SAND2010-0081C

Integrating Nuclear Weapons Stockpile Management and Arms Control Policies to Enable Significant Stockpile Reductions

Sharon DeLand, Arian Pregenzer and Lani Miyoshi Sanders
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 8715

Abstract
Historically, US arms control policy and the US nuclear weapons enterprise have been reactive to each other, rather than interdependent and mutually reinforcing. At the core of the divergence has been the long timescale necessary to plan and create substantive changes in infrastructure vs. the inherent unpredictability of arms control outcomes. We explore two examples that illustrate this tension, some of the costs and implications associated with this reactive paradigm, and illustrate that, while the nuclear weapons enterprise has long considered the implications of arms control in sizing capacity of its missions, it has not substantively considered arms control in constructing requirements for capabilities and products. Since previous arms control agreements have limited numbers and types of deployed systems, with delivery systems as the object of verification, this disconnect has not been forefront. However, as future agreements unfold, the warhead itself may become the treaty limited item and the object of verification. Such a scenario might offer both the need and the opportunity to integrate nuclear weapons and arms control requirements in unprecedented ways. This paper seeks to inspire new thinking on how such integration could be fostered and the extent to which it can facilitate significant reductions in nuclear stockpiles.

Introduction

The nuclear weapons enterprise sits at the nexus of two strategies for assuring national security: (1) nuclear deterrence and nuclear weapons as the ultimate guarantor of national security and (2) arms control and transparency as a mechanism for managing competition, controlling costs, reducing the prospect of war, and gaining better understanding of mutual capabilities. This paper seeks to inspire new thinking on how these two strategies can evolve towards a future, more interdependent and mutually reinforcing state, particularly between arms control policy and (1) nuclear weapons enterprise management, especially stockpile management, (2) planning for capabilities within the nuclear weapons complex, and (3) impacts of monitoring and verification.[1] We also discuss opportunities for, and potential benefits of, better integration in the future.

A Parallel Relationship

Historically, military requirements for creating and sustaining the nuclear deterrent have dominated the planning for, and operations of, the nuclear weapons enterprise.[2] Arms

---

[1] The paper does not address other nuclear weapons policy options such as alert status.

[2] In this paper, we take the nuclear weapons enterprise to encompass the nuclear weapons stockpile, operational deployment and maintenance of nuclear weapons and their delivery systems, and the NNSA

control requirements for elimination of, or reductions in, nuclear weapons systems were addressed by folding them into stockpile planning and operational requirements. At the same time, the nuclear weapons enterprise provided the knowledge base and technical foundations for developing and sustaining effective verification regimes to enable these negotiated reductions and constraints. The nuclear weapons enterprise itself adapted to arms control policy requirements by, for example, opening up missile production facility and deployment sites for on-site inspections. However, it is fair to say that the approach for harmonizing military and arms control objectives focused on how to add monitoring and transparency to the existing system (while protecting sensitive information) but did not go to the level of considering how to manage the nuclear weapons enterprise in a way that enabled deeper reductions in the future.

In recent years, as a result of organizational restructuring at both the national and national laboratory levels and a de-emphasis on arms control during the G. W. Bush administration, the U.S. nuclear weapons and arms control communities have diverged. The result is that arms control policies and the planning and operation of the nuclear weapon enterprise have continued to move along largely parallel paths, reacting to each other when necessary, rather than as interdependent and mutually reinforcing endeavors.

Towards a New Partnership

As we look towards the future, indications point to an increasing intersection of arms control policies and the nuclear weapons enterprise; this calls for new and perhaps unprecedented thinking about the opportunities for integration. In other words, in a potential transition to much lower stockpile sizes, the way in which stockpiles are managed, including production capacity, will likely contribute to global stability in a way that has not been true in the past. Approaching such a partnership begins with considering the obstacles and opportunities. As such, we now turn to two examples from the 1990s – one relating to planning for the size of infrastructure and one relating to developing options for warhead monitoring – to illuminate obstacles to and opportunities for better integration between nuclear weapons and arms control policies.

