. The author makes good points about the military's equipment and lack of it, showing the irony of deploying to an urban environment without basic equipment such as radios or flashlights.[13] These obvious shortfalls demonstrate how improvements need to be made in the planning and undertaking of peace-keeping and "stability and support" missions. She also is correct in asserting that innovative training for these missions is essential. Seeing the needs of an operation and responding to such needs, especially during the planning phase, cannot be overstated.

The author's reasoning begins to unravel when she asserts that our military cannot deal with the extraordinary or unplanned for demands of such operations. She bemoans the fact that Soldiers were "saddled with other unfamiliar responsibilities" and had to "act like cops" or provide electricity or create criminal hearing procedures.[14] It is unclear whether she believes that other more qualified persons from the State Department or other organizations should be performing these duties, but a nagging question arises: Who else can step in when the security situation is too dangerous for civilian workers? Setting conditions for the provision of essential services, and often the provision of such services themselves, is a necessary part of peacekeeping. If the people are angry because they don't have telephones or access to the courts, should we figure out a way to give them these basic services, or just wait for the security situation to improve? Most leaders would say that waiting is no answer. While our military may not be trained in many of the nuances of such pursuits, our military leaders are bright and flexible enough to take on such missions as part of a greater campaign. At bottom, the author's examples of shifting alliances and difficulties in coalition operations don't support her assertions about the misuse of the military in foreign policy. They indicate the need for a highly trained military force to do necessary operations like Bosnia and Kosovo.

The US military vs. US Department of State

It is clear from the start that Dana Priest believes that the military is over-stepping its authority and is outside its depth in conducting any business that could be characterized as "foreign relations." The first chapter is entitled, "Pax Americana," and the author fairly quickly gets to the point of her book, which is that the military should be put in a box—and opened only for fighting wars.[15] The idea seems dated, almost Cold-War era thinking, but she intimates that our military is capable of providing nothing more than an offensive force, and that all other matters of foreign policy should be left to the State Department.[16] Priest neither adequately supports this theory, nor discusses the possible reasons for the gradual shift in the use of military power and influence. Her explanation is overly simplistic and accuses the entire government of being "asleep at the wheel" while the military took over the reigns of foreign policy. She states, "The military simply filled a vacuum left by an indecisive White House, an atrophied State Department, and a distracted Congress."[17] Not only does her assertion ignore changes in global security, it is also internally inconsistent with her later discussion of Secretary Perry's "historic" decision to begin military-to-military operations as a tool to influence foreign governments.[18]

The author's thesis that the military is just the wrong tool for the foreign policy job falls apart under analysis. Most readers will probably come to the more reasonable conclusion that the military cannot do it alone. The bottom line is that while other governmental action may be necessary, the use of the US military in foreign policy engagement is a first step, and does not, in and of itself, equate to a failed foreign policy. The answer seems to be clear: A combined effort is necessary. Just as counter-terrorist training cannot repair the nation's banks, the nation's banks cannot address terrorism.[19] Mutual exclusivity is counter-intuitive. Security and domestic development must both be addressed. Priest seems to miss this idea even when it is pointed out to her. She quotes the Director of the Centre for Democracy and Development in Lagos, who stated, "When you have a military entrenched in politics in such a fundamental way, you must see military engagement as just a step in the transformation, not an end in itself."[20] This comment suggests a need for a cooperative relationship between the Defense and State departments in achieving foreign policy, especially in countries where military governments are involved.

Particularly alarming is her attempt to use economic or social problems abroad as a reason for attacking military-to-military operations. She quotes a "feisty" State Department official who states that those who promote such operations are "pointedly unable" to demonstrate any positive impact in the area of human rights.[21] With this assertion, she puts the proponent of military-to-military operations in the impossible position of having to prove a negative event, specifically the non-occurrence of human rights violations. Does the author believe that human rights violations would decrease if the American military disengaged, or is she merely "muddying the waters" so that she can advocate for more State Department involvement? The answer remains unclear. What is clear is that Priest believes that the military and the State Department are in competition for the foreign policy job. In discussing the US operations in Nigeria, Priest states, "Using the American military to address global problems had become almost a reflex in Washington. . . [m]ilitary programs did little to help political systems move from dictatorship to democracy, or economies from government control to free market."[22] The unwritten conclusion is that the author believes the military-to-military programs should be ended.[23] She does not advocate or investigate integration or increased involvement by the State Department. Such analysis would be beneficial to readers trying to understand her conclusions, but it is not applied.

The question of bias presents itself in this book. The author, a journalist for the Washington Post, is practically destined to view the military with suspicion. Though she shows true admiration for the commanders and troops doing difficult work in the field, her word choice often belies the lack of confidence and disdain she feels for military officers. In addition to cataloging multiple snubs and sleights of State Department diplomats, by the military, she describes as "bullet-headed," a commander in Bosnia who scoffs at the importance of buying sewing machines for civilians.[24] And when General Zinni, "CinC" of Central Command boards an aircraft, he is not described as being accompanied by his staff, but by an "entourage."[25] Comparing the conflicts in Somalia and Viet Nam, she concludes that the planners in both conflicts were practically unable to learn from history, stating, "Perhaps that was because the US military itself had grown increasingly isolated from its own country's culture, as study after study showed."[26]

Conclusion

The Mission is a book worthy of study. Its historical teachings are a full experience by themselves. The well-written descriptions and individual stories grab the imagination and effectively beg forgiveness for the author's scattered organization and flawed analysis. Additionally, military professionals gain the valuable experience of seeing ourselves through the eyes of a critical media reporter, a perspective that is blared into the eyes and ears of the American public every day.

