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Fissile Material Production in a Nonproliferation Regime

By John C. Matter
INMM President

Half a century ago, on December 8, 1953, U.S. President Dwight D. Eisenhower gave his "Atoms for Peace" address to the United Nations General Assembly in New York City. It was a time of rapidly expanding stockpiles of atomic weapons in the West and the Soviet Union. Eisenhower clearly recognized the horrors of atomic warfare and proposed an alternate path. He proposed "an international Atomic Energy Agency" set up under the aegis of the United Nation. This new organization would be responsible for the "impounding, storage, and protection" of fissionable materials contributed by the atomic powers. More importantly it would develop methods to allocate these materials for peaceful applications of atomic energy such as agriculture, medicine, and electrical power. As we know, the International Atomic Energy Agency (IAEA) was eventually established, albeit with a somewhat different set of powers.

Thirty-five years ago, on July 1, 1968, the Treaty on the Nonproliferation of Nuclear Weapons (NPT) was opened for signature and signed by sixty-two countries, including the United States, the United Kingdom, and the Soviet Union. As part of the NPT, member states are required to accept IAEA safeguards. For the non-weapon states the safeguards were to be applied to their declared nuclear facilities and materials. Although safeguards were not required for the five recognized nuclear weapon states as of that date, they voluntarily accepted safeguards on specific civilian nuclear facilities. The NPT also made available to the non-weapon states the technologies for the peaceful use of nuclear energy. The NPT remains the keystone of the international nuclear nonproliferation regime. A decade ago some of the limitations of safeguards applied pursuant to the NPT became widely recognized. This followed the voluntary abandonment of a secret nuclear weapons program in one member state and the discovery of an ongoing secret nuclear weapons program in two other states. This led to a system of strengthened safeguards that was adopted by the IAEA Board of Governors and culminated in 1997 with the approval of a Model Additional Protocol. However, the implementation of full-scope strengthened safeguards is dependent on the voluntary negotiation and acceptance of an Additional Protocol by member states, and many states have yet to act on this.

One decade ago, on December 16, 1993, the United Nations General Assembly adopted a resolution on the Prohibition of the Production of Fissile Material for Nuclear Weapons or Other Nuclear Explosive Devices. It called for the negotiation of a "non-discriminatory, multilateral and internationally and effectively verifiable treaty" for such purpose; requested the IAEA consider verification arrangements; and called upon states to demonstrate their commitment to this objective. That same year, on August 10, the Conference on Disarmament (CD) had decided to give its ad hoc Committee on Nuclear Test Ban a mandate to negotiate a comprehensive nuclear test-ban treaty (CTBT). These treaties were envisioned as complementary. The CD has yet to write and adopt a so-called fissile material cutoff treaty (FMCT). For better or worse, the CD is an organization of sixty-six states that operates on a unanimous approval, basis. The CD has been unable to agree even on a work program. Thus an FMCT has not been negotiated, much less approved. In fact, a draft treaty text has not been written and presented to the CD.

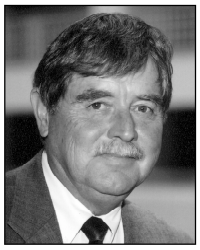
INMM Fellow Tom Shea is personally energized by this challenge. As a means to stimulate an international dialog surrounding a potential FMCT, he has drafted a proposed comprehensive treaty text on this subject. He informally discussed it during the 44th INMM Annual Meeting in July at two of our technical division meetings—Nonproliferation and Arms Control and International Safeguards—and at the Fellows Luncheon. This complete proposed treaty text along with detailed commentary by section is presented on page 34.

The INMM Executive Committee will soon consider holding a workshop on this subject—possibly in spring 2004—that would include discussion of treaty provisions and their technical verification. If approved, this workshop would most likely be organized and conducted by INMM's Nonproliferation and Arms Control and International Safeguards technical divisions.

Today the international nuclear nonproliferation regime is faced with increasing challenges by several states in unstable regions of the world and by the threat of subnational terrorism. Some believe the nonproliferation regime has failed and would abandon it. Others believe that while it is imperfect it has served us well and should be strengthened. A new treaty limiting the production of fissile materials for nuclear weapons may be one means towards this latter goal. As President Eisenhower said in his "Atoms for Peace" speech in 1953, in words that seemingly apply today, "the gravity of the time is such that every new avenue of peace, no matter how dimly discernible, should be explored." INMM supports this exploration as part of its mission in nuclear materials management and begins with Tom Shea's article published herein.

INMM President John C. Matter may be reached by e-mail at jcmatte@sandia.gov.

Annual Meeting, FMCT Featured in Fall *JNMM*



By Dennis L. Mangan
Technical Editor

As in the past, this fall issue of the *Journal* focuses on the highly successful INMM Annual Meeting, held this year July 13–17, 2003. Beginning on page 4, Charles Pietri gives a rather extensive summary of the meeting. I believe this piece highlights his desire to continue to improve the meeting. He openly addresses every issue of the meeting of which he was made aware. I predict that, unless there is some catastrophe, next year's meeting will be an improvement over this year's. Charles is to be commended for his efforts.

At the meeting, our plenary speaker was Dale Klein, assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs. His opening remarks, which were insightful and entertaining, begin on page 9. He discusses nuclear threats and security in the 21st century, discusses the war on terrorism, highlights the impact of the Nuclear Posture Review, gives some insights into the future of nuclear energy, and notes the growing shortage of nuclear expertise in the United States.

As has been the custom for many years, as technical editor of this *Journal*, I host a roundtable question and answer session with the plenary speaker following the plenary. The transcript of the roundtable discussion begins on page 14. As you read Dr. Klein's answers, appreciate (if you didn't know) that before accepting his present position in the Defense Department, he was a professor at the University of Texas in Austin, heavily engaged in fostering nuclear energy. I appreciated his frankness and breadth of knowledge as he participated in this roundtable. The questions cover a range of topics, including guidance on how the Institute might better engage students. I trust you will enjoy reading the roundtable.

Included in this issue is the paper that received the first J.D. Williams Student Paper Award. This award could not have been named after a more unique member of the Institute. J.D. was our immediate past president, served on the executive committee for nearly seven years, and was in principle the founding father of the Physical Protection Technical Division, which he chaired for many years. I'm sure many of you were on his mailing list. J.D. was also an excellent mentor and appreciated inspiring young people. He was extremely sensitive to the feeling and thoughts of people. He had a wonderful outgoing nature, and if he had a fault, I would opine that it was his saying in a paragraph what most people would say in a sentence. His wife Wilma was at the annual meeting and accepted the Institute's resolution of respect for J.D. See her letter of appreciation on page 8.

The student who won this first award was Jarrod D. Williams of the University of Tennessee. His paper, *Analysis of Neutron Reflection in Correlation Measurements*, begins on page 26.

The closing plenary session of the annual meeting included two presentations on homeland security: *Countering Radiological and Nuclear Threats* by Anthony Fainberg of the U.S. Department of Homeland Security, and *The FBI's Nuclear Program* by Bernie Bogdan of the U.S. Federal Bureau of Investigation. These presentations are summarized beginning on page 31, through the efforts of the Government and Industry Liaison Committee. As I have mentioned previously, I believe our Institute has a role to play in homeland security, and I am personally pleased that the closing plenary addressed this topic. There are some who believe that homeland security is more of a U.S. issue than an international issue and thus should not necessarily be a focus within our international Institute. There are those who argue that homeland security is an international issue and rightfully has a place within our Institute. Do you have any thoughts on this?

The final paper in this issue is by Tom Shea, a fellow of the Institute, who offers *The Fissile Material Cut-Off Treaty: A Venue for Future Progress in Arms Control, Nonproliferation, and the Prevention of Nuclear Terrorism.* INMM President John Matter summarized the background and motivation for this paper in his comments on page 2. As Matter notes, there was considerable debate about this article at the annual meeting. It was generally agreed among our officers and various committee chairs that our Institute is a professional open international forum that should promote such debate on issues such as the FMCT. Any comments you have would be most welcomed.

As usual, should you have any questions or comments, do not hesitate to contact me.

Dennis L. Mangan is a consultant and can be reached at dennismangan@comcast.net.

Report of the 44th INMM Annual Meeting—Scorpions and Safeguards

By Charles E. Pietri
INMM Technical Program Committee Chair

There were rumors of a scorpion infestation at the J.W. Marriott Desert Ridge Resort & Spa in Phoenix, Arizona, U.S.A., site of the 44th INMM Annual Meeting July 13–17, 2003. We quickly put those rumors to rest by assembling a team of experts with desert experience (unemployed former weapons inspectors, someone suggested) who determined that the information was false. The only scorpions to be found were in the hotel gift shop safely encased in clear plastic. (But where did they get so many to encase?) INMM Executive Director, Rachel Airth, even with the pressure of orchestrating the Annual Meeting, was so enamored of these creatures that she obtained one for further examination in Chicago—a strange pet even when entombed in plastic.

What do scorpions have to do with safeguards? They both have to be treated with respect and understanding or serious consequences may occur. So both started off the Annual Meeting with a lot of interest. And it was a superb meeting thanks to the efforts of the Technical Program Committee and INMM HQ staff, who organized the meeting, and those who chaired sessions, but most of all to the efforts of the authors and speakers who contributed papers, posters, and their enthusiasm. INMM President John Matter and Vice President Cathy Key were always present to help out, and, of course, the Registration Committee, chaired by the competent Glenda Ackerman, was indispensable to our success. Lyn Maddox, our conference manager, and her assistant, Madhuri Carson, did a great job of organizing at the site. The other interesting note was that attendees seemed to take a more active role in seeing that the meeting ran smoothly—just as if it was realized that this meeting was truly *their* meeting!

The meeting boasted 784 attendees, including 107 companions. We had 275 papers, including nineteen posters and forty-four sessions. (For comparison, last year we had 774 total attendees, including 76 companions, 281 papers including fifteen posters, and forty-four sessions.)

This year's keynote speaker, Dale Klein, assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs, opened the Plenary Session with a description of the strengths and weakness of the programs to combat terrorism and to encourage nonproliferation of weapons of mass destruction. It was encouraging to hear that despite the considerable nuclear threats and security challenges currently facing the United States and the rest of the world, these circumstances are not insurmountable.

A follow-up interview conducted at the INMM Roundtable by *JNMM* Technical Editor Dennis Mangan, provided even further insight into Klein's world, touching on the need to take action to maintain technical excellence and continuity in the nuclear infrastructure currently faced with an aging professional workforce. To read the complete transcript, see page 14 of this issue.

Our closing plenary session, Homeland Security Perspectives, was co-chaired by Jim Lemley and Amy Whitworth, chair and vice chair respectively of the Government-Industry Liaison Committee. Anthony Fainberg, director for federal laboratories, science, and technology directorate in the newly established U.S. Department of Homeland Security, addressed the topic of "Countering the Rad/Nuclear Threat." He was followed by Bernie Bogdan, from the U.S. Federal Bureau of Investigation, who gave another perspective in "FBI Nuclear Counter-terrorism Program." A summary of their talks is published on page 31.

We note that there is ample time at the Annual Meeting to meet with our colleagues and relax at some of the non-technical events. The President's Reception on Sunday, July 13, was one example, although we admit the distribution of hors d'oeuvres could have been better. (See our comments later on but be assured that we'll fix this matter when we return to this hotel in 2005.) President John Matter, Vice President Cathy Key, and INMM Executive Committee members made sure they circulated among meeting attendees and their companions to greet them.

New INMM members as well as new senior members had their own special reception on Monday, July 14. It's rewarding to see some of our more faithful members reach the senior-member level—they form the backbone of the Institute with their experience and interest. Our greatest reward, though, is attracting new members to INMM and we had the opportunity to meet with some of them here.

Perhaps the process of attracting younger professionals is working. If we look at the composition of the meeting attendees we note that there is a broad range of those for whom this is their first meeting (24 percent), those who have attended two to three meetings (25 percent), those attending four-ten meetings (32 percent), and lastly the old-timers with greater than ten meetings in their history (18 percent).

The best student paper competition, now known as the J.D. Williams Student Paper Award in honor of Immediate Past President J.D. Williams who passed away in June just weeks before the Annual Meeting, was held again this year. This initiative started by INMM President John Matter last year to encourage students

to present the results of their research resulted in three contestants. (Last year we had eight contestants and first and second prizes were awarded.) The winning author this year of the J.D. Williams Student Paper Award was Jarrod Edwards of the University of Tennessee. Read his paper on page 26. One of the purposes of the student paper award is to encourage younger professionals to opt for a career in nuclear materials management and to become members of INMM.

The July 15 Awards Banquet featured excellent food (although some disagreed) and noteworthy awards. On a somber note, it was especially significant this year since there were resolutions of respect for three of our deceased members: Katsuyuki Higuchi, who died on September 12, 2002, Hastings A. Smith, who died on April 17, 2003, and James D. Williams, who died on June 6, 2003.

INMM cherishes the constructive comments provided either verbally on site or through our annual meeting evaluation form. Many of the observations have been used to make successive annual meetings more effective and enjoyable. Unfortunately, we usually get about a 5 percent response.

Based on comments we received last year, we changed the evaluation process to an electronic procedure (e-mail request and Web site response) that attendees could make use of within a few days of their return home. We feared that folks would forget or get involved with their work once they left the meeting site so we were ecstatic with the increased returns (28 percent) we collected this year using this method!

This year the Overall Annual Meeting process was rated mostly as good-excellent with especially good commendations for the preliminary and final programs, the pocket schedule-at-a-glance, the registration process, and our outstanding INMM HQ staff; the Technical Information Exchange, Logistics, and Exhibits areas were also rated highly good-excellent. Greater than 97 percent of the respondents indicated that the INMM Annual Meeting met their needs!

However, there were also some significant negatives that we discuss below, some of which we can correct and some of which are beyond INMM's control.

Here are some of the more pertinent comments we received and our responses:

- *The weather!* Too hot—that's what most folks said and we agree. However, for those attending the various sessions and sidebar meetings it was quite comfortable in the hotel. And, it did cool down by about 20° F in the evening so that one could wander about in the nearby shopping mall or sit out in the patio at the rear of the hotel—several groups had dinner *al fresco* each night. But INMM has no control over the weather and we got the best hotel deal in July. (Note that the week after our meeting a cool wave moved into Phoenix—temperatures dropped to about the 100-degree level!) Our focus is to provide the best facilities at reasonable cost so that you can have the best meeting to present your research and hear others' works. Believe me, INMM has scrutinized the hotels that are suitable for the annual meeting and this is a good deal. Next year we're in Orlando where it's relatively cooler but I suppose that some folks will complain about the humidity. It is also interesting to note that, although there was some dissatisfaction about the hot weather in Phoenix, attendees overwhelmingly loved the hotel—and more than 70 percent prefer a resort area.
- *Hotel rates:* If you applied for the U.S. government statutory allowance of 150 percent of federal per diem it only cost you a pittance out of pocket to stay at this world-class hotel. Also, some institutions absorbed the additional cost. So, for the most part it was not a financial burden to attend the annual meeting.
- *Audio systems and microphones:* INMM apologizes for the inconvenience and annoyance caused by the lack of lavaliere microphones for speakers and by sporadic poor sound systems in several rooms. We will work even further with the hotel staff to provide an enhanced audio system for our return in 2005. INMM is also contemplating the purchase of our own lavaliere microphones to assure availability for our speakers at all times. (We need to make certain that there will be no compatibility issues with hotel or leased audio systems.)
- *President's Reception:* We never know exactly how such affairs will turn out in a hotel that we have never visited before. Unfortunately, although everyone seemed to have had a great time, the food distribution was not adequate because of the layout of the room. We tried to do a "fix" during the reception by ordering more food and having it distributed from other locations. Again, our apologies and we plan to make it up to you next year.
- *Business Meeting:* It's hard to gauge the success of the INMM Business Meeting when only fifty to sixty people show up. However, of those who did attend, 96 percent thought it was good-excellent. (I guess that's why they attended in the first place.) How can we encourage more folks to participate in an area that is critical for understanding how the INMM works and the importance of contributing to the welfare of its members?
- *Meeting Programs:* Greater than 95 percent of the meeting participants favored the newly modified preliminary program integrated with the detailed and continually updated Web site information on the papers to be presented. The final program received the same level of appreciation although many attendees continued to be dismayed at the number of changes and withdrawals after its publication. See our discussion elsewhere in this report.
- *Quality of the speakers and papers presented:* Although there were sporadic comments that some papers were rep-

etitious or did not present new information, and that some speakers' presentations needed improvement, these areas were rated good-excellent by about 82 percent of our evaluators. If you can provide specific instances (paper or author), we can evaluate further so as to increase the satisfaction level to at least the 95 percent level. Let's hear from you.

- *Poster session:* Taner Uckan did a great job managing this session alone this year—his co-chair, Sharon Jacobsen, could not make the meeting. But INMM goofed—we underestimated the number of posters and designated too small a room to display all of the good works properly. At times, it almost looked like a New York City subway train at rush hour. Another item that INMM will definitely fix next time around.
- *PowerPoint© presentations and LCD projection:* These capabilities are not yet officially supported by INMM for several significant reasons and they were an ongoing concern by our attendees again this year. We discuss this issue in detail later on.
- *Meals:* We received a few comments that meals at the hotel were too expensive. ("Expensive" is relative: I would expect our Albuquerque folks to be appalled at Chicago restaurant prices—but worse, try to get a sandwich and soft drink in New York City for less than $10!) INMM went to great effort to ensure that the hotel would provide several locations at which one could purchase a continental breakfast for about $4–7 and lunches for $6–9—such prices are within normal meal expenses. In fact, I personally ate at these places and paid those prices. Furthermore, *JNMM* Technical Editor Denny Mangan and I had dinner in one of the patio restaurants for about $35. Maybe some people did not take advantage of the information about meals that INMM and the hotel had made available.
- *Plenary speakers:* We had a favorable but mixed response about the speakers for the opening and closing plenary sessions. Each year we ask our meeting attendees for ***specific*** advice, suggestions, and contacts for those speakers they would like to hear at the annual meeting. The response (or rather, lack of it) we get is not very encouraging. If you have a proposal and are able to make contact with a potential plenary speaker, please let me know. I'll be glad to discuss the matter with you at any time but we need to move on this effort early in the year so as to meet most speakers' annual schedule.

The big change in the meeting this year was the move to a smaller, more economical, and more effective preliminary program that provided the basics of the meeting but left out the paper titles to be presented in each session. The titles of these papers were posted on the INMM Web site and were updated weekly with changes. This practice allowed INMM to provide you with current information about the technical program and reduced the time (and cost) of producing a hard copy document that was out of date by the time it was printed and distributed. For next year we're thinking about reducing the final program to the pocket program alone and, again, posting the abstracts on the Web site and/or some other attractive means of communication.

The reader could download the abstracts of interest before the meeting so as to make a more informed selection of the sessions and papers to be attended. Preliminary indications are that more than 70 percent of those who responded to the meeting evaluation viewed this approach favorably. We are also considering some additional options to enhance the process. As usual, INMM would like to hear more of your views on this proposed approach.

The elimination of the final program will not eliminate the constant problem we have with the withdrawal of papers and changes in speakers. The issue of cancelled papers is so disruptive to the program and is one of the most common complaints from our attendees.

INMM recognizes that there are legitimate reasons to withdraw papers from the program, even at the annual meeting itself. We do strongly urge those who submit papers for presentation to do so only after careful consideration of their ability to attend, the management and classification approvals required, and any other factors that might inhibit meeting their commitments to INMM. For example, we received forty-seven withdrawals out of 341 abstracts originally submitted; twenty-one of those withdrawals were received ***after*** the final program was published three weeks before the meeting. (We also had the deplorable situation of three no-shows—those folks who did not have the courtesy to let INMM know in advance of their decision not to present or even attend the annual meeting.) INMM is quite flexible in facing program changes but at times these late adjustments tend to overwhelm us and makes the technical program less satisfying to the other meeting participants. So we really need your help to eliminate or at least reduce this deficiency. On the brighter side, although we had an unusually high number of speakers who could not present their paper and session chairs who could not get to the meeting, enough of their colleagues spontaneously volunteered to take their places so that a major catastrophe was averted.

Here's more of what happened at the annual meeting this year:

- LCD projection for PowerPoint© presentations continues to be of interest to INMM speakers. (Remember, we said that delay spent in setting up and operating the system diminishes the time the speaker has to make the presentation. INMM cannot permit any activity that would interfere with the program schedule.) So, last year we promised that for 2003 we would have a procedure for presenters to follow if they wished to use such systems. Well, we have the procedure but we lacked the folks to manage it for each session. Once again, we left it up to individual speakers to arrange

LCD presentations with their colleagues and session chairs. However, we did get a strong promise that, for 2004, some of the attendees would volunteer to provide the necessary equipment and staff the sessions to see that the PowerPoint© presentations were done properly. (We have estimated that, for INMM to lease enough projectors at about $500 per day per room, it would cost approximately $14,000 for each meeting; and we would still have the problem of recruiting volunteers to manage the projection process. It costs the same to rent a projector for one hour as it does for one day. Purchase of the equipment including maintenance is just as poor an option.) We are moving forward and as they say about the Chicago Cubs—"wait 'til next year!"

- INMM, for the first time and in response to attendee requests, introduced a speakers and session chairs tutorial led by Paul Ebel and his *Ten Points to Success*—how to present papers exceptionally well and manage a session properly. The tutorial was given following the speakers' breakfast each day and not only was useful and informative but so stimulating that we were talking about it all week in the various sessions. Ebel hopes that speakers and session chairs will put the sage counsel he provided to good use in their presentations and plans to repeat the tutorials next year. INMM would like your comments on the worthiness of these tutorials and any other information you would like to see included. INMM members can see a summary of Ebel's presentation in the summer 2003 issue of the *INMM Communicator,* on the INMM Web site at www.inmm.org.