Relying on Predictions of Arms Control Outcomes to Size Infrastructure

Planning and implementing strategies for managing and transforming the Nuclear Weapons Complex occurs over decades, rather than months or years. For example, it took more than a decade to reconstitute the capability for nuclear weapon pit production at Los Alamos, New Mexico.[3] While arms control negotiations can also take many years, policy can shift more rapidly and can also be strongly influenced by external events. Thus reconciling timescales and planning is a necessary condition for integrating nuclear weapons and arms control policy.

Nuclear Weapons Complex. The NNSA Nuclear Weapons Complex consists of three national laboratories (Los Alamos, Lawrence Livermore, and Sandia), the Kansas City Plant, the Nevada Test Site, the Pantex Plant, the Savannah River Site, and the Y-12 National Security Complex.

[3] *1663: Los Alamos Science and Technology Magazine*, August 2007, http://www.lanl.gov/news/index.php/fuseaction/1663.article/d/20078/id/11870

After the fall of the Berlin Wall, the US found itself in the position of considering a future for its Nuclear Weapons Complex quite different from the past that had shaped both its size and geographic dispersal—more than half the states in the US were home to a nuclear weapons complex facility at one time.[4]

In 1990, the US embarked upon a mission to reconfigure the Complex to meet the needs of the 21st Century; this effort was named Complex-21. Complex-21 struggled to predict the future needs, none more difficult to predict than the size of the future stockpile. From Complex-21 comes an example that illustrates the difficulties in the reactive relationship between arms control and enterprise decision-making.

Complex-21 catalyzed a move to consolidate the non-nuclear missions that was called Nonnuclear Reconfiguation. In particular, the neutron generator production mission was moved from Florida to New Mexico. During the planning for this transition, START I and II were signed, and all evidence led to the conclusion that smaller stockpiles were on their way. The new facility was sized according to this prediction.[5]

During construction in 1995, it became clear that the arms control environment would not evolve as predicted and the capacity of the facility would not be sufficient to meet the larger stockpile size. Modifications and construction, some occurring simultaneously in the space where production was ongoing, were required, with significant increases in cost and risk.

Although modest in scale, this example demonstrates the interaction of arms control policy and management of the nuclear weapons enterprise. It also demonstrates the difference between limitations on capability versus limitations on capacity. For much of the Complex, the size of the stockpile has decreased to a level where the US is capability-limited, rather than capacity limited. This is not generally an intuitive concept. In a practical sense, capability-limited means is that even if the stockpile decreases measurably, the infrastructure cannot downsize substantively—the capability is still needed and the capability, not the capacity, is what drives the overall cost. The operative words here, of course, are *if the stockpile decreases*.

In the neutron generator example, the new facility was designed to be capacity-limited—but the stockpiles ended up being higher than planned. The lesson from this particular example was that if sizing for a capacity-limited facility is based on *predicted decreases* due to anticipated arms control outcomes, meaningful contingency capacity and a specific plans to allay future costs and complications of higher stockpiles are paramount.

The larger lesson is that the enterprise has been struggling for decades with the unpredictability of decreasing future stockpiles and the difficulty in planning for the

[4] *Linking Legacies*, US Department of Energy, January 1997; *Building the Bombs*, Charles R. Loeber, SAND2002-0307P, 2002.
[5] *Transfer of the Neutron Generator Production Mission to Sandia*, Sanders, Detlefs, Pope, Sayre, Waye and Spulak, SAND2005-2875, May 2005.

enterprise that cannot quickly change should those decreases not be actualized. Herein are the challenges—and the opportunities. The core question is: How can planning for the future enterprise include efforts to influence and shape arms control requirements to be the most efficient, logical, technically and fiscally sound for the enterprise as a whole?

Planning for Future Treaty Monitoring Requirements

Up to the present, nuclear weapons arms control agreements have focused on limiting numbers and types of deployed systems, with delivery systems as the object of verification. In a general sense, this has allowed arms control requirements other than those of stockpile size to co-exist largely outside the realm of the Nuclear Weapons Complex. In a sense, this environment has enabled the reactive, vs. interdependent relationship by simply not forcing the interaction.