The real value of the book is in the teachings of leadership at levels from the infantry platoon all the way up to Combatant Commander. The real-world experiences and diplomatic and military problem-solving depicted in *The Mission* are lessons to be filed away and used by leaders of all ranks. From Bosnia to Afghanistan, Nigeria to Indonesia, the exploits of our leaders and other dedicated professionals share a common goal—accomplish the mission—and in doing so, be an American leader. Like General Zinni, we may find ourselves in the position of trying to "light a candle" in some of the darkest places in the world. This book can help us do just that, instead of just "cursing the darkness."[27]

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NOTES

1 PRIEST, supra note 1, at 224.

2 Id. at 90-91.

3 Major General Edward B. Atkeson, Book Reviews, ARMY MAGAZINE, Mar., 2003 at http://www.ausa.org/www.armymag.nsf/(reviews)/2003?OpenDocument.

4 Id.

5 PRIEST, supra note 1, at 385-405.

6 Id. at 122-140.

7 Id. at 141-168.

8 Id.

9 Id. at 91.

10 Id. at 97.

11 Id.

12 Id. at 146.

13 Id. at 284.

14 "At a minimum, Americans should understand the consequences of substituting generals and Green Berets for diplomats, and nineteen-year-old paratroopers for police and aid workers on nation-building missions." Id. at 14.

15 Id.

16 Id.

17 Id.

18 Id. at 97.

19 Id. at 224.

20 Id. at 180.

21 Id. at 223.

22 Id. at 179.

23 Id. at 112. Priest expressed her disbelief that while President Clinton was warning that Pakistan's nuclear tests would bring "world condemnation," military planners were "polishing plans to mingle" sixty American Special Forces soldiers with Pakistanis during exercises outside Peshawar. Id. The author gives no reason why these two events are politically incompatible.

24 Id. at 16.

25 Id. at 118.

26 Id. at 202. The author offers no support for her statement, nor indicates which studies she is citing. Id.

27 Id. at 181.

Catching the Music Between the Notes: The Emerging Role of the United States Army in Support of Counterproliferation and the Proliferation Security Initiative

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The Proliferation Security Initiative (PSI) is a new and emerging tool of the Bush Administration that was designed to reduce and eliminate proliferation of weapons of mass destruction (WMD) and related materials. President Bush announced the initiation of the PSI on May 31, 2003 in Krakow, Poland. Since then, there have been five meetings of the participant nations to coordinate policy and procedures. The PSI is currently composed of an alliance of 14 nations (United States (US), United Kingdom, Germany, France, Italy, Poland, Spain, Portugal, Australia, Netherlands, Turkey, Singapore, Canada, and Japan), with others contemplating joining. The 14 nations represent a familiar group of global leaders and emerging regional players. Interestingly, the PSI has emerged outside of the United Nations (UN), illustrating an emerging trend of ad hoc coalitions working outside the UN to accomplish common goals.

The PSI is designed to interdict WMD materials being transported at sea, air, or over land, and to facilitate the transfer of information between countries about WMD-related materials. To date, the PSI has been active only in a naval and naval-exercise environment. However, the air and ground scenarios are considered in the PSI and are slated for future exercises and possibly, action.

Certainly, the emerging role of landpower in the future security environment will require an ability to conduct operations dealing with WMD. The Army's current doctrine is focused on detecting the battlefield use of nuclear, biological, or chemical (NBC) weapons. However, the lesson of September 11,th 2001 has expanded this consideration to include possible terrorist use against Army installations and facilities. In both cases, the Army has defensive or passive doctrine for dealing with NBC or WMD.

This paper provides a brief overview of counterproliferation, the PSI, and the emerging proliferation environment. Although counterproliferation constitutes a broad category of activities for the Department of Defense (DoD), this article primarily focuses on proactive or offensive-type actions directed at the production, storage, and transport of WMD, as opposed to the entire spectrum of counterproliferation activities. It concludes with the future of the Army and how transformation impacts PSI-related operations.

WMD Counterproliferation

The September 11,th 2001 attack on the US began the first large-scale conflict of the 21st century. The attack set the stage for the Global War on Terrorism (GWOT), which focuses on eliminating terrorists and their sponsors. Given the nature of the attack, namely, mass-casualty-producing actions executed by 19 terrorists, the even more dreadful possibility of 19 men having access to WMD became a primary focus for the Bush Administration. A broad set of measures were introduced in an attempt to lessen the possibility that a WMD attack could be conducted against the US. These measures included both passive and active defenses, as well as the stated possibility of preemptive offensive action to forestall a WMD attack.

President Bush identified the threat of WMD as "one of the gravest security challenges facing the Untied States."[1] The September 2002 National Security Strategy identifies three pillars, to "prevent our enemies from threatening us with WMD":

> "Proactive Counterproliferation efforts, strengthened nonproliferation efforts to prevent rogue states and terrorists from acquiring the materials, technologies, and expertise necessary for weapons of mass destruction, and effective consequence management to respond to the effects of WMD use, whether by terrorists or hostile states."[2]

Counterproliferation is the pillar that will be the focus of this article. Some aspects of the US strategy have caused significant reaction both domestically and internationally. The international furor has subsided enough for some of the same countries to now join in the PSI. The PSI is a unique integration of both diplomatic and military efforts to curb WMD proliferation. The PSI will undoubtedly have periods of high demand for military action, accompanied by sustained diplomatic efforts. Furthermore, the PSI is inherently a coalition operation. Therefore, the need for involved nations to seek approval for action will extend the time horizon involved for any military activity.

