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JNMM Journal of Nuclear Materials Management

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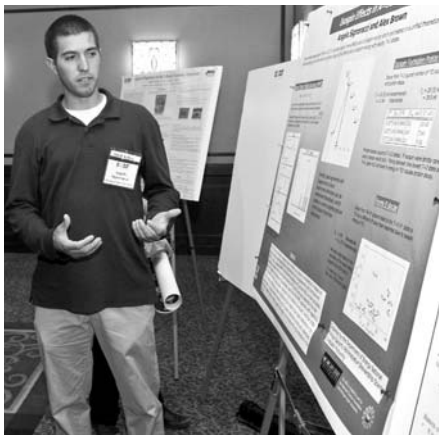

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INMM
INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

As INMM Enters Its 50th Year

By Steve Oritz
INMM President

As I take over the role of INMM president from Nancy Jo Nicholas, I would like to recognize her for the outstanding leadership she provided to the Institute over the last two years. She has been a great mentor and a great friend. I extend our thanks to her for a job well done.

This year's annual meeting was the beginning of the 50th anniversary celebration of INMM. The 49th Annual Meeting was special in many ways. What made it most special for me was to be able to listen to and talk with the many past presidents who were in attendance. Many of them were surprised and pleased at how the Institute had grown in membership and focus. You could sense the pride they had in being part of such an important organization. The festivities planned by Ed Johnson and Debbie Dickman provided ample opportunity to reflect on and celebrate the successes of the last forty-nine years. I want to thank them for their work toward this special celebration. They have more planned for next year's Annual Meeting.

We are at the beginning of a nuclear renaissance. Evidence of this is found in the U.S. Department of Energy's Global Nuclear Energy Partnership (GNEP) Strategic Plan, which says, "GNEP seeks to bring about a significant, wide-scale use of nuclear energy, and to take actions now that will allow that vision to be achieved while decreasing the risk of nuclear weapons proliferation and effectively addressing the challenge of nuclear waste disposal."

It goes on to say "The need for nuclear energy to play a major role in meeting base load electrical energy requirements is now recognized by most of the world's industrialized nations. Similarly, in the United States there is growing recognition of the need to start building new nuclear power plants as soon as possible and to rebuild our national nuclear infrastructure—needs supported by both the Energy Policy Act of 2005 and DOE's Nuclear Power 2010 program. The Global Nuclear Energy Partnership Strategic Plan outlines an implementation strategy to enable a world-wide increase in the use of nuclear energy safely, without contributing to the spread of nuclear weapons capabilities, and in a manner that responsibly disposes of the waste products of nuclear power generation."

Initiatives such as GNEP will require more nuclear material management professionals. The renewed world interest in nuclear energy is evident in the activities conducted by the INMM. We are experiencing increased registration in our annual meetings, an increased number of workshops conducted by our technical divisions, an increase in participation in these workshops, and an increase in membership. Regional chapters of INMM are also much more involved in conducting workshops and seminars. Often they team with technical divisions on a topic of interest to their region. All signs indicate a continuing need for INMM to serve its members through technical dialogue and training in nuclear materials management.

Over the last few years we have also begun to develop student chapters. This is a fairly new endeavor for us but one of huge importance. It is one way to help keep the pipeline of professions supporting nuclear materials management flowing. We plan to continue to grow the number of student chapters by working through our regional chapters. Because student members have different needs we are continually exploring ways to better serve them. A direct result of developing student chapters has been an increase in the number of technical papers presented by students at our annual meeting. This year eighteen technical papers were presented by students.

We will continue to look for opportunities to partner with organizations such as the World Institute for Nuclear Security (WINS) and the American Nuclear Society (ANS). These relationships must benefit our membership and the wider nuclear materials management industry. In the past we have sponsored special sessions at ANS meetings in topical areas that our membership holds expertise. We have also partnered with the Nuclear Threat Initiative in conducting workshops to identify best practices in physical protection and material control and accountability. We are exploring how we can partner with WINS and continue to contribute to the identification and dissemination of best practices. We will continue to pursue relationships with organizations where common interests allow us to leverage resources in order to have a greater impact in the areas of nuclear materials management.

All this cannot be done without planning. This year the leadership of INMM will once again embark upon strategic planning to identify the path forward for the next few years. This planning will allow us to refine goals and opportunities for INMM's future.

INMM President Steve Ortiz may be reached via e-mail at sortiz@sandia.gov.

Highlights from the 49th INMM Annual Meeting

By Dennis Mangan
Technical Editor

As is traditional for our fall issue, this issue of the *Journal* focuses on the recent INMM Annual Meeting held in Nashville, Tennessee USA in July. Charles Pietri, chair of the Technical Program Committee, provides a summary of the event, and as usual, he does a good job. I always enjoy his article and the photos he selects.

This year, as part of our celebration of INMM's fiftieth anniversary, the Annual Meeting had two plenary speakers, David Waller, deputy director of the International Atomic Energy Agency (IAEA), and William Tobey, deputy administer for Defense Nuclear Nonproliferation, in the U.S. Department of Energy's National Nuclear Security Administration. This is only the second time I can recall that we had two plenary speakers at our Annual Meeting. The last time was in 1992 when General William Burns, then special envoy and head of the U.S. Safe and Secure Dismantlement Delegation, and Ambassador Igor Palenykh, then of the Ministry of Foreign Affairs of the Russian Federation and head of the RF Delegation on Dismantlement, discussed dismantlement activities in the RF (INMM Members: see Vol. 21, No 1 in the online *JNMM* Archive at www.inmm.org).

Both Waller's and Tobey's presentations are included in this edition. Waller's presentation, *The First Half Century and Beyond–An IAEA Perspective on Managing the Nuclear Dilemma* is an excellent review of the IAEA history and significant events that have occurred. Tobey's *Plenary Address to the INMM 49th Annual Meeting,* equally excellent, discusses today's challenges and tomorrow's opportunities in a changing international security environment and the nuclear security challenges that complicate it. The Roundtable discussion that followed their presentations is also included.

The closing plenary also featured two excellent presentations. Michael Weber, director of the U.S. Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards, made a presentation on *The Path Ahead for Safeguards* addressing the need for effective safety, security and safeguards if the nuclear renaissance is to continue. The other *closing plenary* presentation was by Roger Howsley, consultant to the Nuclear Threat Initiative (NTI) on The World Institute for Nuclear Security (WINS)—From Concept to Reality. As Howsley noted in his article, a small committee of INMM Fellows were instrumental in formulating WINS after INMM was challenged by NTI President Charles Curtis at our 2005 Annual Meeting to help establish a mechanism to share best practices in nuclear security in a structured and sustainable way. In December 2005 this Fellows committee had a draft business plan of an organization and a name identified. As Howsley notes many people were involved in the final formulation of WINS, but I would be remiss if I did not mention that early on Fellow Ed Johnson spearheaded the first draft business plan, and Fellow John Matter came up with the organization name of WINS. In case you were not aware, WINS was officially launched on September 29, 2008, to an audience of the IAEA's 2008 General Conference attendees and members of the media in Vienna. Former U.S. Senator Sam Nunn of NTI made the announcement with the help of IAEA Director Mohamed ElBaradei and U.S. Energy Secretary Sam Bodman. WINS will be based in Vienna, and with primarily U.S. DOE and NTI funding will have $6 million to begin operations. Howsley will be its first executive director, which I personally believe is an excellent choice. For more information on this announcement see www.iaea.org under "General Conference—and click on first day" or www.nti.org. I believe WINS is a winner for the INMM, NTI, and DOE, and INMM can be especially proud for the initial formulation. (See a letter from NTI's Co-Chair, former U.S. Senator Sam Nunn, thanking INMM for its role in the creation of WINS.)

Included also in this issue is the J. D. Williams Student Paper Award Winner, *A High-Voltage Piezoelectric Transformer for Active Interrogation* by Andrew Benwell (the presenter) and co-authors S. Kovaleski and M. A. Kemp of the University of Missouri in Columbia, Missouri USA. This paper addresses elements of a system to identify hidden fissionable nuclear material using neutron activation.

The final article, *Analysis of the Possible Influence of Nuclear Energy Development Scenarios on the Scale of Inspection Activity to Maintain the Nonproliferation,* is by . Andrianov, Yu. A. Korovin (both from the State Technical University for Nuclear Power Engineering in Obninsk, Russia) and G. M. Pshakin (from the Analytical Center for Nonproliferation also in Obninsk). In it they examine the potential impact of the nuclear renaissance on the inspection needs of the IAEA.

I trust you will enjoy this issue.

If you have any questions or comments, please feel free to contact me.

JNMM *Technical Editor Dennis Mangan can be reached by e-mail at dennismangan@comcast.net*

Report of the 49th INMM Annual Meeting: It's Music to Our Ears

by Charles Pietri
Chair, Technical Program Committee

The Music City—Nashville, Tennessee USA. It lived up to its reputation once again, but in more ways than you can imagine. For the second time, the INMM Annual Meeting was held at the Nashville Convention Center and Renaissance Hotel in downtown Nashville July 13–17, 2008, and it was *music to our ears.* This was one of the best productions INMM has put on in many years especially with all the extra effort and activity stemming from the beginning celebrations for the INMM 50th Anniversary. INMM is indebted to all those who made this meeting such a success. Reports from almost everyone at the meeting gave rave reviews for the content of the papers presented, the topical subjects of interest, the organization and management of the presentations, the number of attendees, the plenary speakers, the performance of our students, and most of all the enthusiasm of the participants.

Total attendance was a near-record (926 as compared to 949 for Nashville in 2006) including seventy-six students, which is a record. (From our survey, there does not appear to be a correlation between the Nashville location and attendance!) There were 316 papers presented including twenty posters and eighteen student papers. Unfortunately, there were eight "no-shows"—those presenters that did not have the courtesy of letting INMM know that they would not (or would not be able to) give their paper. (Some of these persons may have been overseas speakers who could not obtain visas.) We also had thirty-seven paper withdrawals, which was about normal, and thirty-four papers that were presented by other than the original author/speaker, who for one reason or another could not attend the meeting. Our Meeting Report Card, which includes the meeting evaluation from the electronic surveys, session chair reports, and verbal comments at the meeting, was of the usual variety, many complimentary, a few critical, and, as occurs each year, several responses with positive suggestions for future meetings. One disappointment was the thirteen final papers that, at this writing, have not been submitted for publication in the *Proceedings of the INMM Annual Meeting.* We'll deal with that issue later, along with a more detailed evaluation summary.

Since this Annual Meeting was the kickoff for INMM's 50th Anniversary Celebration Year, we tried some innovations in the technical program schedule.

At the kickoff of the Annual Meeting on Monday morning, we had an introduction by Nancy Jo Nicholas, INMM president; Steve Ortiz, vice president and president-elect; and Obie Amacker, chair of the Fellows Committee retracing the fifty-year INMM history and projecting INMM's future.

Figure 1. President-Elect Steve Ortiz, addressing the attentive audience on the occasion of the INMM 50th Anniversary

On Tuesday we blocked off an open period in the session schedule from noon to 3:20 p.m. to allow more time to have lunch, and visit exhibits, posters, and the Anniversary Celebration Lounge. This lounge, that began as a simple booth, was designed and prepared by the Anniversary Committee Co-chairs Ed Johnson (JAI Corp.) and Debbie Dickman (PNNL), their colleagues, and the INMM HQ staff. It was located in the Exhibit Hall and attracted many visitors who came to view a pictorial history of INMM, meet some of the past presidents, and leave with an attractive 50th Anniversary coffee mug. More later!

Figure 2. (left to right) in front: Bob Curl, Ralph Lumb, Joe Indusi, and Charles Pietri enraptured with the INMM history slide show at the Anniversary Lounge

Figure 3. (left to right) Jerry Johnson, Ed Johnson, and Vince DeVito: "Just how many anniversary mugs did you say you ordered, Ed?"

Another innovation was the invitation of two opening plenary speakers that was somewhat of a logistical nightmare initially but in reality turned out to be one of the more spectacular opening events

INMM has sponsored in a long while. Our first speaker, David Waller, deputy director general and head, Department of Management at the International Atomic Energy Agency (IAEA), presented the paper, *The First Half Century and Beyond: An IAEA Perspective on Managing the Nuclear Dilemma.* It was evident to all that Waller thoroughly understood and appreciated the importance and path of future IAEA activities in the somewhat tumultuous international nuclear safeguards surroundings.

Figure 4. Kaoru Naito (President NMCC) captures events at this exciting plenary session.

For the second speaker, we had invited Thomas D'Agostino, administrator for the National Nuclear Security Administration (NNSA), who unfortunately had to cancel at the last minute because of significant work issues requiring his attention. This situation has occurred several times in the past—but INMM acknowledges the difficulty in inviting high-level speakers whose schedules are more dictated by pressing ongoing work events than by the speakers themselves. However, once again, we were able to recover by having Deputy Administrator William Tobey present the paper, *Meeting the Challenge: National Roles and Responsibilities in Global Nuclear Security.* The meaning and impact of these roles and responsibilities in an ever-evolving international nuclear security environment was clearly described. INMM is indebted to Tobey for his undaunted effort to present this paper despite adverse weather and travel delays getting out of Washington, D.C., airports!

Figure 5. (left to right) Will Tobey (NNSA), Nancy Jo Nicholas (President INMM) holding IAEA recognition of the INMM 50th Anniversary, and David Waller, (IAEA)

It is customary for Dennis Mangan, editor of the *Journal of Nuclear Materials Management* (*JNMM*), to hold the INMM Roundtable, normally a luncheon interview, with the plenary speakers. Due to the both speakers' prior travel arrangements, it was necessary to have a joint interview right after the plenary session—another innovation for INMM in an innovative meeting! You can read about them in the Roundtable Interview that is located on page 24 of this issue of the *JNMM* along with complete papers by Waller and Tobey/D'Agostino; these papers also will be found in the *Proceedings of the INMM 49th Annual Meeting.*

As we continued with the innovation process even the Final Program was modified to include abstracts along with the session/papers information in a day by day format. This change made it easier for attendees to locate and read abstracts by day and session rather than the customary placement of abstracts at the end of the program schedule. We retained the Pocket Schedule but added page tabs to more easily locate daily events.

One exceptional highlight of the meeting was a special luncheon for INMM past presidents held to honor these stalwart souls who initiated the Institute, guided it through its early days, set the path forward for the rest of us, and maintained its current momentum.

Figure 6. Past Presidents Luncheon (left to right) Sharon Williams Chrisman and Brad Williams (for James D. Williams), and John Matter

Figure 7. Words of wisdom from the first INMM President (Chairman) Ralph Lumb at the Past Presidents luncheon

We had seventeen past presidents in attendance including surrogates for four deceased past presidents. It was exciting to see the first president (chairman, in those early days) Ralph Lumb and others like Rita and Jim Roth (for Hugh Donovan), Ed Johnson, James Lovett, Barbara Cardwell (for Roy Cardwell), Madge Keepin (for Robert Keepin), Gary Molen, Yvonne Ferris, Charles Vaughan, John Lemming, Dennis Mangan, James Tape, Obie Amacker, Jr., Deborah Dickman, Sharon Williams Chrisman and Brad Williams (for James D. Williams), John C. Matter, and Cathy Key.

On Thursday afternoon, we ended the 49th Annual Meeting with two closing plenary speakers: Michael Weber, director, Office of Nuclear Material Safety and Safeguards, Nuclear Regulatory Commission (NRC), presenting *The Path Ahead for Safeguards* describing how the past fifty years of experience prepares us to meet current and future challenges. He

was followed by Roger Howsley, consultant, Nuclear Threat Initiative (NTI), who, with his paper, *The World Institute for Nuclear Security (WINS)—Current Status and Future Activities,* told us about the progress made in establishing WINS as a global entity, how dramatically the organization has grown both in size and stature, and future activities that are planned. Both of these papers are to be found in the *Proceedings of the INMM 49th Annual Meeting* as well as the *Journal*.

Figure 8. After the Closing Plenary Session (left to right) Jim Tape (Consultant), Roger Howsley (NTI), and Mike Weber (NRC)

To conclude this momentous week, we served a bountiful anniversary cake (courtesy of Nuclear Nonproliferation, Los Alamos National Laboratory) but unfortunately I was not able to convince anybody that we needed ice cream and champagne to complement it. Oh, well, next year!

After resolving the opening plenary speaker issue, there did not appear to be any major concerns. Some of the meeting speaker changes were caused by surrogates stepping up to present papers by several overseas speakers who could not get their visas in time to attend the meeting. One notable instance was a student, Jose Rodriguez, University of Missouri, who graciously presented a paper, *An MC&A Database for Healthcare Facilities and University-based Research Activities,* written by an overseas student Elena Obrezkova, who could not obtain a visa to attend the Annual Meeting.

Before you hear more about this exciting Annual Meeting, we need to recognize the many speakers who, once again, have

Figure 9 . Ralph Lumb concludes the INMM 50th Anniversary celebration for 2008 by cutting the cake (compliments of Nuclear Nonproliferation, Los Alamos National Laboratory).

Figure 10. (left to right) Bob Curl, Teressa McKinney, and Leah McCrackin, enjoying the anniversary cake.

made this meeting a success. As I say everyday to the speakers at the Speakers Breakfast—*"You are the major contributors to success at the Annual Meeting—this is really your meeting. Without your active participation and your quality papers, the meeting could not exist."* So that is an ongoing recognition to our speakers. And, we continue to be indebted to the Registration Committee that meets early Sunday morning to start the meeting process. D.L.Whaley, chair, and his committee deal with attendees in a professional and exemplary manner at all times.

The session chairs, Technical Program Committee, and especially the Technical Division chairs, play a major role in developing and managing the Annual Meeting. Our student attendees were most helpful as projection managers for some sessions and as staff photographers for the meeting. (We are indebted to Brian Boyer, LANL, for his recruitment of students for these purposes.) We are further thankful for our INMM HQ staff lead by Leah McCrackin, our executive director, and Jodi Metzgar, administrator (also known as the "Queen of the Annual Meeting" who is sometimes also known as "pit bull" when you don't meet your obligations to her)—both of whom know everything; Lyn Maddox, our conference manager, who is an expert at avoiding potential hotel problems for us; Kim Santos, our new assistant conference manager who fits in so well it well it seems as if she has worked with INMM forever; and Patricia Sullivan, the *Journal* managing editor and INMM communications manager, hiding in the background but doing everything to keep the program moving successfully.

Please be aware that this report is merely a snapshot summary of a few highlights at the Annual Meeting; it is not meant to be comprehensive, and does not include all individuals, groups, and events. The official opening of the 49th Annual Meeting occurred on Sunday, July 13, but on the day before two important planned events occurred: the INMM Executive Committee met to discuss issues of importance to the Institute and future directions to explore; and, the standing-room-only

Figure 11. Leah McCrackin, "Now how do you spell 'INMM'?"

Annual Meeting of the New Brunswick Laboratory Measurement Evaluation Program took place to review progress in this evaluation of international measurements to date. We continue to note that this opportunity for organizations to meet in conjunction with the Annual Meeting

provides a travel cost savings but more importantly it brings the right people together in a common forum. It's the place to be!

As is customary, on Sunday morning, Amy Whitworth (NNSA), chaired a meeting of the NNSA MC&A Implementation Panel to address interests in that area followed by a meeting of the Government and Industry Liaison Committee (GILC) meeting.

The ANSI/INMM 5.1 Analytical Chemistry Laboratory Measurement Control Committee, an ANSI N15 writing group, chaired by Charles Pietri, consultant, met at noon to note that the revised consensus standard N15.51 *Measurement Control Program—Nuclear Materials Analytical Chemistry Laboratory* (years in the making!) was finally approved and published by ANSI since the last meeting. Also discussed was the treatment of uncertainty in any future revision of the standard with reference to the generally accepted *Guide to the Expression of Uncertainty in Measurement (GUM).* [Further efforts by ANSI N15—this committee met on Wednesday chaired by Carrie Matthews (PNNL)—will address this issue for INMM 5.1 Committee and other writing groups.] The Committee also affirmed support and concurrence with IAEA efforts to revise the International Target Values. Copies of the INMM 5.1 Committee Meeting Minutes can be obtained from cpietri@aol.com, and the ANSI N15 Meeting Minutes from carrie.matthews@pnl.gov.

INMM reserves Sunday afternoon not only for the start of meeting registration but to host the six Technical Divisions who discuss matters of importance to their disciplines. They are generally well-attended and progress toward initiatives for the coming year based on past experience and insight to future are discussed. This year was no exception and the Technical Division chairs report generally much activity and resolutions for ongoing and upcoming efforts in their areas of expertise. Some were even planning for next year's INMM Annual Meeting!

Of course, Sunday evening was the event most of us awaited with anticipation: the President's Reception with plenty of food, beverages, meeting old friends and colleagues, and getting acquainted with some new ones. If that wasn't enough for one full day prior to the *real* meeting, Mark Leek, Battelle, followed up with a well-attended student orientation meeting that generated a lot of enthusiasm for the burgeoning INMM student program—more later.

While we were all either going to meetings, registering, or carousing with buddies on Sunday, the exhibitors were busy setting up their exhibits in the spacious Exhibit Hall that provided easy access for the attendees. The 50th INMM Anniversary Lounge was set up, and of course, the INMM Executive Committee spent much time testing the lounge furniture to see that it was truly comfortable for the visitors. They, along with the Anniversary Co-chairs Johnson and Dickman, devoted an inordinate amount of time deliberating about the correct placement of the anniversary gift coffee mugs—a popular item. By the time, the President's Reception took place in the Exhibit Hall that evening all issues including the proper hanging of the anniversary banner had been resolved.

On Tuesday, July 10, the Business Meeting followed by the INMM Annual Awards Banquet took place. At the Business Meeting the INMM Sustaining Members were recognized for their support of INMM. Further, a very humorous rendition of the history of INMM prepared by Vince DeVito, INMM secretary, was read to the rapt (but laughing) audience by his surrogate, Obie Amacker (PNNL).

But where was DeVito?—As secretary he never (hardly) misses an opportunity to preside over the INMM Business Meeting. Well, there are reports that he had a little contest with an escalator in the hotel—and lost—bumping his head a bit. (We've told him repeatedly not to dance the tarantella on the escalator! Now, for those who don't know the origin of the dance tarantella—also a spider—look it up in Wikipedia and you'll soon see the connection. Also, check the *actual* DeVito *Tarantella* we encountered in the photo on page 8.) So, anyway Amacker stepped in and did a commendable job even though he did stumble occasionally over words with more than two syllables.

Figure 12. Serious conversations at the INMM Anniversary Booth: (left to right) Prof. Nakagome (University of Kyoto), Dr. Shinonaga (IAEA-SAL), and Mr. Kaoru Naito (NMCC President)

Figure 13. Obie Amacker (PNNL) presiding at the Annual Business Meeting

Generally, mostly everyone at the Annual Awards Banquet enjoyed the meal and presentations. There were some concerns about the length and structure of the banquet that will be addressed later in the evaluation comments. Entertainment was provided by Dave Lambert (ORNL) as DJ. (Is this Dave's *real* job?) The following awards were presented: Distinguished Service Award to Senator Pete Domenici (New Mexico), Howard Menlove, Bernd Richter, and John Mihalczo; and the Special Service Award to the International Safeguards Project Office (ISPO). Elevated to Fellow status were Stephen

Figure 14. The *Tarentella*—Is this what caused a problem for Vince DeVito?

Dupree (BNL Retired) and Gary Kodman. Student Award winners were announced—see below for details. Always a sad event at the banquet, several Resolutions of Respect for our deceased members were read: Robert Keepin (LANL retired) (an INMM past president) and Herbert Kouts (BNL retired). Although Domenici could not be present to receive the award personally, he sent a most thoughtful and supportive letter congratulating INMM on its fiftieth anniversary (see page 55).

Professor Paul Ebel, BE Inc., returned once again to conduct his exciting and motivational speakers tutorial following the speakers' breakfast each day. This year Ebel concentrated on the "eleven most important points in making successful presentations." We are certain that there has been a gradual but significant improvement in the paper presentations given over the past several years that Ebel has tutored. It is most evident in the younger presenters who may have the most to learn but our more mature speakers could certainly take heed and change some of their out of date approaches. Even session chair performance this year appears to have shown improvement—many now realize it's not a mere honorary position but an important managerial job. Ebel also coordinates the LCD PowerPoint© projection systems for the

Figure 15. An impassioned plea by Paul Ebel for speakers to be enthusiastic!

speaker presentations. This year he had some excellent assistance from the Technical Division chairs and colleagues including the INMM HQ audiovisual staff and especially from our technical savvy student attendees who really know how to operate computerized projection systems. The process appears to be managed well once again with only a few instances of problems that will be addressed for next year, Ebel promises.

Figure 16. Pietri exhorting the speakers to limit their talks to twenty minutes or face certain drastic consequences from the Session Chair

So now it's time for the "Report Card" that describes how those of you who provided feedback to INMM really rate the Annual Meeting. We told you at the beginning of this report that a variety of means were used in the evaluation including the electronic survey. The Report Card this year was better than the ratings received in previous years and the comments were mostly very positive with some notable exceptions. If the Annual Meeting continues to improve, it is because of input from the participants that we listen to each year—the sensible stuff only, of course. (Wait! Not really, we *listen* to all but take *action* on the sensible ones.) Next year we will start to report some of the more important data in tabular form so that you can compare the results with the previous year's performance.

The responses we get from the electronic survey continue to be relatively small. For example, this year only 19 percent of the attendees responded to the survey—down from last year. In 2007 it was 28 percent, 2006 (29 percent), 2005 (25 percent), 2004 (31 percent), 2003 (5 percent—the last year of the written survey). About 77 percent of the responders were INMM members in several membership categories. So, despite the fact that responses have improved dramatically since we moved to electronic surveys, be aware that these findings may not be representative of the entire group of participants but only those who took the time and interest to respond. INMM greatly appreciates your comments—it's your meeting.

Continuing past trends, this year the **Overall Annual Meeting** process was rated similar to previous year's—**mostly as satisfied-very satisfied** (highest rating) with the highest commendations for the **Pocket Schedule, the Pre-Registration Process, Onsite Registration Process and Staff,** and the responsive and gracious **INMM HQ staff, once again,** had the highest ratings of the entire meeting—a continuing trend for many years now. The new format for the **Final Program** with the abstracts imbedded in the program schedule was rated at almost 87 percent with lots of positive comments. We had a great **student** turnout and the papers and their presentation were **good**. About 82 percent of the responders rated the **Opening Plenary** session as **good-excellent,** while 53 percent of the responders similarly rated the **Closing Plenary**—both an increase from last year. Note that for the Closing Plenary, 37 percent of the total responders did not respond to this question while about 8 percent did not respond for the Opening Plenary. One could interpret lower ratings

for the Closing Plenary because attendance was low—many attendees had already departed. INMM continues to look for ways to attract and retain an audience for the Thursday afternoon closing of the Annual Meeting. Of note there was not a single complaint about the plenary sessions this year even though we had the usual unfortunate change in speaker in one instance.