Today, the likelihood that future reductions may reach the quantities where the warheads themselves must become treaty limited items appears to be increasing. Such a scenario would force an interaction between operations in the Complex and Arms Control in an unprecedented manner.

A great deal of work was done in the late 1990s and very early 2000s to flesh out the technical and logistical implications of verification and monitoring at the warhead level.[6] The goals for these projects included developing potential monitoring options, assessing potential impacts on operations, and assessing whether sensitive information could be protected effectively.

An example of such a project is the Warhead Monitoring Technology Project which was a collaborative effort between the nuclear weapons and arms control communities at Sandia National Laboratories and carried out in close coordination with the U.S. Air Force. The focus of this project was the assessment of warhead monitoring options at DOD storage facilities and feasibility of maintaining continuity of knowledge with respect to transportation between DOD and DOE facilities. The major activities within this project were:

1. The development of a detailed monitoring scenario specifying assumptions about the hypothetical monitoring regime, declarations, monitoring locations, relevant site operations and monitoring processes.
2. The development of an integrated monitoring system including both commercial off-the-shelf and specialized technologies for sensors, tags, data collection, and analysis.
3. Field trials in realistic environments with role-playing for host and inspection teams.

---

[6] See for example:
Rhoades, Robert J., "Field Testing of a Remote and Unattended Monitoring System for Monitoring Warhead Storage," Sandia National Laboratories, SAND2002-2362P, Albuquerque NM, July 2002.
Chambers, William B., Corbell, Bobby H., Desonier, Lawrence M., Martinez, Robert L., Kissock, PamelaJ, Sumner, Machelle, "Remote Storage Monitoring at Defense Nuclear Sites," Presented at the 42nd Annual Meeting of the Institute of Nuclear Materials Management, Indian Wells, CA, July 2001.

4. Vulnerability assessment of proposed approaches.

Overall, the collaboration between the monitoring technology developers, stakeholders representing operational sites, and the nuclear weapons material management community was very valuable in developing an operationally credible monitoring concept. Early engagement with the DOD community enabled the developers of the monitoring concept to understand and accommodate operational requirements. The project illuminated a number of technical challenges such as verifying that an item was indeed a warhead while protecting sensitive information about warhead characteristics. Radiation measurement and modeling expertise derived from the nuclear weapons community combined with data security expertise in the arms control monitoring community were essential to developing a viable technical approach. However, robust continuity of knowledge during the transportation phase remained a challenge, in part due to the design of the active seal used on containers and in part because the transportation systems had not been designed to accommodate additional monitoring.

Additional variations and iterations would have been required to illuminate additional operational requirements across the full spectrum of systems, operations, and locations. However, as it became clear that a START III treaty would not be completed, funding for this effort declined. Nonetheless, the collaboration surfaced and addressed the very real operational and technical issues faced as arms control requirements and the nuclear weapons enterprise are forced to interact in unprecedented ways. Through efforts like this, all parties are able to better envision and innovate a future that is less onerous for some, and more effective for all.

Looking to the Future – A Tiered Approach

In order to identify ways to enable a future that more effectively integrates nuclear weapons and nuclear arms control planning, a first step would be to juxtapose a potential arms control timeline against the planning timelines for the nuclear weapons complex, as shown in Figure 1.