The National Strategy to Combat Weapons of Mass Destruction identifies the nation's efforts to address and reduce the WMD threat. Specifically, the counterproliferation pillar of this strategy requires the following:

> "We will ensure that all needed capabilities to combat WMD are fully integrated into the emerging defense transformation plan and into our homeland security posture. Counterproliferation will also be fully integrated into the basic doctrine, training, and equipping of all forces, in order to ensure that they can sustain operations to decisively defeat WMD-armed adversaries."[3]

This statement provides the guidance to the DoD to begin further active planning for counterproliferation activities. Of course, counterproliferation is a somewhat broad category of operations for the military. The Office of the Secretary of Defense defines counterproliferation as "the full range of military preparations and activities to reduce, and protect against, the threat posed by NBC weapons and their associated delivery means."[4] It is sufficient to say that counterproliferation is a set of active and passive measures to defeat WMD-related production, storage, transportation, and delivery means. However, the Army currently has no specific doctrine for counterproliferation, although there is ample doctrine on battlefield and installation response to NBC use.

The DoD is simultaneously conducting the GWOT and transforming its capabilities and organization to meet 21st century security challenges. Defense planner Andrew Marshall envisions a force less focused on mass and more flexible in composition to accomplish a variety of missions from full-scale war to humanitarian operations.[5] A RAND study points out, "In the years ahead, the US military will face demands to substantially improve its ability to conduct rapid strike operations against a range of terrorist targets."[6] Therefore, it is necessary to look at what the future may hold for the proliferation environment and, specifically, for the Army in terms of its role in the future battlefield and how it might structure its forces.

Proliferation Environment

The expansion of globalization and increasing availability of high-technology industrial manufacturing capacity has placed WMD capability in reach of not only smaller states, but also an increasing number of non-state actors. Globalization and its developing networks have broadened the rapid movement of all manner of goods and services. Furthermore, well-established smuggling networks and front companies can develop, produce, and move materials covertly. Overnight airfreight service is now available to virtually any medium-sized city in the world. Additionally, containerized shipping can move significant amounts of cargo into any large port in the world in less than three weeks.[7] Freight and shipping companies have established air, land, and sea networks to transport cargo rapidly around the world.

Globalization has expanded the movement of all matter of goods and materials. The expanding networks of cargo movement by aircraft, ship, train, and truck has presented would-be proliferators with ready-made methods to move WMD. Improved production technology and information technologies that allow for miniaturization, all at a low cost, place WMD within reach of even poorer states or non-state actors. WMD activities from production to packaging and storage can conceivably take place in a small set of buildings. This environment presents a challenge to nations interested in restricting or halting the spread of these weapons. As the pace of globalization increases, transportation networks, manufacturing technology, and reduced production and storage infrastructure will only improve. Concurrently, the existing smuggling networks in regions of the world will no doubt increase in their ability to move WMD-related materials. As Moises Naim points out,

> "To be sure, nation-states have benefited from the information revolution, stronger political and economic linkages, and the shrinking importance of geographic distance. Unfortunately, criminal networks have benefited even more. Never fettered by the niceties of sovereignty, they are now increasingly free of geographic constraints."[8]

The future represents the potential for disparate amounts of WMD production and transportation on a global scale. As such, counterproliferation and, particularly, PSI operations have a significant "target set" to monitor and then act upon.

The scale of the daily operation of even one global air cargo company or shipping company is immense and should not be underestimated. Consider the number of airplanes, ships, and trucks moving in each country, each day around the world. For example, Federal Express operates 643 aircraft through 378 airports and 877 stations worldwide; this results in 3.1 million cargo shipments daily.[9] The intelligence requirements of tracking such a volume of movement are subsequently enormous. Furthermore, intelligence products will need to be able to identify a particular truck, train, ship, plane, or industrial facility for any operational activity to take place. Without a doubt, this is a unique challenge. As US Undersecretary of State for Arms Control and International Security John Bolton points out, "There are essentially an infinite number of potential circumstances and variations and permutations where interdictions could take place."[10] This proliferation environment certainly presents unique challenges for the US intelligence community and the operational military forces that may be involved in supporting the PSI.

The Future US Army

While "Army Transformation" activities are beyond the scope of this article, it is necessary to conceptualize what missions and roles a "transformed" US Army might be required to execute. This broader perspective allows a greater understanding of specific aspects in counterproliferation and of how the Army can be structured to accomplish those tasks. The current configuration of the Army is not effective for the prosecution of both the GWOT and its associated missions and other expected future security challenges.

Moreover, future potential battlefields may not always require large armored formations backed by massive air and naval power, the Korean peninsula excepted. Consequently, Army transformation intends to change the Army to improve its responsiveness to a broader range of potential operations. Army transformation is an ongoing process with no clearly defined end date. The efforts are also subject to the inevitable budgetary pressures imposed by Congress. Furthermore, a current challenge for the Army is planning and executing these changes while major portions of the force are deployed to Afghanistan, Iraq, and the Balkans, or preparing to deploy there to relieve other forces.