It continues to be very significant to note that 94 percent of the responders indicated that the INMM Annual Meeting was satisfactory-very satisfactory and 96 percent said that the program met their professional needs. INMM Annual Meetings have consistently rated above 90 percent in these categories for many years. Furthermore, about 84 percent of the responders thought that the quality of the papers was good-excellent and 86 percent gave the same rating for the presentations although there were a few differing individual opinions to the contrary.

The **hotel accommodations** were not rated as high as in some previous years as less than two-thirds of the responses gave a **good-very good** rating this year. Almost 81 percent rated the **hotel facilities (meeting rooms, etc.)** as **good-excellent** but there were a number of individual opinions that expressed dissatisfaction—one item being the *excessive* coldness of the meeting rooms. (Be thankful: the weather in Nashville was unusually more tolerable during the week than at other times and perhaps the indoor temperature couldn't compensate for that—and, remember, we will be in Tucson next year!) Despite a few negative comments, 96 percent of the responders visited the **Exhibits** and rated their variety, schedule, and location at greater than 90 percent. We had a few less exhibits than in the past years.

Posters: Poster Session Chair Taner Uckan, ORNL, was so excited with another quality session this year that he thanked ***ME*** when it was ***HIS*** efforts that made it successful. He wrote: "… The new format, not having any concurrent technical session for the Tuesday afternoon [from noon to 3 p.m.] I believe worked reasonably well [but despite all our information, several attendees were unaware of what they should do during this period]. The posters were well-attended (the large room was well utilized)—thank you for making this new change possible… The popcorn was the added attraction to this excellent poster session we had, thank you, Lyn [Maddox] for your great help..." Give Uckan a large room and popcorn and he's in paradise! Enough said! Remember, posters are just as important and significant as oral presentations—they are just another way of presenting the information.

We promoted the Web-based **Program Planner with itinerary builder,** as suggested by several of our attendees two years ago, but again it was not extensively used; those few who did use it found it to be helpful. INMM needs to do more work in this area to improve its use.

INMM has actively promoted **student participation** in the Annual Meeting and other INMM activities for seven years now. With seventy-six students registered at the 2008 Annual Meeting we saw continuing progress in efforts to advance the numbers and the quality of student participation in INMM. This year the number of student attendees and papers presented were very commendable for a growing INMM activity. New student chapters are being formed while existing ones are expanding. High-quality papers are being presented and their actual delivery by some student speakers is improving. (Some folks thought that a few of the student papers were better than the more seasoned presenters—a challenge here.) INMM would like to claim credit: it may be due in part to Professor Ebel's breakfast tutorial on "how to give the best speech of your life." The competition for the J. D. Williams Best Student Paper Award resulted in first place going to Andrew Benwell, University of Missouri, for his paper, *"A High Voltage Piezoelectric Transformer for Active Interrogation,"* and second place going to Nathan Rowe, University of Tennessee for, *"Distributed Radiation Monitoring Via a Secure Wireless Sensor Platform."*

As part of the **Student Program,** the student booth at the anniversary lounge in the Exhibit Hall was organized by the Texas A&M Student Chapter and came off very well. A year-round Web-based mentor program organized by the Student Activities Committee (SAC) was introduced to students; it will be interesting to see how much it is used and how useful students find it. Once again, students from international chapters sponsored by the SAC to attend the Annual Meeting had trouble obtaining visas. Of the three students whose participation was confirmed, only one was able to obtain a visa and actually attend.

The **Student Career Fair & Reception** substantially transformed from past student receptions was also highly successful. The **Career Fair** was the typical format—vendors at tables with literature and displays describing their respective organizations. Based on anecdotal accounts of vendors, students and INMM Members, this was an extremely valuable exercise well received by all. The vendors in particular liked the intimacy of the setting and the chance to meet students at a specially designated time and place. It looks like this is something we can build on in future years. Some constructive comments were made that may further enhance the program; these were sent to Leek, our industrious Students Activities Committee chair, who assures me that he will read them with interest. We also thank Leek for his helpful contributions to this report.

The **New Member/Senior Member Reception** on Monday evening was, as usual, a well-attended, successful event. New regular members and senior members along with new student members had the usual opportunity to meet. Students, especially, were encouraged to become involved in both their technical divisions and local regional chapters.

The **Student Orientation/ Mentorship Program** and the Student **Career Fair and Reception** were well-attended but we received too few comments to thoroughly assess these events. However, some students did provide their opinions. As in the past, I have forwarded these comments to Leek as well.

Figure 17. J. D. Williams Best Student Paper Award: First place: Andrew Benwell, University of Missouri

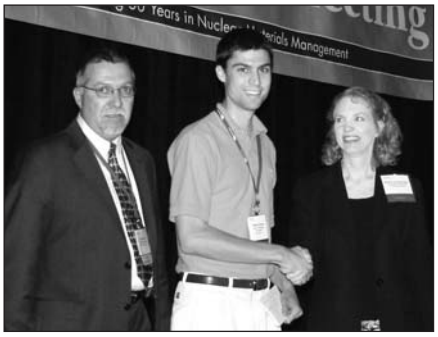

Figure 18. J. D. Williams Best Student Paper Award: Second place: Nathan Rowe, University of Tennessee

A note of significance: we review all comments from all sources and responses are made to those remarks that warrant further discussion. We try to give a ***balanced perspective*** of what our attendees report at the Annual Meeting, whether their perceptions are favorable or unfavorable. That's the only way we learn how to continually improve the Annual Meeting process. And, you know, it really works! (I have not included comments on the weather, hotel location, reserving rooms, and other similar matters since we have discussed these topics many times in the past—please refer to earlier Annual Meeting reports for details.) Some have criticized us for expressing attendees' sentiments that are contrary to their beliefs—it is everyones's right to comment as they see fit and my job to pick those that best represent the variety of comments received. So, here are a few selected comments (some provocative, others thoughtful) in a summary format:

"Always well organized. The emphasis on the fiftieth year was very nice. The continued stress on improving presentations is paying off." "Good talks. Everything was very organized and professional." "It is my first experience of making a presentation at an INMM Annual meeting. I wish I could have attended MORE sessions than I was able to get to....I got so much from the ones I heard." "The broad program from transport safety, physical protection, and safeguards [was valuable.]" "The 50th celebration was great!" "The presentations keep improving from year to year. This is a credit to the speakers' breakfast and the emphasis on how to make effective presentations."

We get the idea! We'll take all the compliments we get!

⁎

"…I noticed that there were too many 'by invitation only' events ….probably paid by registered members, but limited to attendance by few. If and when necessary, such events should be sponsored by other contributions."

Several "invitation only" meetings only require that attendees indicate their wish to attend—this is done so that if a working lunch is served the committee chair knows how many lunches to order and that adequate seating is available, e.g., INMM 5.1 Committee. Other meetings are reserved for elected or appointed INMM officials who provide services in management or administration to INMM, e.g., Chapter President Luncheon, or for functions that directly contribute to the welfare of the Institute, e.g., Fellows Luncheon. All volunteer (non-elected membership) committees are continually available and encourage new member enrollment from the nuclear materials management community. A few meetings are restricted to a specific function so as to focus on the purpose of these attendees, e.g., New Member/Senior Member reception; Past Presidents Luncheon. Costs, if any, incurred by these committees or meetings are borne by INMM as legitimate costs of doing business in the interests of the members of the Institute and participants in the Annual Meeting.

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"As a vendor, it was disturbing that no afternoon coffee break was scheduled for the last full day of the conference. Absent coffee, almost no one walked into the exhibit hall the whole afternoon. Also, the Nashville Convention Center is poorly laid out from our standpoint. Attendees at meetings were very far away from the exhibit area. In other INMM venues, attendees needed to walk right past the doors to the exhibit area on many occasions throughout the day, which encourages 'drop ins.'"

We appreciate this comment but are puzzled in view of the very positive comments we received from some other exhibitors. The comment was passed along to the Exhibits Committee and staff for further review and evaluation.

⁎

"As a young person …recently … a student member, [now]…a sustaining member, …it would be so useful to have a young professionals event, such as a cocktail hour, during the week. [Perhaps] …early-on during the conference would be so helpful for young people making the transition from student membership to regular membership, and make contacts with other young professionals."

A very interesting and thoughtful comment that we will pass along to INMM management for consideration.

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"I was surprised that breakfast was not included in the program for regular conference participants—I find that breakfast is usually the best time to sit down next to somebody one does not yet

know and mingle."

Another interesting comment! INMM does not organize a formal breakfast outside of the Speakers' Breakfast because the cost to the individual at a hotel for an organized breakfast might be prohibitive and the arrangements may not be practical. However, the thought is something we can discuss with the INMM conference management staff and perhaps an alternative can be defined.

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"It would be nice if there were synchronized clocks (i.e., so-called atomic clocks) on display in each meeting room to help the various session chairs remain in sync." "Some chairs did not stick to the program schedule so that [attendees} missed parts of or complete presentations when they commuted between meeting rooms." "Overall schedule was good, but most speakers seemed afraid to use their full time allocation for fear of over-running. Many sessions therefore ran ahead of schedule. This is not good if you are switching from session to session—I missed the start of several talks as a result of this. It was not a case of a few minutes, but in many cases up to 10 minutes." "Some of the chairs did better than others in keeping their speakers on schedule." "Despite your request to not move up speakers to fill ["open"] time slots, the chair did this frequently."

Bad situation, I agree! We have cell phones, digital watches, and PDAs to provide accurate time; and we have accurate electronic timers with more features than needed to track times with speakers. Speakers are instructed to practice and time their talks beforehand to fit the time allotment. But most of all we plan each session to have a competent chair to manage the overall process. Synchronized clocks would be a nice feature but not practical for the many diverse rooms in the hotels INMM uses. Chairs were specifically instructed not to do all the negative things that were reported: they were to start on time, end on time (even if the speaker concludes early); use the printed program to define the time for each talk; not rearrange the papers or alter the schedule, and more. So if the session chair was doing his/her job properly, we wouldn't be hearing these comments at all. I hope these are anomalous comments—exception rather than the rule—since this year we heard glowing reports about the significant improvement in managing the sessions. We had mostly positive session reports from more than 50 percent of the chairs—a three-fold increase from previous years. We'll look into this matter further.

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"Some speakers had great abstracts but horrible presentation skills. The biggest problem [was] to understand what they were saying because [they] are softly spoken persons. The technical information was extremely interesting." "Many… speakers were very under-prepared for actually giving presentations. Their technical data may have been sound but following the time limits, explaining information, and general presentation skills were very poor." "Some kind of course or lecture or something on not giving an utterly atrocious presentation would be nice, except that the people who could most benefit from it are the exact same ones who think they're perfect at it."

INMM has been plagued for many years by this weakness in speakers who have the technical skills but the delivery of the product is woefully inadequate. We have seen (and it has been reported to us) that there has been a gradual increase in proficiency since the introduction of the speakers tutorial at the Speakers' Breakfast. We will continue to urge speakers to perform better but it would be to their own benefit to take a course in public speaking and to encourage their management to sponsor such training.

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"There was no mention of the *Proceedings* in this list. It seems ridiculous to have a 'page fee' for an excess number of pages when the *Proceedings* are not printed on paper. Instead of a page limit, there should be a PDF file size limit of say 5MB or 10MB per paper. If one CD-ROM is not enough for the *Proceedings*, put the *Proceedings* on a DVD-R instead. Also, it would be very helpful if the slide presentations themselves were collected by session chairs during the conference, and made available on the *Proceedings* DVD-R."

You are absolutely right in all respects. INMM recognizes that issue and is currently developing the criteria and a process for such a system. It should be ready for the next Annual Meeting in 2009. One word of caution: one of the reasons for some limit to the content of the papers, besides print cost and print capacity, is to control the size of a paper so that the text is concise, to the point, and clear. Unlimited text has been shown to result in "wordiness" and imprecise/inaccurate statements and redundancy. We will discuss the ability to collect and publish the slide presentations but remember the author's paper should have all the elements from the slide presentations—and more!

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"Sometimes the rooms were too large and sometimes too small... we need to work on this better."

During the meeting planning stage in the early spring, the Technical Division chairs provide a best estimate, based on previous experience with the topical material, of the room size they will need for each session. Sometimes it is difficult to know exactly what the interests for the upcoming meeting will be resulting in the situation described.

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"…did not have the list of papers on a board for each session….should still do

this so that we know if a paper was withdrawn. Also the schedule left empty time slots in the middle of the session for some reason."

The Final Program goes for publication about a month before the meeting. Any changes made after that date are included in an addendum distributed with the Final Program to each attendee upon registration. Subsequently, after the meeting begins an addendum is prepared by INMM HQ staff each morning that notes the additional changes made to the program due to current speaker changes, paper withdrawals, and "no-shows." This process provides attendees as much current information as is known at any time.

*

"The Awards Banquet went on too long. Suggest cutting down on the amount of detail given for each award winner." "…a little tedious." "….give out fewer awards or make the bios shorter." "…very detailed life stories can be posted online." "…include the memorial announcements in the Plenary [Session] on Monday with written salutations in the Proceedings. …always felt that the very well intended acknowledgement at the banquet interrupts the spirit of the evening and contributes to the length of the agenda." "…audience [loses] interest, thus losing the intended purpose of the event." The Awards Banquet was painful."

Attendees rated the banquet as good-very good (51 percent) and as average (24 percent). For years INMM has been restructuring the banquet for greater enjoyment. Based on the many comments we received this year, and for the past several years, we will try once again to come up with a scenario that will be more acceptable to our participants.

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"The scheduling this year had too many of the lectures I was interested in overlapping the same times as others I was interested in." "I think we should have more panel discussions of key issues, such as the discussion of nuclear security in Pakistan a few years ago." "This is the first INMM I have attended in a number of years. As a non-U.S. participant, I was pleased to notice less emphasis on purely U.S. issues such as 'homeland security.'" "More panel sessions, or sessions that end with a dialog or exchange of views; designed sessions are usually far more relevant and interesting due to composition of speakers and interest of attendees."

We try to provide a balanced program that addresses the needs and interests of all of our constituency, domestic and international. However, the Technical Program Committee develops the program from the papers submitted; in addition, we encourage special sessions to be organized to meet special interests; and we strongly endorse the concept of panel discussions to sum up a session of similar topics. For this and other stand alone panel discussions, we require that either papers be presented or that the discussions be summarized in sufficient detail to be useful to others not present at that session—in other words, essentially a paper to be included in the Proceedings of the INMM Annual Meeting. *This practice ensures that the valuable information generated through the dialogue in the panel discussions is not lost.*

As in past years, there seems to be variety of perceptions about the Annual Meeting, its activities and events. We try to please most but it's not practical, or even useful, to please all when some actions would cause problems for other attendees. INMM plans to resolve those issues of significance and will consider those suggestions that are reasonable and within our control. Strong differing viewpoints sometimes make it difficult, if not impossible, to determine proper courses of action.

INMM is aware of the need for continued improvement from year to year in the quality of the presentations, the efforts made by speakers to find surrogates to give their talks when they are unable to attend

Figure 19. This is what one does after the meeting is over (Charles Pietri, seated). See you next year!

the meeting, and the participation of individuals who are not members of the Technical Program Committee who propose and orchestrate special sessions. However, we continue to see that the significant issues facing INMM in managing the Annual Meeting program are excessive paper withdrawals, frequent speaker changes, and, for this year, an increase in late and absent final paper submittals. As we said last year, "INMM will continue to try our best to keep paper withdrawals and speaker changes under control. We need to prepare the Final Program one month prior to the Annual Meeting in order for it to be proofed, printed, and shipped to the meeting. Any changes during this one-month period cannot be reflected in the Final Program but are subsequently posted in the addendum at the meeting. Further, we have many speaker changes at the meeting that can only be noted in the daily addenda. Some of these issues could be avoided by greater diligence from the speakers but others (like speakers not receiving travel visas) may be more complex to resolve."

I know from your conversations with me and your evaluations that most of you will be back next year depending mostly on funding and schedule. You've told INMM how important and useful INMM Annual Meetings are—now tell your management!

In 2009 we return to the JW Marriott Starr Pass Resort in Tucson, Arizona, USA, July 12-16, 2009, for the 50th Annual

Meeting, which concludes the yearlong 50th INMM Anniversary Celebration. Don't miss this event—it's a long time to the 100th Anniversary! So, as I say each year, start planning for it now by completing your research, getting your subject approved by management, writing your abstract, and submitting it by **February 1, 2009.** Then write your paper and submit it early—certainly no later than the **June 9, 2009,** deadline. Remember, for those of you who are planning to organize a special session, you need to contact me by **November 15** or sooner and be prepared to attend the Technical Program Committee review meeting in March 2009. There can be no exceptions! If you wish to discuss any issues with me, please contact me at cpietri@aol.com.

On behalf of Nancy Jo Nicholas, departing INMM president, and, as of October 1, incoming President Steve Ortiz, we look forward with great pleasure to your presence at the 50th Annual Meeting next year—be there!

The First Half Century and Beyond: An IAEA Perspective on Managing the Nuclear Dilemma

Remarks delivered by International Atomic Energy Agency Deputy Director General David B. Waller

I intend this morning to tell a story.

All of you will know parts of the story, and some of you may know much of it—but, that's OK—anniversaries are an occasion to repeat the tale. And by looking back at our past, we improve our vision into the future.

You're, of course, celebrating INMM's half-century mark this week. At the IAEA we celebrated ours just last year. And during those five decades the two organizations have travelled a number of roads together, complementing each other's efforts in controlling nuclear material.

Today I've been asked to give the IAEA perspective on those fifty years.

So, let's start at the beginning. The 'agency', as the IAEA is often called (not to be confused with 'the agency' located near the Potomac River) was established in 1957. But the story in a sense began in August 1945, in Japan, when the destructive horror of nuclear weapons was so vividly, and tragically, demonstrated.

It's a grim beginning, but one that we can't afford to forget.

And, in the years immediately following World War II, there was increasing anxiety as additional countries mastered, or were working to master, the technology to develop such weapons.

The Cold War had begun, and was getting colder by the day.

I, and I'm sure some of you, can remember well, as American schoolchildren in the 1950s, practicing what to do in case of a nuclear attack. And as naïve as that response may look in retrospect, the nuclear threat hanging over world was real.

During that same post-war period, however—on a parallel track—the peaceful use of nuclear science was coming to be seen as futuristic and high tech—with great potential for transforming the way we live. There were bold predictions that nuclear generated electricity would become so cheap it would be provided free of charge—and far-fetched dreams—such as atomic pills to power cars for years.

With gasoline at $4/gallon here in the States, where are those pills when we need them? And doubly so in Europe where we're paying more than $8 per gallon.

But enough about far-fetched dreams. Real nuclear applications were, in fact, being developed—for electricity generation, for sure; but also in medicine, agriculture, and industry; technologies with great potential to advance economic development, reduce suffering, and save lives.

So the pressing issue was how to further develop and promote these peaceful applications, while at the same time prevent the spread of weapons technology.

That was—and, indeed still is—the nuclear dilemma.

General Dwight Eisenhower was elected president of the United States in 1952. Having served throughout the Second World War, his first priority was to maintain world peace, and, in particular, he was determined to deal with the nuclear dilemma.

He wasted little time.

In his first year as president, he made an inspired appeal before the UN General Assembly—a proposal called Atoms for Peace. In it, he urged both the worldwide pursuit of peaceful uses of this energy source; and the reduction of nuclear weapon stockpiles.

And to lead this effort he called for the establishment of 'an International Atomic Energy Agency'.

Just four years later—in the spirit of Atoms for Peace—the International Atomic Energy Agency was created.

Its mission? On the one hand, [it was] to advance and facilitate those promising beneficial nuclear applications, and, on the other, to prevent the spread of nuclear weapons—that is, to manage the nuclear dilemma.

Once the agency existed on paper, the next question was where to physically locate it.

After lengthy debate, Vienna won out over other cities competing to become the agency's headquarters. And so, just over fifty years ago, in 1957, the agency opened for business—on the famous Ringstrasse, Vienna's finest boulevard—in a building that had once been a fine hotel, the Grand Hotel by name.

It was to be a temporary headquarters but, as things turned out, the agency was there for more than two decades. And over the course of those years its staff grew—from a few hundred in the beginning to more than 1,500 by the late '70s. It was overflowing the Grand Hotel building and staff had spread to several neighboring locations.

Eventually, the Austrian government came to the rescue by building our current home—a five-tower complex, with 100 total stories, on the banks of the Danube, called the Vienna International Center. The original rent was one Austrian schilling a year—about a dime in dollar terms. And with Austria's switch several years ago from the schilling to the euro, the rent was changed from one schilling to one euro per year. That's still a bargain—about $1.50 as of this morning.

Yes, Austria was generous. But its investment in the agency has paid dividends. When the Vienna International Center was built it was the only thing on the skyline, in what were then the outskirts of Vienna. But, that area has since

become one of the fastest developing and most dynamic parts of the city. And, there's no question that that growth has a lot to do with the agency's presence, and that of other international organizations. Today the agency has a staff of 2,500 and Vienna—in which more than 100 countries have established embassies or permanent missions—has become an international hub and, together with New York and Geneva, one of the headquarters cities of the UN.

Descriptions of the agency's work often begin with the safeguards or verification area—which includes—but is by no means limited to—our work in Iraq, Iran, and North Korea. It's the part of our work the media watches like a hawk. And it's the part that I assume is best known to many of you, given that nuclear material control was the original focus of the Institute. But—just to be different—this morning I'm going to start elsewhere, with our work in the area of nuclear safety—the activity which, by the way, first took me to the agency.

Sure, the IAEA had safety related activities from the outset. But, as in many areas of our work, there've been watershed events that have had enormous impact on the intensity and scale of that work. One of those events occurred in April 1986, when the world was hit with the shockwave news of the accident at the Chernobyl nuclear power plant in the Soviet Union.

That same day, in Washington, DC, I was in the midst of moving to the (U.S.) Department of Energy, to take up a position as assistant secretary for international affairs. As I was unpacking boxes in my new office, the Secretary of Energy—John Herrington—summoned me and said "David, forget about unpacking boxes—hurry home and pack a bag. You're on a flight tonight to Vienna—to the IAEA."

I hardly knew what the IAEA was, but I was to be part of the U.S. delegation, to consider, together with delegations from capitals around the world, the implications of the Chernobyl tragedy.

A number of special agency meetings were held and comprehensive reports issued on the accident. But, to my mind, the single most important development was the critical acceptance of a simple fact: that an accident at a nuclear reactor in any country could have tragic consequences, well beyond any national border.

So it became clear that insistence on peaceful use of nuclear energy wasn't enough. What was also needed was international collaboration and transparency in the operation and safety of nuclear power and other nuclear technologies.

And the agency's work was key in moving the international nuclear community to recognize this need for a global—not just a national—approach to safety.

What followed were:

- international safety conventions, or treaties
- tougher safety standards
- peer reviews of national nuclear facilities by teams of international experts

And that post-Chernobyl momentum to improve safety has, of course, continued. As we all know, the struggle to ensure safety is never-ending—it must always be seen as a work in progress.

And in this connection, we have gained from the work promoted by the INMM in the areas of both packaging and transportation of nuclear materials, and waste management. And, the voluntary standards of the American National Standards Institute developed under INMM sponsorship have contributed much to the agency's safety standards.

The agency's key policy-making body is its Board of Governors—made up of representatives of thirty-five of our total 144 Member Countries. The Board meets in Vienna four times a year for week-long meetings, and holds additional emergency sessions as necessary.

There've been some rather dramatic sessions of the Board, and not just because of high-quality, spirited debate.

On September 11, 2001, the board was in an afternoon session and by a remarkable coincidence, was discussing what was then our modest program on nuclear security—aimed at protecting nuclear material and facilities from criminal acts.

I was seated on the dais and a conference clerk came over and whispered, "There's a news flash that a plane just crashed into the World Trade Center." As hard as that was for me to imagine, just a few minutes later the poor fellow returned and, this time, tried to convince me there had been a second such crash. But, about that time I began seeing looks of horror in the room, as the shocking news spread. The meeting was falling into disarray when the chair wisely suspended the session and CNN Breaking News was projected onto the large screen behind the dais.

No one moved.

Although those terrorists hadn't targeted nuclear facilities, the world turned to the agency to respond to the gravest of the newly recognized terrorist threats—nuclear terrorism. What would have happened had the terrorists targeted a nuclear power station? And, God forbid, what if they had gotten hold of nuclear material?

Fortunately, Chernobyl had taught us a lesson: Don't wait for an accident or event to put preventive measures in place. So the agency didn't hesitate.

The world's experts on the subject—including a number of you—were quickly gathered in Vienna and within a very few months a much more robust nuclear security plan had been developed, approved, and initially funded.

And since then, our assistance to member states—to prevent terrorists from gaining access to nuclear material and facilities, and radioactive sources—has become a significant part of the broader international effort. We're helping countries protect themselves, for example by strengthening border controls, installing radiation detection devices and raising preparedness for any eventuality.

In this regard, on request we aid and advise countries hosting high-profile events. Take sporting events. Among others we assisted Greece with its 2004 Olympics and Germany during the 2006 football World Cup (that's soccer to many

of us). And, we've helped China in preparing for its Olympics. In these efforts we've had the benefit of working in partnership with NNSA.

Much of this work is to guard against the prospect of terrorists getting hold of a radioactive source for example a source in a radiotherapy machine used for cancer treatment—and using it to make a radiation dispersal device, also known as a dirty bomb.

As I'm sure you know, that's a device that straps a conventional explosive to a radioactive source. Upon detonation, the explosive widely disperses radioactive dust and debris—so as to contaminate a large area, leaving it, in the worst case, virtually uninhabitable for months or even years.

A dirty bomb detonated in downtown Nashville wouldn't kill many people, but the economic and psychological damage could be immense.

Another way we're helping—and here again, in partnership with NNSA—is by removing highly-enriched uranium fuel—potential bomb material—from research reactors and transporting it back to its country of origin. For example, fuel is sent back to Russia from research reactors in former Soviet bloc and other countries. Several of you have been key participants in these and know, first hand, that they can be very tricky James Bond-type operations—carried out under armed guard, in the dark of night.

Finally regarding security, we welcome the initiative that the INMM and the Nuclear Threat Initiative (NTI) have spearheaded—the establishment of the World Institute on Nuclear Security, with that encouraging acronym WINS. And the plan to base WINS in Vienna should foster close coordination and cooperation with the agency.

Not all our work is driven by startling or high-profile events. More often, in fact, we're involved in what are, unfortunately, hidden crises: concerning poverty, hunger, and disease. And this is where we implement the much less publicized humanitarian part of our mission—promoting the beneficial nuclear applications, especially in developing countries.

The agency's efforts to transfer these technologies were initiated in 1958, with a modest annual budget of $125,000 and that, by the way, included a donation of $2.01 raised by a New York City primary school class and presented to the agency's first director general.