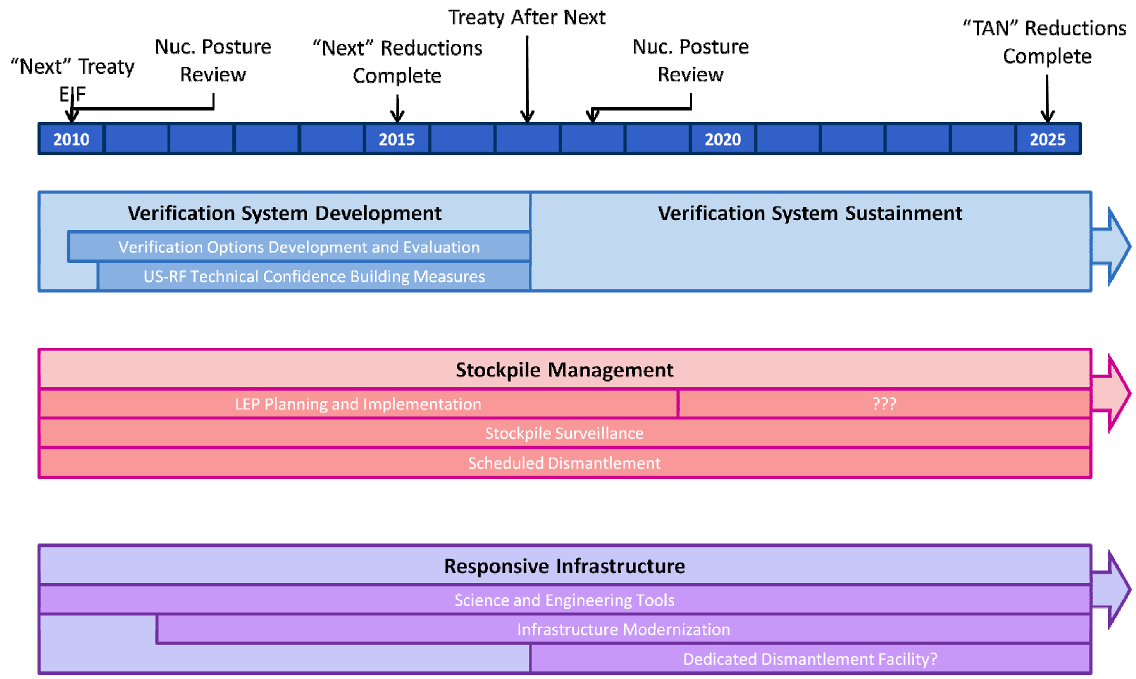

Figure 1: Notional timeline depicting potential arms control and nuclear weapons activities and milestones

For illustrative purposes, we postulate that the START follow-on ("Next" Treaty) currently being negotiated will enter into force sometime in 2010 and that, consistent with past arms control agreements, it would take several years for those reductions to be made and verified. (There is obviously a great deal of uncertainty as to how soon thereafter additional stockpile reductions might be negotiated and what the scope of such a treaty might be.) We have postulated a "Treaty After Next" or "TAN" in 2017 with reductions complete by 2025 but do not elaborate on the size of reductions or scope. We do expect verification of deeper cuts would require warhead monitoring and could require monitoring of nuclear weapons complex infrastructure.

From a verification standpoint, requirements for verifying significant reductions in nuclear weapons stockpiles present both technical and operational challenges. Little research and development for arms control verification, especially warhead monitoring, occurred during the last decade. Given advances in technologies and evolving political contexts, an early start on developing, refining, and assessing monitoring concepts as well as US-RF technical cooperation would greatly facilitate future treaty negotiations.

Nuclear weapons activities are broken here into two components: *Stockpile Management* and *Responsive Infrastructure*. Stockpile management activities are represented by life extension programs (LEP), stockpile surveillance, and scheduled dismantlement. Life extension programs refurbish nuclear weapon system components that may be subject to deterioration over time to enable those systems to stay in the stockpile for tens of years beyond the originally expected lifetime.[7] The planning phase can take several years while implementation can take many, many years. In the time that a "Treaty After Next" might

[7] http://nnsa.energy.gov/defense_programs/life_extension_programs.htm

be negotiated, planning for one or more LEPs is expected to be completed and implementation underway. Stockpile surveillance (that is the assessment of weapons within the stockpile) and dismantlement are additional planned activities occurring on an ongoing basis.

Responsive Infrastructure represents the activities required to ensure the capabilities and infrastructure are in place to sustain the stockpile into the future. Science and engineering tools will continue to develop and evolve to enhance understanding of underlying physics and enable sustainment of the stockpile in the absence of testing. Additionally, infrastructure investments are planned to replace aging production and research facilities with smaller, more sustainable facilities.