Even so, the Army is changing, acquiring new equipment and capabilities, and developing new doctrine for the future. These changes are projected to meet an emerging set of functions and possible operational environments for the Army.

The demands on the Army posed by the GWOT and other future security challenges are numerous. In an Army War College monograph entitled *FUTURE WAR/FUTURE BATTLESPACE: The Strategic Role of American Landpower*[11], Steven Metz and Raymond Millen provide a concise snapshot:

The Objective Force Army

Strategically decisive characteristics:

- Strategic speed
- Full-scale decisiveness
- Broad-band precision
- Success in protracted, asymmetric, ambiguous, and complex conflicts
- Ability to operate in coalition
- Rapid conceptual and organizational adaptation

These characteristics will be essential in support of operations in a future security environment. Specifically, the need for precision, ability to operate in a coalition, and rapid conceptual and organizational adaptation would be critical for the Army in support of PSI operations. The Army certainly can contribute to the goals of both the PSI and counterproliferation, the proactive aspects in particular.

Accordingly, supporting proactive counterproliferation and the PSI call for a modified set of skills for the Army. The Army has traditionally excelled at operational and tactical mobile warfare such as seen in DESERT STORM, Afghanistan, and the initial three weeks in Iraq. These conflicts represent the long-standing focus of the Army on close combat. However, as a paper presented in *Parameters,* the Army War College magazine noted,

> "…future large-scale contingencies by the United States are more likely to be motivated by the desire to conduct preemptive military operations as part of a Counterproliferation operation to disarm a rogue regime arming itself with chemical, biological, radiological, or nuclear weapons, rather than reacting to a sudden act of regional aggression."[12]

The Army has already expanded into peacekeeping operations in the Balkans and Haiti and is currently engaged in large-scale security and stability operations in both Iraq and Afghanistan. All of these experiences over the past 15 years have given the Army a broad range of knowledge and experience in dealing with various operational and tactical environments short of full-scale war. As GEN Montgomery Meigs points out,

> "We must continue to possess the forces and systems we need to provide conventional deterrence and, if deterrence fails, win decisively. As they have been doing in low-intensity conflicts for the last decade, however, these same units must also be able to task organize on short warning into new structures to defeat opponents who seek to apply asymmetrical abilities in idiosyncratic approaches in unconventional settings."[13]

Counterproliferation and PSI operations clearly fit into the lower end of the conflict spectrum, although there are possibilities that could lead to a greater chance of combat. Provided the Army is called upon to support the PSI, it must have applied some level of operational and tactical thought to how it might conduct these operations. The Army's roles in support of the PSI are potentially numerous and will require a range of Army capabilities.

Author's Note: Since this article was written, the Army has stood up the 20th Support Command (Chemical, Biological, Radiological, Nuclear and High Yield Explosive) at Aberdeen Proving Ground, Maryland. This command will provide expertise in responding to a variety of WMD situations. The Command can provide tailored support to Army and joint force commanders, as well as appropriate federal, state, and local officials. In addition, previous NBC Report articles have outlined in detail other actions the Army took in Iraq to increase combating WMD

capabilities, such as creating and deploying the Nuclear Disablement Team. Finally, the Army has expanded the size and role of its Functional Area 52 (FA52) officers. FA52 was previously identified as Nuclear Research and Operations, which characterized its role in the Army during the mid-90s. Recently, FA52 was renamed Nuclear and Couterproliferation to better define the functional area's role and mission within the Army. In all, the Army has begun to take several useful and significant steps to adjust its roles, missions, and function to address this new operating environment and broad new mission area. In Part II of this article, I will discuss the Army's role in PSI operations, provide current examples, and make recommendations for the future.

Major Bret Kinman is a FA52 officer currently assigned to the United States Joint Forces Command J354 Anti-Terrorism/Force Protection. He was previously assigned as a student at the Naval Postgraduate School, Department of National Security Affairs to the USAREUR G3 Executive Office, and to the USAREUR G3 Force Protection & Anti-Terrorism Division. He has a B.A. in Political Science from North Georgia College and a M.S. in National Security Affairs from the Naval Post Graduate School.

ENDNOTES

[1] National Strategy to Combat Weapons of Mass Destruction, December 2002, p.1

[2] The National Security Strategy of the United States, September 2002, p.14

[3] National Strategy to Combat Weapons of Mass Destruction, December 2002, p.2

[4] *Counterproliferation: Threat and Response*, Office of the Secretary of Defense, January, 2001, p.78

[5] Thomas Ricks, *How Wars are Fought Will Change Radically, Pentagon Planner Says*, Wall Street Journal, July, 15, 1994

[6] Lynn E. Davis & Jeremy Shapiro, Editors, *The U.S. Army and the National Security Strategy*, RAND Arroyo Center, Santa Monica, CA, 2003, p.38

[7] Conversation with Mr. James Bergeron, Deputy Political Advisor to Commander US Navy, Europe, Feb 2004

[8] Moises Naim, *The Five Wars of Globalization*, Foreign Policy, January/February 2003

[9] Fact Sheet from www.fedex.com, this does not include various FedEx feeder and other commercial arrangements

[10] Wade Boese and Miles Pomper, *The New Proliferation Security Initiative an Interview with John Bolton*, 4 November, 2003, Arms Control Association, www.armscontrol.org

[11] Steven Metz & Raymond Millen, *FUTURE WAR/FUTURE BATTLESPACE: The Strategic Role of American Landpower*, Strategic Studies Institute, U.S. Army War College, Carlisle Barracks, PA, March 2003, p. 24

[12] Peter A. Wilson, John Gordon IV and David E. Johnson, *An Alternative Future Force: Building a Better Army*, Winter 2003-04, Parameters, US Army War College, Carlisle Barracks, PA, p. 24

[13] GEN Montgomery C. Meigs, *Unorthodox Thoughts about Asymmetric Warfare* (Carlisle, PA, Parameters, US Army War College, 2003) p.16

Surety Update

LTC Larry Jones
United States Army Nuclear and Chemical Agency

All of the Army's surety regulations are in the process of revision. This article will provide an update on the status of the Army's nuclear, biological, and chemical surety regulations. This information has been coordinated with Headquarters, Department of the Army (HQDA), G35, DAMO-SSD.