Current INMM policy is that authors must submit final written papers two weeks before the Annual Meeting so that HQ staff can prepare for their early publication in the *Proceedings of the Annual Meeting*. INMM recognizes there are a few legitimate reasons (but very few!) for authors not submitting their papers on time. Each year the response rate gets better; this year we only had four papers not submitted by the end of the meeting. Again, these negligent authors will now have to be judged for their participation as speakers in future INMM annual meetings. INMM continues to recognize all of you who cooperated so well to make the meeting a success and provide a history of the event through the *Proceedings*.

We continue to get requests from folks who want to organize special topical sessions of interest for the annual meeting. INMM encourages those interested persons, under the mentorship of a Technical Program Committee member, to actively participate in structuring the technical program for the annual meeting. Remember that, for the 45th Annual Meeting, special sessions like these need to be planned carefully and submitted in final form by February 2, 2004, for consideration and review by the Technical Program Committee. Please let me hear from you very soon so that we can reserve space in the program for your special session.

So what can we do better? Any suggestions for INMM to improve meeting practices are welcomed at cpietri@aol.com.

The J.W. Marriott Desert Ridge Resort & Spa was a fabulous hotel for this year's annual meeting in spite of many days of over 100°F weather—we return there for 2005. But next year (for INMM's 45th Annual Meeting, July 18-22, 2004) we return to another INMM favorite, the Renaissance Orlando Resort in Orlando, Florida, U.S.A., guaranteed not to be anywhere near as hot as Phoenix but certainly more humid!

Begin planning to attend the 2004 Annual Meeting now. You can present a paper or a poster, chair or organize a session, be a sponsor and/or an exhibitor, or just come and soak up all that vital information and insight that you look forward to each summer with INMM. Your presence makes the meeting certain success. See you there!

A Note From Wilma Williams

Wilma Williams accepts the INMM's Resolution of Respect from INMM President John Matter at the Annual Awards Banquet at the 44th Annual Meeting.

Dear Executive Committee and INMM Members,

As you can imagine, words cannot express my sincere gratitude for all of your expressions of condolences during this difficult time. I was aware I would be receiving a Resolution of Respect. The annual award for students and the generous donation to Blue Haven Youth Camp were quite overwhelming. These are two things in which J.D. was so very much interested. The children and I feel this was such a tremendous honor for him. Thank you.

Also, I want to express my appreciation for the welcome and acceptance I received at INMM this year. It was a pleasure to be with each of you. J.D. felt it was a special privilege to serve INMM. I felt it an extra special privilege to be there this year.

I wish INMM continued success in the years to come.

Sincerely,
Wilma Williams

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Opening Plenary Remarks

Dale Klein
Assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs
July 14, 2003
Phoenix, Arizona, U.S.A.

Good morning. Thank you for inviting me to speak here today. It is a pleasure to be part of 44th INMM Annual Meeting. I'm Dale Klein, assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs. My primary role is to serve as the advisor to the secretary and deputy secretary of defense on matters related to nuclear weapons safety and security, chemical weapons demilitarization, and chemical and biological defense programs. My office has the principal responsibility of managing the United States' nuclear weapons stockpile and takes an active role in ensuring the safety and security of our nuclear weapons. My office also leads efforts to provide chemical and biological defense capabilities to U.S. military forces, and supports efforts to develop medical vaccines aimed at combating bioterrorism, and oversees the chemical demilitarization program. In addition, my office is responsible for the overall coordination and integration of Department of Defense counterproliferation support program.

I would like to talk to you today about nuclear threats and security in the 21st century. The issues of primary concern to our nation and our allies today cover a variety of subject areas from threats of terror groups to complications resulting from changes to our human capital. First, I will discuss the global war on terrorism—our nation's strategy for combating terrorism in the future—and the progress that has been made thus far. Then, I will talk about international security challenges, including remarks addressing North Korea and Iran. I will also discuss our nation's nuclear deterrent and the generation of electricity using nuclear power. I will conclude my comments by discussing the growing challenge our government faces of recruiting today's youth to one day become the technical experts in the nuclear community. I hope you will find these issues as important as I do.

Since the terrorist attacks of September 11, the United States is reminded that vigilance and sacrifice is the price we pay for ensuring our liberty. In his State of the Union address of January 2003, President Bush stated: "The gravest danger facing America and the world is outlaw regimes that seek and possess nuclear, chemical, and biological weapons. These regimes could use such weapons for blackmail, terror, and mass murder. They could also give or sell those weapons to terrorist allies, who would use them without the least hesitation."

The president's statement serves as a reminder to each of us that the nexus between terrorist groups and countries that supply weapons of mass destruction must be confronted and dealt with appropriately.

Terrorism has threatened global and U.S. security well before September 11, 2001. However, on that day, its threat materialized in the daily lives of Americans. The global war on terrorism seeks to prevent terrorist regimes from having an impact, from having a voice, from having a future. According to the February 2003 National Strategy for Combating Terrorism, the United States' strategic intent against such regimes is structured around "the four Ds": defeat, deny, diminish, and defend. The United States and its allies seek to defeat terrorist organizations directly or indirectly by attacking their sanctuaries; leadership; command, control, and communications; material support; and finances. As a nation, we will deny further sponsorship, support, and sanctuary to terrorists by ensuring other states accept their responsibility to take action against these international threats within their sovereign territory. Additionally, the United States will diminish the underlying conditions that terrorists seek to exploit by enlisting the international community to focus its efforts and resources on the areas most at risk. Most importantly, we will defend our country, our citizens, and our interests at home and abroad by both proactively protecting our homeland and extending our defenses to ensure we identify and neutralize the threat as early as possible.

Dale Klein, INMM President John Matter and INMM Vice President Cathy Key; pictured left to right.

In a September 20, 2001, address to Congress and the American people, President Bush made the following statement on the nature of the terrorist threat today:

"We have seen their kind before. They are the heirs of all the murderous ideologies of the 20th century. By sacrificing human life to serve their radical visions—by abandoning every value except the will to power—they follow in the path of fascism, and Nazism, and totalitarianism. And they will follow that path all the way to where it ends: in history's unmarked grave of discarded lies."

The president's statement reflects this nation's determination, willingness, and desire to rid the world of the threat of terrorism.

So far, the global war on terrorism has proved successful in arresting more than 3,000 suspected terrorists worldwide. In Afghanistan and Iraq, terrorist networks have been disrupted. In Asia and Europe, terrorist plots have been uncovered and cells have been broken. Key al Qaeda commanders have been dealt with, and as President Bush stated in his 2003 State of the Union address, the men who have met a different fate "are no longer a problem to the United States and our friends and allies."

In a speech after the attacks of September 11, President Bush remarked: "No group or nation should mistake America's intentions: We will not stop until terrorist groups of global reach have been found, have been stopped, and have been defeated."

As this statement indicates, America and its allies have not stopped in their efforts to defeat terrorist networks in the global war on terrorism. Great strides have been made, and will continue based on the perseverance of our men and women in uniform and the continuing efforts of all Americans and our coalition partners in this struggle.

In today's world, the United States encounters numerous threats from nations or groups who would use weapons of mass destruction (WMD). Presently, there are twelve nations that have nuclear weapons programs; sixteen nations have chemical weapons; thirteen nations have biological weapons; and twenty-eight nations have ballistic missiles.[1] Nuclear, chemical, and biological terrorism are not the only issues threatening our national security in the 21st century. Information warfare threatens our command, control, communications, and computer systems; the very essence of military technological capabilities today securing both our nation and our allies. While many rogue states have WMD capabilities, it is those nations that are supporters of terrorism that pose the greatest threat to the United States and its allies today. Of primary concern are North Korea and Iran, states that have been identified by the president as being part of the "Axis of Evil."

The current situation in Asia regarding the North Korean nuclear program is an example of one such regime that has the potential to sell weapons of mass destruction to terrorists. It was during an October 2002 visit with James Kelly, U.S. Assistant Secretary of State for East Asian Affairs, that North Korean officials confessed to enriching uranium for use in nuclear weapon systems. The North Korean defense minister was recently quoted by the state news agency as saying that in the event of a nuclear conflict, North Korea would deal a "merciless punishment" to the United States. This admission, along with ongoing concerns regarding the proliferation of chemical, biological, and ballistic missile technology, has elevated the North Korean situation to one of the top global security concerns.

The United States views the situation in North Korea as one that necessitates serious and multilateral diplomatic attention. In addition to pursuing nuclear capabilities, North Korea continues to export complete ballistic missiles, production capabilities, related raw materials, components, and expertise. Additionally, North Korea's chemical and biological capabilities are cause for concern.

The world and the United States are presented with a complex problem. This is not a new problem, but rather part of an ongoing pattern of irresponsible behavior by the North Korean government. The United States should not provide incentives for North Korea to adhere to its international nonproliferation commitments. The United States seeks the verifiable and irreversible end of North Korea's nuclear weapons program and will continue to work through multilateral diplomatic means to achieve this outcome.

North Korea is not the only rogue state that poses a potential threat to the United States and its allies. In December 2002 sources revealed evidence that Iran is attempting to build nuclear facilities. The United States believes Iran is "actively working" on a nuclear weapons program and more recent evidence of a massive nuclear power construction project "reinforce" that belief. State Department spokesman Richard Boucher said, "There is no economic gain for a state that's rich in oil and gas like Iran to build costly nuclear fuel cycle facilities," he said. "I point out that Iran flares more gas annually than the equivalent energy its desired reactors would produce. We've reached the conclusion that Iran is actively working to develop nuclear weapons capability."

In addition to pursuing nuclear capabilities, Iran seeks to produce chemical weapons, and has maintained a biological warfare program since the early 1980s. Of additional concern to the United States is the fact that Iran is swiftly increasing its range of ballistic missile capabilities, and is seeking medium-range ballistic missiles, intermediate-range ballistic missiles, and possibly intercontinental ballistic missiles. Thus far, Iran has conducted ballistic missile tests with significant foreign assistance from Russia, China, and North Korea. While Iran poses a potential nuclear threat to the United States and other nations of the world, the International Atomic Energy Agency believes North Korea is closer to having nuclear weapons than Iran.

It is important to note that the United States has no offensive biological warfare program, no chemical warfare program, and is currently demilitarizing its obsolete chemical stockpile. In addition, the United States is reducing the nuclear stockpile and is planning to convert surplus plutonium into the mixed oxide commercial nuclear fuel cycle.

In an attempt to bolster the nation's defenses against the transport of radiological weapons or devices into the United States the U.S. Customs Department has developed the Container Security Initiative (CSI). Within this program U.S. Customs has and is entering into partnerships with other governments to identify high-risk cargo containers and prescreen those containers at the foreign ports *before* they are shipped to the United States. It currently has four components:

(1) **Identify high-risk containers:** ones that terrorists could use

to conceal weapons and radiation devices

(2) **Prescreen containers before they are shipped**

(3) **Use technology to screen containers:** this technology includes large-scale X-ray and gamma-ray machines and radiation detection devices

(4) **Use smart containers:** tamperproof seals have already been implemented so that customs officials will be able to tell immediately if a prescreened container has been tampered with. There have also been moves to apply CSI to air cargo, known as Air CSI

(Source: http://www.customs.ustreas.gov/xp/cgov/newsroom/commissioner/speeches_statements/aug262002.xml)

To support the Customs Department's CIS program, technologies such as the VACIS and RPM give transportation workers additional tools to combat the illegal importation of radiological materials into the United States.

The relocatable VACIS, or Vehicle and Cargo Inspection System, allows for noninvasive imaging of trucks, sea containers, and other vehicles that may contain contraband, mismanifested cargo, or other threats. It is used for border checkpoint contraband screening, seaport container and truck screening, manifest verification and duty capture, military and high-threat vehicle screening, and VIP vehicle security screening.

In addition to the VACIS system, the deployment of radiation portal monitors (RPMs) allow for additional measures to be taken in the identification of radiological materials in port facilities. The Port of Norfolk (run by the Virginia Port Authority) was the first port in the United States to install RPMs. Between 4,000 and 5,000 trucks carry shipping containers out of the Norfolk terminal each week. These trucks pass through two panels that scan containers for the presence of radiation. In addition, the Virginia Port Authority has begun to use *crane technology,* which uses radiation-detection sensors on the cranes that move containers on and off the ships. These systems are less highly developed than the traditional portal monitors. (Source: http://home.hamptonroads.com/stories/print.cfm?story=48036&ran=84260; also see http://energycommerce.house.gov/108/Letters/03252003_851.htm)

The United States' nuclear deterrent is essential to the security of the United States and our allies. The Nuclear Posture Review was directed by law and complemented the president's desire to transform the U.S. military to better meet the security challenges of the 21st century, and to reflect the end of the Cold War, and hence, a new relationship with Russia. The Nuclear Posture Reviewmade the following significant changes to the U.S. nuclear deterrent: it reduced the number of operationally deployed warheads, initiated the retirement of Peacekeeper intercontinental ballistic missiles, called for the removal of four Trident submarines from strategic service, and developed a new triad.

The decision has been made to convert all four available SSBNs to SSGNs. The first two, the USS Ohio (SSBN-726) and USS Florida (SSBN-728) were slated to begin overhaul in 2003. The USS Florida arrived at Norfolk Naval Shipyard on June 27, 2003, with the USS Ohio to follow thereafter.[2] The USS Michigan and USS Georgia (SSBN-729) will begin in October 2003 (FY 04). The first SSGN is scheduled to enter the fleet in 2007.

In addition, I am pleased to report that the United States Air Force is deactivating more than one Peacekeeper intercontinental ballistic missile per month and thirteen have been deactivated as of the first of this month [July].

The new triad is composed of non-nuclear and nuclear strike capabilities, defenses, and responsive infrastructure tied together via command and control, intelligence, and planning. Thus, it offers a variety of capabilities and greater flexibility in responding to various contingencies. As you will notice, the old triad—composed of intercontinental ballistic missiles, bombers, and submarine-launched ballistic missiles—is embedded in the new triad. It is also important to note that this transition was not designed to occur overnight, but rather over several decades. While the Cold War triad exists in the near term, the new triad will reflect our nation's nuclear deterrent in the long run.

While the U.S. nuclear deterrent is an important part of our nation's national security strategy of the 21st century, the issue of a safe, secure, and reliable nuclear power infrastructure is also important to developed and developing nations. Our power generation infrastructure is a key component of the United States' national security.

There are more than 100 plants across the country in thirty-four states, producing about 21 percent of the United States' electrical power. World wide there are 437 nuclear plants producing 358,461 MW(e), with another thirty-three plants under construction. Overall, nuclear power constitutes 72 percent of all U.S. emission-free generation while avoiding 155 million metric tons of carbon per year and 2.4 million metric tons of sulfur dioxide. Globally, 16 percent of electricity generated is produced by nuclear power plants, resulting in a reduction to carbon emissions by more than 17 percent.

Table 1.

U.S. Electricity Generation (2001)	
Coal	52 percent
Nuclear	21 percent
Natural Gas	16 percent
Hydroelectric	6 percent
Oil	3 percent
Other (non-hydro renewable, including wind)	2 percent

Source: Department of Energy 2001 (http://www.eia.doe.gov/neic/quickfacts/quickelectric.htm)

The Palo Verde plant is located about 70 miles west of our meeting here in Phoenix, Arizona.

Table 1, as indicated, reflects the proportion of U.S. energy generation from fossil fuels, renewable energy, and nuclear power. Although nuclear power is a significant source of energy for the United States, generation of electricity using fossil fuels continues to dominate.

As you can see by this chart the United States has continued to rely heavily on imported crude oil with the daily average rising by more than 185 percent from 1985 through 2002. Although the United States has diversified its imports since the 1970s, we have increased our total dependence on foreign crude.

However, in light of the growing dependence on imported fossil fuels it is important to note that conservation alone will not be enough to meet the energy challenges of the 21st century. The opportunity that this challenge presents is to leverage the technical and creative capabilities of the industrial base to develop new technologies in the area of nuclear power, hydrogen fuel, and clean coal technologies.

Opportunities to broaden the use of nuclear energy led the U.S. Department of Energy (DOE) Office of Nuclear Energy, Science & Technology to develop Generation IV. DOE describes this program as one that supports the "development and demonstration of one or more Generation IV nuclear energy systems that offer advantages in the areas of economics, safety, and reliability, sustainability, and could be deployed commercially by 2030." The Technology Roadmap will extend thirty years and highlight advanced plant and fuel cycle research and development worldwide.[3]

In the 2003 State of the Union address, President Bush announced $1.2 billion dollars in funding for an initiative to study the viable use of hydrogen-powered fuel cells as a fuel alternative to reduce the United States' dependence on foreign oil. Cars, trucks, homes, and businesses powered by the hydrogen fuel cells would produce no pollution or greenhouse gases. This initiative includes $720 million dollars in new funding over the next five years for developing the technologies and infrastructure to produce, store, and distribute hydrogen for use in fuel cell vehicle and electricity generation.

The DOE's Clean Coal Technology Program has worked to provide technologies to effectively control the emissions of sulfur dioxide, nitrogen oxide, and mercury. The goal is to develop and demonstrate coal power systems with near zero emissions, while maintaining low production costs.

As we think about the growing international and domestic security concerns of today, we are wise to consider the ability of our country to meet the challenges of tomorrow. One of the most significant problems the United States government is facing today is the growing shortage of nuclear expertise. As the current workforce retires, fewer competent and qualified personnel will be available to replace them, especially in the national laboratories. The U.S. Department of Defense is facing the challenge of replacing today's experts with young, technical talent.

One area where this shortage can be seen is in the field of nuclear engineering.

According to the Oak Ridge Institute for Science and Education enrollments have declined from approximately 700 in 1991 to 400 in 2001. Although the number of Ph.D. degrees conferred has been stable for the last decade at around 100 per year, the percentage of foreign nationals earning PhDs has increased from 36 percent in 1997 to more than 41 percent in 2001. This has left the U.S. government with a growing shortage of available candidates to replace older nuclear scientists currently employed. In the past most of the foreign engineering graduates stayed in the United States. Now, more of these graduates are returning to their home countries.

The Oak Ridge Institute also noted that the majority of post graduation plans for master's and Ph.D. graduates in the field of nuclear engineering for the class of 2001 did not include a career in the U.S. government. However, indirectly many are supporting the government needs through the contractor base.

Table 2. Complete Breakdown

Employment/Post Graduation Plans	M.S.	Ph.D.
Continued Study	41 percent	10 percent
U.S. Academic Employment	1 percent	20 percent
Federal Gov. Employment	3 percent	5 percent
DOE Contractors	5 percent	13 percent
State and Local Gov. Employee	0 percent	0 percent
U.S. Nuclear Utility Employee	8 percent	1 percent
U.S. Other Industrial Employment	18 percent	29 percent
Employment with Foreign Employer	4 percent	6 percent
U.S. Military Service	9 percent	4 percent
Other	3 percent	1 percent
Seeking Employment	0 percent	0 percent
Unknown	8 percent	11 percent

Source: The Oak Ridge Institute

Critical languages are skills essential to understanding foreign culture and to communicate with partners. We have far too few linguists for our security needs.

The Lawrence Berkley Laboratory also recognizes the challenge of replacing today's retirees in the nuclear field, noting "few scientists are available [today] with a core training in actinide or nuclear chemistry."

Thus, a need exists to recruit today's youth in technical fields such as physical sciences, biological sciences, and engineering, and in critical languages such as Arabic, Korean, Mandarin Chinese, Farsi, and Russian.

The problem of adverse nuclear education trends facing the defense community is not unique to the United States. Other countries, such as China, Japan, and the United Kingdom, will be facing nuclear expertise shortfalls in the years to come. Qualified scientists are critical to ensuring the future of our nation's nuclear stockpile, countering the proliferation of weapons of mass destruction, and supporting defense capabilities.

Recognizing this criticality, Congress has introduced legislation that is intended to strengthen government funding for nuclear education and research through 2006. Specifically, H.R. 6, introduced in the House of Representatives April 7, of this year, calls for the "investment in human resources and infrastructure in the nuclear sciences and engineering and related fields," to include health physics, and nuclear and radiochemistry. The United States has a responsibility, to its future and its citizenry, to address this issue. [Language Skills taken from GAO Testimony before the Subcommittee on International from Susan Westin, managing director, International Affairs and Trade "Foreign Languages: Workforce Planning Could Help Address Staffing and Proficiency Shortfalls" Dated March 12, 2002].

The new challenges of the 21st century require us to act boldly and decisively in order for the United States and other freedom-loving nations to secure our way of life and to promote the democratic ideals of equality and freedom. The ongoing threats presented today serve to remind us of our responsibility to each other and our allies around the world. The dynamic and creative environment that is fostered by the citizens of this country along with other free peoples around the world will enable the United States and its allies to find innovative and flexible means of addressing the problems of nuclear threats and international terrorism.

Thank you once again for your invitation. I would be delighted to entertain any questions you might have.

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INMM Roundtable

Monday, July 14, 2003
Phoenix, Arizona, U.S.A.