Today the annual budget for this effort is more than $80 million, with more than 1,000 projects, in over 100 countries.

One important beneficial nuclear application has been plant breeding. Using radiation—not genetic modification—to accelerate natural crop mutation so as to develop varieties of plants, superior in various ways, such as having greater resistance to drought, high altitude, or salty water.

Indeed, one such rice variety introduced in Sri Lanka has prospered in an area inundated by the tsunami. And we're hopeful it might help restore agriculture in the wake of the devastating cyclone that recently hit Myanmar.

The agricultural economies of many countries have benefited greatly from the more than 2,000 varieties introduced thanks to this method. And with growing world food shortages and soaring prices, and global warming, this work becomes all the more critical.

Our hundreds of projects using various nuclear techniques are driven by unique and pressing needs in our member countries. They cover a broad spectrum—from helping secure desperately needed drinking water in India, to using radiation sterilization to help eliminate insect pests, such as the tsetse fly that kills both livestock and humans in Africa.

And we donated the monetary award that came with the 2005 Nobel Peace Prize to projects aimed at training cancer therapy specialists in developing countries.

Just a word more about our work devoted to cancer treatment. We have a new Program of Action for Cancer Therapy, known as PACT. We are raising funds to help developing countries in their fight against cancer, where the need is great. One hospital that has benefited—with two radiation therapy machines we have provided—is the Ocean Road Cancer Institute in Dar-es-Salaam, Tanzania. But it is the only such facility in a country of 37 million, whereas in the developed world there is one facility for every quarter million inhabitants.

When the two–year-old son of Tanzanian farmer Frank Kamind was diagnosed with cancer, the farmer didn't hesitate. He sold his two goats, borrowed $65 from a friend, and set off with his little boy on a 900-kilometer journey for treatment at the Ocean Road Cancer Institute.

But, there is a lot more work to be done in this respect.

One of the first nuclear applications to be developed was, of course, for generating electricity. Indeed, the first commercial NPP in Obninsk in the USSR, started operation in 1954. So, nuclear power has been part of our work since the birth of agency. And we've established broad capability. We provide: first, economic analyses, to help countries evaluate their options for generating electricity; then, support for countries that, in fact, decide to undertake a nuclear power program; and eventually training and other advice. And as I'll mention later, this has become a real growth area for the agency.

Let's now take a look at the safeguards/verification related part of the story, where the media insist on calling us the world's nuclear watchdog and occasionally have fun with that image, one critic calling us the "watch puppy."

I'm going to assume here—perhaps wrongly—that, like me, at least some of you are not safeguards experts, and I beg the indulgence of the many of you who I know are.

So, what the agency does—in essence—is verify that countries are living up to promises they've made not to divert to military purposes nuclear material intended for peaceful uses, i.e., provide assurance that countries without nuclear weapons don't try to acquire them.

In the 1950s and 1960s, the world began to realize that a legal mechanism was needed—some way of getting each country, individually, to commit to nuclear nonproliferation or disarmament.

And, after years of intense negotiations, this led, in 1970, to the Treaty on the Nonproliferation of Nuclear Weapons—the NPT.

It's based on a fundamental bargain: countries get access to peaceful nuclear technology provided they renounce the development of nuclear weapons. And, the five countries that, at that time, already had nuclear weapons—the United States, Soviet Union, UK, France, and China—pledged to work toward elimination of those weapons.

The NPT soon became, and remains today, one of the most widely adhered to treaties in the world. As you know, the only countries that have not signed are India, Pakistan, and Israel. And I'll touch on the North Korean anomaly in a minute.

The NPT gave the agency unique powers of inspection. But, in inspecting and verifying the peaceful nature of countries' nuclear activities, we, the Secretariat, sit in judgment of those countries, despite the fact that they—as members of the IAEA—are our masters: they set agency policy and pay our salaries.

So, you'll understand why it is that we refer to our occasional need to speak truth to power.

Let me recap some of the key events in our nonproliferation history.

Iraq was one of the early signatories of NPT back in 1970. As required, it entered into a safeguards agreement with us, under which it provided a declaration/inventory of what it said was all of its nuclear activity; and, it permitted our verification efforts, including our routine on-the-ground inspections of those facilities it had declared.

But, in the early 1990s—in the immediate aftermath of the 1st Gulf War—Iraq's hidden nuclear weapons program was uncovered. This led to the first occasion on which the Board of Governors concluded that an NPT state had blatantly violated its safeguards obligations.

To solve the immediate situation, the Security Council granted us special, expanded inspection authority in Iraq—to go anywhere, anytime, and speak to anyone. We were assigned to locate, map out, and either remove from the country or destroy all components of Iraq's weapons program. And we did just that!

But this discovery was also a loud wakeup call. It had demonstrated that a country supposedly in compliance with its NPT obligations, i.e., behaving itself at all facilities it had declared to us, could, at the same time, pursue a parallel secret nuclear weapons program at some facility it had not declared.

It was clear that the agency's safeguards regime had to be reinforced. Our inspectors had to have the authority to operate more like crime scene investigators and use the latest technology—so as to provide the added assurance that a country had no undeclared, hidden nuclear weapons activities.

It took years of tough negotiations—countries instinctively, and understandably, don't like ceding to others additional access to inspect their national facilities.

But, finally, in 1997 the new mechanism was established. Although *Additional Protocol* sounds like the title of a spy novel, it's of course a supplementary agreement under which a country commits itself to provide the agency much broader information, and grant our inspectors greater access.

But, returning to Iraq, there is, as we all know, another chapter in that story.

Beginning in 1998 the situation had deteriorated to the point that our inspectors had to leave the country.

They were absent for four long years until—in the tense months leading up to the outbreak of the second Gulf War, the critical question had become: Did Saddam Hussein have weapons of mass destruction?

So, in November 2002, the Security Council mandated that our inspectors be allowed back in, and that they determine whether Iraq had restarted a nuclear weapons program. And this was no small task—in terms of land mass, Iraq is larger than the state of California; four times the size of Tennessee.

And, yet, after just a few months' opportunity to inspect, in March 2003—against a tense backdrop of threatened war—we were asked to brief the Security Council at a highly charged, televised session. We reported that our inspectors had found no evidence of a renewed program.

That, you'll recall, was contrary to the prevailing pre-war intelligence on Iraq. It was not the answer some expected—or perhaps wanted—to hear. But our conclusion has proved to have been correct, and this has only reinforced our reputation for objectivity, impartiality and credibility.

Truth to power.

The North Korea (DPRK) part of story also has several chapters; and it's clear there're more yet to be written. The DPRK signed the NPT in 1985. But, in 1992, we uncovered serious questions regarding the initial deceleration/inventory that the DPRK had provided us of its nuclear activities.

Was the inventory complete? And was it correct?

Despite those serious questions the agency's board, at first, was cautious about taking action. But then, at a session I'll never forget, dramatic satellite, time-sequenced imagery of highly suspicious activity at the DPRK's nuclear complex in Yongbyon was projected on the boardroom screen.

That compelling evidence tipped the scales, resulting in a quick decision that a special, more intrusive inspection was needed.

And, when the DPRK denied our inspectors that access, the board found it to be in non-compliance with its safeguards obligations, and referred the matter to the Security Council.

Eventually, in 1994, the U.S. and the DPRK negotiated a bilateral agreement, the so-called "Agreed Framework." Our inspection role under that agreement was limited to verifying a freeze of nuclear activity at the facility in Yongbyon. But, at least our inspectors were at that location, on the ground, twenty-four/seven.

But, fast-forward eight years to December 2002, when the DPRK abruptly disabled our surveillance cameras and other equipment in Yongbyon, and on New Year's Eve, expelled our inspec-

tors—and just a few days later, announced its withdrawal from NPT.

Four years passed—without any inspections—during which, in October 2006, the DPRK tested a nuclear weapon.

Progress these last few months achieved both inside/outside the Six Party Talks, the return of our inspectors to monitor the shutdown of Yongbyon facility and most recently the DPRK's submission of its declaration give reason for optimism. We'll see how this plays out, but one thing is certain—any meaningful long-term solution will involve agency verification.

And there are the well-known chapters on Iran, with their many twists and turns.

Iran carried out a secret nuclear program, hidden from the IAEA and the world, for nearly two decades. Despite our determined efforts to piece together and fully understand all aspects of those past activities, some questions still remain unresolved. And that fuels concerns about the nature of Iran's present program.

Again, in recent months, with agreement in October 2007 on a work plan to resolve those questions—there has been progress, but, this is at a delicate point, so stay tuned.

Let me mention one further issue that has recently arisen. In April, the agency was provided with information claiming that an installation in Syria destroyed last September by Israel was a nuclear reactor—not yet operational.

If Syria had been constructing a reactor, it should—under its safeguards agreement—have reported that fact in advance to the agency. And if another country had information about an alleged breach of the NPT, it should have communicated it directly to the agency. At the June meeting of the Board of Governors, Director General (Mohammed) ElBaradei noted that it was "deeply regrettable that information concerning this installation was not provided to the agency in a timely manner and that force was resorted to unilaterally before the agency was given an opportunity to establish the facts." An agency team made a first visit to that location in Syria at the end of June to verify, to the extent possible, the veracity of the information available. Samples were taken and are being analyzed, but this was just the beginning.

One final point on our worldwide safeguards work: its total annual budget is approximately €130 million per year which is less than the budget of the Vienna Police Department. So, not surprisingly, our safeguards activity was referred to as an "extraordinary bargain" by the UN Secretary General's High-level Panel on Threats, Challenges, and Change, a panel including Brent Scowcroft and other distinguished experts.

Let me now turn briefly to the agency's future. As I hope I've demonstrated, the IAEA plays a central role in the global nuclear enterprise:

- It's the caretaker of the NPT.
- It's the central hub from which developing countries gain access to peaceful nuclear technology.
- It's a driving force for nuclear safety and security.
- In short, by managing the nuclear dilemma it's an organization in which all countries have a stake.

So, how will this critical role be impacted in the coming years?

Last year the director general established what he called a Commission of Eminent Persons, consisting of eighteen very senior international figures from a wide variety of backgrounds: diplomacy, finance, government, academia, and industry.

The Commission was chaired by Ernesto Zedillo, former president of Mexico, and included other former heads of government, foreign ministers, etc. Distinguished former Senator Sam Nunn, co-chair of the Nuclear Threat Initiative, was one of the commissioners. You know him as a giant in the field of controlling nuclear materials worldwide.

The commission was charged with making recommendations regarding the future role and funding of the IAEA.

It convened twice earlier this year in Vienna, and—by no coincidence—the commissioners stayed, and held their meetings, in that building that was the agency's original headquarters, which is now, again, the Grand Hotel. But this time it gets five-star rating and is vastly more elegant than when we called it home.

The commission's report projects dynamic growth in the call for the agency's services—a pressing need to prepare for a demanding future.

Take nuclear power for example. After years of post-Chernobyl stagnation, there are now undeniable signs of a rebirth of interest. You know the compelling reasons: enhanced safety; better economics; sharp growth in energy demand—particularly in the developing world; growing fears about the security of energy supply; and of course, the overwhelming concern regarding global warming.

In just the past couple of years, we've been approached by more than twenty countries giving serious consideration to introducing nuclear power programs. Even Europe is getting back into the nuclear game—as with the new reactor now under construction in Finland. And you've heard the recent decisions of the UK to expand, and Italy to restore, their nuclear power programs.

This renaissance in nuclear power—as some are calling it—will only increase member states' dependence on the agency for assistance in terms of safety and security, but also nonproliferation.

And the growing nonproliferation concern is that if more countries gain knowledge of and experience in nuclear fuel technology they will be getting closer to having the capability of producing a nuclear bomb. Because, of course, the same uranium enrichment technology—using cascades of sophisticated centrifuges used to produce low-enriched fuel for power reactors, can—without major re-engineering—be used to produce highly-enriched bomb material.

One solution that's been proposed is the establishment of centers for the manufacture of fuel, operated not by individual countries; but rather, multinationally. But that's going to take a long time.

A more immediate step, however,

would be a regime that assures the supply of fuel, at market price—so no country in compliance with its safeguards obligations could be cut off for political or any other reasons.

The idea is to create an environment where countries wouldn't feel compelled—and, indeed, it wouldn't make economic sense—to produce their own fuel. That is, they wouldn't develop their own—potentially dual use—enrichment technology.

Whatever plays out in this and other areas, it's clear that the added responsibilities for the agency will require greater funding.

But there's a problem: although uniquely independent, the agency is part of the UN system and "zero growth" budget polices have been applied to UN organizations across the board for more than two decades. Those policies—well intended to stem excessive growth in budgets—fail to differentiate between the agency's legally required work, with implications—quite literally—for international peace and security, and the work of some other organizations that perform highly admirable, but discretionary, activities.

And this has led to chronic underfunding of the agency, and resulting underinvestment. Our cramped lab, where critical independent analyses of samples taken at facilities, for example from Iran, should be conducted is—with increasingly obsolete equipment—far from state-of-the-art. And this leaves us ever more dependent on labs in member states.

As Graham Allison of Harvard has said the worst thing would be for there to be detonation of a dirty bomb—or, God forbid, a nuclear weapon—and, amidst the devastation, all we can do is ask: what could and should we have done?

The recently released Report of the Commission of Eminent Persons faces the facts head-on. It notes that without significant additional funding the IAEA will not be able to carry out independent analysis of safeguards samples; play its essential role in combating nuclear terrorism and in ensuring safety; provide an adequate response to an accident or terrorist act; ensure that the many new countries introducing nuclear power do so safely; or respond to pressing global crises in food security, health, and the availability of drinking water.

The report concludes that the cost of providing [these] would be insignificant compared to the benefits to be gained or the costs avoided. And it stresses: "Now is the time to choose."

As we face the challenging future we will continue to rely on the INMM and its members to provide—through your work and meetings, including this one—the pre-eminent forum, the intellectual clearinghouse, the think tank behind so much of what we at the agency are charged with implementing.

We will continue to call on some of you to serve as highly valued experts participating in many of our activities. And, as evidenced by the IAEA recruiter who is here at your meeting again this year, we will occasionally steal away one of your members for a position on our staff in Vienna.

Once again, on the occasion of your anniversary—our congratulations and best wishes!

National Roles and Responsibilities in Global Nuclear Security

Remarks delivered by National Nuclear Security Administration Deputy Administrator for Defense Nuclear Nonproliferation William H. Tobey

Introduction

President Nancy Jo Nicholas, Vice President Steve Ortiz, ladies, and gentlemen, congratulations on your 50th anniversary. I am honored to speak today to the Institute of Nuclear Materials Management, whose members include the foremost nuclear safeguards and security experts in the world.

The broad composition of this conference—more than 900 attendees—demonstrates the global imperative of ensuring adequate nuclear security. I am particularly glad to see so many students here. As the National Nuclear Security Administration's (NNSA) Deputy Administrator for Defense Nuclear Nonproliferation, I am charged with leading NNSA's efforts to reduce the global dangers of nuclear proliferation. This complements NNSA's mission to maintain the United States nuclear weapons stockpile. We take nuclear security very seriously; it is, after all, our middle name.

As my distinguished colleague David Waller noted, nuclear security is both a national and a global responsibility. I will focus my remarks on the national roles and responsibilities in global nuclear security, and how our sense of urgency has driven us to accelerate our efforts.

Today's Challenges and Tomorrow's Opportunities

We are all familiar with the forecasts regarding a changing international security environment and the nuclear security challenges that complicate it: globalization, the rise of terrorism, the global nuclear energy renaissance, the challenges posed by Iran, North Korea, and now Syria, illicit procurement and trafficking, and even the recently publicized U.S. security and accounting incidents. These factors underscore the urgency of our shared mission.

Credible estimates of the expansion of nuclear power suggest that the institutions and arrangements we have built to manage global nuclear security will come under increasing strain.

Additionally, the cadre of expertise to support these institutions and arrangements is shrinking. Fewer experts with technical experience are entering the field, and those in the field are retiring more quickly than they can be replaced. We have recognized this in our own laboratory system, but it is not unique to the United States.

Finally, nuclear security tools, particularly those related to nuclear safeguards and security, are based on technologies developed decades ago. The current technology pipeline is too small and too inflexible to address new nuclear systems under development, which blunts our ability to bring the best science and technology to this problem.

Today's complex security environment demands expanded efforts and renewed commitment, as well as new approaches and tools. I believe that this is a positive opportunity for the world's nuclear security experts to work together to design the nuclear security systems of the twenty-first century, systems that are more robust, effective, cost-efficient, and designed to meet future—not just current—demands. A strategy for maximizing this opportunity rests on two imperatives: international cooperation and domestic innovation.

Meeting the Challenge—International Efforts

I will address international cooperation first. Today, NNSA partners with more than 100 countries across the globe on priority nuclear security issues. These efforts include work to upgrade security systems and at-risk materials at nuclear sites worldwide, safeguards and verification efforts and assistance, physical protection assessments and training, elimination and disposal of surplus weapons materials, and work to help establish and implement international nonproliferation standards. We recognize the urgency of this mission, and have accelerated these efforts in response.

An excellent example of this is the enormously successful partnership with Russia under the U.S.-Russian Bratislava Nuclear Security Initiative, to accelerate our nuclear security cooperation. By the end of this year, we will have completed security upgrades at Russian nuclear sites, under the Bratislava Joint Statement signed by Presidents Bush and Putin. This Bratislava work represents a two-year acceleration of our bilateral cooperation. Although these upgrade efforts are largely drawing to a close after over a decade of work, we will continue security upgrade work at sites added to our work scope after the Bratislava summit, and will continue to work cooperatively with Russia to ensure the long-term sustainability of the investment we have made.

Also under this initiative, we are cooperating with Russia to accelerate the conversion of research reactors in countries around the world from the use of HEU to low enriched uranium and to repatriate the HEU back to Russia and the United States. To date, this partnership has resulted in the conversion or shutdown of fifty-six reactors—twelve of which were converted in just the past three years alone—and the removal of more than 1,900 kilograms of HEU. We are also using the Bratislava mechanism to share security best practices and establish a nuclear security culture.

NNSA's Elimination of Weapons-Grade Plutonium Production program is working with Rosatom to cease permanently the production of weapons-grade plutonium by replacing the heat and electricity produced by Russia's last three weapons-grade plutonium production reactors, allowing the reactors to be shut down. This year we shut down two reactors at Seversk, ending forty-three years of weapons-grade plutonium production there. We accelerated this key work to complete the shutdown of these two reactors six months and eight months early. At Russia's last such reactor, in Zheleznogorsk, NNSA and Rosatom are working to construct a replacement fossil-fueled facility no later than December 2010. In fact, we are hopeful that the Zheleznogorsk reactor shutdown schedule can be accelerated to allow shutdown one full year early, in 2009. The permanent closure of the Zheleznogorsk reactor will end the era of weapons-grade plutonium production in Russia.

This year marks the fifteenth anniversary of the HEU Purchase Agreement. To date, more than 330 metric tons of HEU from Russia's dismantled nuclear weapons have been irreversibly eliminated—which would be enough for over 13,000 nuclear weapons. Instead, 10 percent of U.S. electricity is generated from this material.

This year also marks the tenth anniversary of NNSA-Rosatom cooperation under the Second Line of Defense program. Under this landmark program, we have equipped nearly 120 Russian border crossings with radiation detection equipment, and another forty-three sites outside of Russia. NNSA and our Russian counterparts are on track to equip ***all*** of Russia's border crossing with radiation detection devices by 2011—six years ahead of schedule. This is in addition to the program's efforts to provide such detection equipment to airports, and to key seaports under the Megaports program.

However, while the United States and Russia share unique security responsibilities as nuclear weapon states and advanced nuclear technology holders, we recognize that other countries have nuclear security needs and obligations. In the past eight years, NNSA has significantly expanded its cooperation across the globe, to now include efforts with more than 100 countries, often working in partnership with the IAEA and others.

The United States remains committed to working with partners to establish and implement a set of nuclear security standards consistent with today's nuclear security realities. To that end, NNSA is on the front line of efforts to help countries meet their safeguards, security, and export control obligations under United Nations Security Council Resolution 1540. Last year alone, NNSA trained some 300 nuclear facility operators in foreign countries on material accounting and control procedures and some 1,000 licensing, industry, and customs officers to assess export license applications and identify strategic commodities. Moreover, we have led the Global Initiative to Combat Nuclear Terrorism, which provides the practical means to achieve the legal mandates of UNSCR 1540.

NNSA similarly supports the World Institute for Nuclear Security—or WINS—effort to promote the sharing and implementation of nuclear security best practices, focusing on the facility operators who have first line responsibility for the security of their facilities and materials.

Meeting the Challenge—Domestic Efforts

A second component of an effective global nuclear security strategy is domestic innovation: that is, putting our science and technology capabilities to work in the service of nuclear nonproliferation and counter-terrorism.

The United States—given the technical expertise resident at the U.S. national labs—has both an opportunity and responsibility to lead nuclear security advances. To that end, I would like to share with you new initiatives that NNSA is pursuing to best leverage our capabilities to address future needs.

One initiative that you may have heard about is our Complex Transformation effort. One of its numerous benefits is that Complex Transformation will significantly enhance nuclear materials security within the DOE Complex and reshape the nuclear weapons complex to make it more agile and responsive to our nation's needs. Coupled with the Reliable Replacement Warhead program, this transformation will help reduce the size of our nuclear stockpile to reflect the reduced role of nuclear weapons since the Cold War and to uphold the Nonproliferation Treaty.

We are also taking aggressive action to improve the security of special nuclear material, SNM, and nuclear weapons in our custody. The consolidation of SNM operations and storage allows us to reduce the number of targets that must be defended and reduce the financial burden of physical protection at our sites. Vital to our plans for material consolidation are the plutonium disposition program and the MOX Fuel Fabrication Facility, which will enable us to convert thirty-four metric tons of weapons-grade plutonium into enough fuel to power 1 million households for fifty years.

To support our consolidation objective, NNSA removed material requiring Category I/II levels of physical protection from Sandia National Laboratories in early 2008. We will remove high-security nuclear weapons material from Lawrence Livermore National Laboratory by 2012. This will consolidate Category I and II special nuclear materials that require the highest level of security from six to four sites, with a significantly smaller high-security perimeter at those sites by 2017. We are reducing also the footprint of buildings and structures supporting weapons missions by about 9 million square feet, effecting significant financial and security benefits.

I should note that the entire Department of Energy (DOE) manages nuclear materials at about forty sites, expending over half a billion dollars a year in the process. This introduces a significant management challenge that we are

taking head on by consolidating materials and coordinating plans for disposition. For this purpose, we will establish an Office of Nuclear Materials Integration, which will be responsible for streamlining the nuclear materials management activities of the department's Offices of Defense Programs, Nuclear Nonproliferation, Science, Nuclear Energy, and Environmental Management.

Consistent with the work we are doing internationally to bolster physical protection standards and practices, NNSA has made security enhancements in recent years. For example: we have improved the protection of critical facilities from vehicle bombs and strengthening facilities against attack; hardened storage vaults; improved facility configurations; and implemented an aggressive protection strategy to prevent access to special nuclear material on an NNSA site, or, if that fails, to prevent escape and recover stolen material.

NNSA is focused on technology-based solutions, as force multipliers, to improve site defenses, including the critical aspects of detection, assessment, delay, and response while reducing overall costs of security. Upgrades to NNSA facilities are already underway. At the Y-12 National Security Complex, for example, installation of an Argus security control system will bring alarm systems up to modern standards and supports our broader effort to integrate personnel security and access control across NNSA, avoid duplicative site-level security information systems, and replace antiquated technology.

Recognizing the need to move away from compliance-based systems and towards a performance-based risk management system, NNSA undertook the Safeguards First Principles Initiative (SFPI). The objective of this initiative was to develop a principle-based standard for Nuclear Material Control and Accountability (MC&A) programs that can be tailored to well-characterized risks, and material inventories, and site operations.

To demonstrate proof of principle for the SFPI approach, NNSA conducted test bed applications at two facilities in 2007: the Nevada Test Site and portions of the Y-12 National Security Complex. At Y-12, the facility experienced a significant increase in operational efficiency by gaining four operational work weeks per year and realizing a cost savings of $5.6 million annually while increasing the MC&A program effectiveness.

Both Y-12 and Nevada Test Site now fully implement the SFPI approach for domestic safeguards. The performance of their respective MC&A programs is significantly stronger, defensible, and measureable. Given the success of this initiative, NNSA is continuing its implementation at other NNSA sites.

Enhanced domestic security efforts go beyond DOE/NNSA sites. NNSA's Global Threat Reduction Initiative is working with the Nuclear Regulatory Commission, the U.S. Department of Homeland Security, other federal agencies, state and local governments, and the private sector to reduce risks at civilian nuclear and radiological sites. To date, GTRI has converted fourteen of the United States' twenty-eight research reactors to LEU with two more conversions planned later this year. We have also recovered almost 18,000 excess and unwanted radiological sources, and will begin the installation of enhanced security upgrades at high priority nuclear and radiological facilities.

I would like to close with discussion about an area in which DOE and NNSA have a long history, but to which we are giving new emphasis: international safeguards.

In thinking about the future nuclear security environment, the challenges that we face, and the opportunities to make a difference, it is clear that we must rededicate ourselves to a robust safeguards system.

Although nuclear power holds tremendous promise for a sustainable energy future, we must also be mindful of the proliferation challenges associated with the spread of nuclear energy, particularly fuel cycle facilities and technologies. A foremost requirement to ensure that nuclear power expansion does not result in nuclear proliferation or WMD terrorism is that the International Atomic Energy Agency (IAEA) must have the resources—people, technology, and funding—it needs to carry out its safeguards responsibilities.

Since the early 1990s, demands on the IAEA have grown by every measure—the number of countries and facilities and the quantity of materials under safeguards. The agency has also taken on new responsibilities to ferret out undeclared nuclear activities, carrying out high-profile investigations into the nuclear programs of Iran, North Korea, Libya, and, most recently, Syria.

This widening gap between workload and resources poses a serious threat to the international safeguards system. To address this challenge, at the 2007 IAEA General Conference last September, (U.S. Energy) Secretary (Samuel W.) Bodman announced the launching of the Next Generation Safeguards Initiative, or NGSI, to revitalize the international safeguards technology and capability.

The Next Generation Safeguards Initiative will be a broad and comprehensive effort, including:

- strengthening safeguards policies and institutions
- implementing advanced safeguards concepts and approaches
- developing new safeguards technologies and analytical methodologies
- attracting and training a new generation of safeguards experts
- building safeguards infrastructures in countries considering nuclear power

Immediate program goals include institutionalizing the concept of "Safeguards by Design," an approach that seeks to optimize safeguards implementation at nuclear facilities by designing safeguards requirements into new facilities at the earliest stage of conceptual design. In terms of technology development, we plan to invest in emerging technologies for direct measurement of plutonium in spent fuel as well as to develop a new toolkit of robust, multifunctional detection instruments for use during IAEA inspections.