Nuclear Surety

An update to Army Regulation (AR) 50-5, *Nuclear Surety*, will begin late in 2005. This action is needed based on Department of Defense's (DoD's) efforts to update nuclear surety and personnel reliability program directives. An update to AR 50-5 will allow us to look at ways to promote uniformity between the nuclear, chemical, and new biological surety programs in order to simplify procedures and inspection standards. The review of a new DoD Directive 5210.63, *Security of Nuclear Reactors and Special Nuclear Materials*, has just started.

Biological Surety

The United States Army's biological surety program regulation is nearing completion. The DoD Instruction 5210.XX, *Minimum Security Standards for Safeguarding Biological Select Agents and Toxins*, has been formally coordinated. AR 50-X, *Biological Surety*, has been formally coordinated and is awaiting publication. AR 50-X establishes Department of the Army policies, assigns responsibilities, and prescribes procedures for the Army's biological surety program. The regulations purpose is to ensure that operations with biological select agents and toxins (BSAT) are conducted in a safe, secure, and reliable manner. To allow a smooth implementation of the regulation, an interim guidance memo signed by the HQDA, Deputy Chief of Staff G3 has been published. This begins the implementation period that will last through April 2005, and includes implementation team visits to select sites. At the end of the implementation period the interim guidance will be in effect. The Department of the Army Inspector General plans to conduct a "free visit" as part of a site assistance visit before conducting Biological Surety Inspections.

Chemical Surety

The draft revision to AR 50-6, *Chemical Surety*, has been sent out for formal coordination. Comments are being reviewed and integrated into the draft regulation. A HQDA-G3 decision is pending as to whether the draft requires re-coordination.

LTC Lawrence Jones is a 74A Chemical Officer currently assigned to USANCA's Operations Division as a chemical surety officer. His previous assignment was with the Defense Threat Reduction Agency. He has a B.S. in Biological Sciences from California Lutheran College and is a graduate of the Command and General Staff College, Fort Leavenworth, Kansas.

Do You Know…

Robert Pfeffer
Physical Scientist, United States Army Nuclear and Chemical Agency

DARPA Has an Impact on The Army Survivabliity Program

Once again, the Defense Advanced Research Projects Agency (DARPA) is on the cutting edge of new technology that will see its way into the Army. This short article describes their recent challenge to universities and private industry to come up with one of those technologies now…the first truly robotic vehicle. Such a challenge is accelerating the time when unmanned platforms and systems will become an integral part of Army operations.

The DARPA Grand Challenge

On 13 March 2004, DARPA sponsored a race called the Grand Challenge. Twenty-five robotic vehicles competed for the $1 million grand prize to be awarded to the first vehicle to go from Barstow, CA to Prim, NV (320 km) with no driver, no passenger, and no team members guiding them by remote control. In addition, the course had to be completed in less than 10 hours. Once programmed, these autonomous vehicles had to maneuver over all sorts of on-road and off-road terrain on their own.

There was some bad news and some good news.

The bad news was that none of the 25 vehicles successfully completed the race. A GPS-guided Carnegie Mellon University vehicle made it the furthest (12 km) before failing a series of hairpin turns. The second (a customized dune buggy by Rockwell Scientific and Elbit Systems) and third (a modified Toyota pickup by Velodyne Acoustics) furthest were 11 km and 10 km, respectively. The implication to the Army is that first-generation robotic technology allows for unmanned platforms and systems, but they must be co-located near man.

The good news is that next year's (8 October 2005) grand prize is $2 million!

Army Implications

The National Defense Authorization Act of 2001 authorizes the conversion of a full one-third of the Armed Forces combat vehicles to unmanned equivalents by 2012. This mandate, no doubt, is the driving force behind the DARPA Grand Challenge. The Future Combat Systems presently plans to have five to seven unmanned platforms and systems in their Unit of Action (UA). Some are Unattended Airborne Vehicles (UAVs), but others are Unattended Ground Vehicles (UGVs). These first-generation robotic systems will have to operate and complete their critical mission virtually unsupported for 72 hours. This also means they must survive some level of nuclear weapons effects (NWE) criteria.

At first, manned equivalents are expected to be within a half kilometer of robotic systems. This implies first-generation unmanned platforms and systems will be structurally similar to manned equivalents, will have similar electronics, and will have the same criteria as their manned equivalents. This will be the case, since man will continue to be the most important link in the man-equipment chain. As second-generation unmanned systems are developed, criteria will again be based upon their operational proximity to manned equivalents. If they operate at ranges greater than a half kilometer, the criteria will be based upon equipment susceptibility levels, not man's inherent susceptibility to NWE criteria. A more definitive description of the rationale for establishing criteria for unmanned operational platforms and systems is given in Quadripartite Standardization Agreement (QSTAG) 2041. The United States Army Nuclear and Chemical Agency is currently developing criteria for these second-generation unmanned systems.