Speaker
Dale Klein
Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs

Attendees
Obie Amacker
Chair, INMM Fellows Committee

Robert Curl
INMM Treasurer

Vince DeVito
INMM Secretary

Debbie Dickman
Chair, INMM Constitution and Bylaws Committee

James Griggs
Chair, INMM Communications Committee

E.R. Johnson
Chair, INMM Waste Management Technical Division

Col. Michael K. Kelly
United States Air Force

Cathy Key
INMM Vice President

James Lemley
JNMM Associate Editor

Dennis Mangan
JNMM *Technical Editor*

John Matter
INMM President

Charles Pietri
Chair, INMM Annual Meeting Technical Program Committee

Gotthard Stein
JNMM *Associate Editor*

Patricia Sullivan
JNMM *Managing Editor*

James Tape
INMM Past President

Scott Vance
JNMM *Associate Editor*

Dennis Mangan: I met you a number of years ago, Dale, when you were a professor at the University of Texas in Austin, and eventually became the vice chancellor and then I heard the rumor that you were going to become an NRC commissioner, and then lo and behold I hear you're the assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs. What's the biggest difference between academia, where you lived for quite a while, and this new position that you have now as an assistant to the secretary of defense?

Dale Klein: Well the first is you get a cut in pay. (Laughter) And you get to work longer hours. In my case, I'm separated from my wife since she's the chair of the public utility commission in Texas. And you have a higher cost of living in Washington. But it's a great job. I think there are a lot of similarities in terms of the men and women in uniform that you see are bright, young, energetic, much like at a university where you have bright, young, energetic students. So there are some similarities and some differences.

Mangan: When you made your presentation, I thought it was great and you had great VU Graphs. Some of them seemed to me to have U.S. Department of Homeland Security (DHS) written all over them. What's the relationship between the Defense Department and the new DHS?

Klein: The Department of Defense (DoD) is basically to defend our country and the men and women in uniform do an excellent job of that. The Department of Homeland Security is to secure things internal to the borders. There's a law called *Posse Comitatas* that says DoD will not be involved in a lot of homeland activities unless asked. So there's a fairly strong boundary between what the Department of Defense does for its mission and its role vs. what the Department of Homeland does.

Now, one of the differences is that DoD has an assistant secretary for homeland defense and that person interfaces with the Department of Homeland Security. We also have the United States Northern Command that basically is in charge of looking at the security of the Northern Hemisphere. So there is a relationship, but again the fundamental difference is that DoD protects typically against external threats, whereas Homeland Security looks at the internal side. But we have a lot of things in common. For example, the National Guard is heavily involved. The DoD is involved in training and standing up the civil support teams. In the event that there is a terrorist attack within the United States, it's likely that the DoD will be called to assist for the simple reason that we have the equipment and the people to respond. But there is intended to be a difference. So (U.S. Secretary of Defense Donald) Rumsfeld has tried to make it very clear that our job is to protect the nation primarily in the war-fighting mode.

Gotthard Stein: You mentioned the important relationship between energy and security and maybe we should add environmental issues. In that context you referred to the important U.S. programs

for future nuclear technology and clean coal.

The United States was always a model for free energy and electricity markets and Europe is trying to follow in the same direction. My question is, how will the U.S. government support bringing those clean technologies to the market and what are the measures to improve competitiveness against gas, oil, or other cheap fossil energy resources?

Klein: In the short term, typically the marketplace does play a key role. But I think as a nation, we have to look at the government being involved in long-term sustainable types of energy where companies may not invest and get an immediate return. That's where I think the hydrogen economy, the Gen IV, and things of that nature are really important. The government invests and looks out for the well being of the citizens in the long term. Had they not done that, for example, we would not have nuclear energy today. And if you go back through a lot of the clean coal efforts, the government has to do a lot of the front-end research to do that so that it's a clean environment. Hydro-economy is the same thing. Again, this is long term. The government is involved in solar cells. Historically the government has been involved in advancing concepts and technologies, but then in general the free market is supposed to take over. Where we have to look at economic issues and policy issues merging is when it involves things of national security. I think if we only import and we don't look at developing our own resources, then we are at risk of being able to maintain the freedoms that we and our allies have. So we have to strike a balance between the free market and what's best for the United States and our allies.

So there's no easy answer other than the fact that we have to look long term, which is a responsibility of the government, and then we have to balance that with other incentives. We see that in a lot of areas; for example, in wind power. That is heavily subsidized today because the public would like what they view as a clean environmental source, so we as a nation do subsidize a lot of areas and we just have to do that in a strategic manner.

Stein: Only to add a question for understanding. I saw in your interesting graph how heavily the United States depends on oil imports in your primary energy consumption. What perspectives are here in the United States to gain more diversification in this area? I recognized that the electricity sector has already a reasonable diversification.

Klein: They're looking at a variety of things. One is hybrid cars, electric cars, so we're not dependent on the imported oil for the transportation sector. We're also looking at compressed natural gas. That's been looked at for a long time. I would say that in the area of electrical generation what we have done is import a lot of natural gas from Canada and other areas, so we're still importing but not as much oil. If you look at what our electrical generation was in the `70s, we had a lot more oil-fired plants than we have today.

We're looking at diversification, but I think that in the short term, what we're doing right now, in my view, on electrical generation is that we're putting in a lot of gas turbines. There are low-capital costs but high-fuel costs. This is where we have to strike a balance and I think we need an energy plan where we say these are some issues we look at for the short term, these are some issues we look at for the long term. If you look at the late `60s early `70s, you could not build a natural gas generating plant. There was a law that said that was not an option for a stationary plant. You could only use natural gas for peak-load plants. But then, over time, with the high-capital costs of coal and nuclear, and environmental issues, now what we're seeing in the last five years is all of our electrical plants that have come on have been natural gas. And so I do think we need to strike a balance between short and long term, on where we get our electricity.

But in the free market, there still have to be regulations and requirements. And that's where public policy will cross with pure economics. Other countries are facing the same thing.

Cathy Key: Do you see that there's a potential that we will move more toward nuclear energy? It's much cleaner. It would be a definite education of the public for acceptance of nuclear energy. I go to Russia a lot and we see the nuclear energy plants there along with the fact that the majority of their energy is produced by nuclear. You talked about the cleanliness of the use of oil and the fact that is was up 185 percent since 1985. I found that quite amazing. And also about coal, 52 percent of our energy comes from coal. In Oak Ridge, Tennessee, there's a huge coal plant and you talked about the residuals that come from that. I know that they have a car wash for that community for free that's provided by the government. Tennessee also has a new nuclear facility in Sweetwater, Tennessee, and it has become very well accepted. So basically my question is, do you see a potential move toward additional nuclear energy sites here in the United States? You made the comment that energy and national security are tied very closely together. I'm in full agreement with that and it would be even more important with a nuclear energy facility. How do the two work together, and would we move more toward nuclear?

Klein: Look at the way energy and national security are tied together. Clearly if you're ever involved in conflict, for example in Operation Iraqi Freedom, and you look at the number of tanks and equipment that had to move through, it doesn't take long to realize that with aircraft, ships, and things of that nature we really do have a heavy utilization of fossil fuels in our national defense and national security.

As to how we go for the future for

energy demands, that will be an area where we need as a nation to educate the public on what our real choices are and how can we move forward. In my life as an academic faculty member at the University of Texas, energy was the area where I spent most of my time. At the Department of the Defense, my role has sort of shifted from that area so my database on this question goes back mainly to my academic life. With my university hat on, I'm a very strong supporter of electricity. Growing up on a farm, one of the reasons that I picked the profession that I did was I wanted to go into a field that would provide more electricity for people's well-being and I thought nuclear was the most environmentally sound of those. Electricity has really made farm life much easier as well as all our lives easier. I'm a real fan of electricity. Then you say how you can get it. I think nuclear is one of the most environmentally sound ways to provide that.

I think in the United States, and other countries have a similar problem, you will have a vocal minority that is very good at getting their points across, typically in a way that makes people scared, frightened, or concerned. It's much more difficult to educate and explain facts, because when we start doing that people's eyes will glaze over and roll to the back of their heads. It's an area where it's much easier to scare people than to educate them on what their real options are. But I'm optimistic that we will get nuclear power back in the United States and we will do it economically. I think that if we had standardized plants and a one-step licensing process, we would be much better in the United States and both of those are underway.

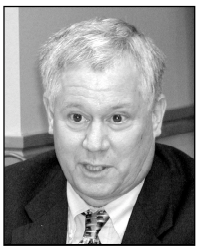
Key: For the energy program that you stated needed to be developed, I would assume that you're taking into consideration the use of nuclear energy and to what percentage is that program developed?

Klein: If you look at when President Bush and Vice President Cheney were elected, one of the key initiatives early on was an energy program and energy policy. Vice President Cheney was heavily involved in trying to come up with an energy program and energy plan. I don't know what that is. So, that's the short answer. Obviously things like September 11, and then Operation Enduring Freedom in Afghanistan and Operation Iraqi Freedom changed our nation's focus.

But we will come back to an energy plan and energy program. I just don't know what it is.

John Matter: In your comments this morning regarding the war on terrorism, you noted that it's not just a U.S. war, but an international war on terrorism. What are some of the programs and activities that you and the department have with international partners that you would expect to be most productive and effective in the war on terrorism?

Klein: I think the initial program that we have with our partners that will be effective in the nearest term is sharing intelligence. I think we've seen that being demonstrated on several occasions where terrorist cells that you didn't know were there, now you know they're there. Countries have stepped up to the plate and have taken action on those. We've seen those in multiple countries: Belgium, Germany, and many other countries where they've identified these cells that people really hadn't focused on. I think in the initial arena, it will be in the area of intelligence, where we will share information and find out where the bad actors are. Then the next area that we are all cooperating on is technology. How do we build better detectors? How do we build better sensors? Do we have a system to respond? Once the detector goes off, what do you do? We also will share in consequence management and so I think we will see this happening on all fronts. I think after September 11, a lot of countries realized they have tall buildings too. We were just the ones who were hit. So I think we've seen a tremendous international cooperation and I think it awakened all of us to the kinds of threats that we now face. I think it was easy in the past to look at countries, and certainly at the United Kingdom with the problems they've had, where you've had bombings, and people sort of take that for granted and it's over there. I think after September 11 there was a real awakening to the whole world and we realize that over there is over here, from every country.



James Tape: You covered a lot of territory this morning and I'd like to pick up on a couple things we haven't touched on yet. One is nonproliferation and the other is the nuclear posture review. There are those who have interpreted the press reporting on the nuclear posture review as making nuclear weapons more usable and therefore in the eyes of some making a negative contribution to nonproliferation efforts. What's your reaction to that interpretation of the NPR?

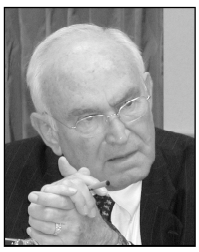
Klein: I think it's incorrect. I believe that for nuclear weapons to do what they are intended to do is to be a deterrent. You never want to use them. In other words, that's the last resort. But on the other hand, for them to be a deterrent, they have to have the perception of being reliable. So if you look, for example, at these multi-megaton devices and you have a terrorist camp that has a surface facility but also has a lot of things underground, I think it's rather obvious that we're not going to use a multi-megaton device to go after that facility. But at the same time you have to look at what role does nuclear deterrent have in today's society when our target is defuse, spread out, and how can we meet that objective. I believe that for the nuclear deterrent to remain effective as a deterrent, those who want to do us harm

need to realize that if they cross certain lines, and those lines are subject to the president's determination, if we have to, we will use nuclear weapons to remove them. So that tells you then that we probably need smaller yields and look at things in the chemical and biological area. For example, if you hit a facility and you just disperse it, is there a technology and a way that if you knew that there was a biological facility that needed to be destroyed and that if you did destroy it, it was highly likely that thousands and thousands of people will die, then we should study and find out whether or not a smaller yield nuclear device would be the best choice in a very difficult situation.

We've had low-yield nuclear devices for a long time, as all of you know. So it's interesting the way the press has been playing this issue. It just depends on how you select their characteristics. That's not a new concept.

I think two things are new. One, can we make low yields that more meet the threats that we have today and two, can we make them obviously more precise? If you look in the earlier days, because of our ability to pick a specific location for a nuclear device, it had to be a big one because likely you were going to miss it by a fair amount. We know a lot more now about precision strikes so that tells us with new advancing technology, with precision, the yield can go down. Because we can put it at the exact location that we want.

I think the most important one that we need to work on is a real robust earth penetrator, one that can put the shock waves in the ground, not in the air, that can collapse very deep tunnels. We have a lot of targets that we know that if we want to take them out, the only way to do it is with nuclear. We do not have the chemical means to release the amount of energy needed to collapse those tunnels. So I think for nuclear to play its role in being a deterrent, it has to be believed to be usable and effective. So those who don't like nuclear weapons and want to claim that we're proliferating by having these will use that for an argument. But I think we should look back and see we haven't tested a device since 1992, and what impact did that have on India, Pakistan, North Korea, Iraq, or Iran? I think our nuclear deterrent nonproliferation policy has been weak; it has not been effective. I think you can point out the facts that go down that path. So I think what we need to do is really look at having a real deterrent and then making sure that we monitor these materials so that they become less available. It's a tough situation but I can tell you from being at the Pentagon, and you know all the levels and the reviews and the safety systems that are on nuclear assets in the United States, we have so many things to make sure they don't go off, and then all the approvals that one has to go through and the fact that the president, a person, has to make the decision on whether to use one, that that is not something that would be taken lightly. So I don't buy the argument that just because they're a robust earth penetrator and lower yield that they're going to be more usable. Because you're still going to have to go through that decision process and that is a very difficult process. On the other hand, if you look at the consequences, whatever they may be, of not using them, that's what a president would have to make the decision on.



E.R. Johnson: Changing the subject a little bit, there's been a potential problem identified regarding the possible vulnerability to sabotage of spent-fuel transportation and storage facilities. In your view, is this a real threat and if so how can it be effectively dealt with?

Klein: If you look at the way a terrorist would want to spread terror, then you typically want to go after something that causes terror and unfortunately radiation is one of those targets because people don't understand radiation and I think that makes it a target just by its inherent nature. On the other hand, terrorists can create their terror other ways and frankly the best way to minimize it is to make the transportation of spent fuel and other things robust enough that terrorists will go after another target. So first what you want to do is keep the terrorists from going after any target. But then you want to make it so difficult that they will pick another target.

When you look at spent fuel and the casks in which it is transported, they're pretty robust. Could they be breached with a tank? If a terrorist had a tank and this truck comes by and you blow it apart? Sure. Is that likely? Probably not. We tend to monitor where the tanks go and things of that nature. I think in terms of making it less of a target we just need to enhance our security, be aware, make sure we share the intelligence. Those who are opposed to things nuclear are going to use this for their argument. And so those whose objectives are to shut down commercial nuclear power will try to use this scare tactic and the devastation that it theoretically could cause to meet their objectives and we have to address that, I think, in an educational program. We also have to be a little astute about not giving the terrorists roadmaps about how to accomplish their activities. One of the national labs had done a study about whether a terrorist could put a plane in one of the containment domes and cause a severe accident. Well, in part of that study they said, "Gee, the containment dome is really too robust, what the terrorists really need to do is …" We really need to be a little smarter than that in releasing that kind of information.

So we don't need to help them in the studies that we need to do. And the dirty bomb is a classic example. Al Qaeda has indicated that the dirty bomb was something they never thought about until we raised the issue. And once we raised the issue they said, "Hey, this is a good idea." So I think the dirty bomb and spent fuel is an area where we need to pay attention, but we need to do it smartly. My concern is that because of the unnecessary fears of radiation, we will put too many resources in that area and we will miss the obvious.

For example the terrorists on September 11 were clever. Rather than spending millions and millions of dollars developing a missile, they took something that was in our civilian society and they turned it into one. Those are the things we need to watch.

Michael Kelly: Sir, could I add one thing to that? In my military background, part of my time was spent supervising people who did targeting and if you want to look at the difficulty of a targeting problem, the easiest one is a soft, fixed facility, and then there's a hard, fixed facility, and then there's a mobile target, and the hardest is a deep underground hard, fixed facility. If you look at what we're trying to do to move our fuel storage, you can just go right down that hierarchy and the sooner we get it to Yucca, the better off we'll be. Moving it to Yucca, it's going to be hard to hit and those are going to be very robust structures that are moving. And I don't think there are going to be too many terrorists who are going to be able to formulate the necessary firepower to take one of those out without us being able to do something about it.

Charles Pietri: And you never hear about that in the news media.

Johnson: But one of the things that was the big talk for a long time was the possibility that a TOW missile can blow a hole in a cask. But as far as dispersing the content…. Bob Halsted (a consultant to the state of Nevada) came up with the scenario that you blow a hole in the casks—and the spent fuel inside is dispersed into the environment. When it was shown that very little of the spent fuel was dispersed because it had no vented pathway, he changes his scenario to firing two missiles into the cask sequentially so that there was a vent hole for some of the radioactive material to escape.

Kelly: In the same hole, Sir. Consecutive miracles. (Laughter.)

Klein: I think that's an area that we need to educate the public on. As you indicated, a lot of people don't realize that spent fuel is solid, they tend to think that it's a liquid, you know, the green slime that's out there. I think that's one of the problems we have out there in our profession is that it is so easy to scare people on the front page with a headline; it is very difficult to educate and alleviate those kinds of fears because if we started getting into all the technical details, the eyes are going to glaze over and they just shut down. The other thing that's unfortunate, and I don't want to be too critical of the news media because we do live in a free enterprise system, is often times the media delivers what the consumer wants and it is that kind of headline. But the news media is not in the business of education. It's a very competitive business. As we've all seen over the years, it's not who gets there accurately, it's who gets there first. We see that time and time again.

We are in an emotional field; anything that involves radiation is emotional. It's very difficult to educate, and, as we heard in the audience today, we are not putting enough emphasis at K through 12 in our science education, so people do not understand what the science really is, so when that happens, the emotions take over and that's a very difficult situation to be in.

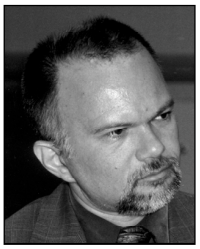
James Griggs: You discussed in your presentation this morning the change in the nuclear defense posture from the Cold War to the post-Cold War triad. During the Cold War, we had a very large direct nuclear capability. Now we have a smaller capability but it's supported by more intelligence and analysis. I was struck by the triangles being the same size. Could you comment on the relative costs of the old way of doing business and the new ways, and what additionally do we need to fill that support gap beneath the small triangle.

Klein: There was not intended to be a relationship between the size of the triangles and the amount of money we spend. I think that the Cold War arsenal did its job. We had peace for a long time. The United States and the Soviet Union did not go after each other. So they served us well. They were expensive. And as we look to the new triad, what we're looking at is a series of things. Part of that is a missile defense system, part of that is intelligence, so you know where things are and prevent it from happening. And then if you do have to use devices that release a large amount of energy, whether they're nuclear or conventional, then we look at both of those—nuclear/nonnuclear. In that area we have much more accurate targeting, we have a lot of new devices, the thermobaric weapons, white phosphorous and other things that are sort of specialized conventional weapons today.

I think the good news in the fact that the Cold War is over is that the number of deployed nuclear assets in the United States and Russia are being reduced. However, when you do that it also puts a burden on the nuclear community to make sure that you really understand those smaller devices, in the small number of assets we have. That puts a burden on stockpile stewardship in that if you have a limited number of nuclear devices of different types and different numbers then you really better understand how they work and that they do work. You hope you don't have to use them but if you do have to use them, you don't want to say, "Gee, I hope they work today." They would have to work.

It's interesting, the cost of maintaining the stockpile and learning as they age, because they've been in the stockpile much longer than people expected initially. In

the era of non-testing, it's actually more expensive than if we did test. A lot of people don't realize that the stockpile stewardship, under the way we're going, which is a science-based stockpile and is important to understand, is really more expensive than if we did limited testing to answer some of stockpile stewardship questions. I think the important thing is that we need to understand how the nuclear assets work to make sure that they are a deterrent today. We don't want to use them, but if we do use them, we have to make sure they work.



Scott Vance: I want to follow up on Ed's question and get your opinion on the responsibility of the private nuclear industry to protect against war-type events. The NRC has had a long-standing policy that it's not the commercial industry's responsibility to do that, and yet there's been legislation recently introduced that would require things such as anti-aircraft missiles at nuclear power plants. I'm just wondering what your opinion is in regards to the responsibility of the defense establishment and the responsibility of the commercial industry.

Klein: Anyone who would propose to put anti-aircraft missiles around a nuclear plant is silly. You can see what would happen. Someone's grandmother would be flying in her little plane, she would get off course, and boom, it comes down. I think when you look at those kinds of activities, you have to peel back a layer and say why are they really proposing that? Anyone who would do that is clearly, in my mind, motivated to shut down nuclear power. They want to make it so expensive that you would have to do so many things that it would be uneconomical so that you could not provide safe, clean, reliable energy at a cost we could afford.

I think the area that the NRC has just indicated, and I haven't read the entire legislation or what their plan is, but I do know that the NRC just came out with a sort of a defense posture. In my mind the NRC has a role to play in that, but its role, in my view, is to make sure that they're safe, reliable, and secure. If it goes beyond a certain level, then it becomes a responsibility of the Department of Homeland Security, not the NRC. If it becomes so burdensome on the consumer, then the government needs to evaluate that. So what I'd like to see us not do is get into a surrogate situation where you shut down a nuclear plant because you put a lot of unnecessary safeguards and security. Clearly we have to do safeguards and security in the right, smart way, but we also have to be astute enough to know that there are people that have an outcome that's other than security.

Vince DeVito: To return for a moment to the conversation you had with Mr. Griggs and the triads. I want to mention a statistic you had in your presentation today where we're removing four Tridents. Now, if my recollection is correct, we don't have many more than that. And I presume that is because that was a strategy associated with the Cold War and the strategies for our defense being changed is one of the reasons we're moving those?