In the area of human resources and training, NNSA has initiated pilot programs to develop course materials on safeguards technology, policy and information analysis, summer internships at the national labs to stimulate interest in pursuing international safeguards as a career path, and others.

We are also working to solidify partnerships with aspiring nuclear energy countries to ensure that international safeguards and security factor into their long term planning. The goal of this initiative is not to put the United States or DOE in the driver's seat in regard to international safeguards; rather the goal is to put fuel in the tank for the long road ahead. I am particularly pleased that this meeting will include a special session on this initiative so that we can begin the process of shaping NGSI priorities in a way that reflects a consensus path forward.

Conclusion

In conclusion, what we seek is agreement on means to advance nuclear security globally, both through international partnerships and the widest possible application of effective security practices at home. As the A. Q. Khan network example demonstrated, proliferators or terrorists need just one weak link in the nuclear nonproliferation regime to get their foot in the door. A country's nuclear security responsibility does not stop at the boundaries of its nuclear facilities, but rather it requires the sharing of best practices, the facilitation of those practices in countries worldwide, and vigilant efforts to ensure that international security institutions and standards keep pace with technological and international developments.

Never before have the challenges to nuclear security been so many, but never before has the potential benefit from the dedication of experts working together to address these challenges been so enormous. Standing here today, I know that you are the very group that will blaze the path forward, by taking on this challenge directly and maximizing this historical opportunity. I wish you all success. Thank you.

INMM Roundtable

Opening Plenary Speakers

William Tobey, *Deputy Administrator for Defense Nuclear Nonproliferation, National Nuclear Security Administration*
David Waller, *Deputy Director General, International Atomic Energy Agency*

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Editor's Note: This year's JNMM *Roundtable is a bit different. In honor of INMM's fiftieth anniversary, the Opening Plenary Session featured two speakers, William Tobey, deputy administrator for defense nuclear nonproliferation at the National Nuclear Security Administration, and David Waller, deputy director general, at the International Atomic Energy Agency. After discussions with the speakers, which speaker would get the first question was determined with a coin toss. The result of this unusual Opening Plenary and* JNMM *Roundtable are presented here.*

Dennis Mangan: David, you gave an excellent presentation that I really enjoyed because I was involved in international safeguards for several years so you took me down a nice path of remembrance. One thing though that surprised me and I'd like to know a little bit more about if it's possible is the IAEA's support of the China Olympics. How did you guys get involved? What are you doing for them? Is this common—because you mentioned other things you help too—but I just found it interesting that you were involved in that.

David Waller: Yes, I mentioned our work in connection with the Beijing Olympics as an example of one of the high-profile events for which we provide radiation detection assistance. As I mentioned to you out in the corridor, when one looks back at 1972 Munich Olympics, for example, these events really are prime targets for terrorists, and a lot of people lose sleep protecting against such attacks. You mentioned the Super Bowl in the United States.

Mangan: When are you going to take care of it?

Waller: When we are asked for assistance. We've been contacted and asked to assist in connection with these events. We're not out looking for this work. I tried to find, by the way, a good photo of our work in Beijing that would show the radiation detection devices being installed—against the background of the Bird's Nest Stadium—the icon of these Olympics. We had some but they didn't show the devices particularly well so I didn't include one in the slides I presented this morning.

Anita Nielson is the head of our nuclear security program. I'm sure many of you know her. She's an INMM member, and a proud one.

I don't know exactly where this work is going to go. We obviously don't have the human and financial resources to assist with every high-profile event that's going on around the world. You were asking earlier about whether the work could be done by others and the answer is yes—if they have the equipment and the knowledge. And so it's likely it will be more commercialized, privatized in coming years.

Bernd Richter: You mentioned three major items in your speech: security, safety, and safeguards. My perception is that safeguards is the only area with a legal basis, whereas security and safety are national responsibilities. So, I wonder whether you would like to expand on this to make it clear that the International

Atomic Energy Agency has more influence on imposing safeguards measures, for instance, under the NPT and, in particular, the Additional Protocol. I think the most important event in the past was the disclosure of Iraq breaching the NPT, and, therefore, that really gave a large push to safeguards also in legal terms.

Waller: You're exactly right about the three Ss—safety, security, and safeguards. But, don't forget the other area of the IAEA's work that I mentioned—our technology transfer or humanitarian work—plant breeding, cancer therapy, hydrology, and all of the other peaceful applications of nuclear technology.

But, you're absolutely right that in terms of statutory mandates, safeguards is the only one of the three Ss. And it was in that context that I mentioned the critical need for additional funding—because we don't have any choice about doing that inspection work. It's not discretionary. We have more than 230 safeguards agreements in force in 163 countries around the world and more than eighty Additional Protocols. And it's our responsibility to conduct safeguards, that is, verification work in those locations. With the amount of nuclear material and the number of nuclear facilities growing, and zero growth budget policies being imposed on organizations across the UN system—including the IAEA—there's a potential train wreck. And so we are really struggling financially.

Will Tobey's words this morning not only acknowledged that fact, but also underscored the United States' support for addressing the agency's chronic funding problem. And that's music to my ears.

On the safety side, as the nuclear power renaissance, if you will, moves forward, I think you may see more migration toward something—if not legally mandated—at least a little closer to that than we have at the present time. That is, the safety standards we promulgate would come closer to being mandatory. At present, they're looked to as models but are not required. Currently, although they're often adopted and implemented by national governments, that's voluntary. They're looked to as models.

And on the security side, as I mentioned, there's our work in response to requests to aid in connection with high profile events, but there's also border controls strengthening, and all the other things that I mentioned. But, again, at the end of the day these are national responsibilities.

Mangan: Will, you mentioned the Next Generation of safeguards initiative and I found it interesting. I believe it's an IAEA-focused program. Right? It's not a national program.

William Tobey: It's both.

Mangan: Is it? Could you explain that a little bit?

Tobey: Well we recognize, as David (Waller) cited, Chernobyl as a watershed event. In the United States of course Three Mile Island was a watershed event. And following Three Mile Island, the amount of investment the United States put in energy technology diminished greatly. At the same time, the investment in safeguards technology diminished proportionately. We had, I believe, been fairly regarded as leaders in developing the safeguards systems and as U.S. investment in that system declined, overall investment in that system declined. With the advent of a nuclear renaissance, we recognized that we needed to spend more money in developing U.S. capabilities and by that we mean facilities technologies and perhaps most importantly people and that the fruits of those efforts appropriately should be shared with the IAEA. So I would argue that it is really a two-pronged effort.

Gotthard Stein: I have a question for both speakers. In the Kyoto protocol we have different mechanisms and measures to reduce CO_2 emissions on a joint basis between countries e.g., through joint implementation. So the idea is for example to export clean coal power plants with the effect that the importing country has less CO_2 emissions and the exporting country can benefit on his own CO_2 emission reduction goals by gaining additional credits through this deal.

Unfortunately nuclear technology and nuclear power plants are not part of the possible measures since nuclear power plants are missing in the list of approved environmentally sound technologies in the Kyoto mechanisms. That means that the export of nuclear power plants has no accountable effect for the different Kyoto mechanisms. What are the IAEA and the DOE doing to improve this situation?

Tobey: Well the Department of Energy is squarely of the view that if we're going to meet the world's rising demand for electricity, as well as address concerns about dependence on Middle Eastern oil and greenhouse gas emissions, nuclear energy must be a part of the mix. To further that view we've launched the Global Nuclear Energy Partnership (GNEP) that is aimed at providing the means to allow for the expansion of nuclear power while meeting our nonproliferation and waste disposition objectives. We've tried to be strong champions of nuclear power.

Waller: As you asked that question I was recalling an event that I attended I think it was in The Hague about ten years ago—one of the early meetings of the Intergovernmental Panel on Climate Change. And if you think you're rigid in terms of limiting your speakers' time here, there it was unbelievable. Representatives of the key organizations had three minutes to get up and say what they were going to

say. I was there for the IAEA. France held the rotating presidency of the EU at that time and so Jacques Chirac got up and gave a pitch about how France had per capita carbon emissions that were, on average, one-third of those of the U.S. But, because he was speaking as president of the EU—and the EU includes a handful of strong anti-nuclear countries (e.g., Ireland, Denmark, "nuclear". Well, I was several speakers later, but when I got up I added a little line to my prepared remarks to the effect that the reason France has one-third the emissions of the United States is, of course, because nearly 80 percent of its electricity is generated by its impressive nuclear power program.

You asked what we are doing about that. Promoting nuclear power, per se, is not our mandate, although we're occasionally accused of doing so. At the same time our mandate does include getting out accurate information, as I mentioned in my remarks, about the pluses and minuses of nuclear vis-à-vis the other electricity generation options available to a country. And we serve as a forum and catalyst to improving the technology and safety. So we try to walk this tightrope between, on the one hand, disseminating accurate information, helping countries as they're assessing which options to pursue, and fostering technology and safety advances, and, on the other hand, being careful that we aren't viewed as lobbying for nuclear power. All that said, to my mind, as almost a lay observer, I do see significantly greater appreciation of nuclear power and recognition of its merits in the climate context today than we did ten years ago. When you see Greenpeace occasionally finding something positive to say about nuclear, it's significant.

Charles Pietri: A question for both of you. I was excited to hear of the potential upgrade to safeguards analytical laboratory and I was wondering whether you would say a little bit more about that. And based on that I have another question I'd like to propose to you.

Waller: Well let me begin by saying something about the United States, in particular, since, after all, this meeting is taking place here and the INMM has a predominance of American members. The United States is fundamental to the good health of the IAEA, as it has been historically—through Democrats and Republicans, on the Hill and in the administration. The U.S. has been a staunch supporter of the IAEA. Do we get into quibbles with the administration or with members of the Congress from time-to-time on this or that? Of course we do. But those are passing things and don't affect the underlying foundation of support.

I'll put that in the context of our Safeguards Analytical Lab or SAL. As you know, the financing of a desperately needed upgrade of SAL is in play at the present time. We've had one contribution, a significant contribution, from Japan, this past year to purchase new secondary ion mass spectrometry (or SIMS) equipment without which we put at risk our independence in the analysis of safeguards samples. But the grander issue is the lab itself. It's not adequately secure and it's not anywhere close to being adequate in terms of size and capability. It occupies one corridor of an old Austrian research center. Senator Richard Lugar used the word "pathetic" when he visited it not long ago.

Pietri: Like an afterthought.

Waller: It certainly gives the appearance of being an afterthought. Because of lack of space and so forth and this is in desperate need of being addressed. We did a rather comprehensive study this past year of the requirements and a German consulting company came in and did some cost estimates. So all of that is now before our member states and the issue is well framed. The remaining question though is how to finance it. And we have been thus far looking at doing it in an "off-line" way—that is, outside of our regular annual budget.

Unfortunately that's the way things work in the UN system. If you have a high-ticket item like that the organizations are ill equipped to deal with it. There's no provision for capital planning. You have to deal with things in a given year—within an annual budget—which is not the way to do business. You should amortize and do it the right way but that has not been done to date for a variety of reasons connected with the accounting requirements of the UN, some of which, fortunately, will be corrected beginning in 2010. The last comment I would make is that the Commission of Eminent Persons that I referred to in my remarks spoke specifically and at some length on the lab and the dire necessity to bring it up to speed.

Tobey: We certainly recognize the need for the IAEA to have robust analytical capabilities and the current capabilities fall short of that standard. As you know, we've been large supporters of the IAEA budget. That funding is largely done through the State Department. The Department of Energy support tends to be of an in-kind nature. We take it seriously and we believe it's helpful but it's ultimately probably a decision to be made in consultation with other U.S. agencies and through State Department funding channels, which, given Senator Lugar's interest in this, is appropriate because he'll have significant influence over that.

Pietri: That's good. So we're basically at the money level right now, which is interesting because one of the things that INMM does well is that we're very active. I'm a measurements and standards person so I have my own parochial interest in this.

The condition that I see the United States in is that we're losing expertise in this area and we're going to have to regenerate it. Why regenerate it when we can kind of save it? And the point you made well is that having SAL as an independent source is valuable. We have U.S. laboratories that are good but the fact that we have an independent, a global independent laboratory is really essential. One of the things that INMM likes to do is they like to get into the standards, the consensus standards area also. One of the things that we've done in the past is these good practices workshops. And I think I've talked to Jim Tape about that. We'd like at one time in the future to see that these good practices turn into international standards, but we need a mechanism and an infrastructure to do that. SAL may be one of the ways to lead forward to that. What can INMM do if anything to support the activities that you folks are working on, as far as SAL and standards and such?

Waller: I think you're doing great work as it is. And I would say just keep up that good work and keep at it because we need the reinforcement. As I mentioned, we see you as the idea people behind so much of what we're doing. In your meetings you discuss these issues and, as a result, they start getting traction. And that plays back in the Standing Advisory Group on Safeguards Implementation (SAGSI) and some of the other advisory committees that the Director General has established.

Pietri: You know that's good to know because many of us feel that we are kind of incestuous. We come up with these great ideas, have great presentations and such and it goes no further. But that's very interesting that it does go further than just this forum here.

Waller: Well it goes further if you make it go further. We're probably not doing as much reaching in and grabbing it as we should, but we also need you to push it forward, to get it to us. And again, I see personally through the SAGSI channel and other meetings that take place at the IAEA an opportunity for INMM to come and participate. That's where more knowledge transfer can take place.

Tobey: I certainly agree with what David said. I would add to that perhaps a suggestion to become more actively involved in the Global Initiative to Combat Nuclear Terrorism. That is, I think, a highly successful group of nations. Already we've got some seventy-plus members dedicated to coming together and sharing best practices on the whole scope of possible responses to prevent and deal with nuclear terrorism at the earliest stage from material controls and accounting, to export controls, to emergency response. The whole gamut. And the hope is that mechanism could provide an umbrella organization that would make it more politically acceptable for many nations to discuss openly these issues. For example, one of the efforts that is under way is to stand up an information portal that would allow the sharing of best practices. We're even contemplating—we'll have to probably kick this around a little bit—a wiki-based area that might allow members to discuss how to improve their practices. And I should stress that this is not in any way in competition with other existing bodies, particularly the IAEA. The IAEA was a founding observer, and has participated in each of the successive meetings. The hope is that this can help to better coordinate some of these activities and also make it more politically acceptable for nations to take action.

Debbie Dickman: This question is primarily for Will but I would certainly welcome David's comments on peripheral aspects of it. We see that the nuclear renaissance is upon us now. And yet it has been pretty clear that our congress has shown less enthusiasm and therefore financial support for our established GNEP "program" per se than we were looking for. I'm wondering if you could comment on the opportunities for DOE to keep the momentum up in the nuclear renaissance area in light of what we have seen out of the congressional budgets? Do you see other opportunities for the efforts to go forward, either as "GNEP" or another approach? David, I would appreciate your thoughts also and be interested in anything you might want to add.

Tobey: I think your analysis is correct. I think the congressional action really reflects an attitude that is behind the times with respect to where other countries in the world are and where they're going with nuclear energy. Several of you, all of us, have cited and are familiar with the advances in nuclear energy that are going on around the world: robust programs in Russia, China, India; new programs or resurgent programs in places like Italy and elsewhere. I think that it is inevitable, and while there have been some political setbacks for the GNEP program and funding setbacks for the GNEP program recently, this is not ultimately a matter of choice. If we're going to supply the baseload needs of modern cities, conservation is good, solar is good, wind is good. All of these things are important and should be done, but nuclear will have to play a role. Especially if we're going to address, as I mentioned before, concerns about dependence on Middle Eastern oil and greenhouse gas emissions. So we're just going to keep our head down, keep trying to push forward with these programs. With respect to nonproliferation programs that I can speak to specifically, one of the things that we've stressed is that even if the United States lags a bit in terms of advancing nuclear energy, it's clear the rest of the world is moving out smartly and that being the case, we need to be equally fast paced in our response in terms of safeguards. And that is why we're pushing forward with the Next Generation Safeguards Initiative. It has gotten a good response on the Hill. People have enthusiastically received it. While I'm hopeful that our colleagues in the nuclear energy

sector will enjoy greater success, we're pushing as fast as we can on our part.

Dickman: And that's my side of the house so that's the side that I'm familiar with and I think the efforts within NA-20 are particularly important from the nonproliferation side. If we can just draw our other brethren along with us. David, did you want to comment?

Waller: I fully embrace what Will has said. The only thing I would add is I think there is a problem that is bigger than the nuclear question and it's the issue of long-term planning by governments—something that many of them are not very good at, one exception being the French, who certainly have demonstrated tenacious long-term nuclear planning. An issue like nuclear requires a vision and milestones and tenacity.

Cameron Coates: We have talked about money but I'd like to couch it a little differently in terms of resources. That encompasses a lot and I have a question for David and a related question or a mirror question for Will. Given the need for the increased resources, is there and if there is what is the IAEA's plan to create a sea change rather than incremental change in funding and resources, and cooperation. Perhaps you could give us a little more on the Commission of Eminent Persons and what they've said. And for Will with the success and the growth of things like the MPC&A and now the GTRI programs, which are clearly international programs, you've supplied support over the years for the IAEA and looking at the clear need for resources at the IAEA and then setting nuclear safety and security area, does the NNSA or DOE see a possibility for a significant increase, (a sea change) in support and cooperation with the IAEA?

Waller: This is a subject near and dear to my heart, given my responsibilities for the management of the agency, and that includes its budget. As I mentioned in my remarks, the UN system for about two decades has had zero growth policies, which basically means an organization's budget this year will be its budget next year. And if it makes a really compelling case perhaps an inflation factor will be added. If not, the organization's purchasing power is diminished by the amount of inflation.

Coates: That's really the heart of my question.

Waller: And we have worked hard frankly to try to impress upon capitals that that's just a formula that doesn't work for the IAEA. We've had some success but not enough by a long shot. Just to cite an example. When we were preparing our budgets for the current biennium, the 2008-9 biennium, which we were doing a year and a half or two years ago, we included a number of capital expenditures like SAL that simply need to be done and cannot be accommodated within a zero-growth budget. The IAEA is largely made up of *people*—doers and thinkers and implementers—so about 70 percent of our budget is salaries. So by the time you pay the salaries and buy some equipment and so forth the amount of discretionary money is pathetically little. So you don't have any room at all to do the big projects that come along from time to time. Given that, we presented a budget to our member states in the form of our regular budget with zero real growth *plus* off-line what we called 'essential investments,' things that we just have to do if we're going to keep the wheels from falling off. And basically, because of the zero-growth policies, 95 percent of the "essential investments," were rejected, yet again. So what that leaves us doing is going around and rattling the tin cup, passing the hat. Maybe the best example recently is when, fortunately, thanks to advancements in the Korean situation our inspectors were going to go back in but we had no money in the budget for that. We knew that might occur but we didn't have the luxury with these budget constraints to include funding for it in our budget. This costs about a million euros and thank goodness the United States once again very much came to the rescue. Japan was also helpful and a few other countries. But it's just no way to run a railroad. It's pathetic and shortsighted. So having gone through that drill yet again in the biennium that I mentioned, the 2008-9 biennium, the director general and I and others were just tremendously frustrated knowing that this is going to cause a train wreck sooner or later.

So we established this Commission of Eminent Persons, a group of wise, independent, persons to look at what the future requirements will be. We called our internal study 20/20, as in the 20/20 vision thing, but it was also to capture the idea of looking out to the year 2020 and beyond. What would be the requirements—in the light of the renaissance, in the light of proliferation threats, in the light of safety concerns, in the light of developmental requirements and requests on us in the humanitarian areas? And the commissioners really rolled up their sleeves and went to work on this thing. And on the financial side, they did not skirt the issue. It's right there in the report that this model doesn't work and something has got to be done about it.

Tobey: I agree with David's overall analysis. I would only add that it is made all the more urgent by the growth of nuclear energy that we've talked about. As I mentioned, the funding by the United States is done by the State Department, largely in terms of the cash contributions, and we're supportive of an increased contribution but it's not our direct issue. We have tried to aid in ways that I've mentioned before, the Next Generation Safeguards Initiative. We aim to give it a budget of about $30 million annually and while that would be spent largely in the United States, I think the fruits of that labor would accrue to the benefit of the IAEA. There is really almost no other way to implement those new technologies so we would hope that it

would prove to be a significant in kind contribution.

Waller: Can I make one more point on that just to leave a jarring statistic? Our nuclear security program is 90 percent dependent on voluntary contributions—90 percent. In our nuclear safety arena it's 40 percent dependent. In other words not funded by our regular budget. And, even in safeguards, it's 15 percent.

Mangan: I know Anita has trouble every year.

Waller: Indeed.

Scott Vance: Because I know not to ask a question of a lawyer, I have a question for you, Mr. Tobey.

Tobey: I'll keep it short.

(Laughter)

Vance: Actually you mentioned in your talk and you also mentioned in response to a question this morning the issue of terrorism. I come at this from a slightly different perspective than many around the table. I don't work for a lab. I work for a generating company. And I can tell you as we look at the nuclear renaissance we see terrorism as a major issue because it has been used by those opposed to nuclear power as a method of creating controversy. I am sure that you know about the California ruling. I'm just curious what your perspective is from the point of view of NNSA in terms of a generator's responsibility to respond to terrorism as opposed to the government's responsibility.

Tobey: I'm an economist by training and that might be even more frightening than attorneys. I believe it's most efficient to internalize all the costs associated with a particular economic activity. Security and waste disposition are important elements of nuclear power and probably do need to be internalized and we struggle as a society as to how to do that. But it's not unique. I mean we also have trouble internalizing pollution costs associated with fossil fuel power generation. I think that we will have to continue to deal with that issue. I believe that we need to deal with it both as a national security matter and as an economic matter. I would like for private companies, particularly those involved in, for example, radiological endeavors to spend more time on the security and disposition of for example radiological sources. My sense is that the power generation companies are a little bit ahead of their colleagues in that regard. Security has always been a primary concern.

Nancy Jo Nicholas: We've talked a little bit about budgets and facilities and initiatives. I'd like to talk about people for a minute. We have a recruiter here from the IAEA talking at our meeting about job opportunities so I'd like to ask you both about recruiting. First, Will, about what the United States is doing to help fill temporary slots in Vienna, temporarily working through the Next Generation Safeguard Initiative or other initiatives. I'm also interested to hear from David about what the IAEA is doing differently to help recruit new people, specifically addressing some of the issues with nepotism (or the two bodied problem) or associated with more working couples these days and then the economics. The difference between the euro and the dollar is big, so the economics of moving to even a beautiful city like Vienna can be challenging.

Tobey: Well, we're pretty constantly trying to encourage the IAEA to hire more Americans. Let there be no doubt. At least there is agreement on that point. And I have to admit that I have also tried to work on, but with limited success, some of the problems associated with Americans going over there in terms of returning to duties here. It was a problem that was put to me by Linton Brooks when I first arrived at the NNSA and I must admit that despite some reasonable effort to deal with it, I'm not sure we've gotten very far. There are competing demands with respect to our own security clearances and there are bureaucratic issues. I think probably more the latter than the former. But it is a problem we still need to address. There is obviously tremendous demand for nuclear-related talent. Dale Klein tells me that it's his goal to hire 400 engineers a year for the next several years so that he can sustain a net increase of 200 engineers. Now not all of those are nuclear engineers but they're all nuclear related.

Nicholas: That's at the NRC?

Tobey: Yes, and that's just one small aspect of the problem. We're hiring a class of twenty nonproliferation graduate fellows this year which is I think one of the primary ways to get into our organization.

Nicholas: But they're hearing that you value positions at the agency, temporary positions.

Tobey: Absolutely, yes.

Waller: On that first point, the United States pays about 26 percent of the IAEA's budget. The next highest payer is Japan at around 16 percent. But we don't take that as an indicator of how many staff members there should be. If we did, the United States would have somewhere in the vicinity of 200 professional staff members. In fact it has about 90. The United States recognizes that the more important thing is to maintain the universal sense of the agency. That's a delicate issue and I can tell you that the director general, and I, and others, spend a tremendous amount of time selecting people for different positions. It's very, very complicated because of the issues of geographic distribution, of gender concerns, of countries that have no representation at all and countries that are

grossly under represented or over-represented. We have some countries like India and Russia that are currently over represented because they've got a lot of good nuclear talent. And we have a number of member countries with none of their nationals serving on our staff. It's a continuous balancing act.

Tobey: Get them to increase their contribution and kill two birds with one stone.

(Laughter)

Waller: Anyway you mentioned, Nancy Jo, the effect on recruitment of salaries and exchange rates and all that. The bottom line in that regard is that we can't compete on salaries. Not even close, and so usually somebody who comes to the IAEA is one who maybe has been an INMM member for example. Who knows about us and is interested and values the idea of coming and working in that stimulating multicultural environment and likes the idea of living in Vienna, one of the great cities of the world. So those are factors on which you can't place a value and they are really the determining ones much of the time. In other words, if you're looking to make money, the IAEA is not the place to go, as my wife occasionally reminds me.

Felicia Duran: I'd like to come back to safety, security, and safeguards, the three major areas you discussed in your speech. I'd also like to tie these to some of the budget issues that we've discussed because some of the work that I'm doing involves looking at integration among those areas. I believe that doing so would provide a lot of leverage and promote more efficient and cost effective facility designs and operations. I think that some of our safety functions also provide security functions and vice versa within the types of nuclear systems that we're talking about. I understand that within the IAEA the key area is safeguards, legally speaking, but Will also mentioned the "Safeguards by Design" initiative, and my understanding from what I've heard is that it's also considering safety functions. I'd like to hear both of your perspectives because I do believe that cost savings in terms of our facility designs and operations can be realized with a level of integration among those three areas.

Tobey: I think that's exactly right. I think this is an area where you all can provide leadership. I think it's all part of a good culture, and when I took the Department of Energy's nuclear executive leadership training course a year ago, I learned there about how the better operating procedures that were put into place largely for safety reasons have led to tremendous advances in efficiency, so that nuclear power (despite the fact that we haven't built a new plant in many years) has sustained the same level of percentage participation in our total energy budget. So you go from seventy days of down time for a refueling to seventeen days of down time or something like that. The amount of energy from nuclear power can grow, without building new plants. And I think all of that shows a tightness of operations that is healthy for all three of those concerns.

Waller: I have nothing to add to that.

Mangan: Well it's unfortunately time for you, David, to head to the airport so we'll close this session. I want to thank you both and I want to thank everybody who came to participate. I want to end by saying that this was kind of like the Illinois connection in Tennessee. David and Will both grew up in Decatur, Illinois. I'm from Springfield, Illinois. Patricia and Charles are from Chicago, Illinois. We've got it here.

Waller: One quick comment on that. Will and I never met in Decatur, Illinois. I'm older than he is so we missed each other there but I guess it was the first term of this administration, Will had the Iraq file for the National Security Council. I was in Washington together with Mohamed ElBaradei, and Will and I went out to lunch and so we're sitting there talking about the latest issues in Iraq or whatever but then we somehow discovered that we were born in the same town in central Illinois. It was quite an interesting thing. We've been good friends ever since.