Further Reading

QSTAG 2041, A Rationale for Establishing NWE Criteria for Unmanned Operational Platforms and Systems, 11 September 2003.

www.darpa.mil/grandchallenge/gc05RulesAug04.pdf.

Helping Hand, Government Computer News, pp. 23-24, 28 June 2004.

Functional Area 52 Professional Reading List: an Addendum to Dr. Davidson's Earlier Article

MAJ Bret Kinman
Naval Postgraduate School, Department of National Security Affairs

Army officers have a professional obligation to study and expand their knowledge of their specific skills, as well as to gain a broader understanding of warfare. Throughout our careers, officers are educated through the Army's education system, to include officer basic and advanced courses, the Command and General Staff College, and the Army War College. Some are fortunate enough to attend graduate schooling to enhance their knowledge and analytical abilities. In the Fall/Winter 2002 issue of *NBC Report,* Dr. Charles N. Davidson provided a basic set of doctrinal and policy related materials in his article entitled, "Professional Library for Functional Area 52." Each Functional Area 52 (FA52) officer should have these references. In that spirit, I propose the following list of additional works that might enhance the knowledge of FA52 officers. Although I have not included any scientific works, the basics of weapons design and the associated physics are addressed in some of the works listed.

I developed this list during my master's degree work in the National Security Affairs Department at the Naval Postgraduate School in Monterey, California. I have provided the standard academic citation along with a brief description of the work. Of course, this is only a partial list of the numerous works on nuclear weapons, nuclear strategy and policy, and related nuclear and weapons of mass destruction (WMD) issues. I welcome other input on works that the FA52 community would find useful in expanding its knowledge base. I have attempted to provide those works that have withstood academic scrutiny and are widely referenced by students, academia, and policy-makers.

Classics of Nuclear Strategy

- *The Absolute Weapon: Atomic Power and World Order*

Brodie, Bernard. New York: Harcourt, Brace, 1946.

- *Strategy in the Missile Age*

Brodie, Bernard. Princeton, NJ: Princeton University Press, 1959.

A follow-on to Brodie's initial work noted above. This work expands on his initial thoughts and further considers the impact of nuclear weapons and intercontinental ballistic missiles.

- *The Evolution of Nuclear Strategy*

Freeman, Lawrence. New York: St. Martin's Press, 1981.

This book is a modern analysis of nuclear strategy and the development of its key facets (massive retaliation, limited war, etc.), from the end of World War II through the early 1980s. The book is a useful reference on the progression of the arms race during the height of the Cold War.

- *History and Strategy*

Trachtenberg, Marc. Princeton, NJ: Princeton University Press, 1991.

This book focuses on strategic thinking in the US from 1952-1966. This work is also an analysis of the relationship of history and strategy, looking at the early- and mid-Cold War periods, including the Berlin and Cuban Missile Crises and the rearming of NATO.

- *The Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960*

Rosenberg, David Alan. International Security, Vol. 7, No. 4 Spring, 1983.

This is an article that looks at the early history of US strategic nuclear policy. The article is a useful history of the early struggles the US and its leadership had with nuclear policy. The interservice struggles over nuclear assets, roles, and missions are also documented.

Nuclear Weapons History

- *The Making of The Atomic Bomb*

Rhodes, Richard. New York: Simon and Schuster, 1986.

Rhodes' work represents an expansive history and analysis of the scientists and other personalities involved in the Manhattan Project. Rhodes also provides extensive details on the physics behind the atomic bomb.

■ *Dark Sun: The Making of the Hydrogen Bomb*

Rhodes, Richard. New York: Simon and Schuster, 1995.

This is Rhodes' follow-up work to *The Making of the Atomic Bomb*, and is equally extensive in analyzing the personalities and the physics involved. Both works are essential histories of the beginning of the US nuclear weapons program.

The US Army and Nuclear Weapons

■ *The Pentomic Era: The U.S. Army between Korea and Vietnam*

Bacevich, A.J. Washington, D.C.: National Defense University Press, 1986.

Bacevich has written an essential analysis of the US Army during this period. The book takes a close look at the Army's interservice conflicts over budget, roles, and missions. The book also looks at the Army's internal struggles over the same issues. This work is insightful reading for FA52's and the Army in general, and is uniquely applicable to the current Army transformation process.

■ *The Evolution of U.S. Army Nuclear Doctrine, 1945-1980*

Rose, John P. Boulder, CO: Westview Press, 1980.

Rose provides an in-depth study of the development of US Army nuclear doctrine from World War II through 1980 and its impact on Army forces during that time. Rose also looks at the relationship between nuclear doctrine in the Army and national policy. Although an older work, this is one of the few references that look at the Army's nuclear doctrine throughout the Cold War.

■ *Deadly Illusions: Army Policy for the Nuclear Battlefield*

Midgely, John J., Jr. Boulder, CO: Westview Press, 1986.

Midgley looks at the relationship between the Army's nuclear arsenal capabilities, policy, and employment guidance given to commanders. This and the above works appear to be the three most in-depth histories of Army nuclear forces, associated policy, and doctrinal issues.

Emerging Nuclear Issues (Proliferation, New Nuclear States)

■ *The Spread of Nuclear Weapons: A Debate Renewed*

Sagan, Scott D., and Kenneth N. Waltz. New York: W.W. Norton and Company, 2003.