Klein: Yes, the four that we will be taking out of service and converting to other means will be the kind that we call the boomers, Ohio-class, or SSBNs, but we will still have fourteen. We now have some of those based on the West Coast and some on the East Coast.

DeVito: We still have some Polaris, don't we?

Klein: No, all the Polaris nuclear-capable missiles and their submarines have been decommissioned. We have different assets now. Again, what I think we will see in the submarine area is that we, as Col. Kelly indicated earlier, want a mobile platform that's moving around and that's very quiet so people don't know where it is so that it can provide a deterrent. So that if someone wants to do you harm, they know that we have the ability to retaliate in some way and they will be more cautious on what they do to us. We will have fourteen boomers still out there. They will be effective. We will probably see some new technologies coming into some of these where Special Forces may be using some of the four converted Ohio-class submarines in a different way. I think we'll see some advancing technologies in the submarine fleet to meet the threats that we see today rather than the Cold War.

DeVito: One more question. We talked about the lack of college students coming into the nuclear field. Has the government and DOE considered scholarships?

Klein: There have been a series of those, but never enough. I think the other thing, in talking with Undersecretary Bob Card at the U.S. Department of Energy, he believes the best incentive to get young people into the nuclear field is to build nuclear plants. So I think we have to look at a lot of incentives, but jobs is certainly one of them. One of the things we certainly do not want to do is have a lot of scholarships and not match it with the jobs. Because if we have the throughput and you come out with your degree and there's not the employment opportunities, that word will spread really fast.

Pietri: Well, that's how most of us got into the program in the beginning; there were no new nuclear programs. We came in because of the industry. We wanted to be part of this big thing.

Klein: I think in terms of the commercial sector, providing the amount of electricity that the nuclear plants generate today and the fact that a lot of the people are retiring, those plants are still going to be running, so there are certainly jobs. But the media will often times indicate that we haven't

built a plant since Three Mile Island, and things of that nature, and what's interesting, when you talk to the students at the university, is that the parents and high school teachers are usually the ones who are more anti-nuclear than the students themselves. It's an exciting area and robust, and we just don't do a good job of getting the positive side out: that there are exciting jobs to be had, even if we didn't build new nuclear plants. The nuclear Navy has some exciting needs, as does the Air Force. So there are things out there to provide an exciting career for young people today. But we need to get that word out.

Pietri: Does your office have any programs to support and enhance this concept at all?

Klein: The Department of the Defense doesn't really have a proactive program in that area, except the nuclear Navy has an excellent recruiting program. They do a first-rate job in that area. In my office, we have begun an internship program with Air Force cadets, to bring them into the Pentagon in the summer, to let them see the opportunities they have in the nuclear part of the Air Force. So we're trying to develop a lot of young people who are at least aware of these opportunities. So my office is more directed on the DoD side of the house than the commercial generators. But I think we, all of us in the nuclear industry, have to make sure we have the pool of talent that will meet the future needs.

Kelly: Sir, if I could talk just a little bit about the Army, the Navy, and the Air Force and how they do that. The Army has a limited need for nuclear engineers, but they do have a program to get engineers the appropriate number of graduate degrees. They have their requirements well identified and well taken care of. It's a fairly small community and the Army has that under control. The Navy, because it has a nuclear propulsion program, does a great job going out and getting students interested, getting naval ROTC scholarships. They graduate a lot of people from the Naval Academy who go into the nuclear propulsion field in the Navy and a number of those people can then cross over and then help work nuclear weapons issues as well. So the Navy is in great shape, as long as people are still willing to go into the Navy.

The Air Force, which for a large part of its early history was the primary nuclear power of the U.S. military, has in large part walked away from its nuclear heritage. There are few people in the Air Force today who are nuclear experienced. The Air Force is tracking those because it's a small and perishable resource. The Air Force Institute of Technology does have programs. The ROTC scholarship program, for example, recently listed their priorities for the technical fields they want to award scholarships to and nuclear engineering was priority 4. Things like electrical engineering and computer engineering were up in priority 1. I don't have the exact list in my head, but I do remember the nuclear engineering was down at priority 4. So there is a difference in the emphasis among the three major military services as far as nuclear expertise. But it is possible for a student who is interested in doing the military and doing nuclear, there are opportunities in all three services. Clearly the Navy has the largest and most successful program.

Mangan: Today you pointed out this need for filling the pipeline with new, fresh blood, in the nuclear business. I've heard Linton Brooks from NNSA (National Nuclear Security Administration) say the same thing. I've heard (U.S. Energy) Secretary (Spencer) Abraham say the same thing. How come there's not a focused program in the government to help this pipeline get filled? You commented that building a nuclear reactor would help jump start some things, and I have to agree with that, but the concern is our population is getting old and there's still stuff to be done nuclear and there's not going to be anyone coming in to fill our shoes.

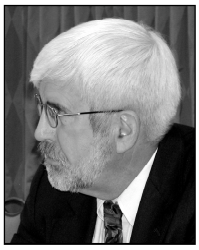
Klein: I don't think there is a national program to address that issue. So then you sort of leave it to each of the areas. For example, if you look at the commercial sector, what they do is they steal from each other and they recruit from the naval program. Then you look at the national labs, they go to a lot of college campuses. But the number of nuclear programs in this nation is decreasing, so that one is getting smaller. So that is sort of left to each individual. There's not a systematic approach to that pool. Each area is looking at it and addressing it, but there's not a comprehensive program. Then you would say, well, whose job is it? The way the Department of Defense historically structured it has been they've let each of the services make sure they get their own pool. Which is why I think the naval program is so good. The Air Force needs a lot of people to move the nuclear assets, and store them and put all the codes, and things of that nature. We're working internally to address that issue. There is not an integrated approach. It really needs to be tied together. This is a case where the private sector, the government, the national labs, and the universities all need to be engaged in this in an integrated way. I think the problem now is that everybody sort of points at everyone else and says, "It's your job. It's your job. It's your job." And it's really all of our jobs.

One would think that the Department of Education would be the one to look at the needs of the nation in the technical fields all across the board, but they don't seem to be driving that issue. I think by default a lot of the scholarships that have come out historically have come out of things like the Atomic Energy Commission. Probably a lot of people around this table came into the nuclear business via the Atomic Energy Commission fellowships. There are a small number of nuclear scholarships and fellowships but not enough to meet the needs. But right now there's not any integrated approach.

Key: I don't know if you're aware that it's a little bit ironic. The MPC&A program is to develop an actual nuclear materials

management degree program at the Moscow Engineering and Physics Institute (MePhI). And then we make a concerted effort to take those graduates and place them at nuclear facilities in Russia. I think it would be a very positive thing if we also did something like that here in the United States. That may indeed help the situation.

Klein: One of the things that we were trying to do in Russia was to create a culture of self-responsibility and a way of thinking that was missing in the past. Where Russia did a very good job was in having people in very narrow fields and they would be experts. Then we would try to work with some of the individuals in Russia who were experts on computations on fast reactors, and we would want them to look at computations on VVERs to see if there was a way that we could look at the surplus plutonium and they would say, "That's somebody else's job." They were computational experts but only for fast reactors. So we were trying to work with that culture. We want to do that on a safety and management approach, where they would look at a more broad area. I think in the United States, we have a lot of flexibility within our educational institutions that MePhI didn't have and so students at the undergraduate level in engineering were pretty well restricted on what they would take, not on what they can take, but typically they only take enough classes to get their degree, then they go out and get a job. So lifetime learning is an area we need to address so that you don't stop learning after you get your first, second, or third degree. But our graduate degrees have a lot of flexibility where they can take that. But again, I think a student going into graduate engineering work today would probably not even think of nuclear materials management as an option because where would they hear of it. They wouldn't hear of it typically in their undergraduate curriculum. They would hear it by going to conferences like this or talking to relatives or talking to people in the business. So part of that is just an awareness.



James Lemley: I'd like to return to this incentive idea for getting new people into the industry or to constructive uses of nuclear energy and nuclear science. I'll start with an observation. First, if you put science in the elementary grades, and I think that's a good thing to do, but so often it happens, at least in my experience in New York state, that's often with a very, very strong anti-nuclear bias. Science in the elementary grades is environment and nuclear is bad for the environment is the way that often goes. I think we have to try to make it work.

Second, I wonder if there's a consistency in what we're promoting, in particular, in promoting uses of nuclear energy. You mentioned this morning that we know Iran is doing some bad things with nuclear energy but do they also have a legitimate use? They started those reactors many, many years ago when the shah was in power and needless to say Iran has lots of fossil-fuel resources but the same is true of Russia. Both countries have huge amounts of fossil fuel resources, and a country can decide it wants to use the fossil fuels as an export tool or to keep its exchange rate right and decide to use nuclear instead for its own energy needs. So I guess what I'm asking is, is our encouragement of nuclear energy consistent in all areas? And another thing, you come from the military side of the house, and you certainly mentioned the defense uses of nuclear energy rather than the peaceful and civilian uses, although you certainly did promote the nuclear power business very strongly.

Klein: There are two areas I'd like to comment on. First, on science teachers, that often times is the case. I've given lectures to high school science classes and just to get the students sort of engaged, I'll say, "How many of you are anti-nuclear in the classroom?" And it's amazing the number of times they would say, almost in unison, "Only our teacher." That tells you that there's an opportunity for the technical societies, industry, the private sector, to have programs to educate teachers on the positive benefits of commercial nuclear power. So there's an opportunity to make that better.

When I was at the University of Texas, for a number of years I had a program called "Electric Power and the Environment," where we would bring science teachers in for two weeks to teach them.

People go through and are weak in science and math. You can really see that in math if you're ever at a checkout counter and the cash register fails and you see the people there struggling to make change. So there's a lot we can do to improve science, math, and engineering education across the board. That's one thing that we all need to work on and that's where unfortunately we're in a dilemma now. Because that program that I talked about where science teachers came in for a two-week program was funded by the investor-owned utilities in the state of Texas. Well, as competition comes in, after a while, the way that they could return their investments became a shareholder issue. In other words, if you're spending a lot of money on educating science teachers, that's not really what the stockholders are investing in that company for. So somehow we need to look at an educational incentive for a lot of companies and certainly the utilities where in the past they were in a regulated environment, that was considered sometimes a legitimate expense to pass on to the consumers. Once that's removed then those programs have just, nationwide, gone away. I think we need to look at how we can educate people in electricity, and nuclear electricity is certainly an important issue.

On the issue of Iran, I don't believe that there would be very significant objection to Iran having a commercial nuclear power plant if that was all that they were doing. The issue is not fundamentally the commercial nuclear power plants. It's the other things that are going on. If you look at the massive enrichment program that

they're involved in with having only two nuclear power plants and the world surplus of enrichment capabilities, one has to ask, why are they building an enrichment facility? I think the answer is clear and that's going to be a difficult issue that the world is going to have to address.

Their infrastructure for commercial generation in no way justifies an enrichment plant. Period. If they need fuel for a reactor, for two reactors, they can buy that from a number of private companies; the availability is there. So I think the Iranian situation is one in which some difficult questions are going to have to be answered.

Lemley: Could you generalize that to promoting nuclear energy in other Western industrial states? Can nuclear power generation be promoted in a consistent way internationally?

Klein: I believe that there could be a very effective nuclear power program worldwide. I know that the Department of Energy is looking at more proliferation-resistant fuel cycles and things of that nature. One of the easiest ways to do that is to have a program for the return of spent fuel. There are all kinds of ways we can make that work. There are also all kinds of ways that people can get around that system if that's their intent. So what we need is a smart system. The Atoms for Peace program was basically structured so that you would provide countries with electrical generation but have a barrier so that people would not develop nuclear weapons from that cycle. I think those same incentives exist today in a lot of countries where they need electricity. If we're concerned about the burning of fossil fuels, and depleting a limited natural resource, if we're concerned about global warming, we do need to look at the nuclear option. It works; it's there. But we need to look at the whole system so that we can minimize the proliferation. I think technically there are answers to that but we also need to look at the public policy standpoint. What kind of controls do you put on situations? We look for example at the North Korean situation. They had the IAEA inspectors there. When the inspectors were asking the hard questions and wanted to look at certain facilities that were suspected of doing things that they shouldn't be doing, they kicked them out. What's the response when they do that? It's very difficult for a country that wants to develop a nuclear weapon not to do so. The physics works the same in those countries as they do in the United States. Then you have to have some kind of an agreement among a lot of countries on what the policy should be for those countries that want to go down that path and particularly those countries that are known for harboring terrorists.

Obie Amacker: I just wanted to shift bases a little. Being from Hanford, where we have a slight problem with clean up of defense nuclear waste, we're also really close to the Umatilla Chemical Depot where they are attempting to clean a large inventory of chemical munitions and containerized chemical agents and I was interested in your comment today about the delay in the clean up and also the tremendous increase in cost and just wondered what your perception is as to why that is. Is it technological? Is it politically driven? Where is the delay?

Klein: Yes.

Amacker: Because you don't seem to hear about the delays in the clean up of chemical sites as much as you do the delays and cost increases related to nuclear clean-up activities.

Klein: It's really kind of interesting when you look at getting rid of the old chemical weapons that we had. You have a lot of the similarities to those who are opposed to nuclear power; you have a lot of the emotional issues; you have a lot of people who can generate unnecessary fears and so forth. In the case of getting rid of the chemical weapons, there has been a change in the environmental regulations and changing regulations, as we all know, causes challenges. Then environmental practices change over time. What used to happen at Hanford, when you had the threat of a lot of missiles coming at you, whether or not you stored liquid residue in a tank that would last ten, twenty, or thirty years was not your primary issue. So there has been be some change in that area. The other things that happened with the chemical weapon destruction program is there's a fairly large group that's opposed to incineration. Technically, we know how to do incineration; we know how to put the filters; we know how to monitor it. A very large group developed that was against that incineration technology. That has caused a lot of delays, a lot of lawsuits, and delays end up costing money.

Incineration technology is technically sound but the last several facilities we did an analysis on were using a neutralization method. Neutralization works. Incineration works.

In general, in the early days, incineration was well understood and that plant was duplicated at other facilities, for example at Tooele, Utah, the plant has been running there for a number of years, and it has destroyed a lot of chemical weapons. Johnson Island has destroyed all the chemical weapons that were in Europe that were brought back. So incineration was sort of the one that was chosen. So there were other factors. You had those who were opposed to incineration. You also had the BRAC issues where people were concerned about the facilities being closed, and they would use the stockpile as a reason not to close certain sites. There were a lot of factors that went into that. Incineration is a proven technology but it does cause people to react emotionally, much like radiation. The fear of that one molecule coming out that's going to kill the whole city.

Kelly: I think we should define BRAC.

Klein: BRAC is base realignment and closure. As we move away from the Cold War, there are a lot of DoD facilities that are not necessarily needed in today's environment.

You ask a global question: Should we close several of the military installations? And the answer is yes. But then you start picking one and that's when the argument starts.

Debbie Dickman: I'd like to change the flavor of this discussion just a little bit. As administrations change and we have new senior leaders, such as yourself, who come into a position, I wonder if you could reflect on the initial challenges that you thought you were facing when you came into the position, and how you got your feet on the ground to address those. Now that you've been in the position, do you find the challenges changing and how have you used your background and some of your technical advisors to be able to meet those challenges? I'm always struck by the process that changing administrations and new leaders use to get moving and be effective in their new roles. How did you move forward to make headway in the key areas you saw needed attention when you came in?

Klein: I think one of the areas that was fascinating to me, being in public service in education in my chosen career, but this was the first time I've been in public service for the federal government, so that was a new job for me. I think that one thing for people like me that come in is you have to spend a lot of time learning and reading. You have to hit the ground running and you have to work hard. So it's not a forty-hour week by any stretch of the imagination. It's long hours. But one of the characteristics that I found the most rewarding that I did not expect, not having been in the military, was the talent that exists within the Department of Defense that's in that system.

One of the things that makes the DoD different than the Department of Energy is the rotation of young men and women that come through for your support structure. You have a culture within the Pentagon that's number one, we're here to do a job and we're to do it right and we're here to accomplish things and you have a culture that's well suited for a change in administration—because that happens all the time within the Pentagon. That doesn't happen in other federal agencies.

I'm sure you've heard, in some of the other agencies, of the B-Team—be here when you came and be here when you're gone.

I've been very impressed with the talent of the people in the Pentagon and the hours that they put in. They work until they get the job done. You don't have much watching the clock. When I was getting ready for my confirmation hearing, we were there until 8 o'clock at night getting ready. No one looked at their watches, civilian or military. So I think that the things have been most impressive to me are the work ethic and the talent pool within the Pentagon. I think DoD is much more able to respond to changing administrations than other agencies because of that culture that's built up, that you have bright young men and women in uniform who come in on assignment and their job is to make things happen, it's not to slow things down, it's not to put up a barrier, and it's not for job security. It's to do a job and to do it right.

So I think that is one of the most surprising and positive experiences that I've had as a non-government worker. I think what happens when people like me come in is you have to spend a lot of time learning and really learning what the issues are. Clearly with my nuclear background, that was the easiest for me because I've spent my life in the nuclear field but the chemical and biological defense areas, I had to put a lot of time into those areas. Chemical demilitarization for the chemical stockpile, I was told after I'd been announced, that I would find that to be very challenging and it is. But that was an issue that I had never looked at. I never had a reason to look at it. So, you just have to do a little on the job training and work hard.

I would highly recommend any of you around this table who has a chance to do public service for the federal government to do it. It's rewarding. It may not be financially rewarding, but it's certainly rewarding otherwise. I think after September 11, with the portfolio that I have with nuclear, chemical, and biological defense, I had an additional incentive. I think any of us who can contribute to making our country safer would do the same thing that I did. So I think the portfolio that I have is an exciting one. It is one that you have to hit the ground running. You have to work hard but you have a good talent pool to make it happen. The other thing that you learn is you have to have assistance from the contractor base. It's not an area that you do it all within the federal government. You have to rely on that industrial base that's out there.

Dickman: You walked in the door with a set of given ideas about the problems that you'd work and the leadership challenge you'd face. Do you find after having been in that role now that that's changed or is it pretty much like you thought it would be when you walked in?

Klein: When I walked in, I don't think I knew what all the challenges were. (Laughter.)

Dickman: Or you might not have walked in. (Laughter.)

Klein: When I walked in I didn't know about chemical demilitarization. I didn't know the challenge of getting the anthrax vaccine facility up and running. So there were certain things that I didn't know but I think on the nuclear side of the house, I pretty well knew that side. It was the other aspects that were most important to learn. I think the other part that frustrates all of us is that sometimes it's more difficult to get things to happen than you would like. Part of that is good and part of that is bad.

If you have, for example, an administration that wants to diminish the nuclear capabilities that this country has, then slowness is good. If you have another administration that wants to make things more positive and make some changes, then that's bad. So it does depend on what the overall vision of the administration is and I think, from my perspective, I've been fortunate in having an administration that has high moral and ethical values. It's a president that you want to work hard for and support. It's a secretary that you want to work hard for and support. And it's a nation that you want to work hard for and support.

So it has a lot of compensation other than monetary to do the job. My goal is to leave the nation stronger than it was when I came. Time will tell if that's actually the case.

Matter: Earlier in our discussion you recognized the difficulties in educating the public on technical issues when there's the natural tendency to fear the unknown, in communicating with commercial broadcast media that concentrate on being first rather than correct, and in overcoming the misinformation the anti-nuclear and anti-technology interest groups present. Because you have credentials in education, what are your ideas for overcoming those obstacles, and are there any initiatives in the department to do that?

Klein: I think on the nuclear side of the house, one of the things I was surprised at when I was still at the University of Texas and you do some media tours where you'll go out to radio stations and television stations to explain those issues, what I was surprised at were the number of TV and radio stations who really want people to come out and be on their programs. So there is a natural source through which we can get our message out. There are a number of TV stations, networks, and so forth that would love to have people come in and tell the other side. I don't think that as a nuclear community that we do a very good job of taking advantage of that. But I can assure you that those who are opposed to nuclear sure take advantage of that.

One of the difficulties is that most of us have full-time jobs so we're busy. But there is a large segment of the population that has more time to do the things that they want to do so they're more effective at getting their message out than we are.

But what I was surprised at was the receptiveness of these TV and radio stations that actually would like to hear the message that those who favor nuclear issues would like to get out there.

In the Pentagon, we have a public affairs office that tries to get the message out to explain issues. So I think that typically we are more often in a reactive mode than a proactive mode because we have a mission to do and we try to do it. But we do have a public affairs office that does help us get messages out but it typically is correcting information that is already there as opposed to we say "OK, these are the points we want to get out on nuclear issues or chemical issues or biological issues." I think we're the same in the Department of Defense as industry and academia and other agencies. We don't spend enough time educating the public; we just do our jobs. We could probably be more proactive in that area. I think on the nuclear side of the house, you sort of hope that the Nuclear Energy Institute and American Nuclear Society and INMM will all do that. So we all need to be more proactive on that. But at the Department of Defense we have, from my perspective, no major educational public relations program. You know the secretary of defense has his press conference, the chairman of the Joint Chiefs of Staff is there. But again, that's typically to answer questions. They don't wake up every morning and say, "This is what I'm going to talk about today." They look at the world events and respond to those.

DeVito: I don't have a question, but I want to make the assumption that I'm sitting in your chair and going through this and you want to ask a question. And going back to the lack of getting people into the nuclear industry, what I want to talk about is what the INMM is doing about this. We have a student membership that costs practically nothing. We have a program where we award monies to the best student paper and sometimes to second place. So we're trying to get at least that aspect. We have chapters and those who are close to universities—Oak Ridge and Albuquerque for example—are doing programs to develop student interest in nuclear energy in those cases. And student scholarships. So at least we're trying from that aspect. So I would encourage you in those programs where you have students to get them involved in the INMM.