Mangan: Thank you.

The Path Ahead for Safeguards

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Abstract

Following the principle that the past is prologue to the future, a review of the history of events and trends in the safeguards program for civilian nuclear material provides insight about the path ahead. The safeguards program has evolved during the last fifty years in response to technology development, significant events that prompted public and government attention, and societal trends. Experience and current issues reveal trends that are certain to shape the future of safeguards. Many signs point toward a future with more nuclear facilities, which will pose more safeguards challenges than existing plants do. Although significant uncertainty exists about the specific future, nuclear power will most likely be called on to meet future energy requirements worldwide. Advances in technology and information management are making it easier to gain access to nuclear technology and material. These changes facilitate proliferation of technology and technical capability. If today's safeguards environment is challenging, tomorrow's will be more so. The public will demand that governments enhance already stringent controls to ensure nuclear safety, safeguards, and security. In addition, openness and transparency are two essential elements of effective programs for safeguarding nuclear material and assuring its safe use. Our experience during the last fifty years prepares us to meet these daunting challenges. What role will you play as a safeguards professional in helping to advance safeguards, safety, and security?

Introduction

On behalf of the United States Nuclear Regulatory Commission and the NRC's Office of Nuclear Material Safety and Safeguards, I want to congratulate the Institute of Nuclear Materials Management on its fiftieth anniversary. There is a special connection between INMM and NMSS, not only because we share some of the same words in our names, but more importantly because of the common objectives that we share. Chair (Dale E.) Klein, in his recent letter congratulating the INMM, recognized the INMM for its contributions to safety and safeguards. In the fifty years since its founding, the INMM has been a major contributor toward advancing the goals of safeguarding and securing nuclear material and preventing nuclear proliferation. The INMM and its members have advanced the safe and secure use of nuclear material through development and implementation of nuclear materials management techniques and programs, standards, and research. The work of the INMM has significantly helped the NRC fulfill its mission of protecting the public health and safety, and promoting the common defense and security. The Commission looks forward to fifty more years of successful cooperation with the INMM in ensuring safe and secure use of nuclear materials.

I would also like to thank the organizers of this meeting for providing the opportunity to address the closing plenary session of this annual meeting of experts on security, safeguards, and nonproliferation. You are the people who will be developing and encouraging adoption of effective security and safeguards practices in the coming years of nuclear renaissance. I have the privilege of working with one of NRC's safeguards experts, Martha Williams, who helped co-write this paper while she was doing her full-time job, recuperating from an injury, and taking care of her new grandson.

We titled this presentation "The Path Ahead for Safeguards" because the opportunities to make a difference and contribute to the safe and secure use of nuclear material abound. It is easy to get caught up in the euphoria of the nuclear renaissance, but it is essential to remember that this resurgence will be short-lived unless we collectively ensure the continued safety and security of these materials. We have learned these lessons on the path that we have already journeyed. By examining the milestones along this path, we learn from our experiences and prepare to address the challenges that lie around the next bend. One of my roles as a senior leader at the NRC is to ensure that we capture and share this knowledge to better accomplish our mission of protecting people and the environment.

NRC Mission

The NRC's mission is to license and regulate the civilian use of nuclear materials in the United States to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment. The NRC has two goals that you can read in our strategic plan. Our safety goal is to "ensure adequate protection of public health and safety and the environment." Like our safety goal, our security goal, which includes safeguards, is to "ensure adequate protection in the secure use and management of radioactive materials." To accomplish its mission and achieve these goals, we ensure that licensees establish adequate safety, security, and safeguards programs.

These three disciplines—safety, security, and safeguards—have been referred to by the International Atomic Energy Agency and the G8 members as the "3 Ss." If there is a nuclear renaissance, safety, security, and safeguards must be assured. The systems put in place to achieve safety, security, and safeguards must be effective and communication about them must be sufficiently open to establish stakeholder confidence. Openness is one of the NRC's organizational objectives. These are the topics that I plan to address today: that the success of a nuclear renaissance depends on the establishment of effective safety, security, and safeguards programs; and that openness and transparency, when compatible with national security and non-proliferation objectives, are critical to ensuring safety, security, and safeguards.

Nuclear Renaissance

That there is a nuclear renaissance is clear. Nuclear plants are seen as an excellent source of low carbon energy that is needed to meet the growing domestic and international demand for electricity. Nuclear power is viewed as an alternative to sources with much greater carbon-dioxide emissions and as "clean air" energy. I understand that the climate bill recently considered in the U.S. Senate implicitly relied upon a large number (hundreds) of nuclear power plants in the United States by the middle of this century. Nuclear power will very likely be called on to meet future energy requirements in the United States and worldwide as long as it remains safe and secure. Of course, such plants are supported by other facilities that make up the front and back ends of the nuclear fuel cycle.

Recent developments point toward a nuclear renaissance in the United States:

- In the past year, the NRC has received nine applications for a total of fifteen new power plants and expects three or four more applications for new power reactors by the end of 2008. The potential number of new units anticipated in the foreseeable future is thirty-two, in addition to the 104 power reactors currently licensed to operate.
- Two uranium mills that have ceased operation are expected to resume operation in the future as a result of the increase in the price of uranium.
- The NRC expects as many as twenty-one new applications for conventional milling and in situ uranium recovery facilities in the foreseeable future.
- Construction is underway on two new gas centrifuge enrichment facilities, the Louisiana Energy Services' National Enrichment Facility in New Mexico, whose license NRC issued in June 2006, and the USEC Inc., American Centrifuge Plant in Ohio, whose license NRC issued in April 2007.
- NRC expects two more enrichment facilities to submit license applications in the next two years, GE-Hitachi in North Carolina and AREVA in Idaho.
- NRC is currently reviewing the mixed oxide (MOX) fuel fabrication facility application in support of the Surplus Plutonium Disposition Program and the facility is currently being constructed in South Carolina.
- The (U.S.) Department of Energy submitted its application for the proposed geological repository at Yucca Mountain in June 2008.
- The possibility of reprocessing spent nuclear fuel was reintroduced as part of the Global Nuclear Energy Partnership. NRC would regulate proposed commercial spent fuel recycling facilities and advanced recycling reactors. In anticipation of these developments, the NRC is conducting a first order gap analysis of the existing regulatory framework for recycling facilities.

But the nuclear renaissance is much broader than the United States. In many ways, the global nuclear resurgence is ahead of developments in the United States. Recent headlines reflect the renewed interest worldwide in building nuclear power plants and other facilities that support the nuclear fuel cycle. A sample of international headlines during the last couple of months reflects this resurgence of interest, including:

- "China, India Plan to Build Their Own Experimental Fast Reactors"
- "Italy to Reintroduce Nuclear Power by 2013"
- "Japan Agrees to Help Vietnam Develop Nuclear Power Plants"
- "EU Power Firms Make Urgent Call for Nuke Plants"
- "Jordan, France to Sign Nuclear Cooperation"
- "Syria Says It Wants Nuclear Energy under Arab Umbrella"
- "Congo Seeks Help to Reopen Famed Uranium Mine"
- "South African Cabinet Approves Nuclear Policy"
- "Russia Signs $1 Billion Deal with China to Build Nuclear Fuel Plant"

Many more countries have approached the International Atomic Energy Agency (IAEA) with plans for starting civilian nuclear energy programs and others are interested in all aspects of the fuel cycle, including enriching uranium and reprocessing spent fuel. In fact, the United States and other supplier countries have been approached by forty-five emerging nations for advice and support in developing new nuclear power plants in countries who lack a nuclear infrastructure. Many signs point toward a future with more nuclear facilities, which will present even more challenging safeguards issues than do existing plants.

Obstacles to a Nuclear Renaissance

The nuclear renaissance is not without its obstacles. One obstacle is opposition by stakeholders about nuclear safety, nuclear proliferation, nuclear security, and radioactive waste disposal. Another

obstacle is the high financial cost of constructing new nuclear facilities and developing the necessary infrastructure. It is not sufficient to build and operate just the power plant. Countries also need the engineering and vendor support, access to front and back end support of the fuel cycle, and an effective safety and security regulator. An additional obstacle is the divided focus on operating and proposed new facilities. Competition for resources occurs in various key areas—financial, human resources, political, and national. The challenges are not limited to the United States; they are worldwide. A nuclear event anywhere—an accident, a nuclear explosion, a dirty bomb—could impact the safe and secure use of nuclear material worldwide.

Fears of an increased likelihood of proliferation accompanying a nuclear renaissance present another obstacle. A worldwide nuclear renaissance facilitates proliferation of technology and material to states and non-government organizations. Advances in technology and information management are making it easier to gain access to nuclear technology and material. Acquisition of nuclear weapons capability in Pakistan, India, and North Korea represents a potential destabilizing factor in Asia. Iran's desires could destabilize the Middle East. Some countries appear to want weapons programs as a sign of national pride, and at the same time there appears to be a growing sense of nationalism among states in most regions of the world. A nuclear program is seen by some states as a sign of scientific and technological achievement. Moreover, states have an increased sense of vulnerability as other states acquire nuclear weapons. A nuclear weapons program is a sign of great power. There is also the problem of extra-governmental organizations—namely terrorist organizations—that have openly expressed a desire to acquire nuclear weapons technology. Proliferation concerns figure prominently in international efforts to multilateralize the nuclear fuel cycle and develop proliferation resistant technologies. All of these problems pose a threat not only to international cooperation and diplomacy, but to the resurgence of interest in nuclear power and to the safe and secure use of nuclear material.

The public will demand that government enhance already stringent controls to ensure nuclear safety, security, and safeguards. The three disciplines—safety, security, and safeguards—must work together, if the goals of protecting the public and the environment and promoting the common defense are to be achieved.

Fundamentals of NRC Regulation

The foundation of the NRC program is the law and our regulations, Title 10 of the U.S. Code of Federal Regulations (10 CFR). NRC requirements in 10 CFR provide the necessary controls for safety, security, and safeguards. Before a facility can be licensed by the NRC and receive nuclear material, the operator must demonstrate its capability to meet the regulations and operate safely and securely.

For example, the ability of a fuel processing facility to meet the safety requirements is demonstrated by means of an integrated safety analysis (ISA). Although the primary focus of the analysis is safety, it also helps inform NRC's assessment of the facility's security and safeguards. The NRC licensing process addresses all three disciplines when an application for a license is submitted. In some rare instances, there can be a safety-security tradeoff. For example, the NRC recently proposed new requirements in 10 CFR 73.55 for power reactor licensees to periodically review physical security plans to evaluate their potential impact on safety. Licensees conduct vulnerability analyses for security and diversion path analyses for safeguards. Safeguards are incorporated in the design criteria, as are safety and security. In the case of safeguards at fuel cycle facilities, licensees must develop a written procedure (a fundamental nuclear material control plan) covering all aspects of the safeguards program. This written plan is subject to approval by the NRC prior to issuance of a license to operate and subject to updates, which must also be approved, when certain changes are made to processes. Vulnerability and security assessments provide the basis for security controls and commitments that are documented in security and contingency plans.

The NRC increasingly relies on the use of risk assessment, including integrated safety analysis and probabilistic risk analysis (PRA). However, these techniques distinguish between the random effects inherent in safety-related events analyzed by PRA or ISA. They do not account for deliberate actions that threaten security and safeguards (and sometimes safety). In assessing security and safeguards, conditional PRA and other analyses may be appropriate, in which case the overall risk is contingent on the attack or diversion occurring. For security and safeguards risks, such as the risk associated with loss of material, risk is a function of its usefulness in constructing a weapon.

Licensed facilities are subject to inspection, assessment, and enforcement action from NRC to ensure compliance with the regulations and safe and secure operations. Allegations made by various people, including licensee employees, are investigated by the NRC as potential safety, security, and safeguards concerns. Regulatory guidance and generic communications supplement the regulatory framework to facilitate safe and secure operation. Operational experience is taken into account, and the regulations undergo periodic evaluation. By sharing operational experience, operators and regulators help ensure awareness about potential risks and problems that may not have been considered in the initial or subsequent design and operational assessments. If operational experience indicates deficiencies in the regulations, the NRC modifies the regulations through an open and transparent rulemaking process that encourages participation by licensees and stakeholders.

Although NRC strives for a stable and predictable regulatory framework, the regulations are far from static. In response to the terrorist attacks of 9/11, for example, the NRC issued new orders for physical protection of licensed facilities, expanding the secu-

rity requirements, and undertook a complete review of the MC&A (materials control and accounting) regulations. This adds some uncertainty from a business and legal perspective, but ensures that NRC is achieving adequate protection.

Safety, security, and safeguards are interconnected and an incident that affects one may be a threat to the others. A facility that is not secure and whose material is not adequately safeguarded may not be safe. Security controls protect nuclear material, safety systems, people, technology, and information. Adequate safeguards make possible the detection of loss, unsafe storage, and improper disposal of nuclear material. Safeguards measures make it possible to verify that nuclear material has not been diverted for use in producing a nuclear weapon or for other unauthorized purposes. Knowledge of the location and quantity of material is essential to safe operation of nuclear facilities, including power reactors, fuel manufacturers, enrichment facilities, and storage and disposal facilities. Such knowledge is also essential for the protection of the public health and safety. The NRC adheres to "defense in depth" and this applies to all three disciplines, safety, security, and safeguards.

The NRC and its licensees are continuously looking for safety, security, and safeguards enhancements consistent with NRC's strategic goals of ensuring adequate protection of public health and safety and the environment and ensuring adequate protection in the secure use and management of radioactive materials. The NRC constantly evaluates the adequacy of its programs in light of operational experience, technological development, and advances in capabilities and motivation.

NRC Safeguards Approach

Turning now to the specific area of safeguards, the NRC safeguards program for domestic uses of special nuclear material is part of this wider integrated approach. The NRC safeguards program fulfills the requirements of the Agreement Between the United States and the International Atomic Energy Agency (IAEA) for Application of Safeguards in the United States. Parties subject to safeguards agreements are required to open their nuclear material accounting records to inspection by the IAEA and their systems of control must be transparent.

The NRC safeguards program and the Atomic Energy Commission's (AEC) predecessor program have evolved over five decades in response to a variety of factors and significant events. The initial approach to safeguards for special nuclear material was the single requirement that licensees keep records of receipt, inventory, and transfer of special nuclear material. The approach was based on the assumption that the high financial value of nuclear material would cause licensees to account for it and maintain control over it. The vulnerabilities associated with the assumption soon became evident. Following losses at NUMEC identified in 1965, greater emphasis was placed on preventing loss of material and discouraging diversion, and in 1967 the AEC issued the material control and accounting regulations that form the basis for the regulations in existence today.

Other instances of material that could not be accounted for occurred during the 1960s and 1970s. These incidents climaxed in an apparent loss of material at Nuclear Fuel Services in the late 1970s, and led to the Material Control and Accounting Reform Amendment and creation of stand alone requirements in 10 CFR Part 74, where most of NRC's MC&A regulations reside today. These regulations addressed the need to account for and control nuclear material not only when stored, but also during processing. They took into consideration the risk significance of the material and resulted in stricter regulations for accounting for and controlling material whose risk significance was greater. The requirements in Part 74 represent some of the earliest "risk informed" requirements issued by NRC, although the term only emerged formally more than a decade later.

Problems with material control identified at Millstone nuclear power plant in late 2000 associated with the licensee's inability to account for all of its spent fuel led to reinstatement of the safeguards inspection program for nuclear power plants, which had been discontinued in the late 1980s because of a lack of inspection findings. The NRC reviewed the existing regulations for reactor safeguards and concluded that they were adequate. However, the experience reinforced the lesson that periodic inspection is an essential part of NRC's regulatory process. Today, the NRC is incorporating safeguards in the reactor oversight program (ROP) and developing a significance determination process (SDP) for evaluating the significance of reactor safeguards inspection findings.

The NRC material control and accounting requirements feature three basic elements that apply to licensees who possess special nuclear material:

- Licensees are required to maintain complete records of all material transactions including receipt, location and quantity, inventory, disposal, and shipment;
- Licensees establish and follow accounting and control procedures; and
- Licensees perform periodic physical inventory listings of all material, including comparison of the results of the physical inventory with the book inventory records.

The foundation of the safeguards program is accurate and complete records of all transactions involving special nuclear material, including receipt, location and quantity, inventory, disposal, and shipment off site. These records must be auditable, which means that they are open and transparent to the regulator and other parties who have the right to know the information (e.g., potential buyers of the nuclear power plant). In addition to implementing a program with these basic elements, licensees must report possession and transfer of special nuclear material to the national database, the Nuclear Material Management and Safeguards System (NMMSS).

Facilities that process special nuclear material must also submit to the NRC for approval a plan for:

- Establishing measurement quality control and assurance programs,
- Assuring that all nuclear material amounts in the physical inventory are measured values,
- Evaluating and resolving differences between the book and physical inventories, and
- Establishing a distinct cut-off between inventory periods.

These basic elements have remained unchanged since the material control and accounting regulations were issued in 1973.

The Reform Amendment, which NRC issued in 1991, placed additional requirements on fuel processing facilities. Facilities that process low-enriched uranium are required to establish programs to perform frequent tests to ensure the accuracy of item control records that list item locations. Facilities processing high enriched uranium and plutonium are required to establish more extensive programs for monitoring and controlling material between physical inventory listings. The magnitude and complexity of the program is directly related to the security and safeguards risks associated with this nuclear material. Material in process is monitored using statistical process control techniques, consisting of frequent calculation of the difference between process input and process output and comparison to historical average input-output differences and standard deviations. In addition, items are monitored using statistical loss detection methods.

Safeguards Guidance

Although the NRC regulations for MC&A safeguards are undergoing review and analysis, we can expect these basic elements to remain the same. The practices developed and implemented at NRC domestic nuclear facilities have proven effective. As with other parts of NRC's regulatory framework, the NRC complements the regulations periodically using guidance and generic communications, such as Information Notices, Generic Letters, Bulletins, and Safeguards Advisories. Recent inspection findings for fuel processing facilities and Information Notices have emphasized the connection between safety and safeguards. Although we know that licensees understand this connection, we have repeatedly seen how knowledge of problems and solutions can become "stove piped" within separate organizational units who focus solely on safety or safeguards or security. We work daily within the NRC to foster the necessary communication to avoid this kind of stove piping.

For example, in 2005 NRC issued an Information Notice (IN 2005-22) informing licensees of the importance of maintaining open communication between criticality safety and safeguards personnel at licensee sites. This Information Notice described a case where licensee safety personnel had missed indications of degraded conditions because of inadequate communication between safety and safeguards personnel. In the example, which involved an incinerator, the licensee's criticality safety analysis of the incinerator had concluded that very limited amounts of ash would carry over from the incinerator primary combustion chamber to the remainder of the incinerator system and that mass controls on the primary combustion chamber would limit uranium concentration in the ash throughout the incinerator system. However, licensee MC&A staff possessed sampling data showing concentration levels above the established limits in some parts of the incinerator system. In addition, the licensee MC&A staff was aware from approximately fifteen years of operational experience that substantial amounts of fissile material routinely accumulated in parts of the incinerator system where criticality analysis assumed only minimal accumulation. The material accumulation event was identified when a licensee criticality safety engineer reviewed MC&A sampling data. Fortunately the problem was identified before an accident occurred. The NRC considered the circumstances serious enough to inform all fuel processing licensees about the importance of open communication between safety and safeguards. The problem could have been avoided if communication between safety and safeguards personnel had been more open and effective.

Another example of the importance of establishing and maintaining effective communications between safety and safeguards personnel is the nitric acid spill that occurred at the THORP reprocessing facility in the United Kingdom. According to open source reports, the large leak that occurred within the process cell was identified as early as August 2004 based on safeguards calculations. However, operations staff remained unaware of the concerns until April 2005. Open and effective communications between safeguards and operational staffs could have led to an earlier identification and resolution of the problem.

Open communication between security and safeguards personnel is also important. NRC security and safeguards inspectors compare inspection findings to determine if inspection findings in one area affect the other area. Incidents that could have led to loss of material—but that were discovered before actual loss of material occurred—are investigated from both security and safeguards perspectives. As an example, one incident involved a licensee's failure to make a record of material that was transferred from a processing unit to a storage area; another incident involved a licensee's failure to secure material in a storage area, leaving it instead on a transfer cart overnight. In both instances the NRC took enforcement action against the licensee for violating both safeguards and security requirements.

As safeguards problems were identified in the past—even the recent past—the NRC has resolved them by revising regulations, issuing a generic communication (usually in the form of an information notice), and reinstating or revising the inspection program. A safeguards program cannot be static, but must be maintained through constant review in order to meet future chal-

lenges. The same is true for safety and security. This is part of the journey that we have travelled. Our experience on the journey prepares us for meeting future challenges.

Effective Safety, Security, and Safeguards

To accomplish our regulatory mission, safety, security, and safeguards need to work together effectively. The ideal is recognition of the inter-connectedness and the interdependence of all three disciplines. Physical security depends on MC&A safeguards to provide knowledge of the location of nuclear material. MC&A safeguards and safety depend on physical security to protect nuclear material and limit access to it. Nuclear safety depends on MC&A to quantify material, thus providing the knowledge necessary to ensure safety. MC&A personnel depend on safety to ensure safe storage and use of nuclear material. The three disciplines must work in a complementary manner.

The effectiveness of safety, security, and safeguards programs can be limited by artificial barriers imposed by the organizational culture or structure. For some organizations, safety and safeguards are closely linked and placed in the same part of the organizational structure. In others safety and security are in the same organization; in others security and safeguards are more closely linked. If an apparent conflict arises in satisfying a requirement in one area that contradicts a requirement in another, operators and regulators should work together to achieve "net best risk." Effective communication and cooperation between safety, security, and safeguards personnel are essential to protect people and the environment.

Before a nuclear power plant or fuel cycle facility in the United States receives a license to operate, the operator must demonstrate that it has in place effective measures that will ensure safety, security, and safeguards. Authority to develop a nuclear program or operate a nuclear facility should be contingent on a firm commitment to establish and maintain effective safety, security and safeguards. Imposition of penalties for failure to abide by the rules—even possible shutdown—is part of the NRC regulatory program. U.S. commercial facilities pay for the regulatory program, including licensing and oversight, through fees imposed by the NRC. This system of independent regulation is consistent with both the IAEA Safety Fundamentals and the Convention on Physical Protection of Nuclear Materials. Comparable systems should be in place in other countries who wish to use nuclear energy for peaceful purposes.

The success of the nuclear renaissance worldwide will be contingent on ensuring the effectiveness of safety, security, and safeguards programs at all nuclear facilities. Decision making by states, regulators, and operators needs to reflect a strong commitment to safety, security, and safeguards. Nuclear energy is viewed differently by the public than the use of other technologies that may pose greater risks to society. A strong regulatory framework is essential to covering all three disciplines, with emphasis placed on defense in depth, risk assessment, and tried-and-true techniques.

Openness and Transparency

Safety, security, and safeguards, however, are not sufficient alone. The public will demand openness and transparency. Openness and transparency are key to public acceptance of the peaceful uses of nuclear energy, provided they do not contribute to proliferation or threaten security, safety, and safeguards. Openness and transparency make good business sense, too.

With growing interest in recycling, new reactors, new fuel processes, and new enrichment facilities, it is essential that operators, regulators, and governments address the potential problems inherent in this rapid expansion. At the NRC, we value openness. Improved communication with the public and other stakeholders is essential as we move forward.

Nuclear regulation is the public's business. This principle was first stated by Williams Anders, the first chair of the NRC, in 1975, when the United States was undergoing an earlier nuclear renaissance. Anders identified openness along with independence, efficiency, and effectiveness in what eventually came to be known as the "Principles of Good Regulation." The NRC involves stakeholders in the regulatory process. The NRC promotes openness and transparency while protecting sensitive information, whose release would be damaging to the national defense or security, and proprietary information whose release would endanger the economic competitiveness of its licensees.

NRC has identified openness as one of our organizational effectiveness objectives. The NRC Strategic Plan says this means that "NRC appropriately informs and involves stakeholders in the regulatory process." The NRC programs are carried out as openly as possible to maintain and increase public confidence. The NRC holds meetings with the public and other external stakeholders to keep them informed, allow them the opportunity to participate in the regulatory process, and to encourage public understanding of the decision making process. A stated NRC openness strategy is to provide for "meaningful stakeholder involvement in [its] decision making without disclosing classified, safeguards, proprietary, and sensitive unclassified information. The NRC recognizes that some information should not be shared, such as information that could be exploited by a terrorist or rogue state. While we strive to be open, we must balance openness with safety, security and safeguards concerns. This means achieving openness without creating a threat to the public health and safety or to the common defense and security.

Safety, security, and safeguards records also need to be accessible to the public to the extent that they do not reduce programmatic effectiveness. Safety, security, and safeguards records also need to be transparent. Records that are not transparent are not inspectable. By transparent, I mean the records are complete, obvious, available for review, and readily understood by knowledgeable individuals. In the safeguards area, NRC licensees are required to keep records showing the receipt, acquisition, inventory, transfer, and disposal of all special nuclear material, to maintain those records, and to retain them for three years following

transfer or disposal of the material, regardless of the origin of the material or how it was acquired. The records must be detailed and transparent. Nuclear material records worldwide should be transparent and open to international authorities.

Domestic nuclear facilities in the United States are subject to what some consider an intrusive oversight program, including inspection, assessment, and enforcement. This program extends equally to safety, security, and safeguards. Licensee programs are required to be open and transparent to the NRC inspector. This approach can serve as a model worldwide in order to ensure that facilities operate safely and that material is not diverted to weapons use.

To counter the threat that exists and may grow as the nuclear industry expands, safety, security, and safeguards rooted in adherence to international laws and treaties are essential, as are programs that are open and transparent and that exist in an effective regulatory framework. In addition, operators and regulators around the world can contribute to safety, security, and safeguards by sharing operational experience and "best practices," while ensuring protection of the most sensitive information that could undermine these fundamental goals if it is disclosed to individuals and organizations dedicated to destruction.

Will the global nuclear renaissance be realized or will it succumb to concerns about safety, security, or proliferation? Many countries are willing to share nuclear technology. That is all the more reason to establish the safety, security, and safeguards controls needed to protect people and reduce the threat. Before states, organizations, or individuals acquire nuclear technology or material, effective safety, security, and safeguards controls are necessary, with effective regulatory controls that ensure openness and transparency, while protecting the release of sensitive information and technology that could undermine these goals. The right to use nuclear material must be contingent on establishing and maintaining effective safety, security, and safeguards controls.

Conclusion

Thanks for journeying with me on the path ahead for safeguards. We bear the burden as nuclear operators, nuclear regulators, and other nuclear professionals to ensure the safety, security, and safeguards for nuclear material. As safeguards, security, and safety professionals, we are called on to assist in establishing the necessary controls to achieve these fundamental goals.