Sagan provides the latest version of the classic and ongoing debate that developed two camps on weapons proliferation - proliferation pessimists and proliferation optimists. Other subjects addressed include India and Pakistan, terrorism, and missile defense.

■ *Planning the Unthinkable: How New Powers Will Use Nuclear, Biological and Chemical Weapons*

Lavoy, Peter R., Scott D. Sagan, and James J. Wirtz, Editors. Ithaca, NY: Cornell University Press, 2000.

A broad look at the emerging issues related to WMD and security policy. This work was on Dr. Davidson's original list. I have also included it because I believe it is worthwhile.

■ *The Absolute Weapon Revisited: Nuclear Arms and The Emerging International Order*

Paul, T.V., Richard J. Harknett, and James J. Wirtz, Editors. Ann Arbor, MI: The University of Michigan Press, 2000.

In the spirit of Brodie's original volume, this newer work is a collection of views on the strategy and policy of nuclear weapons in the post-Cold War era. Although the Cold War rivalry has ended, nuclear weapons remain and add a degree of complexity to the contemporary environment.

Encyclopedic References

■ *Atomic Audit: The Costs and Consequences of US Nuclear Weapons Since 1940*

Schwatrz, Stephen I., Editor. Washington D.C.: The Brookings Institute Press, 1998.

This book is part of the Brookings Institution's US Nuclear Weapons Cost Study Project. This work is a comprehensive gathering of all aspects of the US nuclear program, specifically delivery systems, warheads, facilities, and associated costs.

■ *The Cold War: A Military History*

Miller, David. New York: St. Martins Press, 1998.

A comprehensive catalog of the policies, alliances, strategies, tactics, and weapons that were developed and used by both sides throughout the Cold War; a useful reference of all things Cold War from strategic to tactical.

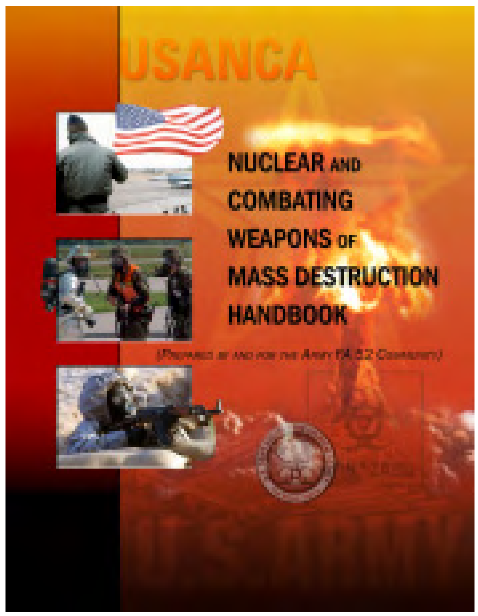
Major Bret Kinman is a FA52 officer assigned to the United States Joint Forces Command, J354 Anti-Terrorism/Force Protection. He was previously a student at the Naval Post Graduate School. He was also assigned to USAREUR G3 Executive Office and USAREUR G3 Force Protection & Anti-Terrorism Division. He has a B.A. in Political Science from North Georgia College and a M.S. in National Security from the Naval Postgraduate School.

Nuclear and Combating WMD Handbook

LTC Tom Moore
United States Army Nuclear and Chemical Agency

Professionals rely on checklists and consolidated infomational guides to step them through the critical tasks of their given occupations. The military is no exception. Artillery officers recognize the value of the *Executive Officer's Handbook* as an aid for the many details of artillery operations. Similarly, Army Rangers depend on the *Ranger Handbook* to quickly spell out the steps of many warfighting tasks. These two references are useful because they are compact, speed the retrieval of important information, and are updated by the Soldiers that use them. As a result of their utility and efficiency, both handbooks are in demand from Soldiers outside of their intended audience.

Functional Area 52 (FA52) officers are responsible for a large breadth and scope of technical and operational information. A handbook that could consolidate this information would be an ideal tool for the FA52 community as well as other professionals that are involved in combating weapons of mass destruction (WMD). The Defense Threat Reduction Agency (DTRA) proposed the idea of a "FA52 Handbook" to Dr. Charles N. Davidson, the Director of the United States Army Nuclear and Chemical Agency (USANCA), in June 2004. Dr. Davidson approved the concept. Currently, Science Applications International Corporation is working with DTRA and USANCA to finalize the first Nuclear and Combating WMD Handbook (FA52 Handbook). Like the two references mentioned above, the FA52 Handbook will be compact (5"X8"), will allow users to retrieve critical information quickly, and will solicit feedback by the community it serves.



Distribution

The FA52 Handbook will be distributed with two compact disks (CDs). The CDs will include a complete electronic copy of the handbook as well as interactive links to hundreds of references useful to FA52 officers. One of the disks can be used as a link to classified resources through the SIPRNET. The CDs will also have two search engines to help speed through the voluminous data quickly and efficiently.

The prototype handbook was developed and reviewed in mid-December 2004. The final copy was reviewed at the end of January 2005. All FA52s will receive an unclassified copy in the mail. Therefore, it is important that the FA52 Proponent Manager at USANCA has your current address.

This reference will be of benefit to anyone involved in combating WMD, and expectations are that it will be in high demand. Additional copies will be approved on a case-by-case basis by contacting the Operations Division at USANCA via email at: nca@usanca-smtp.army.mil. This first edition will be limited to approximately 500 copies.