Klein: One of the areas where you might be able to help in is, having been a faculty advisor for the American Nuclear Society student branch on campus, it's hard, because your pool is so small, to have a really effective student chapter. And I was also the advisor for the honor society Phi Tau Sigma. There you have a much larger group that you can work with. And then you look at the American Society of Mechanical Engineers (ASME). There you have a much bigger pool. So you start with like ASME, the number of students that can be members of that student organization. Then you start narrowing it in, and so I would imagine that the INMM, which is even smaller, would be more challenging than even the American Nuclear Society. So one thing you may want to try is to have a relationship with every ANS student branch chapter, and INMM affiliate. I can tell you from all the students that I dealt with in my undergraduate activities and probably even at the master's level, they probably would not have heard much about INMM unless it was through their faculty advisor. So I think that getting your message out, that would be one area that you might try.

We're just in a specialty, and I know, from my ANS experience compared to my ASME experience, your pool of people to begin with is small. So what you might try to do is affiliate with some of the other

technical societies' student branches, like ASME, which has a bigger pool, because you don't have to be in the area of material science; it doesn't have to be a nuclear person necessarily because your fundamental issues would be materials science, which might have radiation affiliated with it, and there you'd pick up your materials science. So I don't know if you might have any kind of affiliated student branch, but I would imagine that it would be challenging for you to get the word out to undergraduate students about your organization. The only way I would know to do that is to try to tie in to those other organizations. I think it would be difficult for you to have enough of a critical mass, so to speak, to form your own INMM branch on even a campus as large as University of Texas Austin. But you can get your word out by tying in with some other student branches.

DeVito: Well, we do have some connections with ANS in other programs, but we have not developed that aspect.

Matter: I think that's a good idea. We have attempted recently to establish some student chapters and it's not going very well at all. So tying in with these other groups may be a good idea.

Klein: I would pick the biggest one first. I would try to tie in with ASME.

Kelly: I just wanted to add one idea that struck me. From the podium you acknowledged everyone who supported this meeting by whatever they did: buying golf balls, buying towels, whatever. Sir, I'm a golfer and I love golf so I'm not making fun of golfers, don't get me wrong. I can do ballistic analysis with the best of them. But if it's really a priority to emphasize the student work more, then maybe you should solicit your sponsors into the prizes for the student papers or other student related activities instead of golf balls.

DeVito: Well, there is a substantial amount of money that's available for our student programs.

Klein: But the question is, do the students even know about it?

DeVito: We're weak there.

Klein: And I think, having spent a few number of years on a university campus, it would be really good for you to pick a few campuses for you to target, just say you're going to have ten campuses and you're going to pick on certain areas and try to build up an awareness, and if that succeeds, then you can go forward, but I would pick a limited number that you can target and find what works and what doesn't work and it will vary from campus to campus, and then try to tie into those others to get the word out about your organization and what you have to offer.

Key: We do have regional chapters in the INMM and some of them are really starting to concentrate at the universities within their regions.

Klein: I wouldn't forget the services. The Naval Academy is one I would go after first because of their need for things nuclear.

Kelly: The Air Force Institute of Technology…

Klein: So there are several out there that you can target.

Mangan: Well, let's close up this session. First of all I'd like to thank all you ladies and gentlemen for good questions and more importantly to Dale and to Mike for great answers. Thank you for your time.

Klein: Thank you. Keep up the good work.

Analysis of Neutron Reflection in Correlation Measurements

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Abstract

The Nuclear Materials Identification System (NMIS) procedures that rely on the fast correlation measurement of neutrons and gamma rays from fission are in use at the Y-12 National Security Complex and elsewhere. In active measurements, an external source of neutrons is used to induce fission in the sample to be analyzed. Typically, a Cf-252 source inside an ionization chamber is used. Previous studies and measurements showed that the environment, primarily the proximity of the floor or a wall to the instruments, affects the measured signatures.

In this paper, we present an analysis of neutron reflection based on a large number of simulations performed with the MCNP-PoliMi code. The simulations were performed for the time-of-flight configuration. The Monte Carlo program and its post-processor allow us to partition the total signature into the direct and scattered components. The direct component consists of uncollided neutrons and gamma rays traveling from the source to the detector. The scattered component is composed of particles that were reflected from the floor. The aim of this paper is to identify and quantify the latter component.

The analysis of the data consisted of a search for an empirical fitting curve for the scattered component of the signature. The fitting curve depends on a number of parameters that are mainly related to the geometry of the setup. The results show that the fitting procedure was able to model floor reflection with good approximation for the range of cases considered. Equations have been developed that approximate the neutron floor reflection and can be used in applications to calculate the floor reflection component so that it may be removed from the measured signatures.

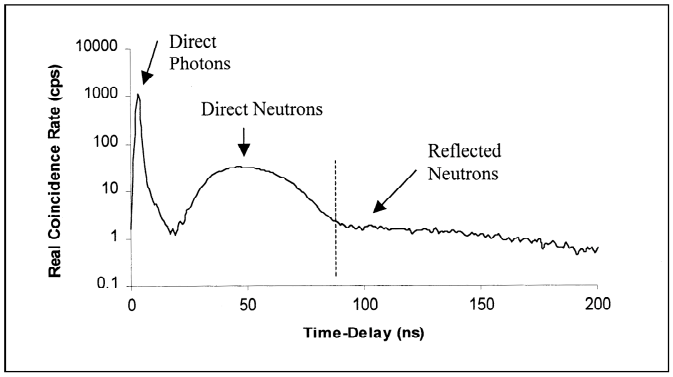
Introduction

The Nuclear Materials Identification System (NMIS) is useful for many applications involving fissile materials, including identifying and quantifying such materials for nuclear materials control and accountability.[1] NMIS procedures that rely on the fast correlation measurement of neutrons and gamma rays from fission are in use at the Y-12 National Security Complex and elsewhere.

NMIS has two interrogation modes: active and passive. For active measurements, a Cf-252 source provides an external source of neutrons, which excite the target material. Two or more detectors, located near the material, acquire gamma and neutron radiation. In passive measurements, the Cf-252 source is omitted and spontaneous fission within the sample itself acts as the neutron source. Each NMIS measurement produces a time domain signature obtained from cross correlation between the detectors and the Cf-252 ion chamber, if present.

Radiation reaches the detector either by direct transmission from the source, source particles scattered from the environment, or from induced fission within the target material. Measurements have shown that the presence of particle reflection from the surrounding floor and walls complicates measured signatures. The goal of this paper is to identify and quantify the neutron reflection component of the measurement signatures from the floor. Analysis of photon reflection will be extended in a future study. Figure 1 shows a typical NMIS signature wherein the area following the dashed line is the discernible contribution due to reflection. The rest of the contribution is combined with the direct neutron contribution immediately to the left of the dashed line.

Figure 1. Example NMIS signature

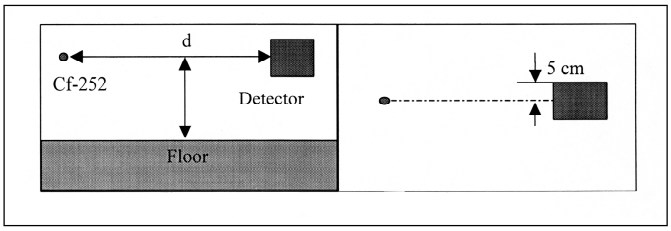


Because physical experiments are both time-consuming and not readily quantifiable, simulations of experiments were performed using Monte Carlo methods. The experimental setups modeled were time-of-flight experiments using a Cf-252 source and one plastic scintillation detector wherein the distance between the source and detector and the height of the source-detector pair from the floor were varied. The simulations were processed and analyzed using Matlab™. This analysis was used to develop look-up tables and equations that approximate the contribution of neutron floor reflection to an NMIS signature. In this paper, a comparison of the model formed by the equations with the results of the simulations is presented. Finally, the model is compared with laboratory results.

Simulations

Experiments modeled were time-of-flight experiments using a Cf-252 source and one plastic scintillation detector. The source was positioned in line with the center of the detector face perpendicular to the floor. The distance, d, between the source and the detector was varied between 10 cm and 100 cm in 10-cm increments, and the height, h, of the source/detector pair was varied between 5 cm and 45 cm in 10-cm increments. The height of the detector was measured from the center of the vertical detector face. This established a matrix of fifty physical arrangements for simulation. Figure 2 illustrates the setup of the experiments.

Figure 2. Sketch of geometry used in the simulations



The experiments were simulated using MCNP-PoliMi.[2,3] This code is a modification of the Monte Carlo particle transport code MCNP that enhances the realism of MCNP. In particular, MCNP-PoliMi samples neutron collision types before performing secondary gamma generation. This is not the case in standard MCNP, where neutron collision and secondary gamma generation are uncorrelated. MCNP-PoliMi also has other features, such as the inclusion of fission sources as source particles, allowing the user to specify a number of fission events to be modeled as opposed to a specified number of neutrons or photons. Furthermore, MCNP-PoliMi allows the user to track all interactions between modeled particles and target nuclei within a specified cell by creating a data file that records information about each particle interaction within the cell. Cross sections used by MCNP are from ENDF-V and ENDF-VI.

The scintillator was modeled using material information acquired from Saint-Gobain for the BC-420 model plastic scintillation detector.[4] The active detector dimensions are 10 x 10 x 10 cm.

For typical NMIS measurements, the item being investigated, or the target, is located between the source and the detector. Thus, it is conceivable that neutrons reflected from the floor could collide with the target and scatter to the detector consequently increasing the contribution of the floor to the measurement signature. However, this contribution is assumed to be negligible because the compounding probabilities of a neutron scattering from the floor to the target, then from the target to the detector is sufficiently small to be ignored. Also, the target will likely contain neutron absorbers that will further decrease the likelihood that a neutron scattering from the floor to the target would reach the detector. Consequently, by eliminating the item of investigation from the simulations, the complexity of the simulations is decreased, and the applicability of the study is increased to include all target materials without a significant increase in error.

Analysis

There were two goals of the analysis of the MCNP-PoliMi data files. The first was to develop a time-dependent shape function, which characterizes the shape of the floor reflection component of an active NMIS signature at a given time. This function is independent of the distance between the source and the detector, the height of the source-detector pair from the floor, and the neutron energy threshold of the detector. The second goal was to develop equations that could be used to adjust the shape function to fit the reflected component of a specific case signature. The characteristics that these equations approximate are the amplitude, mode, and full width at tenth maximum (FWTM) of the floor reflection component of the signature for a particular distance, height, and detector threshold.

Analysis of the data output from MCNP-PoliMi was performed using a postprocessor program developed in Matlab™. These data output files are a collision history for each particle that enters the detector cell. The postprocessor used the collision histories to separate the contributions to the detector response by neutrons that traveled directly to the detector from those that scattered from the floor. In addition, to model the detector response more accurately, the postprocessor converted energy depositions into light outputs, and ignored neutrons generating a light output lower than a user-specified threshold. The final output from the postprocessor included a time dependent histogram of the fraction of neutrons that arrived in the detector cell after having collided with the floor.

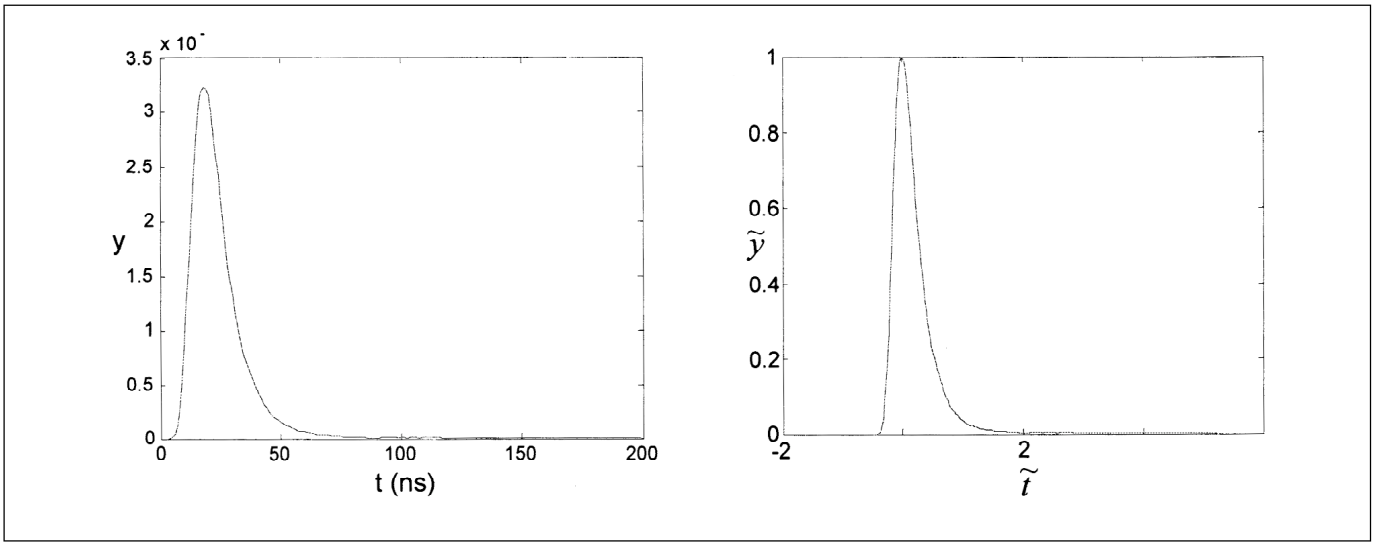
Each of the fifty simulations was postprocessed using ten different neutron energy thresholds, 0.6 MeV to 1.5 MeV in 0.1 MeV increments. The resulting 500 cases were averaged using a 7-point floating average, and the amplitude (A), mode (m), and FWTM (w) was determined for each case. The histograms were then normalized using the following relationships:

$$(1)\quad \tilde{t} = \frac{t - m}{w}$$

$$(2)\quad \tilde{y} = \frac{y}{A},$$

where t is the time bin, y is the fraction of neutrons from a given source fission arriving at the detector within time bin t, and $\tilde{t}$ and $\tilde{y}$ are the normalized t and y values, respectively. The result of this transformation was to give each an amplitude, mode, and FWTM of 1, 0, and 1, respectively. Figure 3 illustrates this normalization.

Figure 3. Normalization of the curves for the case d=10cm, h=5 cm, T=0.6 MeV



Next, the 500 resulting curves were combined to form one average, normalized histogram, which was used to determine the coefficients a, b, and c in the shape function, given by:

$$(3)\quad \tilde{y} = \exp\left(\frac{-(4\tilde{t})^2}{a\tilde{t}^2 + 2b\tilde{t} + c}\right)$$

Using the shape function and the 500 normalized curves, the optimum amplitude, mode, and FWTM of the shape function was determined for each combination of distance, height, and threshold. Both the shape-curve coefficients and case-specific characteristics were determined using unconstrained nonlinear optimization. The amplitude, mode, and FWTM of the actual (non-normalized) curves were determined using the following relationships:

$$(4)\quad A = A_0 A'$$
$$(5)\quad m = w'm' + m_0$$
$$(6)\quad w = w_0 w'$$

where A_0, m_0, and w_0 are the original amplitude, mode, and FWTM, respectively, and A', m', and w' are the optimized amplitude, mode, and FWTM of the shape function. These optimizations were performed recursively until the minimum cumulative error between the model and the simulated data was found.

In calculating the amplitude of the reflection curve, the dependence on distance (d) and height (h) may be reduced to the dependence on a single variable, reflection distance, which is the length of the path that a reflected neutron traveled. The reflection distance is calculated as follows:

$$(7)\quad R = 2\sqrt{\left(\frac{d}{2}\right)^2 + h^2}$$

After making this substitution, the trend of the amplitude as a function of reflection distance is exponential. This is improved using a quadratic term in the exponential expression. In order to account for dependence on threshold, each coefficient in the quadratic term is substituted for a linear term dependent on threshold (T). Thus, the final equation for the amplitude of the reflection curve is:

$$(8)\quad A = \exp\left[(a_{00}T + a_{01})R^2 + (a_{10}T + a_{11})\,R + (a_{20}T + a_{21})\right]$$

The trends for the mode and FWTM of the reflection curve are best fit using equations having a system of nested linear terms. Accordingly, the equation for the mode is linearly dependent on distance. The coefficients of this equation are each linearly dependent on height, and each of the coefficients in those expressions are linearly dependent on threshold. Therefore, the equations for mode and FWTM, respectively, are as follows:

$$(9)\quad m = \left[(b_{000}T + b_{001})h + (b_{010}T + b_{011})\right]d + (b_{100}T + b_{101})h + b_{110}T + b_{111}$$
$$(10)\quad w = \left[(c_{000}T + c_{001})h + (c_{010}T + c_{011})\right]d + (c_{100}T + c_{101})h + c_{110}T + c_{111}$$

The optimized values of the coefficients in the shape function are: a = 1.6679, b = 0.9997, and c = 1.0859. Optimized values for the other equations are given in Table 1.

Table 1: Coefficients for amplitude, mode, and FWTM model equations

Amplitude		Mode		FWTM	
a_{00}	-2.7348E-05	b_{000}	7.87E-05	c_{000}	0.00323
a_{01}	1.9533E-04	b_{001}	-0.00364	c_{001}	-0.00422
a_{10}	5.0059E-03	b_{010}	-0.08395	c_{010}	-0.23623
a_{11}	-0.06450	b_{011}	0.49534	c_{011}	0.57201
a_{20}	-1.16266	b_{100}	-0.19358	c_{100}	-0.59150
a_{21}	-6.54230	b_{101}	1.23573	c_{101}	1.82940
		b_{110}	-2.07568	c_{110}	-2.20298
		b_{111}	8.56378	c_{111}	22.77148

Results

A model of the contribution of neutron reflection by the floor to NMIS signatures has been developed. This model consists of a time-dependent function that characterizes the shape of the curve and three other functions which adjust the amplitude, mode, and FWTM of that curve according to the distance between the source and the detector, the height of the source detector pair, and the energy threshold at which the detector is set. The model developed using the fitting procedure provided a good approximation to simulated results. Figures 4 and 5 illustrate this approach for a few cases throughout the ranges covered.

Figure 5 illustrates how the model compares with an NMIS measurement. Because in the experiment we are unable to partition the signature into its direct and scattered components, the fitting uses the reflection models developed here in conjunction with direct models previously developed to fit both components simultaneously.

Conclusion

The portion of an NMIS signature due to neutron reflection from the floor may be adequately quantified using Monte Carlo methods. Equations have been developed that approximate this contribution well. These equations, as well as the tables of amplitudes, modes, and FWTMs used to develop them, are currently being used in applications to calculate the floor reflection component so that it may be removed from measured signatures. In this application, a previously developed model that approximates the direct neutron component is used to determine the efficiency and threshold of the detector. Then, using the Hooke-Jeeves algorithm, the direct and reflected components are optimized simultaneously.

The floor reflection model may be modified for the use of a liquid scintillator instead of a plastic scintillator. Also, additional simulations were performed that demonstrated that the results do not change significantly depending on the type of concrete used in the measurement. There are, however, some limitations to this study, which future work could improve upon. The model is limited by the fact that the external source must have the same neutron angular and energy distribution as Cf-252. Also, the model could be improved by accounting for the detector response to photon reflection and secondary photon generation.