What is your role in the nuclear renaissance? How will you enhance safety, security, and safeguards? This is the challenge that confronts us today. Your answers may help shape the program fifty-one years from now for the 100th Annual Meeting of the INMM. Remember, keep nuclear materials safe and secure.

The World Institute for Nuclear Security (WINS)—From Concept to Reality

Dr. Roger Howsley, Consultant
Nuclear Threat Initiative

I should like to thank the INMM for this excellent opportunity to bring the annual meeting up to date on the World Institute for Nuclear Security, WINS, a new international forum to be formed for nuclear security professionals to exchange best practices, with the aim of improving nuclear security worldwide.

I also hope it will be an opportunity to seek your views and ideas, given the vast experience and knowledge in this room and that WINS will provide a forum for you to promote and share your own areas of excellence.

(INMM Past President) Jim Tape gave the INMM Annual Meeting an update on behalf of the WINS Coordinating Committee this time last year in Tucson and it is my privilege to do so this year on behalf of the Coordinating Committee, consisting of Corey Hinderstein, Joyce Connery and, of course, Jim Tape.

I have spent most of my career as a nuclear security director and chair of the police force responsible for the dedicated armed response at nuclear sites in the UK, and in my opinion it really is time for those in the nuclear security field to create more of the opportunities for professional development and dialogue that are so taken for granted by our colleagues in the field of nuclear safety. We have a great deal to learn from their techniques of learning from experience, sustaining operational excellence, and promoting a strong safety culture, as I hope to begin to illustrate today.

So, if I may, I will summarize the WINS journey so far.

Let me say at once that the INMM, NTI (Nuclear Threat Initiative), and the U.S. DOE (U.S. Department of Energy) have been central to this program. It is they that have had the vision to promote the ideas behind WINS. It is they that have thought through the benefits of such an organization. It is they that should be congratulated for their contribution to such an important subject as nuclear security.

The journey started when NTI and the INMM decided to collaborate on a nuclear security best practice workshop in Prague in June 2004. The following year, NTI President Charles Curtis challenged the INMM to help establish a mechanism to share best practice in a structured and sustainable way and it was a committee of INMM Fellows who identified and proposed in December 2005 that the World Institute for Nuclear Security be so named and formed. Subsequently, a tripartite WINS Coordinating Committee was established, consisting of INMM, NTI, and DOE.

This team recognised immediately the importance of early consultation with the IAEA (International Atomic Energy Agency), which has its own, very successful security program. I had the honor last November to be asked by the IAEA to chair a review of its security program, looking back to 2002 when it first started, and forward over the next few years. I can tell you that the IAEA security team, under Anita Nilsson's leadership, is doing and has done a fantastic job. But they would be the first to say that they have limited resources based on voluntary member state contributions and have focused their interactions, quite understandably, with member states. We jointly believe that what is necessary is outreach to operators and facility licensees, both governmental and private, who are almost always the organizations that are legally responsible for security.

The IAEA was one of the participants at a WINS workshop held in Baden, Austria, in November 2006 to discuss the concept of WINS and also attended a follow-up event in Washington, DC, in September 2007 to consider what the WINS organization might look like, how it might function, what it might cost and who would fund it. The WINS team has kept in close contact with the IAEA and intends to collaborate and cooperate with the IAEA in future, to one another's mutual benefit.

Last autumn, October 2007, the Norwegian government offered to work with the Coordinating Committee and host an international workshop on security best practices at research reactors fuelled with highly enriched uranium, using a WINS-type format. Feedback from that workshop was excellent and the participants went away with new ideas to consider and implement.

And that brings us to 2008. I was delighted to be asked to join the Coordinating Committee in March and we have been jointly developing and reviewing the proposed modus operandi for WINS during the spring. The current status of the program is that the NTI Board of Directors confirmed in April that it would provide WINS with a foundation grant to allow it to be established as a not-for-profit organization based in Vienna, and there have been pledges of support from other organizations. We are continuing to talk to governments and organizations around the world that have responsibilities for security to gauge their interest in participating in and supporting WINS and the response has been encouraging. And we have now instructed lawyers to begin the legal proceedings to establish WINS over the weeks ahead. Subsequently, we will be setting up business premises, business

systems and recruiting the necessary staff, so it is an interesting and busy time for WINS.

It was particularly gratifying last month to receive formal endorsement for WINS from the Director General of the IAEA, Dr. Mohammed ElBaradei.

Dr. ElBaradei has expressed his support and endorsement for WINS, "confident that establishing a forum to help share and promote best practices ...will improve nuclear security and contribute to and complement the efforts of the IAEA."

And I would like to tell you about some of the other support that we have received from private companies, regulators, and government owned organizations. It has been interesting to see the reasons for support, each organization viewing WINS from their perspective and how WINS could add value to and benefit their organization, in addition to a feeling that WINS will contribute to a greater sense of confidence in the security arrangements elsewhere in the world.

Let me start with my home team in the UK. The Nuclear Decommissioning Authority (NDA) is the organization that now owns nineteen nuclear sites in the UK; sites previously owned and operated by BNFL and the UKAEA. In total, the sites store and process more than 100 tons of separated plutonium and three tons of highly enriched uranium, as well as a very significant proportion of the total nuclear waste legacy in the UK. The NDA is currently selecting contractors to manage the sites on its behalf, very much as does the DOE on its sites.

The NDA has a legal responsibility to satisfy itself that its contractors are using best practices in discharging their contractual commitments and sees WINS as a forum for helping identify better implementation methods. In that sense it sees WINS helping the NDA discharge its own responsibilities. And given that we are seeing an increase in the international composition of the contractors teams bidding for work in the UK, with joint teams from the United States, from the UK, from France, for example, it makes increasing sense to think about security implementation in an international context, with the best international practices being adopted to meet nationally defined regulatory requirements.

And the opportunities for international benchmarking are growing all the time given that an increasing number of contractors and suppliers service the international nuclear market. The Finnish nuclear regulator (STUK), which strongly supports WINS, has highlighted that the construction of the Finnish EPR reactor involves more than 1,000 companies from more than twenty countries. So international comparisons and benchmarking will become the norm, including for security.

Secondly, let me highlight the supportive remarks of the chair of British Energy, the operator of all but two of the UK's nuclear generating stations. Sir Adrian Montague rightly identifies the immense benefits that have been derived by British Energy from being a member of WANO, the World Association of Nuclear Operators, and the realization that a safety event anywhere in the world will impact public confidence, regulatory attitudes, and investor sentiment, affecting every industry participant.

He notes that the ability to share good security practice has in previous times been more the prerogative of the regulators but that WINS has the potential to fill the gap in international cooperation, providing an effective and trusted means by which operators could work together to deliver a more secure industry, particularly as the nuclear industry once again moves into an investment phase.

And this last remark concerning investment is extremely important.

Few people would challenge the role of the IAEA to establish the international framework of security guidelines and recommendations, or the role of governments to set security policy or national authorities to regulate the nuclear industry. But there is something of which we must not lose sight.

A significant percentage of the existing nuclear reactors, enrichment, conversion, and fuel fabrication facilities in operation today is owned and operated by private companies and the international trend is one of increasing privatization of nuclear operations. Private companies with private shareholders—shareholders that have invested hundreds of billions of dollars in their facilities and that are now looking to finance the predicted expansion of nuclear power in the decades ahead. Huge financial investments will be necessary and the financiers will demand a thorough and comprehensive risk assessment, particularly given the concerns over terrorism, which is also increasingly international in nature. So confidence that the security arrangements are effective and efficient and properly benchmarked should become the norm.

These organizations will be already benchmarking almost every aspect of their operations with international best practice, whether it's the implementation of finance systems, safety culture, or management development. So extending this to security should be relatively straight forward once WINS is established and able to provide a forum for such discussions.

We also need to begin to challenge some of the reasons why security can sometimes seem isolated from mainstream activities in organizations and to try and integrate security management as much as possible so that it benefits from well-developed managerial techniques. We need to appreciate that the attributes of good security management are little different from any other sector of management. Those attributes include strong leadership, partnership, clarity of purpose, being performance orientated with performance metrics, and having appropriate resources. And we must try and eradicate the attributes that can damage the effectiveness of the security arrangements, which include having a reactive or complacent attitude, being only rule and procedure based, compliance without testing, and a lack of resources and ownership by those legally accountable for security.

The legal accountability and ownership of security performance are of fundamental importance. Those familiar with nuclear

safety will know that the weakest form of safety culture is one where the licensee only ever does what the regulator tells it to do—there being no evidence of ownership. By contrast, the strongest form of culture is one where individual employees and contractors that work for the organization are the ones that own safety and constantly act with it in mind. We should not use the size of the nuclear safety regulator or the size of the corporate safety department as the most important metrics to define safety performance. At the end of the day, what matters most is an ingrained safety culture on the ground, at the workplace, when people are unsupervised and behaving instinctively with high safety standards. Doing the right things for the right reasons.

The parallels are evident for security. In most states, security is hierarchical, from government to regulator, regulator to operator, with the regulator frequently having a dominant role in defining not only what has to be done but also how it has to be done. We need to think carefully about if this top down, vertical compliance structure is the right model, or whether a more enlightened approach would be more effective, based on teamwork and collaboration, seeking and implementing best practice, to achieve the common goal of effective security. Words like partnership, mutual respect, consultation, and performance testing come to mind.

None of this erodes the power of the regulator but draws attention to the responsibility of the licensee board to protect their investments and to take ownership of security performance.

That starts with good corporate governance, because nearly all boards of nuclear organizations, whether in the private sector or in government, have a legal duty to assess risk and take appropriate measures to mitigate risk. And from that should flow a variety of activities driven by the board to oversee the quality of security, including, importantly, learning from experience inside the organization and from peers outside the organization facing the same or similar issues.

These are some of the issues that WINS wants to encourage and promote, though ultimately the activities of WINS will be driven by its members; details about membership are provided in the WINS FAQ document. Topic areas for best practice themes could include corporate governance arrangements, the definition of security performance metrics, how to develop a strong security culture, how nuclear materials management methods can assist with good security and one that I want to focus on today—encouraging members to promote their own areas of excellence. I have no doubt whatsoever that this audience is full of individuals that have an enormous amount to offer to help improve security. So my questions to you would be, in the context of WINS,

- What does your organization do that is best of breed?
- What special skills or knowledge do you have that could be transferred to other organizations to help improve security?
- Where do you need assistance with an improvement area and do you know who to go to?
- How can you help WINS to help others?

The formation of WANO was in response to the Chernobyl disaster. The formation of INPO (the U.S. forerunner of WANO) was a reaction to Three Mile Island. We must not wait for a dirty bomb, a sabotage attempt, or worse before we take collaborative action to improve security and share best practice.

WINS is expected to be in business by the end of the 2008. I sincerely hope that you will become involved via your organizations to make it the success that it needs to be.

And finally let me address the issue of whether discussing good practice is in itself a risk to security.

Theoretically, there may be a risk. As John F. Kennedy said, "There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction."

We need to remember that international bilateral meetings between organizations have taken place for many years to discuss security issues. I have taken part in many such meetings but in general haven't found them to be the most efficient or efficient method for identifying sustained improvements to security.

During my time with BNFL we conducted a national stakeholder dialogue over a period of six years between 1999 and 2005 covering many aspects of our operations, and some of the participants wanted a dedicated working group on nuclear security, which was formed as a result. We met over a period of nearly two years, including people with strongly held anti-nuclear views. Let me quote from the summary of the final published report, which was a consensus of everyone involved in the group:

> "The Group's purpose and hope was to contribute to the improvement of the security of BNFL's plant and activities, including in particular the transport of nuclear material, by the production of a quality review, using stakeholder dialogue, unique in this security context. The report is the fruit of rare collaborative effort on the part of a number of individuals from a variety of backgrounds with many differences in outlook. Notwithstanding that such differences in view were so divergent that in some instances they appeared to fully contradict each other, the group has produced what it considers to be a constructive and forward-looking contribution to the manner in which security is provided for BNFL's activities. This report is now accepted and fully endorsed by the full body of the BNFL National Stakeholder Dialogue."

So the fact that we were able to discuss security and publish a considerable report with some sixty recommendations under these circumstances is, I think, evidence that properly facilitated meetings can be very productive and need not compromise security in any way. As a consequence of the working group, BNFL changed and improved some of its security arrangements.

So this feeling that we need a more active network of practitioners working on a variety of themes, to drive forward and to promote and share best security practice in a sustained

manner is a view also shared amongst the international community, which is looking for greater international collaboration on nuclear security.

WINS is entirely consistent with the purposes and methods of the Global Initiative to Combat Nuclear Terrorism, which was founded by the United States and Russia in 2006 and now counts seventy states among its members.

One of the guiding principles of the Global Initiative to which states have agreed is as follows:

"Participating in or hosting expert-level scenario based exercises to test capabilities, develop new operational concepts and enhance preparedness, as well as expert-level workshops to share best practices and develop means for the rapid exchange of technical and operational information among participating states under the condition of appropriate protection of the confidentiality on any information exchanged in confidence."

WINS exists to help achieve these objectives, and will meet the test of confidentiality.

So as we look forward, we are looking for champions and leaders to help set the nuclear security agenda for the future.

We are looking to the future with confidence and determination.

And we look forward to a continuing collaboration with INMM, thank it for its support and wish it well as it enters its second half century.

Thank you for your attention.

J. D. Williams Student Paper Award Winner

A High-Voltage Piezoelectric Transformer for Active Interrogation

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Abstract

Detection of nuclear or fissile materials is made difficult due to the speed, quantity, and variety of entrance points of transported goods in a global market. Inspecting transported goods under these conditions requires a convenient and portable device that uses proven methods. Active nuclear detection can be performed by using neutrons to induce a nuclear reaction in a radioactive material, which can then be detected by an appropriate sensor. The University of Missouri is developing an ultra-compact deuterium ion accelerator to induce D-D fusion as a source of neutrons for detection purposes. The accelerator utilizes a lithium niobate piezoelectric transformer capable of producing a 100 kV output when driven with a low radio frequency resonant voltage. The transformer is a Rosen-type transformer composed of a rotated y-cut polarized rectangular crystal, with the primary voltage applied through the crystal's thickness and the secondary developed along its length. The transformer will be used to supply and accelerate deuterium ions by field emission from a tip attached to the crystal's output electrode. The deuterium ions then impact a deuterated target inducing a $D + D \longrightarrow {}^{3}He + n$ reaction. Advantages of this circuit include low power consumption, quick turn on, and compactness. The piezoelectric transformer characteristics have been measured and are presented along with the design of the neutron source.

Introduction

In order to prevent the unauthorized transportation of nuclear or fissile materials, especially special nuclear materials (SNM), through common shipping routes, detection methods must be implemented. Detection of SNM is difficult due to both the speed of transported goods, and the variety of entrance points in a global market. The large volume of goods shipped to the United States provides ample opportunity for nuclear or fissile materials to be hidden inside shipping containers.[1] Fast, reliable, and portable methods for detection of SNM must be developed to protect the United States from attack.

While it is possible to detect the natural emission of neutrons and gamma rays from both ^{235}U and ^{239}Pu, the decay products can be attenuated by objects between the initiation source and the detector.[2] As a result, passive scanning of a fissile material may be inaccurate. Alternatively, active interrogation provides a method to cause fission reactions and increase radiation such that detection of SNM inside of containers is much more likely.[3] Many techniques for active interrogation have been considered.[4-6]

One method that has produced positive results is neutron active interrogation. By introducing neutrons from various sources to SNM, specific fission reactions take place producing signature neutrons and gamma rays.[7] This can make detection possible even in shielded containers. Some of the forms of neutron active interrogation are discussed in Reference 8. Neutron active interrogation is scalable and can be used in smaller scale detection applications such as at post offices or office buildings, or in larger scale detection applications such as at shipping ports.

A deuterium-deuterium (D-D) fusion reaction can be used to produce neutrons of an appropriate level for active interrogation.[9] This reaction can result by creating and accelerating a deuterium ion into a *deuterated* target resulting in ^{3}He plus one ~ 2.5 MeV neutron. In order for D-D fusion to occur, deuterium ion energies of at least 30 keV must be reached.[10]

Several portable systems to create neutrons have been designed for use in active interrogation,[3] however new methods are being researched.[11] Recent publications have described the use of pyroelectric properties of specific crystals to create the deuterium ions necessary for D-D fusion.[12] This process creates field emission by thermally stimulating pyroelectric crystals as described by Rosenblum.[13] The pyroelectric properties of specific crystals generate large electric potentials, which are used to drive a field emitting tip for ion production.

The piezoelectric properties of lithium niobate ($LiNbO_3$) crystals have also been used for ion production.[14] A Rosen-type piezoelectric transformer (PT) can be used to create high electric potentials on an output electrode.[15] Simulations have shown that with a specific geometry, 100 kV can be produced on the output electrode with less than 1 kV applied. A field emitting tip fixed to the output electrode can be used to field ionize deuterium gas. The potential is then used to accelerate the ion into a *deuterated* target resulting in D-D fusion. In this paper the design and early experimentation of a Rosen-type PT for integration into a neutron source is presented. The proposed neutron source is an accelerator based neutron source for active interrogation that is very compact, has low power consumption, can be turned on quickly, has a high neutron yield and is relatively inexpensive.

Theory

The neutron generator consists of a driving circuit, a PT, and an ion diode. With a field ionization source applied directly to the secondary of the transformer, the input power can be scaled and ions can be produced and accelerated in one integrated unit. By then using a metal hydride target, significant neutron yields can be produced in a simple and cost effective system. A schematic of the neutron generator is shown in Figure 1.

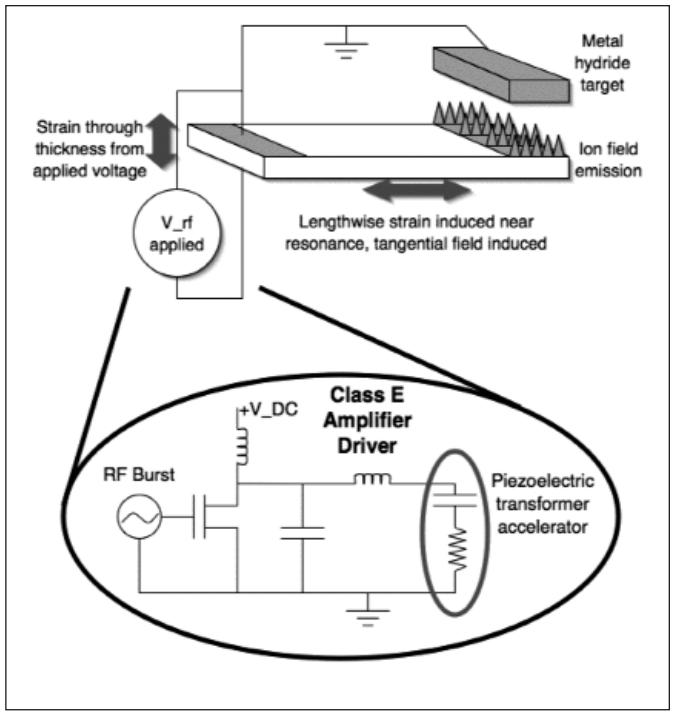
At the heart of the generator is a PT to develop the large voltages necessary for accelerator neutron sources. The piezoelectric material is a poled, single crystal of lithium niobate; it transforms low-voltage radio frequency input to high-voltage output. A rotated Y-cut crystal is used to maximize transformer output. Input electrodes are placed across the thickness at one end of an elongated rectangular crystal. When excited with radio frequency voltage, strain is induced through the thickness of the crystal. If the frequency corresponds to the mechanical vibration resonance in the longitudinal direction, the thickness-oriented strain induces longitudinal strain. This longitudinal strain in the lithium niobate results in a voltage being developed along the length of the crystal.

The input driver circuit consists of an oscillator circuit driving the gate of a MOSFET switch that resonantly excites an RLC circuit. The oscillator circuit is a variable duty cycle burst oscillator, which can output bursts of rf near the piezoelectric resonance, at repetition rates from 10 Hz to 2,000 Hz. This enables duty cycle control of power consumption and average neutron yield. The oscillator drives a MOSFET that resonantly excites an RLC tank circuit, with a resonant frequency near the piezoelectric resonance of the transformer. Since the input portion of the transformer is a capacitive circuit element, it serves as the capacitive element in the tank circuit. The circuit is then fed by DC input power from a battery or power supply.

The ion diode consists of an ion source and a target, and is either deposited on or electrically connected to the high voltage end of the piezoelectric transformer. The ion source can either be an ion field emission source or a surface flashover source. The produced ions are then accelerated across the gap to impinge on a grounded target containing the desired target atom, in this case deuterium.

In order for ion emission from a PT to occur, a high electric potential must be developed on an output electrode. To determine the conditions under which ion emission by piezoelectricity occurs, the PT was simulated using ATILA finite element code.[16] Simulations were performed with a Rosen-type PT driven through the thickness with the output potential developed along the length of the device. The results of the simulation are shown in Figure 2. The simulated transformer ratio is 300 indicating that 100 kV can be generated with 350 $V_{applied}$.

Figure 1. Schematic of the piezoelectric transformer accelerator neutron generator



Experiment

The first step in making a piezoelectric driven neutron source is to build a transformer that can provide the appropriate electric potential. Aluminum electrodes were attached to a $LiNbO_3$ crystal by aluminum evaporation. The direction of polarization with respect to the electrodes is shown in the experiment diagram in Figure 3. A 50 Ω signal generator was matched to the higher impedance of the crystal with an impedance matching transformer. Current and voltage were measured at the input of the crystal with a Pearson 2877 current transformer, and a Tektronix 10 MΩ voltage monitor. The output voltage was measured on a variable impedance capacitive probe over a range of 3 to 15 MΩ. The voltage was applied in bursts of 1,000 cycles with control over the applied frequency and voltage amplitude.

Piezoelectric transformer performance also depends highly on the driving frequency. As the frequency of the applied signal approaches an acoustic resonant frequency, the electrical energy is more efficiently coupled into mechanical energy. The resonant frequencies depend on the dimensions and material properties of the PT. Near resonance the input impedance is very small. There are also associated anti-resonances at which point the input impedance is large. Figure 4 is a simulation that predicts the location of the resonant frequencies for different modes of the device after taking into consideration the materials and dimensions used. The intersection points, ω_1 and ω_2, represent half and full wavelength resonant frequencies where a half and full acoustic standing wave are created in the crystal. The asymptotes represent anti-resonance.

Figure 2. ATILA simulation of a Rosen-type piezoelectric transformer. a) $V_{applied}$ is placed across the primary of the transformer and surface potentials are generated along the length of the bar. b) Simulation of one geometry using lithium niobate. The magnitude of voltage multiplication is labeled.

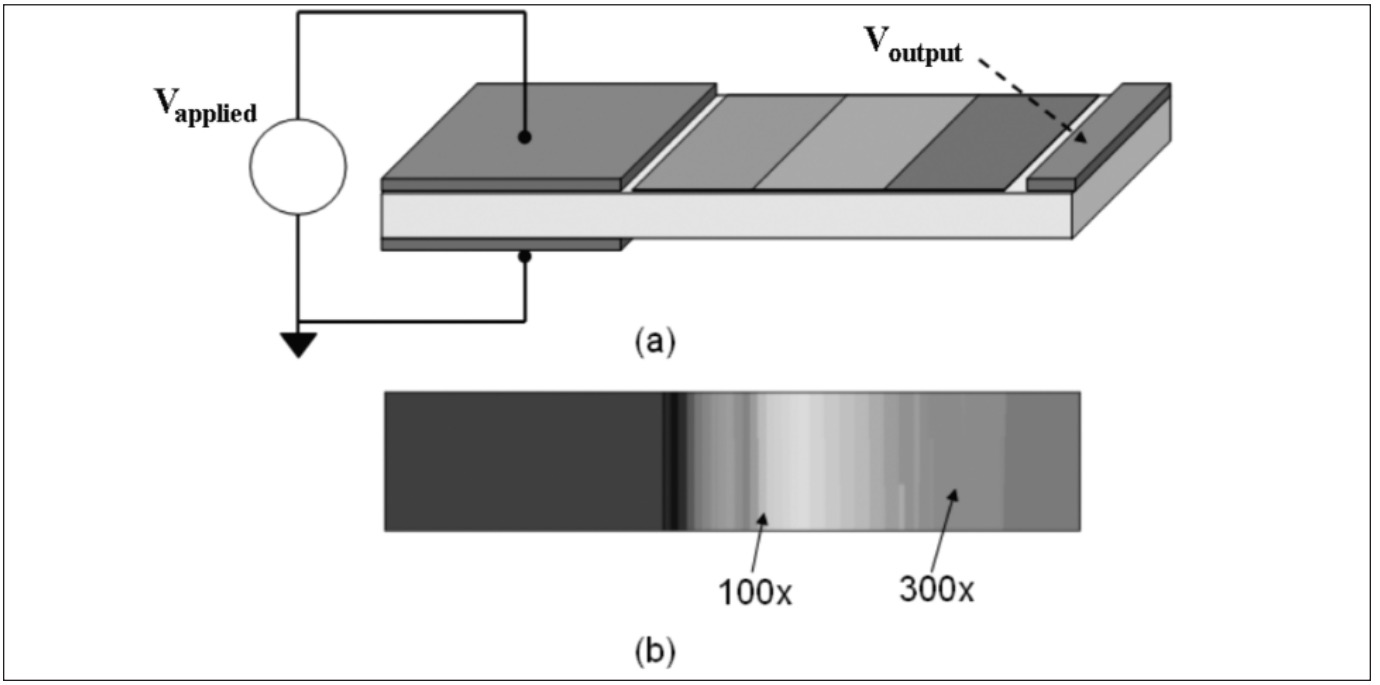
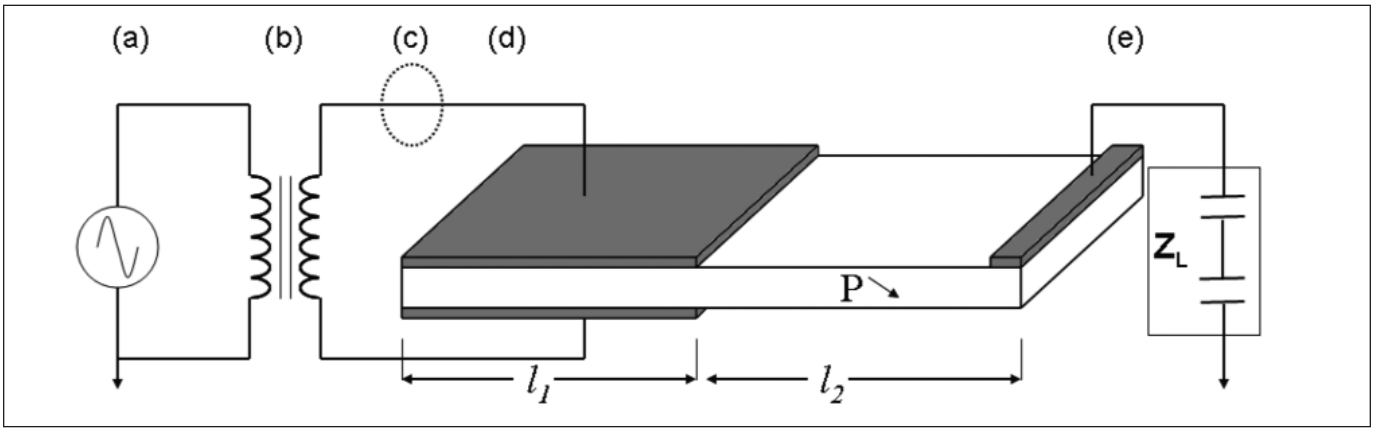


Figure 3. Diagram of setup with electroded crystal. The input and output dimensions are labeled l1 and l2 respectively. a) signal generator, b) impedance matching transformer, c) current transformer, d) input voltage monitor, e) variable impedance capacitive probe



The input impedance was measured over a range of frequencies that included the half wavelength resonance. These results are shown in Figure 5. A drop in the measured input impedance occurred near the expected resonant frequency within about 2 kHz. Moving from low to high frequency, low impedance near the resonance is followed by a region of high impedance representing anti-resonance. The close match between the measured and expected resonant frequencies indicates that the actual transformer is performing as predicted. The range of frequencies near the half wavelength mode will encompass the most interesting experimental results.