If you do not receive a copy or simply forgot your copy at the office when you deployed, do not worry. You will be able to consult the FA52 Handbook on-line if you have an Army Knowledge Online (AKO) account. The FA52 Handbook will be posted on a "nuclear page" that will help foster collaboration within the combating WMD community. The classified references will be available through the existing nuclear page on the AKO-SIPERNET (see page 68 of the Spring / Summer 2004 *NBC Report*). The FA52 handbook will be approximately 200 pages in length. Below is a snapshot of the Table of Contents:

General Information

- Guidelines for Use
- Functional Area 52 Nuclear and Counterproliferation Staff Officer

Doctrinal Matters-Combating WMD (CWMD)

- National Strategy to Combat WMD
- Joint CWMD Doctrine (JP 3-40)
- Army CWMD Doctrine

Operational Matters-Planning and Operations

- Planning
- Field Operations
- Modeling and Analysis Tools
- Nuclear
- Radiological
- Chemical
- Biological
- High-Yield Explosives

Appendices

Points of Contact

Do you want to know more? For additional information about the FA52 Handbook please contact Major Michael Aitken, david.aitken@dtra.mil or LTC Tom Moore, thomas.moore@us.army.mil.

LTC Tom Moore is a FA52 officer currently assigned as a Theater Nuclear Planner in USANCA's Operations Division. His previous FA52 assignments were with the Defense Threat Reduction Agency and United States Pacific Command. He has a B.A. in Psychology from Saint Anselm College, a M.A. in Organizational Management from the University of Phoenix, and a M.M.A.S. from the Army Command and General Staff College.

THEATER NUCLEAR OPERATIONS COURSE (TNOC)

For all Joint Nuclear Operations Planners
Army ASI 5H certifying training

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 effects, determination of force protection and warning measures, and the theater nuclear plan approval and execution process.

Course Number: DNWS-R013 (TNOC)

1-4 Aug 05
Defense Nuclear Weapons School
Kirtland AFB, Albuquerque, NM
Quotas:
Call DNWS Registrar at
(505) 846-5666 or DSN 246-5666

Joint Planner's Course for Combating WMD

Review, revise, and coordinate combating WMD plans IAW US strategy. Course dates are:
4-8 Apr 2005
11-15 Jul 2005
Defense Nuclear Weapons School, Kirtland AFB, NM
Attendance: DoD staff officers with combating WMD responsibilities
Additional information/availability: Lt Col Hiram Morales, DTRA CSOP, hiram.morales@dtra.mil or (703) 325-1294

NBC CIS Warning and Reporting Panel Meeting

Formerly known as the ATP Warning and Reporting Panel. They will hold their next meeting, 18-22 April 05. Ottawa, Canada. Discussion includes the next version of the ATP. Our current manual is the ATP-45B with the "C" version expected for release late 2006.
For more information on these meeting, address request to:
Ken Harris
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Chemical Division, USANCA
(703) 806-7874
harris@usanca-smtp.army.mil

Tell It To The Community

You may submit calendar items, small notes, items of interest, etc. to the USANCA Bulletin Board. Email items to The NBC Report Editor at nca@usanca-smtp.army.mil or call DSN 656-7857/(703) 806-7857

The next issue of the NBC Report is scheduled for publication the first week of June 2005. Bulletin Board submissions for the issue should cover dated items from July-December 2005 and must be submitted NLT 30 April 2005 for publication.

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

SMR

Army Specific Military Requirements for Radiation and Nuclear Weapons Effects

Provides DA-G3 approved rank ordered list of requirements for information:
- Nuclear Weapons Effects
- Related Electromagnetic Effects
- Related Directed Energy Effects

The FY05/06 SMR was disseminated December 2003.
For a copy of the FY05/06 SMR contact USANCA's Nuclear Division at (703) 806-7860 or DSN 656-7860
The two-year publication cycle of the FY07/08 SMR will start early 2005 with a MACOM meeting at USANCA. Any one interested in attending should call one of the above numbers for details.

Nuclear Research and Operations Officer Course (NROOC 2005)

Functional area qualifying course for officers assigned to FA52.
NROOC 2005
11-29 July 2005
Defense Nuclear Weapons School, Kirtland AFB, NM
Attendance:
Initial priority is given to officers TDY enroute to a FA52 assignment or currently serving in a FA52 position.
Additional information/availability:
Call the FA52 Proponent Manager,
(703)-806-7866, DSN 656-7866

Upcoming NWE-Related Events

Hardened Electronics and Radiation Technology Conference: 21-25 MAR 05, Tampa, FL
DoD E3 Program Review: 4-8 April 05, Las Vegas, NV
Nuclear and Space Radiation Effects Conference: 11-15 JUL 05, Seattle, WA
For more information on these activities, address requests to:
Robert Pfeffer
Nuclear Division, USANCA
(703) 806-7862
pfeffer@usanca-smtp.army.mil

HQDA Surety Conference 2005

MACOM surety representatives and HQDA G35 SSD are planning the Army's annual surety conference. This year's theme is "Army Surety Moving Toward a Common Approach" and will cover not only chemical but also biological and nuclear surety.
Mark your calendars for 4-7 April 2005 at the Holiday Inn Riverwalk Hotel in San Antonio, Texas.
POC is Ed Reynolds at edward.reynolds@us.army.mil

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