Opportunities for integration could be considered in three tiers:

- Level I Integration: How could monitoring and transparency measures be *added to the current system* with minimal operational impact and while contributing to effective verification?
- Level II Integration: How could potential impacts across the interfaces between arms control and infrastructure *planning* be managed better?
- Level III Integration: How might arms control requirements *be incorporated into future* life extension plans or other stockpile management strategies – for example, are there desirable features that would make warheads easier to monitor?

The Warhead Monitoring Technology Project described in the last section is an example of Level I Integration. Looking toward the future, we suggest that a new effort, focusing on monitoring a different warhead system likely to be impacted by the next treaty would be valuable. New operational issues will emerge, which would provide treaty negotiators with valuable data during the negotiating process. It would also allow testing and evaluation of different levels of monitoring intrusiveness, so that negotiators could have a range of options.

Forward Compatibility

With respect to Level II and Level III integration, the timelines in Figure 1 demonstrate the importance of beginning the process of coordination now. As life extension programs (LEPs) for different weapon systems are initiated and elements of the infrastructure are modernized and consolidated, there are opportunities to consider *explicitly* how arms control requirements might be reflected in planning and implementation. Considering and anticipating requirements and, in a sense, designing the future infrastructure and warheads to be "forward compatible" with future arms control requirements, would be the embodiment of the new partnership we envision.

For example, with respect to planning for the overall nuclear weapon complex, Level II integration would consider how to adjust dismantlement plans and capacities to carry out deep reductions in nuclear stockpiles if required under a future treaty while ensuring that future negotiators are aware of operational constraints that could affect future timelines.

Furthermore, Level II integrations would consider how current infrastructure planning could enable a future infrastructure transparency regime. The extent to which the processes or material flows most important for monitoring are separated from other activities significantly influences intrusiveness and operational impacts of monitoring regimes. For example, building in flexibility for a specialized dismantlement facility could provide cost and operational savings. Given the difficulties in the past with respect to planning for uncertain future arms control, arms control considerations alone are not likely to be a sufficient driver for change. However, consideration as to whether features and capacities that enable arms reductions also serve to enhance safety or security could lead to new opportunities.

Level III integration represents a completely new way of considering and coping with the intersection between arms control and nuclear weapons and the inherent tension between transparency and secrecy. In a sense, Level III considers opportunities first, and barriers second, in order to expand the possibility of new and unprecedented thinking. We note the life extension programs planned and observe that from an arms control perspective, it could be valuable to consider what, if any, features might be embedded to facilitate monitoring—or how new approaches to accounting and security could be embedded into the weapon in life extension programs and later leveraged for arms control purposes. Again, we stress a mentality of "forward compatibility"; in other words, a mindset that is anticipative, rather than reactive, to futures that do not mimic the past. Development of frameworks or "stages" for reaching future deeper reductions in nuclear stockpiles will be useful in that such frameworks create alternative visions of the future that challenge and strengthen current planning assumptions.[8]

Conclusion

One of the significant challenges facing the Nuclear Weapons Complex, and the National Laboratories in particular, is how to retain capabilities and attract new staff in the face of a declining mission. While the current life extension program approach poses technical challenges and provides opportunities to exercise certain capabilities, this strategy continues the reactive relationship between nuclear weapons policy and arms control objectives. Given the difficulties in the past with respect to planning for future arms control agreements, arms control considerations alone are not likely to be a sufficient driver for change. However, consideration of how infrastructure planning or life extension features that enhance safety and security could be leveraged to enable future verifiable reductions, or vice versa, could lead to new ways to sustaining needed capabilities while also enabling deeper stockpile reductions.

---

[8] For example, a recently proposed framework includes a multilateral nuclear weapons complex transparency regime and a stage involving "latent" deterrence in which there are zero deployed nuclear weapons but some countries retain the capability to reconstitute a physical deterrent in a timely manner. See George, Garry, "Integrated Nuclear Security in the 21st Century: Thinking Multilaterally," Sandia National Laboratories, SAND 2009-5641, Albuquerque NM, October 2009.