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Figure 4. Comparison of data with model for: (a) d=10 cm, h=15 cm, and T=0.6 MeV, and (b) d=30 cm, h=15 cm, and T=0.8 MeV

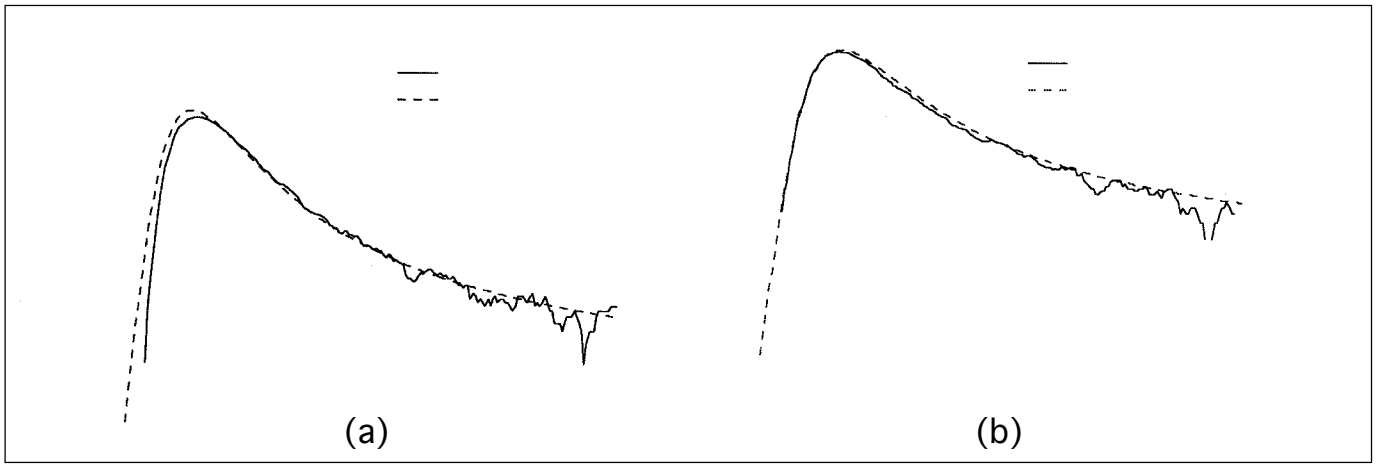


Figure 4. (continued) Comparison of data with model for: (c) d=70 cm, h=35 cm, and T=1.2 MeV, and (d) d=100 cm, h=45 cm, and T=1.5 MeV

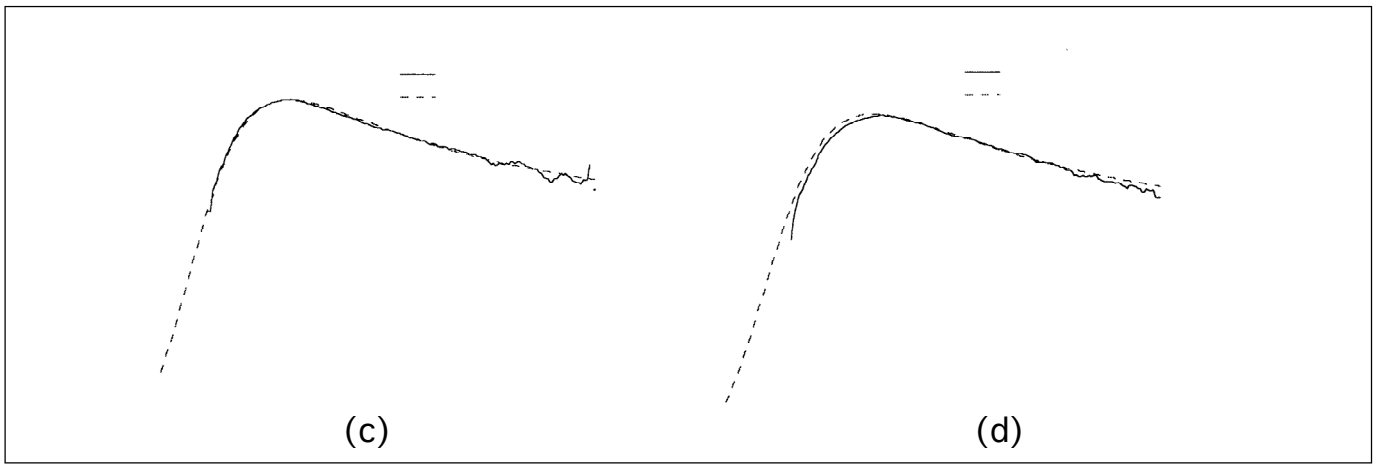
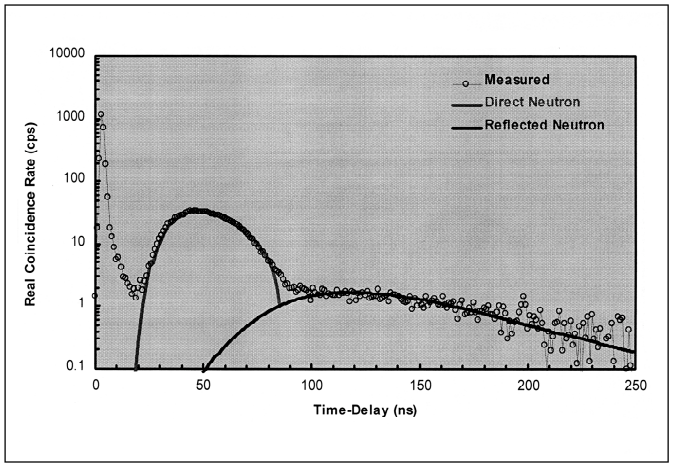


Figure 5. Comparison of model with NMIS laboratory measurement



Homeland Security Perspectives

A Summary of the Closing Plenary Session of the 44th INMM Annual Meeting

James Lemley
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Vice Chair, INMM Government Industry Liaison Committee

This year's Closing Plenary continued last year's focus on the post-September 11 environment and efforts by government agencies to address increased threat levels. At the annual meeting, almost two years had passed since that infamous date and significant progress had been made in building new and strengthening existing government programs to counter terrorism.

We were fortunate to have two very distinguished presenters from complementary government agencies; Tony Fainberg from the U.S. Department of Homeland Security Science and Technology Directorate and Bernie Bogdan from U.S. FBI headquarters. Fainberg's presentation focused on efforts by the Department of Homeland Security in establishing a program to counter radiological and nuclear threats while Bogdan's presentation outlined how the FBI bolstered their existing nuclear threat response programs.

INMM GILC Chair Jim Lemley, Anthony Fainberg, Bernie Bogdan, and GILC Vice Chair Amy Whitworth.

Countering Radiological and Nuclear Threats

Anthony Fainberg
Acting Director for Federal Laboratories
Science and Technology Directorate
U.S. Department of Homeland Security

Anthony Fainberg, of the Science and Technology Directorate of the U.S. Department of Homeland Security (DHS), gave a presentation on "Countering Radiological and Nuclear Threats." He discussed the institutional issues with DHS and how the many different pieces that come from different organizations within the government work together. He outlined the principal elements of border and transportation security: the Bureau of Immigration and Customs Enforcement, the Bureau of Customs and Border Protection, the Transportation Security Administration, the Federal Protective Service, and the Office for Domestic Preparedness (formerly part of the U.S. Department of Justice).

Summary

Fainberg provided the current organizational chart for DHS Science and Technology Directorate. The first stage for the Science and Technology Directorate was the Transition Planning Office, which was set up in July 2002 and staffed with a small core group of scientists, primarily from the national laboratories. Additional staff was added in December 2002 and January 2003. This group planned the organizational structure and set up research and development programs. DHS organizationally stood up in January 2003 and the relevant portions of other agencies joined in March 2003.

At the time of the INMM annual meeting, the current business process was just beginning with a budget starting to flow. The Science and Technology Directorate began with broad agency announcements through the existing infrastructure of the Technical Support Working Group (TSWG). The Science and Technology Directorate had one major advantage over the other DHS directorates, Fainberg said, because it was beginning from scratch and had no agencies to integrate. It focused on getting the

Homeland Security Advanced Research Projects Agency (HSARPA) established and functional.

HSARPA is similar to the Defense Advanced Research Projects Agency (DARPA) in that it has forward-looking research and development, but HSARPA also includes rapid prototyping accomplished through the TSWG. HSARPA forms the main link of the directorate with the private sector and is divided into program areas of interest to include chemical, biological, and radiological/nuclear areas. HSARPA will work mainly through broad agency announcements and the competitive process.

Some of the roles of the Science and Technology Directorate outlined by Fainberg include:

- Deploying some instrumentation immediately in field trials
- Prototyping equipment that is nearly mature within an eighteen-month timeframe
- Developing and carrying out a long-term research and development program focused on protecting the homeland against major terrorist attacks
- Working with other directorates and with state and local authorities as customers

He discussed the radiological/nuclear portfolio, which was focused from ten areas of activity down to four primary areas. One of the primary areas that Fainberg discussed was attribution. Attribution is a powerful tool because the ability to attribute acts of radiological/nuclear terrorism can be a major deterrent as it supports decisions on retribution. The biological portfolio includes system studies and response tools (including plume modeling), biosurveillance, biodetection, first responder tools, and decontamination following an event. The chemical portfolio includes system studies, medical countermeasures, first responder tools, facility protection, forensics, and identification of toxic industrial chemicals.

The Science and Technology Directorate has seen some progress in the first 100 days of the stand up of the organization with *Biowatch* and radiation detection. Biowatch involves the deployment of biosensors, both at fixed sites and within some transportation modes. DHS is also conducting some field trials of radiation detection technology in cooperation with the Port Authority of New York and New Jersey. The field trials started as a U.S. Department of Energy initiative in 2002 and moved to DHS. The field trial tests out detectors, response protocols, and strategies in various transportation modes. The Science and Technology Directorate leads the field trial, working with other DHS directorates and other agencies. This is expected to be about an eighteen-month effort with expansion to follow on regional, and possibly national, levels.

DHS is developing an effective deterrent against the radiological/nuclear threats. As Fainberg stated in his presentation, an effective deterrent requires detection, intelligence analysis, preparedness, and response (to include attribution). Some of the major radiological/nuclear initiatives include border security, intramodal and perimeter defense, enhanced search and crisis capabilities, and consequence management and recovery.

Fainberg briefly discussed the Science and Technology Directorate's budget, which had an initial $521 million reprogramming in fiscal year 2003. Using a small portion of these funds, the directorate initiated a quick start effort through the TSWG that included all the portfolios. The fiscal year 2004 request was $803 million of which a large portion will be passed through HSARPA.

The Science and Technology Directorate is working towards international cooperation on radiological and nuclear issues with other national and international organizations with relevant expertise.

They are also building their coordination with state and local officials, which is required for the efficient transfer of technology and expertise to local levels that will lead to the ultimate success of the directorate. The Science and Technology Directorate will provide state and local officials with standards for equipment purchases, advice through emergency preparedness and response and directly, training standards for equipment use, and close collaboration on specific projects.

The FBI's Nuclear Program

Bernie Bogdan
FBI
Counter Nuclear Terrorism Program

Bernie Bogdan, of the U.S. FBI's Counter Nuclear Terrorism Program, gave a presentation on the FBI's nuclear program. The criminal jurisdiction for the FBI nuclear program is outlined in three main legal vehicles: the Atomic Energy Act (AEA), 18 USC Section 831, and 18 USC Section 2332a (WMD statute). The AEA addresses criminal and civil (licensing) violations. Most violations involve U.S. Department of Energy (DOE) and U.S. Nuclear Regulatory Commission (NRC) licensing regulations, missing classified documents, leaks of classified documents or information to the media, and espionage and sabotage.

Summary

Bogdan discussed potential nuclear targets to include U.S. Department of Defense (DoD) facilities (nuclear weapons storage sites and deployed warheads), DOE facilities (nuclear weapon production/dismantlement facilities, special nuclear material production facilities), and facilities with significant amounts of spent nuclear material), and commercial facilities licensed by the NRC (power and research reactors, nuclear fuel cycle facilities with enriched uranium).

Bogdan outlined the FBI's strategy for nuclear material trafficking. The goal of the program is to prevent the acquisition of nuclear materials by terrorists by aggressively investigating all allegations of smuggling, assisting foreign law enforcement, limiting the potential for creating a market for nuclear material, and the prompt reporting of all incidents for national-level dissemination.

The specific case of Stuart Adelmann was briefed. Adelmann used an NRC license to order Sodium-22, Cadmium-109, and Carbon-14. He was subsequently arrested for violating Title 18, Section 831, which prohibits transactions involving nuclear material. In this case, there was no evidence of malicious intent by Adelmann, however, he plead guilty to a violation of Title 18 and was sentenced to five years in prison. Bogdan stated that nuclear cases were only the tip of the iceberg and that many nuclear incidents never reach the point of case initiation but they require notification, assessment, and coordination.

Bogdan discussed the nuclear threat assessment process, which is coordinated between the FBI and the Department of Homeland Security (DHS). The Nuclear Assessment Program (NAP) is managed by the DHS through the Lawrence Livermore National Laboratory (LLNL). The assessments address behavioral, operational, and technical aspects. If circumstances dictate, an initial assessment can be completed within one hour and a final assessment within four hours. The threat will be declared non-credible or credible with a low, medium, or high level of confidence and an accompanying rationale is provided. These assessments are coordinated with the FBI Laboratory located in Quantico, Virginia. The specific units involved include the Hazardous Material Response Unit for operational and technical aspects and the National Center for the Assessment of Violent Crimes (NCAVC) for behavioral aspects. Bogdan noted that all threats should be furnished to FBI headquarters so that they can be included and analyzed in the LLNL historical database.

Next, Bogdan gave a historical perspective on nuclear/radiological threats. Historically, there has been limited credible information regarding specific targeting of domestic nuclear materials/facilities. The threats that had been seen were usually directed against commercial power reactors and had been assessed as non-credible. While a few incidents involved misuse of small quantities of material, they reflect a minute percentage of overall incidents.

Since the events of September 11, there has been a dramatic increase in threat reporting. This is attributed to heightened awareness, increased security levels at nuclear facilities, and FBI field coordination with facilities to resolve any reports of suspicious activities. There is an increased emphasis on Al Qaeda and their documented interest in weapons of mass destruction materials and capabilities and increased reporting of Al Qaeda threats against critical infrastructure, including nuclear facilities.

The concerns post-September 11, include threats to nuclear power plants, suitcase "nukes," radiological dispersal devices ("dirty bombs"), the potential for Al Qaeda to acquire nuclear/radiological materials, and public panic in response to these concerns. To address these concerns, the FBI strengthened the Nuclear Site Security Program. The purpose of the program is to ensure that the FBI field offices are familiar with the nuclear facilities in their regions and have compatible, well-coordinated and exercised plans for response to nuclear facility emergencies. The elements of this program include interagency coordination, facility familiarization, continuing liaison, coordinated contingency plans, and joint exercises and training.

Bogdan outlined the responsibilities of FBI headquarters and its field offices. FBI headquarters is to provide and coordinate policy, coordinate national-level support, and provide program oversight. The FBI field offices are to conduct liaisons with facilities; prepare coordinated site-specific contingency plans emphasizing containment, hot pursuit, handoff, and use of deadly force; respond to incidents; resolve crises; and conduct investigations.

In summary, Bogdan stated that there is a large interagency coordination effort to address and respond to nuclear/radiological threats. FBI headquarters created a National Joint Terrorism Task Force and established Joint Terrorism Task Forces in all fifty-six FBI field offices. The FBI has also increased liaison with the intelligence community. Greater emphasis has been placed on information sharing, including state and local agencies. There is close coordination with DoD, DOE, and NRC in the assessment of threats to their activities, facilities, and materials. The FBI has coord inated with the interagency in the development and refinement of emergency response protocols for suspected nuclear/radiological incidents and expanded its capabilities for training and conducting exercises.

The Fissile Material Cut-Off Treaty: A Venue for Future Progress in Arms Control, Nonproliferation, and the Prevention of Nuclear Terrorism

Thomas Shea
INMM Fellow

Note: *For an introduction to this article, see INMM President John Matter's column on page 2.*

The idea of controlling the production, distribution, and use of fissile material as a nuclear arms control measure has been around in various forms since the 1940s. Such controls could help cap existing nuclear arsenals and would provide a means to monitor progress towards nuclear disarmament. Ten years ago, the United Nations adopted a resolution calling for the negotiation of a non-discriminatory, multilateral, and internationally and effectively verifiable treaty banning the production of fissile and fissionable material for nuclear weapons or other nuclear explosive devices. However, the Conference on Disarmament, the United Nations organization responsible for negotiations, has been blocked from starting its work by political intervention.

The fissile material cut-off treaty (FMCT) could encourage progress towards nuclear disarmament, bolster the nonproliferation regime, and contribute to the prevention of nuclear terrorism. The FMCT, or any proposed draft, should be viewed through four perspectives:

1) How and to what extent will such a treaty achieve its intended objectives on a global scale, assuming it would be universally adopted?
2) Could the FMCT be accepted within each state considering becoming a party—including the security issues associated with inspections at sensitive locations?
3) What benefits would each state gain as a result of the FMCT being adopted by states who are potential adversaries?
4) Are the provisions for implementation workable, including governance, finance, and provisions for noncompliance?

I have followed the prospects for the FMCT closely over the past ten years. I headed a working group created within the International Atomic Energy Agency to consider the potential implications of such a treaty. I have addressed delegations of the Conference on Disarmament on many occasions over the past ten years, most recently under the Dutch Exercise in September 2002 and at a seminar organized by the German Foreign Ministry in December 2002. I participate in the Oxford Research Group FMCT project, and have published articles in the *UNIDIR Journal* and presented my ideas at INMM meetings and at a Stanford summer study on fissile material. In the course of those activities, I came to a vision of what I believe the FMCT should be about, how it could complement the NPT and other existing arrangements, how it could work in a practical sense, and how it might be financed.

Until now, FMCT considerations have always been without such a specific starting point. It is my hope that with this modest contribution, the potential security benefits of such a treaty will start the considerations necessary for the FMCT to become reality.

I have chosen to present the proposed text in a two-column table, with the treaty elements in the left column and a commentary in the right column providing clarifications and the reasoning for why the draft is as it is.

PROPOSED TREATY PROVISION	COMMENTARY
Treaty Banning the Production of Fissile Material for Use in Nuclear Weapons or Other Nuclear Explosive Devices	*This title is consistent with the United Nations General Assembly resolution and follows the form of the actual title of the NPT. Given the scope, however, the title could be changed to reflect the broader control elements provided, and could be known as the* FMCT *or* FMT.

PROPOSED TREATY PROVISION	COMMENTARY
The States concluding this Treaty, hereinafter referred to as the "Parties to the Treaty," *Certain* that weapons of mass destruction pose unparalleled dangers to humankind, and of the consequent need to strive towards the elimination of existing nuclear arsenals, the prevention of further proliferation of nuclear weapons and the prevention of nuclear terrorism,	*The first part of the preamble establishes the relevance of the treaty to weapons of mass destruction and brings together the concerns arising from existing arsenals, proliferation, and nuclear terrorism.*
Convinced that controls on fissile and fissionable materials would limit the manufacture of nuclear weapons, and provide a mechanism for international verification related to nuclear disarmament and nonproliferation,	*This establishes the foundation for fissile material controls as a means to address the three concerns.*
Concerned that the peaceful use of nuclear energy should not contribute to the manufacture of nuclear weapons; that fissile and fissionable material used for peaceful purposes should be protected from diversion or theft for use in the manufacture of nuclear weapons or other nuclear explosive devices; that hazardous radioactive material should not find use in radiological dispersal devices; and that nuclear installations or transport systems are protected against sabotage,	*Here, the link to peaceful use is introduced, noting the potential dangers that might arise from proliferation, theft, or sabotage.*
Confident that the participation of all States in a treaty banning the production of fissile and fissionable material for use in nuclear weapons and other nuclear explosives, on an equitable, non-discriminatory basis will serve to ensure peace, security and prosperity, and *recalling* United Nations General Assembly Resolution 48/75L of 16 December 1993 and subsequent Resolutions calling for a non-discriminatory multilateral and internationally and effectively verifiable treaty banning the production of fissile and fissionable material for nuclear weapons or other nuclear explosive devices,	*This is intended to establish the link to the UN General Assembly resolutions. The resolution provides the basis for including disarmament, nonproliferation and prevention of nuclear terrorism. Subnational groups might steal fissile material and manufacture a nuclear explosive device; any production of fissile material for peaceful use should be protected against theft for that reason.*
Recognizing that "banning production" includes the cessation of activities carried out prior to the entry into force of the treaty and a prohibition of future production intended for nuclear weapons or other nuclear explosives subsequent to entry into force in all States, and recognizing the concomitant responsibility of States to ensure that *fissile material* permitted under the treaty for peaceful use or for non-explosive military applications must not become available for use in the manufacture of nuclear weapons or other nuclear explosive devices by other States or sub-national entities,	*This provision establishes the disarmament, nonproliferation, and anti-terrorism dimensions of the treaty.*
Noting that States party to comprehensive Safeguards Agreements with the International Atomic Energy Agency (hereinafter referred to as "IAEA") are subject to *de jure* prohibitions on the production or acquisition of nuclear material except for peaceful use, and that in accordance with the terms of IAEA agreements, safeguards apply to all source or special fissionable material in all peaceful nuclear activities within the territory of each State, under its jurisdiction or carried out under its control anywhere, to verify that such material is not diverted to nuclear weapons or other nuclear explosive devices,	*This notes the relevance of existing comprehensive IAEA safeguards agreements as constituting a requirement prohibiting fissile material production except for peaceful purposes in non-nuclear weapon states, i.e., all nations except France, India, Israel, Pakistan, the People's Republic of China, the Russian Federation, the United Kingdom, and the United States. The status of the Democratic People's Republic of Korea is not clear.*

PROPOSED TREATY PROVISION	COMMENTARY
Acknowledging the ability of the IAEA to undertake the verification responsibilities of the Treaty and thereby coordinate the verification required under the Treaty with IAEA non-proliferation safeguards implemented under existing IAEA safeguards agreements, to provide for the convergence of those measures as progress towards nuclear disarmament occurs, and to assure that the verification of this Treaty will be carried out in a non-discriminatory manner with minimum cost and intrusion into legitimate activities of the Parties, Have agreed as follows:	*The alternatives are to create a new verification authority or to give the job to the IAEA. Establishing the IAEA as the verification authority would ensure that verification in all states would be undertaken in a nondiscriminatory and cost-effective manner. It would also avoid the complications of creating a second verification organization with overlapping responsibilities, and would avoid the possibility that FMCT verification might undermine IAEA safeguards.*
A. OPERATION	
Article I **Basic Undertakings**	
1. Each Party to the Treaty undertakes not *to produce,* import or otherwise acquire *fissile* or *fissionable material* meeting the definition of *material subject to this Treaty* for use in nuclear weapons or in any other nuclear explosive device.	*This undertaking prohibits states from acquiring fissile material through any means for use in nuclear weapons or other nuclear explosives.*
2. Each Party to the Treaty undertakes not to develop, manufacture, receive or otherwise obtain from any source whatsoever any *fissile* or *fissionable material* meeting the definition of *material subject to this Treaty* or any facility, equipment, material or technology suitable for the production of *material subject to this Treaty,* except when such facility, equipment, material or technology has been approved for peaceful use by the Conference of States Parties.	*This undertaking requires parties to the treaty to have the prior approval of the Conference of States Parties for imports of material subject to the treaty, or equipment, facilities, or technology.*
3. Each Party to the Treaty undertakes not to transfer to any recipient whatsoever *fissile* or *fissionable material* meeting the definition of *material subject to this Treaty* for use in nuclear weapons or other nuclear explosive devices.	*This undertaking prohibits parties from supplying fissile material to states for use in nuclear weapons or other nuclear explosive devices.*
4. Each Party to the Treaty undertakes not to transfer to any recipient whatsoever any *material subject to this Treaty* or any facility, equipment, material or technology suitable for the production or use of material subject to this Treaty, except for transfers to States when such facility, equipment, material or technology is approved for peaceful or non-explosive military use by the Conference of States Parties, and provided said *material subject to this Treaty* or facility, equipment, material or technology is subject to IAEA verification under the Treaty.	*This is the complement of §2, requiring advance approval of the Conference of States Parties for all exports by a state of material subject to the treaty, or any facility, equipment, material, or technology for such production or use*
5. The Conference of States Parties shall determine whether such transfers require individual approval by the Conference, or whether such transfers can be made according to lists adopted by the Conference of States Parties for this purpose and implemented by the Director General of the IAEA.	*This is a practical implementation arrangement.*