The highest output voltage of the transformer can be expected near resonance. The input and output voltages were measured over a range of 40 to 50 kHz. The transformer ratio was then calculated over that region. Using an applied voltage of about 40 V_{pp} output voltages of 8 kV_{pp} were measured demonstrating a voltage gain > 230. Figure 6 and Figure 7 display the output and transformer voltage ratio near the first resonant frequency. At resonance, as the input impedance drops, the driving circuit has to provide higher current to displace the crystal. The increase in current causes a slight drop in the applied voltage. As a result the driving voltage was not constant throughout the fre-

Figure 4. The resonant frequencies are predicted using the physical properties of LiNbO3 and the geometry of the transformer. Intersection points represent the half and full wavelength resonant frequencies and asymptotes represent anti-resonance.

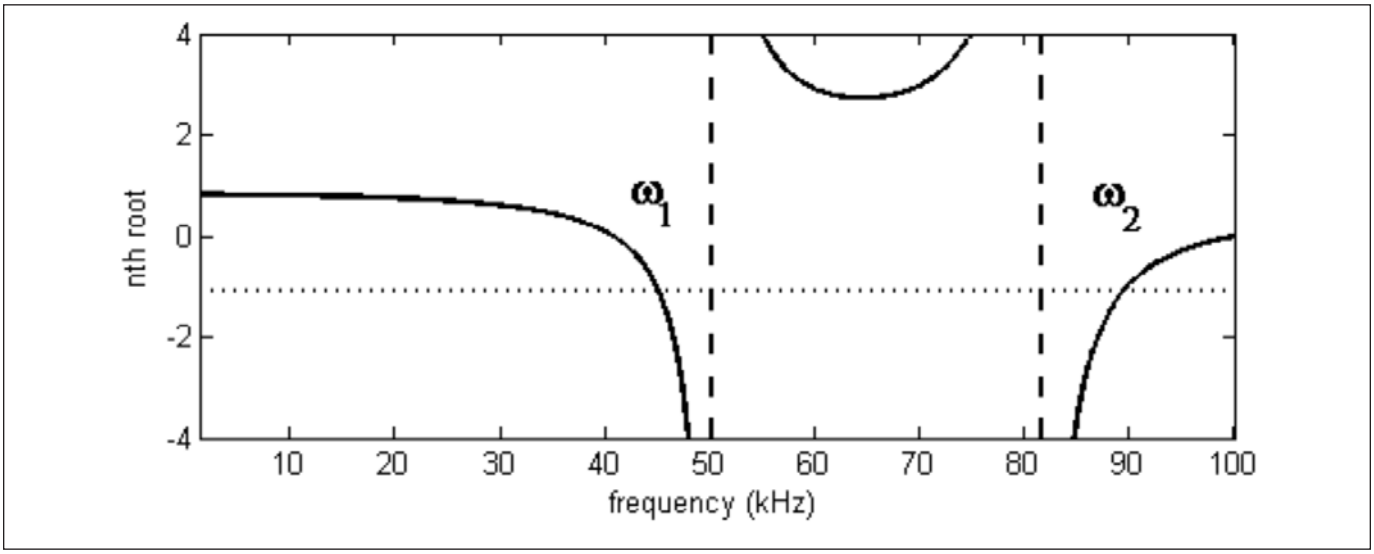
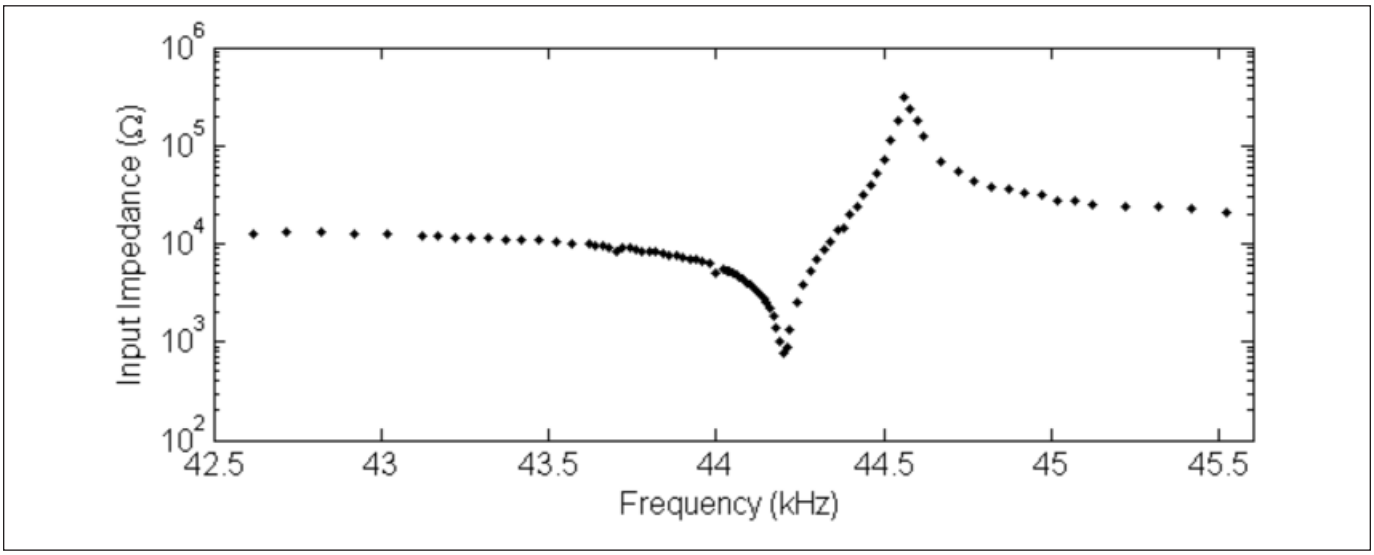


Figure 5. The measured input impedance of the PT close to the half wavelength frequency. Near resonance, the input impedance decreases.



quency spectrum. This resulted in a slight discrepancy between output voltage and transformer gain shown Figure 6 and Figure 7.

Discussion

The gain demonstrated by this transformer is close to our expected performance level but is still being optimized. Strides toward reaching the gain and output voltage that we would like to attain are continually being made. There are yet a number of factors in our PT design that can be researched and modified in order to reach our desired specifications.

Once an acceptable gain has been reached, the input voltage will be increased to create a higher output voltage. As demonstrated, when the driving frequency is close to resonance, the input impedance becomes small. While the input impedance is at a relatively low value the transformer input power becomes larger. As a result, the driving circuit must be able to drive significant power into the transformer in order to maintain the desired input voltage. Our data have already demonstrated that the driving circuit currently is a limiting factor in generating high voltage. A power amplifier is being implemented into the driving circuit of the PT.

Conclusion

A high-voltage gain piezoelectric transformer has been built and tested at the University of Missouri. Voltages above several kV have been attained and a transformer ratio above 230 has been

Figure 6. Transformer output voltage near the first resonant frequency

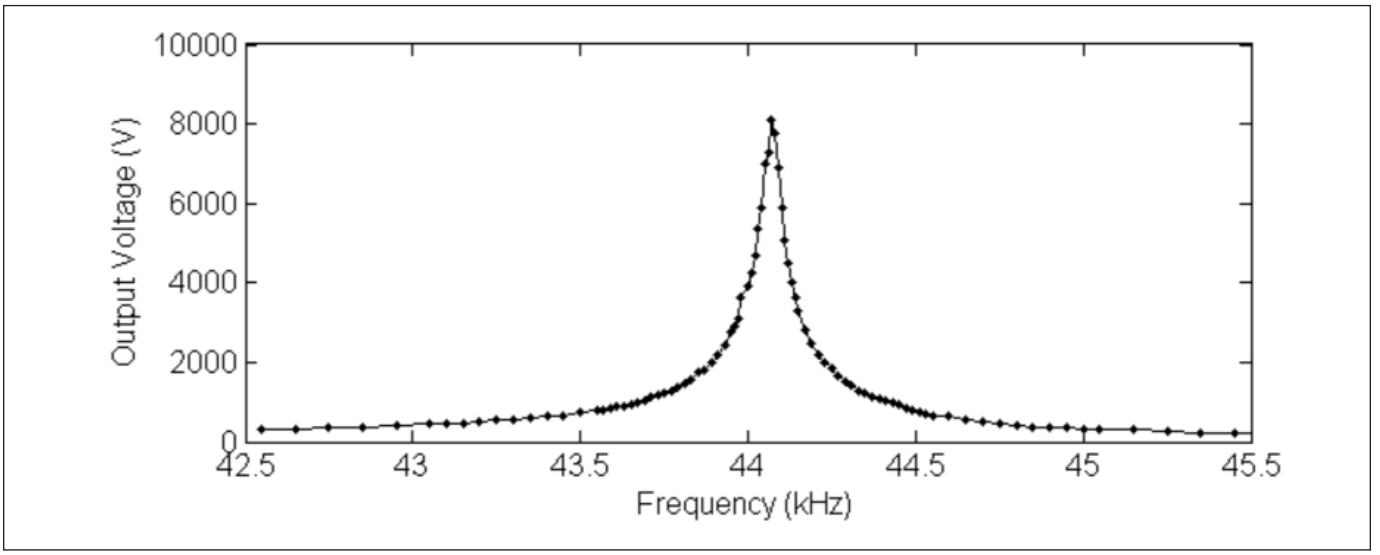
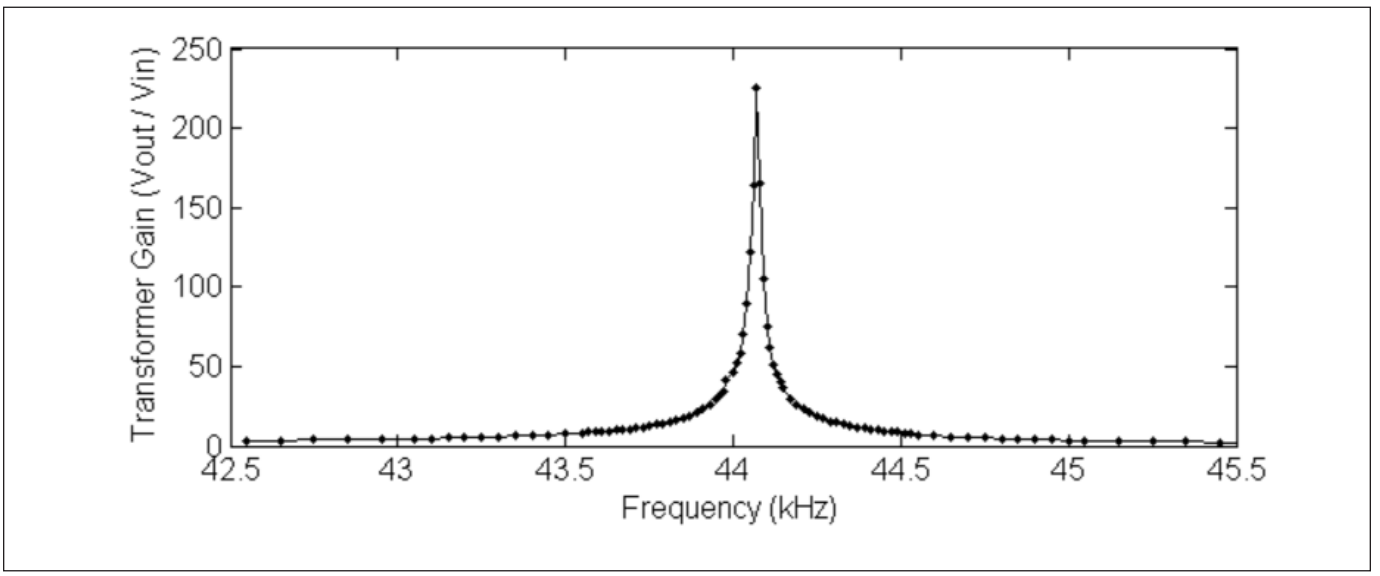


Figure 7. Transformer input to output voltage ratio near the first resonant frequency



demonstrated. However, some research needs to be performed to optimize the operating characteristics of the transformer.

Once the desired electric potential has been created, a field emitting tip will be fixed to the transformer output electrode. The field emitting tip is currently being designed and calculations have indicated the diode impedance will be above 10 MΩ which is within the operating range for the piezoelectric circuit. The addition of a field emitting tip will initiate experiments for the creation and acceleration of deuterium ions for D-D fusion. Experiments thus far have been promising towards the development of an ultra-compact neutron source for interrogation purposes.

Acknowledgements

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Analysis of the Possible Influence of Nuclear Energy Development Scenarios on the Scale of Inspection Activity to Maintain the Nonproliferation Regime

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Abstract

An analysis of the influence of possible nuclear energy development scenarios on the scale of inspection activity required to maintain the nonproliferation regime is presented. The study was done based on nuclear energy development models by estimating the dynamics of nuclear materials growth and composition change for different development scenarios and strategies of nuclear materials management in the nuclear fuel cycle. The analysis was performed both for the evolutionary development scenario, assuming conservation of the present-day infrastructure and extrapolation of the current trends of nuclear energy development into the future, and for the innovative development scenario, assuming introduction of innovative nuclear reactor systems into the nuclear energy mix and solution of urgent problems of nuclear energy by means of these systems.

Introduction

Over the three last decades the safeguards system created by the International Atomic Energy Agency (IAEA) has been ensuring the world community that the members of the Nonproliferation Treaty observe their assumed obligations.

In the very unsteady political climate, the agency safeguards system has been adapted to the evolution of nuclear power systems, accompanied by a number of changes in priority resulting from national fuel cycle development. This process has advanced more or less efficiently, but, on the whole, the safeguards system has remained an adequate and reliable instrument ensuring the world public that the nonproliferation treaty is not violated.

Nowadays, for some objective reasons, there has appeared a renewed interest in nuclear power all over the world, which was appropriately called "the nuclear renaissance." Potential growth of demand for nuclear power is challenging the international inspection system. In the context of increased demand for nuclear power, it is essential that the safeguards mechanism continue to be an adequate device supporting verification of the nonproliferation of nuclear weapons. To attain this, it is required not only to optimize the agency safeguards system itself, with the aim of enhancing its efficiency, but also to choose a strategy of handling nuclear materials that would not complicate the IAEA Safeguards Department's activities.

This paper discusses the possible influence of nuclear power development scenarios on the scale of inspection activities required for the maintenance of the nonproliferation regime. The analysis has been conducted based on growth dynamics evaluation of total nuclear material quantity in the fuel cycle as well as modifications of the material components under different scenarios of nuclear power development and strategies of handling fissile materials in the fuel cycle.

Safeguards Mechanism Operation in the Present-Day Nuclear Power Context

Let us consider the current state of the international safeguards system and nuclear fuel cycle industry. This will allow us to identify the problems and determine starting and boundary conditions for making forecasts as to prospective needs in the inspection activities.

Current Problems of the International Safeguards System

By the end of 2004, the agency had agreements on safeguards with 144 countries. These agreements comprised 923 fuel cycle installations. During the year, 2,302 inspections that covered 164,000 t of nuclear material, including 32 t of HEU and 89 t of separated plutonium, had been conducted at 598 installations.[1]

Figure 1 presents the nuclear power development dynamics and quantity of nuclear materials, in terms of significant quantity (SQ, Table 1), placed under agency safeguards. The graph shows the following basic tendency: the quantity of nuclear material under international safeguards is proportionate to power production but not to nuclear power capacity. So, for example, during the period 1980-2000, when the capacity of nuclear power dou-

Figure 1. Dynamics of nuclear power capacities growth and quantities of nuclear materials put under safeguards

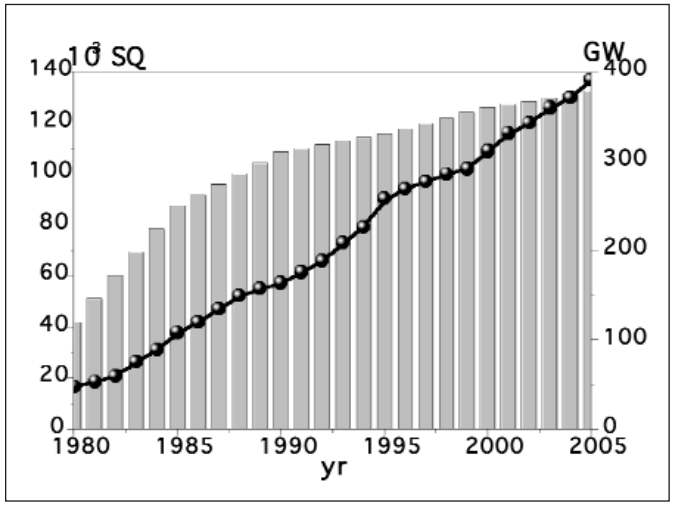


Table 1. Estimation of civil nuclear materials quantity and the materials put under safeguards

	Estimation of civil nuclear materials quantity[9]	Nuclear materials put under safeguards
HEU	175 t.	32 t. (667 SQ)
Separated plutonium	238 t. (+ ~70 t. surplus for the purposes of defense)	89 t. (11124 SQ)
Plutonium in SNF	1334.5 t.	795.1 t. (99395 SQ)
Plutonium in fresh fuel	33.2 t.	14.3 t. (1777 SQ)

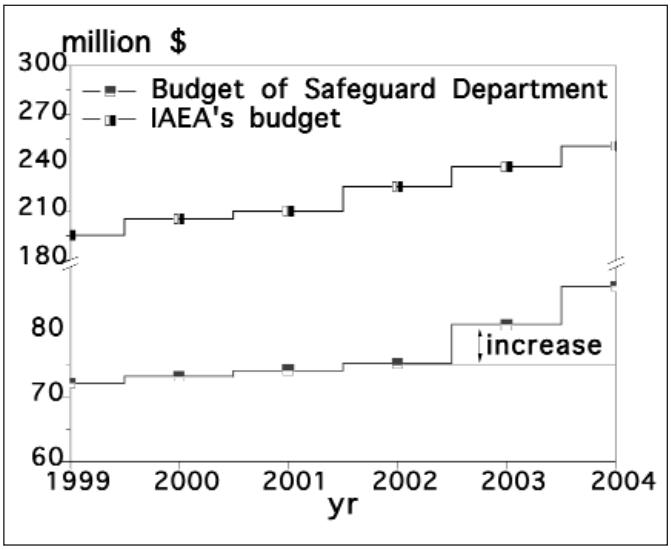
bled, the quantity of materials under safeguards, in terms of SQ, grew five times. This tendency results from the present-day structure of nuclear power, which lacks a full-scale closed nuclear fuel cycle, and, as a result, from an imbalance between production and consumption of nuclear materials.

The IAEA safeguards inspection system had been adequate up to the end of the past century, not provoking any objections: the moderate scale of nuclear power development and the agency's ability to optimize the practice of conducting inspections made the activities of the IAEA Safeguards Department highly efficient. To illustrate the verification mechanism efficiency, we shall cite Bruno Pellaud, IAEA deputy director general for Safeguards 1993-1999, who claims a reduction of annual costs associated with the exercise of safeguards per unit of nuclear materials in SQ from $3,000 in 1980 to $1,000 in 1995 made it possible to increase the quantity of nuclear materials under safeguards without any real growth of the Safeguards Department budget.[2] It was a shining example illustrating the safeguards system efficiency which, in practice, determined its development over two decades.

Despite this success, the nuclear power development, and its fuel cycle, led to a number of problems, which caused anxiety in the world community regarding the inspection efficiency. P. Goldschmidt, deputy Director General of IAEA for Safeguards (1999-2005), notes that the agency safeguards have been carried out for a decade and a half in almost total absence of budget growth while the reserves for enhancement of efficiency and personnel reapportionment for meeting the increased requirements without detriment to quality of work have been exhausted.[3]

Financial restrictions have become a real problem. In this connection, the risk of decline in inspection quality and, therefore, loss of confidence in the results of activities of the Safeguards Department and the IAEA itself, caused by steady growth of

Figure 2. The budget of Safeguards Department



nuclear material, has considerably increased. The budget was actually frozen for fifteen years, and in 1998–2003 averaged $105,000,000 per annum in terms of 2003 dollars.[4]

In this situation, a Safeguards Department budget increase was seen as a temporary solution to the problem. But to realize such an increase was rather problematic because of the existing structure of financing the agency. Nevertheless, after the 47th General Conference in 2003 the budget increased (see Figure 2[4]), which can be interpreted as further evidence of public anxiety about the inspection activities being considered by experts as inadequate to the present conditions.[5]

Figure 3. Dynamics of structure change of nuclear materials put under safeguards (in SQ terms): 1. plutonium in the irradiated fuel, 2. LEU, 3. the separated plutonium, 4. raw materials, 5. plutonium in fresh fuel, 6. HEU

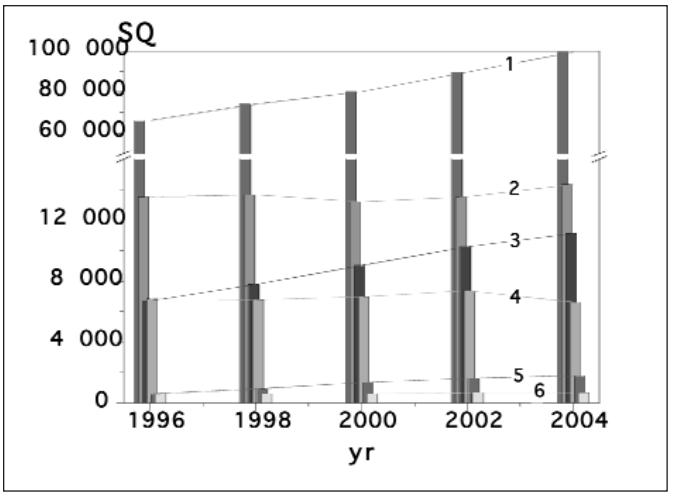
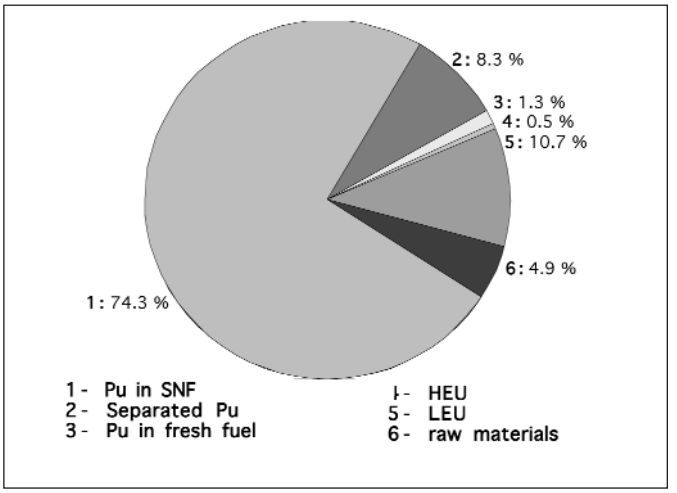


Figure 4. Structure of nuclear materials under guarantees in 2004 (in SQ terms)



The Fuel Cycle Development Trends and Their Influence on the Scale of Inspection Activities

Let us analyze the reasons that led to these consequences. The following three factors can be designated as the most significant:

- growth of nuclear material quantity under international safeguards;
- additional protocols ratified by several countries;
- implementation of advanced means of detecting undeclared nuclear activities.

However, it is the experts' opinion that the first reason is the most essential.[1]

The quantity of nuclear material placed under agency safeguards grew steadily during the past decades. The dynamics of its structural changes is presented in Figure 3.[6] In 2004, the plutonium share averages 85 percent in SQ terms (Figure 4) and obviously accounts for the agency inspection costs.[7]

This structure of nuclear materials placed under safeguards reflects the current trend of accumulating different forms of plutonium in the world. For example, the separated civil plutonium accumulation will continue at least up to 2010. This is caused by the imbalance between its production and consumption (circa 30 tPu/year against 12 tPu/year, respectively). The declared stock of plutonium in countries handling plutonium averaged 230t in 2001.[8] The plutonium taken out of defense programs, which totals up to 70 t, should also be added to the civil plutonium (according to the intergovernmental agreement on recycling the plutonium declared as plutonium no longer necessary for the purposes of defense).

There are good reasons to believe that the relative fractional contribution of the other nuclear materials (LEU, HEU, raw materials) to the total material balance will be reduced in time as these materials will be involved in energy production and their stocks will be decreased, while the trend of accumulating plutonium in different forms remains. According to rough estimates, the world production of plutonium averages 7 kg per hour. It is but natural that the world community is anxious about this fact.

At present, only a little more than 50% of the total quantity of the most attractive nuclear materials used in the civil nuclear power is placed under international safeguards (see Table 1). These materials mostly belong to non-nuclear-weapon countries. The lack of progress in the process of disarmament in nuclear-weapon countries causes dissatisfaction among other countries, which are beginning to demand more and more insistently to apply full-scale safeguards procedures to the civil sector of nuclear-weapon countries. It is obvious that doubling of nuclear materials under safeguards, even if the process goes gradually, will aggravate the serious problems pertaining to financing the agency inspection activities.

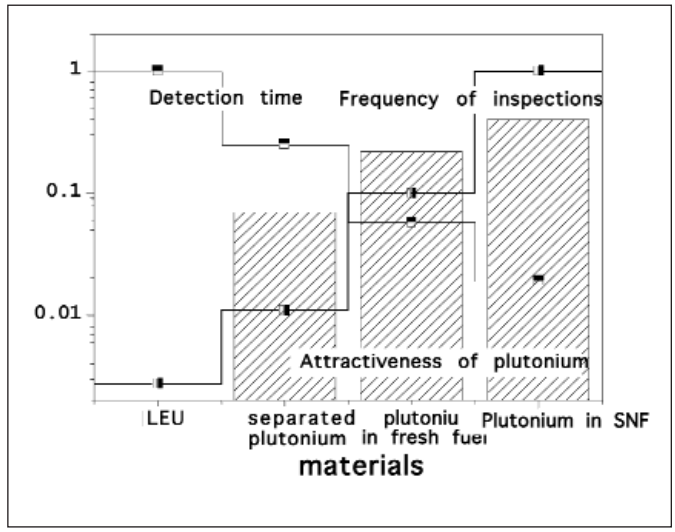
If the trends of fuel-cycle industry development continue, at least in the short-term, then there are good reasons to suggest that no decrease in the growth of nuclear materials under safeguards will occur in the future. On the contrary, in case "the nuclear power renaissance" comes, the rate of growth will increase greatly and the safeguards regime will inevitably be confronted with serious financial and personnel problems.[10]

That is why it seems extremely important that the Safeguards Department coordinate its efforts with the member states' national policy of handling nuclear materials in order to give safeguards activities a structure in which the increase in safeguarded materials would not considerably affect the cost of the agency inspection activities. The cardinal solution of the problems will be plutonium involvement in power production, which will not only reduce its stocks, but also limit the rate of commissioning enrichment facilities in accordance with the new initiatives aimed at strengthening the nonproliferation regime.[5]

Table 2. Significant quantities and detection time of different forms of nuclear materials

	SQ	Detection time
Separated plutonium	8 kg	7-10 days
Plutonium in mix	8 kg	1-3 weeks
Plutonium in SNF	8 kg	1-3 months
Separated HEU	25 kg	7-10 days
HEU in mix	25 kg	1-3 weeks
HEU in SNF	25 kg	1-3 months
LEU	75 kg	3-12 months

Figure 5. Correlation of inspection parameters and factors of plutonium attractiveness (R. Krakowski's approach)



To answer the question of ensuring adequate safeguards resources in a way that supports the anticipated increase of nuclear materials in the fuel cycle yet keeps the nonproliferation regime insensitive to the scale of nuclear power, let us consider the factors that determine the safeguards system efficiency and theoretical instruments that enable us to make evaluations of this type.

Factors Determining the Safeguards System Efficiency and Their Connection with Heuristic Models of Proliferation Risk Evaluation

The goal of conducting inspections is to promptly detect and define the change-over of a significant quantity of nuclear material from declared to undeclared processes. All the safeguards technical structure is based on two main parameters—significant quantity (SQ) and detection time. According to the safeguards criteria the frequency of inspections at a particular installation, with its attendant man-hour and inspection costs, is defined depending on quantity and physicochemical state of the nuclear materials.[11,12] Table 2 presents quantities of different nuclear materials and the time required for converting them into the form fit for making weapons.

The inspection cost calculation is a direct method that enables one to optimize inspection activities, but its application is limited by the available information about the site. For example, in the present work[13] it is concluded that, according to the man-hour cost calculations relative to inspection of an advanced fast sodium reactor installation along with its associated fuel cycle facilities (the processing plant, separated plutonium storage facility and MOX fuel production plant), the costs of the agency safeguards inspection of the fuel cycle facilities are higher by 5–30 times than those on nuclear power plants. As the authors state, this leads to the necessity to centralize spent nuclear fuel reprocessing and fresh fuel production services in order to reduce the costs of maintaining the nonproliferation regime with minimum stocks of separated plutonium as determined by NPP overload provision demands.

Let us consider the theoretical approaches used to analyze the nonproliferation problem. The recent models of proliferation risk evaluation based on system analysis enable us to understand the problem more completely, while avoiding objective difficulties associated with the absence of concrete information on inspection activities but still providing a possibility to take into account the most important system factors.

The models of quantitative evaluation of proliferation risk developed up to the present time for the whole fuel cycle can be divided into two groups: the so-called "scenario" and "attributive" groups. Most of these groups are based on the following methods—Delphi, comparative evaluations, multi-attribute analysis, probability risk analysis, fuzzy sets, and interval algebra.

Some of the attribute approaches have been applied to the developing nuclear power systems in order to take account of the changing scale of nuclear power, its development dynamics as well as various system restrictions.[14-18] In this field, the methods of multi-attribute analysis have become the most commonly used. One of the heuristic simplified methods successfully used in a number of researches concerning the evaluation of nuclear power development prospects— "proliferation risk exposure"—was proposed by R. Krakowski (Los Alamos).[14] The approach represents a hybrid of the earlier researches in this field conducted by P. Silvennoinen and A. Papazaglou.[16, 17]

All the above-mentioned approaches are based on the following three factors: 1) nuclear material quantity, 2) its attractiveness from the viewpoint of using the material in weapons programs and 3) handling time at a certain point in the fuel cycle.

Figure 6. Change of quantity of plutonium in the NFC: 1. plutonium in SNF, 2. separated plutonium, 3. consumed plutonium, 4. annually stored plutonium, 5. declared stocks of plutonium

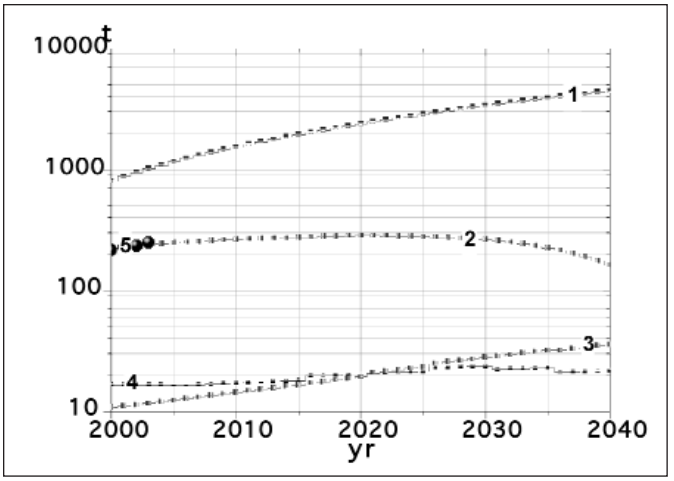
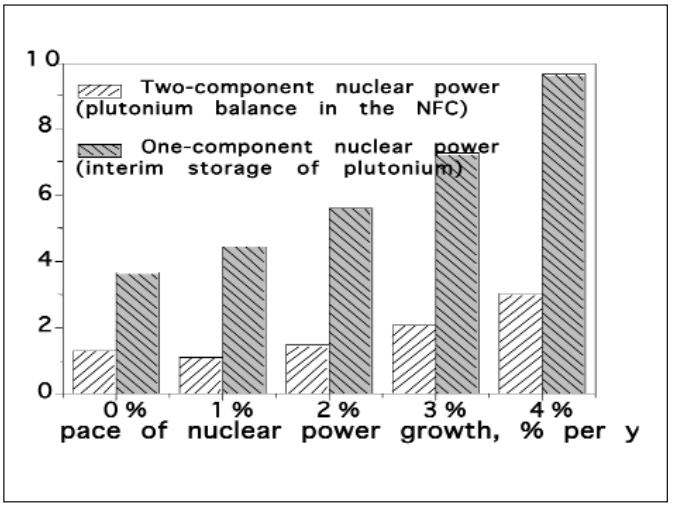


Figure 7. Increase of total plutonium quantity for sixty years



The main difficulty associated with the implementation of these models is in the evaluation of the attractiveness factor due to its subjective definition. Even the use of up-to-date mathematical methods such as fuzzy sets and interval algebra does not improve the situation. However, the following aspect appears to be important: evaluations based on different approaches, as shown in Reference 18, lead to qualitatively similar trends. This means that there is common ground among the different approaches which make it possible to include them into a self-consistent package of proliferation risk evaluation instruments.

The safeguards technical structure, as such, is built on the same principle: more attractive material with the least time of conversion into a form fit for making explosive devices should be inspected more frequently and more carefully than less attractive material. The difference in the safeguards treatment of these materials could be seen only in the rules regulating the agency Safeguards Department activities. To illustrate this statement, Figure 5 shows parameters in relative units which determine the frequency of inspections and factors of plutonium attractiveness (based on research[19] in which Krakowski's methods were used). Owing to the distinctively traced correlation of these values, we can say that this approach reflects the timing factors regulating inspection activities. In the next section we shall discuss the results of calculations using Krakowski's methods applied to the innovation of nuclear power development based on fast reactors.

In conclusion, it should be noted that the experience of applying the described approaches allows us to say with confidence that they give reasonable and explainable results. These approaches help not only to uncover the problems but also to trace ways to solve them, thereby enabling the optimization of both nuclear power structure and the strategy of handling fissile materials in the nuclear fuel cycle. The latter is important, since it is directly related to improving nonproliferation regime maintenance efficiency.

Nuclear Power Development and Plutonium Quantity Change Dynamics in the Fuel Cycle

In the previous section it was shown that plutonium constitutes the largest contribution to the total quantity of inspection effort applied to nuclear materials placed under international safeguards. Due to this, the costs of inspection of plutonium-containing materials become substantial. Therefore, it appears to be imperative to define the most probable dynamics of plutonium accumulation in the fuel cycle in every possible nuclear power development scenario as well as to find an answer to the question—in what way could its quantity in the cycle be reduced?

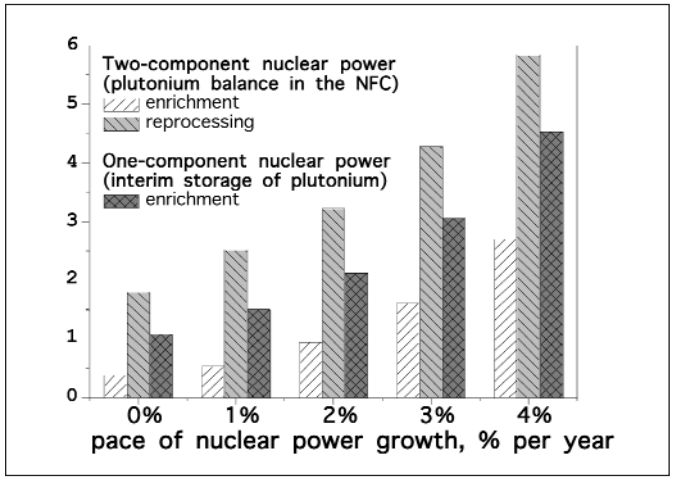
Trends of Plutonium Accumulation in Evolutionary Development Scenario

Let us consider plutonium accumulation dynamics in the fuel cycle if the current trends of nuclear power and infrastructure restrictions are extrapolated into the future. This implies the assumption that a number of countries will realize their intentions to change their existing reactor fuels to the mixed plutonium-oxide fuel (MOX) as a potential for reducing civil plutonium accumulation.

The calculations are based on the following assumptions. Two types of thermal reactors have been considered: pressurized light-water reactors using uranium and mixed-oxide fuel (1/3 of MOX load into reactor core with one-time plutonium recycle) and thermal reactors with low fuel burn-up. It was assumed that 30 percent of total spent fuel unloaded from light-water reactors is reprocessed within five years. The stated stocks of civil plutonium produced[8] were used as reference points for the calculations.

The calculations show that, in the scenario of nuclear power growth at 1 percent per year, for countries to carry out their obligations of handling plutonium, accumulation of the quantity of

Figure 8. Increasing of average needs for capacities of the NFC facilities



total separated plutonium will begin to decrease in the second half of the next decade, reaching its maximum of 300t in 2020 (roughly). The further reduction of plutonium stocks will take place at the average rate of 6t/year (see Figure 6). However, the quantity of plutonium in spent fuel will increase, reaching the value of about 5,700t by the middle of the century. In such a situation there is no point in speaking of any man-hour reduction of inspection activities. The quantity of plutonium contained in spent fuel as a fraction of all nuclear materials under international safeguards will increase. The reduction in the quantity of safeguarded material will become problematic if the present trends of development continue in the future.

Plutonium Multiple Recycle: Advantages from the Viewpoint of Nonproliferation

As is known, plutonium cannot be recycled more than one time in traditional reactor systems—the number of possible recycles is restricted by the problems of diminution of safety. Therefore, to evaluate the advantages of repeatedly recycling plutonium into energy production, we shall consider its recycle in an advanced fast reactor installation without extended fuel reproduction. Being introduced into the nuclear power structure, such installations can efficiently convert plutonium of practically any isotopic composition into energy production, considerably reducing its stocks, with a future prospect of turning to self-fuelling without accumulating plutonium in the external fuel cycle.

Optimization according to the proliferation risk exposure minimization criterion in the framework of the above-mentioned Krakowski approach,[20] allows us to make the following conclusions. First, in order to reduce plutonium proliferation integral risk, it is required to stop extracting the plutonium and to force plutonium incorporation into energy production. Second, if plutonium is available in several forms, the procedure of its incorporation into power production is determined by the degree of risk which, however, can lead to temporarily using less attractive forms of plutonium caused by the lag of refueling processes in the cycle along with the system restrictions. Third, despite different possible initial conditions and various transitional processes that may occur while the system is being expanded, the innovative installations discussed here make it possible to initiate their development while there is no plutonium accumulation at any point of the fuel cycle apart from the nominal balance of the existing fuel cycle.

To illustrate this, Figure 7 shows the growth of integral plutonium quantity in the fuel cycle, regardless of its form, as a function of growth of demand for nuclear electricity and the strategy of handling nuclear materials (open fuel cycle with interim storage of spent nuclear fuel and accumulated plutonium, as well as closed fuel cycle with plutonium balance in two-component nuclear power). As can be seen from Figure 7, in case the innovation scenario of nuclear power development is realized, the plutonium growth rate will become less sensitive to the scale of nuclear power.

It should be noted also that the acute need for building new processing plants caused by the increased demand for fuel cycle services is reduced by more than half but, at the same time, the need for processing plant capacity increases by a factor of 6 (see Figure 8). In this connection, a question about possible regional distribution of fuel cycle capacities arises: whether they will be located only in nuclear countries which possess all necessary nuclear power infrastructure or in newly created international fuel cycle centers.[21] However, searching for the answer to this question is beyond the bounds of the present work.

There is no doubt that the realization of this strategy is not economically sound at the present prices for fuel cycle services, even taking into account the costs of inspection activities concerning all civil nuclear materials. As the estimates show, the total expenses over a period of forty years will be ~1.3 times more than those of the plutonium once-through fuel cycle in fast reactors. The contradiction between national programs of fuel cycle industry development based on economic reasons, and global requirements for reducing proliferation risk, should be resolved by means of an adequate compromise which is still to be found.

Conclusions

The expected intensive development of nuclear power technology in the next decade may lead to serious problems concerning the efficiency of the existing international safeguards system. To avoid a critical problem, it is necessary to coordinate activities in the field of fuel cycle development on national, regional and global levels as well as to harmonize such development with safeguards inspections.

The closing of the fuel cycle, which will involve the multiple recycle of many potentially dangerous nuclides, will lead to a situation in which the risk associated with a possibility of fissile materials theft will be proportionate to the nuclear power capacity instead of integral nuclear energy production.

The centralization of services regarding processing of spent fuel, production of fresh fuel components, and minimization of nuclear materials stocks appropriate for making nuclear explosive devices will considerably reduce the expenses associated with the nonproliferation regime maintenance and will enable the creation of a structure of fuel cycle in which the scale factor of developing nuclear power systems will not substantially affect the agency inspection costs.

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July 11, 2008

Ms. Yvonne Ferris, Chair
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Dear Ms. Ferris,

I want to thank you and all the members of the Institute of Nuclear Materials Management for awarding me with your organization's 2008 Distinguished Service Award.

The work of your organization is critical. Today nuclear nonproliferation remains at the top of the list of international concerns. It shares the spotlight with the challenge of global energy supply. I believe that the path ahead is clear—the use of nuclear power must expand to meet global energy demands.

The INMM has an important role to play in ensuring that this happens. Effective nuclear safeguards and security are critical to maintaining international confidence in the use of nuclear power. The application of the technologies developed by your members will enable the full benefits of nuclear power to be realized.

Throughout my career I have been a staunch supporter of nuclear nonproliferation efforts. I also understand the vital role our national laboratories have played along the way. From IAEA safeguards and treaty verification to cooperative threat reduction and fissile material disposition, our laboratories have used science and technology to reduce nuclear threats around the world.

I encourage the national and international chapters of the INMM to continue to seek creative and durable solutions for the future. I wish you well in your endeavors.

Sincerely,

Pete V. Domenici

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DOE Announces Loan Guarantee Applications for Nuclear Power Plant Construction

The U.S. Department of Energy (DOE) announced in October 2008 that it has received nineteen Part I applications from seventeen electric power companies for federal loan guarantees to support the construction of fourteen nuclear power plants. The applications reflect the intentions of those companies to build twenty-one new reactors, with some applications covering two reactors at the same site. All five reactor designs that have been certified, or are currently under review for possible certification, by the U.S. Nuclear Regulatory Commission (NRC) are represented in the Part I applications. DOE also has received Part I applications from two companies for federal loan guarantees to support two different Front-End Nuclear Facility Projects.

DOE and the U.S. nuclear industry have partnered to share the cost of programs to improve the design and licensing processes of the first new nuclear power plants to be constructed in the United States in more than twenty years. Industry is asking the DOE to provide loan guarantees of $122 billion, which significantly exceeds the $18.5 billion in loan guarantees available under the June 30, 2008, Nuclear Power Facilities solicitation. The aggregate estimated construction cost of these fourteen projects is $188 billion. If all projects are constructed, they would add 28,800 megawatts of base load electric generating capacity. DOE also has been asked to provide loan guarantees in the amount of $4 billion for Front End Nuclear Facility Projects, which exceeds the $2 billion in loan guarantees made available for this type of project in the June 30, 2008, solicitation.

License applications for the nuclear power projects are currently being reviewed by the NRC as part of the new Combined License process, which simplifies and adds more predictability to the process of licensing new nuclear facilities, thereby reducing financial risk. DOE's Loan Guarantee Program Office (LGPO) is concurrently reviewing the financial and construction aspects of the projects as part of its initial review and selection process, and will follow closely all aspects of the NRC licensing process.

DOE will review the Part I submissions and will assign initial rankings of the projects based on the factors summarized in each solicitation. The initial project rankings of the applications will provide applicants information to help them determine whether to complete and submit to DOE a Part II application. Regardless of their position in the initial queue, all applicants who submitted Part I applications are invited to submit Part II of their applications in accordance with the solicitations issued on June 30, 2008. Part II submissions, which are due on December 2, 2008, for the Front-End Nuclear Facilities Projects and on December 19, 2008, for Nuclear Power Facilities, will be thoroughly vetted by the LGPO. DOE will review Part II submissions, and then select final projects to enter into negotiations that will lead to the eventual issuance of loan guarantees.

The authority to offer and enter into loan guarantees for nuclear power projects and front end nuclear facilities was granted by Congress in the Consolidated Appropriations Act, 2008. Similar authority was also granted under that Act for loan guarantees for renewable energy and fossil energy projects for an overall total of up to $38.5 billion. Pursuant to this authority, DOE issued solicitations on June 30, 2008, for up to $30.5 billion for energy efficiency, renewable energy and advanced transmission and distribution technologies; nuclear power facilities; and advanced nuclear facilities for the 'front-end' of the nuclear fuel cycle. DOE issued a subsequent solicitation on September 22, 2008, for up to $8 billion to support coal-based power generation, industrial gasification and advanced coal gasification facilities projects that employ advanced technologies that avoid, reduce or sequester emissions of air pollutants and greenhouse gases.

DOE to Transport Moab Mill Tailings by Rail

The U.S. Department of Energy (DOE) reaffirmed in August its prior decision to relocate mill tailings predominantly by rail from the former uranium-ore processing site near Moab, Utah USA, thirty miles north to Crescent Junction, Utah USA. As determined previously, oversized material that is not practical to be sized to fit into the containers will be transported by truck.

As part of its evaluation of options for transporting the tailings, DOE reviewed a traffic study commissioned by the Utah Department of Transportation (UDOT) of the U.S. Highway 191 transportation corridor that would be used to haul the material. A final transportation agreement is pending between the railroad and EnergySolutions, DOE's Remedial Action Contractor responsible for initiating cleanup of the Moab site. The substantial rail infrastructure work is anticipated to begin in fall 2008 and is expected to be complete in late spring 2009. DOE and EnergySolutions are also working with UDOT on highway access requirements for the trucks carrying containers across State Route 279 to reach the rail load out area and for road upgrades needed at crossings along the railroad.

Two other recent actions have also paved the way for this project to move forward. First, the DOE approved the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project performance baseline, which contains the collective key schedule, scope, and cost parameters. The DOE's Moab UMTRA Project 2028 baseline allows construction of transportation infrastructure on the project to proceed and will facilitate the goal of a 2019 completion date, if sufficient additional funding is appropriated by Congress. Additional appropriations will be required to complete the work earlier than 2028. Further, early completion is also subject to many factors beyond sufficient funding, including infrastructure and workforce capacities and shipment disruptions.

The second action that will advance the Moab UMTRA Project is the U.S.

Nuclear Regulatory Commission's (NRC) conditional concurrence of DOE's Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site (Remedial Action Plan), which allows DOE to proceed with construction of the disposal cell at Crescent Junction. The DOE has been collaborating with the NRC since August 2006, when DOE submitted its draft Remedial Action Plan for the cleanup of the site. Once a final ground water remedy has been implemented at the Moab site, the NRC will be able to give its full concurrence on the Remedial Action Plan.

Department of Energy Awards $15 Million for Nuclear Fuel Cycle Technology Research and Development

The U.S. Department of Energy (DOE) announced in August that it will award up to $15 million to thirty-four research organizations as part of its Advanced Fuel Cycle Initiative (AFCI). AFCI is the DOE's nuclear energy research and development program supporting the long-term goals and objectives of the United States' nuclear energy policy. These projects will provide necessary data and analyses to further U.S. nuclear fuel cycle technology development, meet the need for advanced nuclear energy production and help to close the nuclear fuel cycle in the United States.

These one-year awards range in value from $200,000 to $2,000,000 and will support the efforts of university, national laboratory, and industry researchers to develop the technologies necessary to close the nuclear fuel cycle. Of the thirty-four organizations selected for awards, there are twenty project teams comprised of seventeen U.S. universities, ten national laboratories, and seven U.S. companies. The project teams will conduct innovative research and development across a full range of program areas including spent fuel separations technology, advanced nuclear fuel development, fast burner reactors and advanced transmutation systems, advanced fuel cycle systems analysis, advanced computing and simulation, safeguards, and advanced waste forms.

The AFCI awards selected today are the result of rigorous review of competitive and innovative applications received in response to the Department's funding opportunity announcement in April 2008. This announcement adds to the more than $343 million DOE has already provided to universities, national labs and industry since AFCI was first funded in 2004. As part of President Bush's Advanced Energy Initiative, AFCI aims to accelerate development and deployment of advanced fuel cycle technologies to encourage clean energy development, responsibly manage nuclear waste, and reduce the risk of nuclear proliferation.

NNSA Completes Successful Year of U.S.-origin Nuclear Fuel Returns

The National Nuclear Security Administration (NNSA) recently concluded a successful fiscal year of U.S.-origin highly enriched uranium (HEU) fuel returns by returning more than twenty pounds of U.S.-origin spent nuclear fuel to the United States from Germany. This spent fuel shipment, transported by ship and rail under secret and secure conditions, was the fourth U.S.-origin HEU spent fuel shipment completed by NNSA during the past year.

The four shipments returned a total of almost 115 pounds (52 kg.) of HEU spent fuel, and eliminated all U.S.-origin HEU eligible for return from four additional countries—Argentina, Portugal, Romania, and Germany.

This mission was completed as part of NNSA's Global Threat Reduction Initiative (GTRI), which works to reduce and protect vulnerable nuclear and radiological materials located at civilian sites worldwide. Through GTRI, the United States works in close cooperation with individual research reactors and foreign governments to return weapons-grade nuclear material to Department of Energy and NNSA sites in the United States.

These shipments support the Global Initiative to Combat Nuclear Terrorism, which expands international partnerships addressing the global threat of nuclear terrorism. The countries with which GTRI worked to complete these shipments are key partners in the initiative and their participation in NNSA's program to remove the fuel demonstrates their strong commitment to the initiative's goals.

Since its inception in the 1990s, the U.S.-origin fuel removal program, now part of GTRI, has returned 45 shipments of U.S.-origin fuel from 27 countries, for a total of over 1,190 kilograms (2,600 pounds) of HEU fuel—enough for over 45 nuclear weapons—and more than 8,500 fuel assemblies.

The program has removed all eligible U.S.-origin HEU fuel from the following sixteen countries—Argentina, Brazil, Chile, Colombia, Denmark, Germany, Greece, Italy, Philippines, Portugal, Romania, Slovenia, South Korea, Spain, Sweden, and Thailand.

NTI
Working for a Safer World

October 20, 2008

Ms. Nancy Jo Nicholas
Immediate Past President
Institute of Nuclear Materials Management
111 Deer Lake Road, Suite 100
Deerfield, Illinois 60015

Dear Nancy Jo:

On behalf of our entire team here at NTI, thank you for participating in the launch event for the World Institute for Nuclear Security (WINS) and for your exceptional work in helping make the event possible. We have valued the partnership with the Institute of Nuclear Materials Management (INMM) throughout the WINS development process and appreciate your personal leadership in the effort.

We were honored to work with you and your colleagues at the INMM on the creation of WINS, and we look forward to our continued cooperation.

Sincerely,

Sam Nunn

Nuclear Threat Initiative
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7th Floor
Washington, DC 20006
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Calendar

January 14–16, 2009
Spent Fuel Management Seminar XXVI
Mandarin Oriental
Washington, DC USA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
E-mail: inmm@inmm.org
Web Site: www.inmm.org/meetings

February 25–27, 2009
Proliferation Assessments and Methods
Location: TBA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
E-mail: inmm@inmm.org
Web Site: www.inmm.org/meetings

March 3–19, 2009
Safeguard Specialists: Workshop on Human Resource Development
University of Missouri, Columbia Campus
Columbia, MO USA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
E-mail: inmm@inmm.org
Web Site: www.inmm.org/meetings

March 10–11, 2009
3rd Annual Workshop on Reducing the Risk from Radioactive and Nuclear Materials
Double Tree Albuquerque
Albuquerque, NM USA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
E-mail: inmm@inmm.org
Web Site: www.inmm.org/meetings

July 12–16, 2009
50th INMM Annual Meeting
JW Marriott Starr Pass Resort
Tucson, AZ USA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
E-mail: inmm@inmm.org
Web Site: www.inmm.org/meeting

July 11–15, 2010
51st INMM Annual Meeting
Marriott Baltimore Waterfront Hotel
Baltimore, MD USA
Sponsor: Institute of Nuclear Materials Management
Contact: INMM
+1-847-480-9573
Fax: +1-847-480-9282
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Make Plans to Attend!

INMM Spent Fuel Management Seminar XXVI

January 14 –16, 2009
Mandarin Oriental
Washington, DC USA

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