PROPOSED TREATY PROVISION	COMMENTARY
Article II **Cessation of Production for Nuclear Weapons and Verification of Excess Military Stocks**	
Cessation of Production 6. Within 90 days of entry into force of the Treaty, each State Party shall provide a declaration to the Director General providing information on all *production* facilities that were constructed in each State, including the name of each *production* facility, its address and geographical coordinates, its purpose, the date of its construction, the date(s) of operation, its operational status and plans for reconfiguring the *production* facility for non-proscribed purposes or decommissioning. This information shall include facilities which were constructed but were never put into operation.	*This provision requires states to declare all facilities that have been used for producing fissile material for nuclear weapons or that could be used for such purposes. All states party to comprehensive IAEA safeguards agreements have no weapon production facilities and have already declared all peaceful fissile material facilities.*
7. Upon entry into force of the Treaty, all facilities used for, or intended for use for, or capable of the *production* of fissile material or fissionable material for the manufacture of nuclear weapons shall either cease operations permanently, or shall be maintained on standby pending approval by a Conference of States Parties for the modification and operation of said facilities for legitimate and prudent peaceful use.	*This provision fixes the requirement for states to stop fissile material production for nuclear weapons use, and to shutdown or modify production facilities for nonproscribed uses (peaceful use or non-explosive military use).*
8. All production facilities shall be subject to inspection by the IAEA to confirm that operations remain stopped, or if subsequent operations are approved by the Conference of States Parties, to confirm that the operations remain in accordance with the approval, and that all *fissile material* or *fissionable material* which should be subject to the Treaty is submitted to IAEA safeguards.	*This is the verification provision for military production sites. This requirement would only impact states possessing unsafeguarded fissile material.*
Excess Materials Released from Military Use: Declarations and Verification 9. Within 90 days of entry into force of the Treaty, each State shall declare to the IAEA its existing stocks of *fissile material* and *fissionable material* meeting the definition of *material subject to the Treaty,* which each State has determined to be excess to its military needs.	*This requirement is for an initial declaration of fissile material determined to be excess to its defense programs.*
10. Within 18 months of entry into force of the Treaty, each State and the IAEA shall present for adoption by the Conference of States Parties a proposed plan to verify said excess material as *material subject to the Treaty.* The verification provisions shall ensure that no information classified by the State relevant to the design or manufacture of nuclear weapons shall be divulged through or as a result of verification activities carried out by the IAEA.	*This requires states having excess fissile material from defense programs to submit such materials to verification under the FMCT. The provisions would include items with classified characteristics, following the methods established, e.g., under the Trilateral Initiative.*[i]
11. In conjunction with nuclear arms reductions after entry into force of the Treaty, each State shall identify proportionate amounts of fissile material or fissionable material meeting the definition of material subject to the Treaty to be declared as excess to its military needs. The implementation of these provisions shall be subject to review by the Conference of States Parties prior to implementation and the results attained shall be reported to the Conference.	*The amount of fissile material in a nuclear weapon is classified and hence no specific amounts can be required. In some weapon states, even the average amount in a collection of weapons is classified. States knowledgeable about such matters might establish common guidelines.*

PROPOSED TREATY PROVISION	COMMENTARY
Article III **Peaceful Use**	
Declarations and Approvals 12. Each State Party to the Treaty shall have the right to pursue peaceful applications of nuclear energy, provided that the activities a State selects comprise a rational and coherent nuclear energy program, and are introduced in a time frame which is consistent with the aims of this Treaty.	*This requirement says that peaceful programs must be consistent with the needs of disarmament, nonproliferation, and the prevention of nuclear terrorism.*
13. Within 90 days of entry into force of the Treaty, each State Party shall provide a declaration to the Director General providing information on all facilities dedicated to the peaceful use of nuclear energy that produce, process, store, utilize and dispose of the nuclear species defined as material subject to the Treaty, or could carry out such functions on said material. That information shall include *design information* together with information describing the peaceful nuclear program of the State, the role of each facility within that program and the future plans for each facility, including decommissioning.	*This is the formal declaration by the state, which serves as the basis for subsequent verification of ongoing peaceful nuclear operations.*
14. Within 90 days of entry into force of the Treaty, each State Party shall provide a declaration to the Director General providing information on all irradiated fuel assemblies discharged from nuclear power and research reactors within the State, including the identification of each fuel assembly, the date of final discharge, the initial and final composition of fissile material and fissionable material, the disposition of that fuel assembly, and its present location. Thereafter, the State shall provide periodic updates on the disposition of the fuel assemblies already declared and information on irradiated fuel assemblies discharged after the entry into force of the Treaty.	*This requirement, together with the verification provisions of INFCIRC/153 and INFCIRC/540, makes it possible to exclude reactors from verification under the FMCT. Note that as progress towards disarmament is made, verification under the NPT and the FMCT should converge, which could require extending the FMCT verification requirements later on.*
15. Within three years of entry into force, a Committee of the Conference of States Parties shall review each State's peaceful nuclear energy program. As appropriate, consistent with the spirit of the Treaty, the Committee of the Conference of States Parties may recommend modifications, and it may, as deemed necessary, order the cessation of operations in whole or in part.	*This provision establishes the supra-regulatory authority of the Conference of States Parties over peaceful nuclear applications, specifically addressing the existing situation in all states at the time the FMCT enters into force.*
16. Subsequent to the initial review, the State shall submit any plans for the construction of any new facility, or physical modification or change in operation of any existing facility intended to or capable of production, processing, storage, utilization or disposition of *material subject to the Treaty.* Where such construction or modifications involve importing *material subject to the Treaty,* or a facility, material, equipment or technology specified on the Nuclear Supplier's Group Guidelines, the exporting State and the importing State shall make representations to the Committee of the Conference of States Parties to assist in the determination. The IAEA shall present its analysis to the Committee of the Conference in those proceedings.	*This provision extends the regulatory authority of the Conference of States Parties to oversee future nuclear operations in all states party to the FMCT. It adopts the Nuclear Suppliers Group Guidelines, but introduces a review requirement before exporting to ensure that the use is prudent and legitimate.*
17. In the event that the findings of the Committee are not acceptable to the State, the State may appeal to the Conference of States Parties.	

PROPOSED TREATY PROVISION	COMMENTARY
Verification 18. Within 90 days of entry into force of the Treaty, all existing separated *fissile* or *fissionable* material stocks meeting the definition of *material subject to the Treaty,* including production for each State or on behalf of any other State, shall be declared by the State to the IAEA as *material subject to the Treaty* and shall be subject to IAEA verification thereafter.	*These requirements would have essentially no impact in non-nuclear weapon states, but would pose substantial requirements in other states, especially France, India, Russia, and the United Kingdom.*
19. All facilities within the purview of this Article shall be inspected by the IAEA to confirm that the physical features and technical capabilities of the facilities conform to design information provided by each State to the IAEA, and that all operations carried out conform to information to be declared by the State to the IAEA, to confirm that the operations remain in accordance with the approval granted by the Conference of States Parties, and that all *fissile material* or *fissionable material* which should be subject to the Treaty is submitted to verification under the Treaty.	
20. All separated fissile material or fissionable material meeting the definition of material subject to the Treaty produced after the entry into force of the Treaty shall be declared by each State to the IAEA as *material subject to the Treaty* and shall be subject to IAEA verification thereafter.	*This is the basis for assuring that all fissile material produced after entry into force becomes subject to FMCT verification.*
21. All *fissile or fissionable material* meeting the definition of material subject to the Treaty imported into each State after the entry into force of the Treaty shall be declared by the State to the IAEA as *material subject to the Treaty* and shall be subject to IAEA verification thereafter.	*This provision closes a possible loophole, requiring all imports to be subject to the FMCT.*
Proliferation Resistance 22. States Party to the Treaty shall pursue peaceful applications of nuclear energy in a manner intended to prevent or inhibit the misuse of such applications for the development or production of nuclear weapons or other nuclear explosive devices. States intending to develop nuclear capabilities shall proceed in measured steps that are clearly consistent with prudent and legitimate peaceful use.	*This section and the paragraphs included below establish requirements of parties to pursue peaceful nuclear applications in a transparent manner, taking steps as they are programmatically appropriate.*
23. Nuclear reactors and associated fuel cycles shall be selected, designed, deployed and operated so as to achieve robust *proliferation resistance:* a. Nuclear energy systems shall be designed to the extent practicable to avoid the use or production of separated *fissile* or *fissionable material* meeting the definition of *material subject to this Treaty.* Recognizing the special risks associated with highly enriched uranium, the enrichment of uranium used in nuclear power reactors and research reactors shall be below the values stipulated for *fissile material* meeting the definition of *material subject to this Treaty.* Future naval propulsion reactors should be designed using lower enrichment uranium to the extent possible. b. Intrinsic features shall be incorporated into each nuclear energy application to physically inhibit the diversion of nuclear material; to inhibit undeclared production of *fissile* or *fissionable material* meeting the definition of fissile or *fissionable material* meeting the definition of *material subject to this Treaty;* and to incorporate physical structures, instruments, monitoring systems and data collection systems to facilitate verification as required under the Treaty.	*This paragraph provides specific areas for the implementation of proliferation resistance, which should apply to indigenous nuclear programs and programs involving the export of nuclear facilities, equipment, materials or technology. It combined design options, engineered features, and deployment arrangements intended to reduce the risk that peaceful nuclear programs might be misused to further nuclear weapon ambitions.*

PROPOSED TREATY PROVISION	COMMENTARY
c. Nuclear energy systems shall be deployed under institutional and commercial arrangements that include *extrinsic proliferation resistance measures* to inhibit their misuse as a means to acquire *fissile* or *fissionable material* for use in nuclear weapons or other nuclear explosive devices. Transfers of isotopic enrichment technology and reprocessing or other technologies for separating and purifying *fissile* or *fissionable material* meeting the definition of *material subject to this Treaty* should be discouraged and deferred. Other States or Groups of States under proliferation-resistant arrangements should meet the needs of States for fresh fuel and for the management of radioactive wastes arising from nuclear energy applications, wherever possible. d. Nuclear energy systems shall be operated in such a manner as to avoid the accumulation of material subject to this Treaty in excess of specific requirements and approved schedules.	
24. The Conference of States Parties shall determine the adequacy of *proliferation resistance* in new projects and modifications to existing projects in each State Party to the Treaty, taking into account the national energy demand, the existing nuclear capability, the incremental change in the State's proliferation capability that would result from the proposed project, the technical, legal and financial infrastructure, and proliferation risk.	*The intention of this requirement is for the international community to decide in advance how peaceful nuclear energy applications should proceed. Such a requirement would help to prevent any further proliferation attempts.*
Article IV **Undeclared Production**	
25. All production and importing of fissile or fissionable material meeting the definition of *material subject to the Treaty* within the territory of a State Party to the Treaty or under its control anywhere, shall be carried out under the provisions of the Treaty and shall be subject to IAEA verification under the Treaty.	*These two requirements are intended to make it clear that all production after entry into force is only to be carried out as authorized under the FMCT and subject to IAEA verification.*
26. Upon entry into force of the Treaty, the IAEA together with each State Party to the Treaty shall establish agreed arrangements to assure that all fissile material or fissionable material meeting the definition of *material subject to the Treaty* produced or imported subsequent to the entry into force of the Treaty is declared by the State Party to the Treaty to the Director General and is subject to verification thereafter.	
27. Upon entry into force, the IAEA and each State Party to the Treaty shall agree upon additional measures to provide assurance of the absence of undeclared production or imports of fissile material or fissionable material meeting the definition of *material subject to the Treaty*. The registry of irradiated fuel assemblies declared under §14 shall be used, *inter alia*, in planning such additional measures.	*Non-nuclear weapon states under INFCIRC/540 would have no additional requirements. The provisions in other states may require special considerations to ensure that inspections do not provide access to information related to the design or manufacture of nuclear weapons.*

PROPOSED TREATY PROVISION	COMMENTARY
28. The Director General shall prepare guidelines for such arrangements for approval by the Conference of States Parties, and shall report on the arrangements agreed and, from time to time, on their implementation.	
Article V **Non-Explosive Military Use**	
29. Each Party to the Treaty shall have the right to produce and employ *material subject to the Treaty* for non-explosive military applications, noting the requirements of §23.a, according to these provisions: a. Within 90 days of the entry into force of this provision of the Treaty, existing stocks of fissile material or fissionable material intended for non-explosive military applications shall be declared to the IAEA and shall be subject to IAEA verification thereafter. b. At least two years prior to actual need, each State shall request the approval of the Conference of States Parties for the release of a specified amount of *material subject to the Treaty* for a specified non-explosive military application. The amount specified shall be indicated in terms of the specific intended use, including, as appropriate, the name and model of any vessel or spacecraft to be powered by the use of such material. The amount requested shall include reasonable amounts for the process requirements corresponding to a maximum of 18 months of fuel manufacturing operations, including anticipated scrap and waste. c. At least two years prior to the commencement of production, each State shall request the approval of the Conference for the production of *material subject to the Treaty* for use in specified non-explosive military applications. The fissile or fissionable material to be produced shall be subject to IAEA verification and shall be released in accordance with the provisions above. The amounts of fissile material or fissionable material to be produced for non-explosive military use shall not exceed the amounts necessary for more than five years of processing and use.	*This provision is intended to prevent naval propulsion reactors from constituting a potential loophole for circumventing the purposes of the FMCT.*
30. Upon completion of a process campaign, the remaining unused material (feed, intermediate products and any scrap material) shall be resubmitted to IAEA verification.	*Recognizing the highly secretive nature of naval fuels in particular, it may be necessary to devise appropriate verification arrangements.*
31. The IAEA shall carry out managed access inspections of all processing and storage facilities used in conjunction with non-explosive applications of *material subject to the Treaty,* using appropriate inspection methods to confirm, to the extent possible taking into account the classification of information for such military programs, that the *material subject to the Treaty* has not been diverted for use in nuclear weapons or other nuclear explosive devices, or for purposes unknown.	
32. The IAEA shall carry out managed access visits to vessels or other locations where the military applications are carried out, or to install monitoring systems intended to limit inspector access, for the purposes of confirming that such applications are in fact carried out.	*It may also be possible to use installed monitoring equipment as a means to provide the assurance sought, especially systems employing a mail-in arrangement of encrypted data storage.*

PROPOSED TREATY PROVISION	COMMENTARY
Article VI **Prevention of Nuclear Terrorism**	
33. States Parties to the Treaty shall remain accountable for establishing measures within their territory or anywhere under their control to conduct any operations defined within the Treaty in such a manner as to minimize opportunities for nuclear terrorism, to protect all installations and transport systems associated with the operation of the Treaty, to implement measures to detect acts of terrorism in time to prevent their effect, to respond with appropriate means to prevent their success, and to bring to justice those responsible for the planning, support and execution of such acts.	*These requirements simply fix the responsibilities of states within their respective sovereign rights.*
34. States Parties to the Treaty shall, under the auspices of the Treaty, cooperate and collaborate in exchanging information on threats of nuclear terrorism and on the mechanisms intended to prevent such acts. States Parties to the Treaty shall remain responsible for the countermeasures implemented within their respective territories and under their control.	
35. States Parties to the Treaty shall accede to the Convention on the Physical Protection of Nuclear Material and shall implement the provisions of INFCIRC/225, "Recommendations for the Physical Protection of Nuclear Materials."	*This requirement would expand the participation in the Convention on the Physical Protection of Nuclear Material (CPPNM) and establish common guidelines for use.*
36. States Parties to the Treaty shall adopt and implement *physical protection intrinsic features and extrinsic measures* to: a. minimize and control access to *weapon-usable* and other nuclear material, hazardous radioactive material, facilities and transport systems (e.g., through the use of personnel authorization systems, physical barriers, detection equipment, and other appropriate measures); b. minimize the vulnerability of nuclear reactor plant systems to cyber attack; c. provide immediate response, including use of force, if an act of nuclear terrorism is suspected or if unauthorized access to weapon-usable and other nuclear material, hazardous radioactive material, facilities and transport systems is anticipated or attempted; d. take immediate action to recover any stolen material and minimize the consequences of any act of nuclear terrorism; and e. protect vital equipment required to maintain radioactive materials in a safe state, in particular, for reactors the safety systems which provide reactivity control, decay heat removal, and radionuclide confinement.	*This is a clarification of the scope of activities required of states in relation to the prevention of nuclear terrorism.*
37. There shall be created within the International Atomic Energy Agency a physical protection inspection service, which shall be staffed with qualified experts who shall carry out their duties in accordance with the strictest standards of confidentiality. States Parties to the Treaty may undertake this inspection service on a voluntary basis or as may be specified in legal arrangements concerning nuclear commerce.	

PROPOSED TREATY PROVISION	COMMENTARY
B. VERIFICATION AGREEMENTS	
Article VII	
38. Within 180 days of the entry into force of the Treaty, the following verification agreements shall enter into force between each State and the IAEA: a. A comprehensive safeguards agreement incorporating all articles of INFCIRC/153, without diminution, together with a Protocol Additional to the safeguards agreement incorporating all articles of INFCIRC/540, without diminution; and b. A complementary verification agreement specific to the Treaty, setting out the obligations and responsibilities of each State and the IAEA for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty. This verification agreement shall address separately the obligations arising from Articles I through V of the Treaty.	*There are two alternatives for verification agreements—establishing new agreements that would create a discriminatory condition for states possessing nuclear weapons, or using the identical agreements for all states, but modifying (suspending) some provisions of the standard agreements to reflect the restrictions needed in states having nuclear weapons programs, and reflecting that the scope of verification under the FMCT would be limited to "fissile and fissionable material subject to the Treaty" rather than "all nuclear material."* *The complementary agreement foreseen in §38.b will be required by all parties to adopt additional requirements, as applicable.*
39. For Parties to the Treaty having nuclear material at the time of entry into force of the Treaty which is not subject to IAEA safeguards, the complementary verification agreement specific to the Treaty shall have the effect of suspending relevant parts of the comprehensive safeguards agreement and Additional Protocol as necessary to prevent classified information relevant to the design or manufacture of nuclear weapons from being divulged through or as a result of the implementation of IAEA verification.	
40. The Conference of States Parties shall consider steps appropriate to bring about the convergence over time of the verification requirements to a single, non-discriminatory system, with the ultimate goal of removing the suspensions noted in §39, at intervals not to exceed ten years, and upon the entry into force of any arms reductions or nuclear arms control measures.	*This mechanism is intended to aim toward a single verification system for all states as time passes.*
C. CONFIDENCE BUILDING MEASURES	
Article VIII **Transparency**	
41. States Parties to this Treaty are expected to conduct all nuclear operations within their territory or anywhere under their control in an open manner, intended to maintain the support of their citizens and to assure neighboring States and the international community that the activities they carry out are consistent with the spirit of this Treaty and its provisions.	*The provisions of Part C are advisory in nature.*
Article IX **Participation in Complementary Treaty Regimes**	
42. The provisions of this Treaty are intended to complement and extend the scope and provisions of the Treaty for the Non-Proliferation of Nuclear Weapons. States Parties to this Treaty are encouraged to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories.	

PROPOSED TREATY PROVISION	COMMENTARY
Article X **Cooperative Threat Reduction**	
43. In furtherance of the aims of this Treaty, States Parties are encouraged to resolve potential threats to the security of States under the auspices of the Treaty. No Party to the Treaty should seek to gain a security advantage through a Cooperative Threat Reduction project carried out under the auspices of the Treaty.	
D. ADMINISTRATION	
Article XI **Conference of States Parties**	
44. The Conference of States Parties shall determine the manner in which the Treaty is implemented, in accordance with the Articles below. Three years after the entry into force of this Treaty, the first Conference of States Parties to the Treaty shall be held in Vienna, Austria, to establish its rules and procedures to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realized. Thereafter, the Conference of States Parties to the Treaty shall convene at regular intervals to be established by the Conference to review implementation of the Treaty and the timing of transitional implementation measures. The Conference of States Parties to the Treaty may be convened on an urgent and essential basis upon the request of any Party, or upon the request of the Board of Governors of the IAEA (hereinafter referred to as the "Board of Governors").	*This provision establishes the Conference of States Parties as the principal body responsible for setting the rules and monitoring implementation of the FMCT.*
45. The Conference of States Parties shall review and approve of the collection and disbursement of funds for the purposes of verification of the Treaty, for support to States Parties to the Treaty to facilitate, as necessary, the implementation of the Treaty, and for other purposes as may be approved by the Conference which are consistent with the aims of this Treaty.	*This provision should be seen in relation to the financing scheme proposed in Article XV below. If such a scheme is adopted, at the rate indicated, the Conference of States Parties would collect substantial amounts of money, part of which would support the verification activities. A substantial investment could be necessary to provide for implementation in states that could not otherwise join the FMCT. Those costs would decrease once the initial investments are made, leaving a substantial amount of money for large-scale projects, e.g., in developing countries.*
Article XII **Responsibilities of the IAEA**	
46. The Depository for the Treaty shall be the Director General of the IAEA (hereinafter referred to as the "Director General"). This Treaty, the Arabic, Chinese, French, English, Russian, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Director General. The Director General to the Governments of the signatory and acceding States shall transmit duly certified copies of this Treaty to all States Parties.	*Standard depository conditions. The languages cited are the official languages of the UN.*

PROPOSED TREATY PROVISION	COMMENTARY
47. The verification and confidence building measures set forth in the Articles above shall be implemented by and through the Director General and the Secretariat of IAEA. Parties to the Treaty shall conclude verification agreements with the IAEA as specified in Article VII of the Treaty.	*Implementation arrangements*
48. At periodic intervals to be established by the Conference of States Parties, the Director General shall report to the Conference of States Parties on the implementation of the Treaty separately for each State Party, in respect of the nuclear energy program agreed by the Conference of States Parties, information received from the State, the verification activities carried out and the conclusions drawn from those verification activities. The Board of Governors shall review such reports prior to their submission to the Conference of States Parties and shall take appropriate steps to implement any actions specified by the Conference arising from its consideration of such reports.	*This provision would provide transparency to the implementation of the treaty.*
49. The Director General shall establish and maintain a special fund to be created for the purpose of collecting and disbursing funds for the implementation of this Treaty, under the supervision of the Conference of States Parties, as established in Article XI §45 above.	*Implementation arrangements*
50. The Board of Governors shall recommend to the Conference of States Parties the budget for implementation of the Treaty, together with the organizational structure and staffing of the Secretariat of the IAEA for this purpose. The budget shall include the costs to the IAEA Secretariat for the implementation of the Treaty in all aspects, together with the costs of projects in States Parties meeting the provisions of Article XI §45 as necessary for the implementation of the Treaty.	*Implementation arrangements*
Article XIII **Entry into Force**	
51. The Treaty shall enter into force in two steps. Upon ratification by 35 States, except for Articles II §9-11, IV and V, the Treaty shall enter into force. Articles II §9-11, IV and V, shall enter into force when a minimum of five States, which possess material subject to the Treaty that is not subject to IAEA safeguards, deposit their instruments of ratification. Any State possessing such material may waive this provision and bring the remaining Articles into force before the minimum condition is met.	*This formula is intended to delay entry into force until a substantial number of states have concluded their ratification arrangements. It recognizes that the full scope of implementation should not take mandatory effect until a significant number of states possessing nuclear weapons sign on, but not demanding that the FMCT is an all or nothing arrangement.*
52. Any State that does not sign the Treaty before its entry into force may accede to it at any time thereafter.	*Standard treaty provision*
53. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Director General. The Director General shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession, the date of the entry into force of this Treaty, and the date of receipt of any requests for convening a conference or other notices.	*Standard treaty provision*

PROPOSED TREATY PROVISION	COMMENTARY
54. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.	*Standard treaty provision*
55. This Treaty shall be registered by the Director General pursuant to Article 102 of the Charter of the United Nations.	*Standard treaty provision*
56. The Treaty shall remain in force indefinitely.	*In 1995, the NPT was extended from its initial lifetime of twenty-five years to indefinite duration. This provision establishes the FMCT on the same basis.*
Article XIV Amendments	
57. Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Director General who shall circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Director General shall convene a Conference of States Parties, to which they shall invite all the Parties to the Treaty, to consider such an amendment.	*This provision was copied from the NPT.*
58. Any amendment to this Treaty shall be approved by a majority of the votes of all the Parties to the Treaty. The amendment shall enter into force for each Party that deposits its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.	*This provision was copied from the NPT.*
Article XV Finance	
59. Upon entry into force, each State Party to the Treaty shall commence the collection of a 1% surcharge on all electricity or other energy products produced within each State through the use of nuclear energy. The funds collected by each State shall be deposited at quarterly intervals in the special account established for this purpose under the provisions of Article XII §49 above.	*Without adequate funding, participation would be limited to states that could afford to pay to support their own obligations, which could entail facility modifications, equipment costs, and staff. Without adequate funding, IAEA verification would not meet the expected levels of effectiveness. Without separate funding, the interests of maintaining parity with technical cooperation funding would increase the requirements for assessed contributions.*
60. If for any reason the funding provided through §59 is deemed to be insufficient to allow the Treaty to be implemented as intended, the Conference of States Parties shall determine whether to increase the rate from 1%, or to include the shortfalls in the regular budget of the IAEA, to be secured according to the procedures specified in the IAEA Statute.	*This is a fallback measure in case the nuclear industry is reduced to the point that the surcharge does not meet the minimum requirements necessary to maintain the effectiveness of the FMCT.*

PROPOSED TREATY PROVISION	COMMENTARY
Article XVI **Non-Compliance**	
61. Any State Party to the Treaty, or the Director General, may convene a special meeting of the Conference of States Parties to raise a question of non-compliance by a State Party to the Treaty with any of the Treaty's provisions. Such a meeting would commence not less than 24 hours nor more than 48 hours following the notification to the States Parties, and to the Director General, as appropriate. In such cases, the States Parties participating in the special meeting shall constitute a quorum.	*Given that the FMCT is related to the potential use of weapons of mass destruction, anomalies must be resolved in a time frame consistent with the associated threat. The requirements indicate a prompt requirement to start to resolve allegations.*
62. The special meeting of the Conference of States Parties shall hear the allegations and the response of the State Party or States Parties for which non-compliance is raised. This hearing shall be of a preliminary nature and shall not extend beyond 72 hours of the commencement of the special meeting.	
63. The special meeting of the Conference of States Parties may decide to refer the allegation to the United Nations Security Council, or the special meeting of the Conference of States Parties may establish a judiciary panel for the purposes of determining the merit of the allegations and the remedies to be effected.	*A judicial panel is proposed as an alternative to the Security Council. Given that the allegations may give rise to tensions, the option may encourage diplomatic resolutions to potential conflicts.*
63. Such a panel would be comprised of nine senior justices or diplomats of ambassadorial rank or above. Three of the panel members shall be named by the State Party or States Parties or by the Director General, as appropriate, alleging the non-compliance. The State Party or States Parties alleged to be in non-compliance shall name three of the panel members. The final three panel members shall be chosen to be mutually acceptable to the State Party or States Parties or by the Director General, as appropriate, alleging the non-compliance, and to the State Party or States Parties alleged to be in non-compliance. In the event that the Parties are unable to agree upon the panel within 72 hours of the request, the Secretary General of the United Nations shall provide appropriate panelists.	*This provision is intended to lead to a fair hearing of an allegation.* *It would be reasonable for the director general to maintain a roster of candidates for the judicial panel to expedite the selection and the subsequent hearing.*
64. One panel member of the latter group shall be selected to be the President of the Special Panel. Should the selection not be made within 48 hours, the Secretary General shall name the President of the Panel.	*Procedural arrangement*
65. The Panel shall have the right to call witnesses and to receive any and all information supporting the allegation and the response, with the exception of information deemed to be sensitive in relation to the design or manufacture of nuclear weapons.	*Procedural arrangement*
66. The Panel shall conclude its investigation as soon as possible. Its findings shall address the validity of the charges alleged and the remedies to be pursued.	*Procedural arrangement*

PROPOSED TREATY PROVISION	COMMENTARY
Article XVII **Withdrawal from the Treaty**	
67. Each party to the Treaty shall remain a Party to the Treaty for as long as the Treaty remains in force.	*Recognizing the security framework that the treaty would establish, and its ultimate universality, there is no means provided through which a state might leave the regime and undermine that framework.*
In witness whereof the undersigned, duly authorized, have signed this Treaty. Done in duplicate, in Vienna, the <nth day of <Month>, two thousand and <year>.	
Annex: Definitions	
68. *Fissile material* shall mean any nuclear species that will fission when struck by a neutron of any kinetic energy; *fissionable material* shall mean any nuclear species that will fission when struck by a neutron of kinetic energy in excess of a threshold value.	*Physics definition*
69. *Material subject to the Treaty* shall mean *fissile* and *fissionable materials* separated from fission products: i. plutonium containing any combination of isotopes, except for plutonium containing 80% or more of the isotope ^{238}Pu; ii. uranium containing any mixture of the isotopes ^{235}U and ^{233}U such that $(\%^{235}U + 5/3(\%^{233}U)) = 20\%U$; iii. neptunium; and iv. americium. Additional *fissile* or *fissionable* materials determined to be suitable for the manufacture of nuclear weapons or other nuclear explosive devices, or changes in these parametric values, may be modified by a simple majority of the Conference of States Parties.	*Note that "material subject to the Treaty" does not include low-enrichment, natural or depleted uranium, or thorium, and does include the minor actinides neptunium and americium. It does not include spent fuel, only the specific fissile and fissionable materials noted.* *The provisions for amending the list is kept simple in the event that additional materials with appropriate fission physical properties become available in sufficient amounts to pose a risk in the future.*
70. *Physical Protection* shall mean the use of technical, administrative and operational measures to prevent the theft of *material subject to the Treaty,* theft of hazardous radioactive material for use in a radiological dispersal device or sabotage of a nuclear installation or transport system.	*This clarifies the specific intentions of physical protection and hence the scope of physical protection requirements.*

PROPOSED TREATY PROVISION	COMMENTARY
71. *Production* (of *material subject to the Treaty*) shall mean: i. Enrichment of isotopes to produce uranium or plutonium with enhanced fission properties; ii. Separation of any *fissile* or *fissionable* material from fission products through reprocessing or any other process, provided that the fissile or fissionable material separated qualifies as *material subject to the Treaty* under §69; iii. Separation of americium from plutonium, except from plutonium produced prior to entry into force which has not been submitted to verification under the Treaty. A *production facility* shall mean any facility in which any *production* activity is carried out, or could be carried out.	*The requirements in §71.iii are intended to exclude the separation of americium from plutonium weapon components that are recycled. Including that americium would run the risk that verification could reveal classified information related to the design or manufacture of nuclear weapons.*
72. *Proliferation resistance* shall mean the ability of a nuclear reactor and its associated fuel cycle to impede the diversion or undeclared production of *fissile* or *fissionable material* meeting the definition of *material subject to the Treaty*. *Proliferation resistance* shall include: • *Intrinsic features:* physical properties or characteristics of nuclear energy systems that are intended to reduce the usability of the nuclear material for *nuclear weapons* or *nuclear explosive devices,* restrict physical possibilities for diversion, prevent or inhibit undeclared production of *fissile material* or *fissionable material,* and facilitate verification; and • *Extrinsic measures* resulting from States' undertakings to: strengthen international norms against proliferation; reduce the incentives of States to acquire enrichment or reprocessing technologies; restrict access to sensitive nuclear materials and facilities; implement verification at the local, State, regional and international level; and provide for prompt and effective resolution of anomalies and violations.	

i See, for example, Shea, T. 2003. The Trilateral Initiative: The Initial Charge and What Follows. *Proceedings of the 44th INMM Annual Meeting.*

NNSA Ships SRS HEU to Tennessee

The U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) and the Savannah River Site (SRS) have sent the first shipment of low-enriched uranium to Tennessee, where it will be adapted to help supply the nation's energy needs.

The shipment is part of the High-Enriched Uranium (HEU) Blend Down Program. The HEU Blend Down Program takes HEU and blends it with natural uranium to make low-enriched uranium (LEU), which cannot be used in weapons. The LEU is shipped to Nuclear Fuel Services in Erwin, Tenn., who will prepare it for fabrication into a fuel for use in Tennessee Valley Authority's reactors.

At the end of the Cold War, when SRS ended production of special nuclear materials, more than 33 metric tons of HEU were left over in various stages of the nuclear production cycle. That material was included in the 174 metric tons of uranium nationwide that was declared in 1994 as excess to the nation's security needs. The Office of Fissile Material Disposition, now part of the NNSA, was formed to determine a final disposition path that would meet nuclear nonproliferation goals for these materials. In 1997, the DOE signed a Memorandum of Understanding with TVA, which then entered into agreements with two additional companies, Nuclear Fuel Services and Framatome, to take part in the conversion to commercial nuclear fuel.

U.S., Russia to Open Doors to Closed Russian Nuclear Cities

Officials from the United States and Russia signed agreements in July 2003 that allow access to the traditionally closed Russian nuclear cities of Seversk and Zheleznogorsk to begin the shut down of the last weapons-grade plutonium production reactors in operation in the former Soviet Union. This agreement is a major step in the U.S.-Russia Elimination of Weapons-Grade Plutonium Production Program (EWGPP).

Reaching agreements on access arrangements for the former "secret" cities of the Russian nuclear-weapons complex is an important prerequisite to replacing the nuclear reactors with coal-fired heat and electricity plants.

In March 2003, the United States and Russia signed an agreement that will stop plutonium production at the last three Russian plutonium production reactors. As part of the agreement, the DOE, working with its partners in Russia, will provide replacement fossil-fuel facilities to produce replacement energy for heat and electricity currently produced by the reactors and serving the two closed cities in Russia.

The reactors, although originally designed to produce weapons-grade plutonium, also provide heat and electricity for the surrounding communities in Siberia. The EWGPP program is providing fossil-fueled energy plants to supply heat and electricity to the surrounding communities, facilitating the shut down of the reactors.

The three plutonium production reactors will continue to operate until the fossil-replacement plants are completed. These reactors have deficiencies in the areas of design, equipment, and materials, and are considered to be among the highest risk reactors in the world. To ensure reactor safety, high priority safety upgrades are being expeditiously pursued. The DOE's Pacific Northwest National Laboratory will be responsible for necessary nuclear safety upgrades at both sites. These upgrades will not extend the life of the reactor facilities.

DOE, Kentucky Agree to Accelerated Cleanup Strategy for Paducah Gaseous Diffusion Plant

The U.S. Department of Energy (DOE) announced in July 2003 that a letter of intent has been signed with the state of Kentucky to enter into an agreement to accelerate cleanup at the Paducah Gaseous Diffusion Plant in Paducah, Kentucky.

As outlined in the letter, the parties will work to complete cleanup activities at the plant by 2019 and have identified strategic initiatives to accelerate this date.

The letter of intent was developed under the DOE's Environmental Cleanup Reform Initiative to resolve all outstanding violations and compliance issues. Through this initiative, DOE works with states and regulators to address health and environmental cleanup issues. The initiative is designed to accelerate the pace of cleanup to reduce the greatest health and environmental risks at national laboratories, nuclear weapons production sites, and research and test facilities.

Initiatives for accelerating cleanup and reducing risks under the Paducah Gaseous Diffusion Plant include:

- Groundwater source term removal contributing to off-site contamination at the plant
- Decontamination and decommissioning of inactive facilities on the site
- Investigation and any necessary mitigating actions at the on-site burial grounds
- Characterization and removal of contaminated soils at the gaseous diffusion plant

The letter of intent is available on the DOE Environmental Management Web site at http://www.em.doe.gov.

IAEA Expert Review Mission Completes Assessment of Fuel Cleaning Incident at Paks Nuclear Power Plant

In June 2003, the International Atomic Energy Agency (IAEA) completed its expert review mission to investigate the April 10, 2003, fuel cleaning incident at the Paks nuclear power plant in Hungary. The mission was requested by the Hungarian government to provide an independent assessment of the causes and actions taken by the plant and Hungarian authorities. The team was composed of nuclear and radiation experts from the IAEA, Austria, Canada, Finland, Slovakia, the United Kingdom, and the United States.

Regarding management, the team concluded that the Hungarian Atomic Energy Authority and Paks are committed to improving the safety of the plant and noted that as a result of steam generator

decontamination in previous years, deposits became attached to the fuel assemblies. A decision was made to clean the fuel and contract an outside company to develop and operate a fuel cleaning process. The team found that the design and operation of the fuel cleaning tank and system was not accomplished in the manner prescribed by the IAEA Safety Standards. Neither the Hungarian Atomic Energy Authority nor Paks used conservative decision-making in their safety assessments for this unproven fuel cleaning system.

The team determined that there was an over-reliance on the contractor selected for the design, management, and operation of the fuel cleaning system. Time pressure related to a prescribed fuel outage schedule, combined with confidence generated by previous successful fuel cleaning operations, contributed to a weak assessment of a new design and operation, which involved fuel directly removed from the reactor following a planned shutdown.

The IAEA team provided a number of recommendations for improvement in this and other areas. The team turned over a draft of its findings and recommendations to the Hungarian Atomic Energy Authority.

NRC Releases Final Version of Yucca Mountain Review Plan

The Nuclear Regulatory Commission has issued draft revision 2 of the plan it would use to review an expected application from the U.S. Department of Energy (DOE) to construct a high-level nuclear waste geologic repository at Yucca Mountain, Nevada.

The principal purpose of the Yucca Mountain Review Plan is to ensure the quality and uniformity of the NRC staff's reviews. The plan has separate sections for potential reviews of repository safety before permanent closure, safety after permanent closure, the research and development program to resolve safety questions, the performance confirmation program, and administrative and programmatic requirements. Each section defines how NRC will review DOE's compliance with NRC regulations.

A copy is available on the NRC Web site at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1804/. Hard copies may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-0001.

In Brief

IAEA Board of Governors Recommends Landmark Budget Increase

The International Atomic Energy Agency's (IAEA) Board of Governors in July 2003 agreed on the first IAEA significant budget increase in more than a decade and a half. The increase of $15 million over the $245 million 2003 regular budget is envisioned to grow to $25 million by 2007. The budget is subject to approval by the IAEA's General Conference in September.

U.S., South Korea to Conduct Joint Research

The United States and the Republic of Korea in September 2003 signed a bilateral agreement to conduct joint research and development on advanced proliferation resistant fuel cycle technologies. The five-year agreement is the sixth in a series of implementing arrangements under a memorandum of understanding that promotes collaborative laboratory-to-laboratory exchanges between the United States and South Korea on advanced nuclear energy technologies.

Author Submission Guidelines

The *Journal of Nuclear Materials Management* is the official journal of the Institute of Nuclear Materials Management. It is a peer-reviewed, multidisciplinary journal that publishes articles on new developments, innovations, and trends in safeguards and management of nuclear materials. Specific areas of interest include physical protection, material control and accounting, waste management, transportation, nuclear nonproliferation/international safeguards, and arms control and verification. *JNMM* also publishes book reviews, letters to the editor, and editorials.

Submission of Manuscripts: *JNMM* reviews papers for publication with the understanding that the work was not previously published and is not being reviewed for publication elsewhere. Papers may be of any length.

Papers should be submitted *in triplicate*, **including a copy on computer diskette.** Files should be sent as Word or ASCII text files only. Graphic elements must be sent in TIFF format in separate electronic files. Submissions should be directed to:

Dennis Mangan
Technical Editor
Journal of Nuclear Materials Management
60 Revere Drive, Suite 500
Northbrook, IL 60062 USA

Papers are acknowledged upon receipt and are submitted promptly for review and evaluation. Generally, the author(s) is notified within sixty days of submission of the original paper whether the paper is accepted, rejected, or subject to revision.

Format: All papers must include:

- Author(s)' complete name, telephone and fax numbers, and e-mail address
- Name and address of the organization where the work was performed
- Abstract
- Camera-ready tables, figures, and photographs in TIFF format only
- Numbered references in the following format:
  1. Jones, F. T. and L. K. Chang. 1980. Article Title. *Journal* 47(No. 2): 112–118.
  2. Jones, F.T. 1976. *Title of Book*, New York: McMillan Publishing.
- Author(s) biography

Peer Review: Each paper is reviewed by at least one associate editor and by two or more reviewers. Papers are evaluated according to their relevance and significance to nuclear materials safeguards, degree to which they advance knowledge, quality of presentation, soundness of methodology, and appropriateness of conclusions.

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Calendar

November 16–20, 2003

ANS/ENS International Winter Meeting and Nuclear Technology Expo

Nuclear Technology: Achieving Global Economic Growth While Safeguarding the Environment

Hyatt Regency New Orleans
New Orleans, Louisiana, U.S.A.

Sponsor: American Nuclear Society

Contact:
Web site: http://www.ans.org/meetings/winter

January 28–30, 2004

Spent Fuel Management Seminar XXI

Loews L'Enfant Plaza Hotel
Washington, D.C., U.S.A.

Sponsor: Institute of Nuclear Materials Management

Contact:
INMM
60 Revere Drive, Suite 500
Northbrook, Illinois 60062
Phone: 847/480-9573
Fax: 847/480-9282
E-mail: inmm@inmm.org

February 29–March 4, 2004

7th International Conference on Facility Operations—Safeguards Interface

Francis Marion Hotel
Charleston, South Carolina, U.S.A.

Sponsor:
American Nuclear Society–Topic conference; Co-sponsored by the INMM Central Region Chapter

Contact:
Web site: http://ntr.ornl.gov/ANS2004

June 13–17, 2004

ANS Annual Meeting

2004 International Congress on Advances in Nuclear Power Plants (ICAPP '04)

Embedded International Topical Meeting

Omni William Penn Hotel
Pittsburgh, Pennsylvania, U.S.A.

Sponsor:
American Nuclear Society

Contact:
Web site:
http://www3.inspi.ufl.edu/icapp04

July 18–22, 2004

45th INMM Annual Meeting

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Orlando, Florida, U.S.A.

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September 20–24, 2004

PATRAM 2004: The 14th International Symposium on the Packaging and Transportation of Radioactive Materials

ESTREL Convention Center
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