# Hedging Nuclear Deterrence

## Reserve Warheads or a Responsive Infrastructure?

*Dallas Boyd*

Barring any significant global upheaval, the long post–Cold War trend of de-emphasizing nuclear weapons in US security policy will continue for the foreseeable future. The role of these weapons will be further circumscribed in US declaratory policy, and additional warhead cuts will likely occur beyond the limits of the New START.[1] In particular, President Obama has stated his intention to pursue reductions of not only deployed strategic weapons, but also nondeployed warheads held in reserve.[2]

Targeting these reserve weapons for future cuts has significant implications for the US "hedging" strategy, which reflects the belief that the United States must maintain an elaborate insurance policy against technical problems in the stockpile or adverse geopolitical developments. Today the United States maintains a crude means of hedging against technical or geopolitical surprise in its ability to add, or "upload," significant numbers of reserve warheads to its delivery systems in a relatively short period of time.[3] The president's intention to reduce this reserve force hinges on confidence in an alternative hedging model—a "responsive nuclear infrastructure"—in which the capabilities of the nuclear weapons complex serve as surrogates for large numbers of reserve warheads.[4]

The concept of a responsive infrastructure was first introduced in the Bush administration's 2002 *Nuclear Posture Review* (*NPR*) as part of the "New Triad." Under this concept, the traditional strategic triad of ground-, sea-, and air-launched nuclear weapons would be dubbed "offensive strike systems" and comprise merely one leg of the new triad. The other two legs would consist of "active and passive defenses" and a

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Dallas Boyd is a senior policy analyst for Leidos (formerly SAIC), addressing nuclear weapons policy and counterterrorism. His writings have appeared in *Nonproliferation Review, Washington Quarterly, Bulletin of the Atomic Scientists*, and *Studies in Conflict and Terrorism*. He received a Master of Public Policy degree from Harvard University's John F. Kennedy School of Government.

"revitalized defense infrastructure," of which a key piece was a responsive nuclear weapons sector.[5] While the new triad model has since been discarded, allusions to the responsive nuclear infrastructure have persisted. The 2010 *NPR* issued by the Obama administration framed the concept thusly: "As critical infrastructure is restored and modernized, it will allow the United States to begin to shift away from retaining large numbers of non-deployed warheads as a technical hedge, allowing additional reductions in the U.S. stockpile of non-deployed nuclear weapons over time."[6]

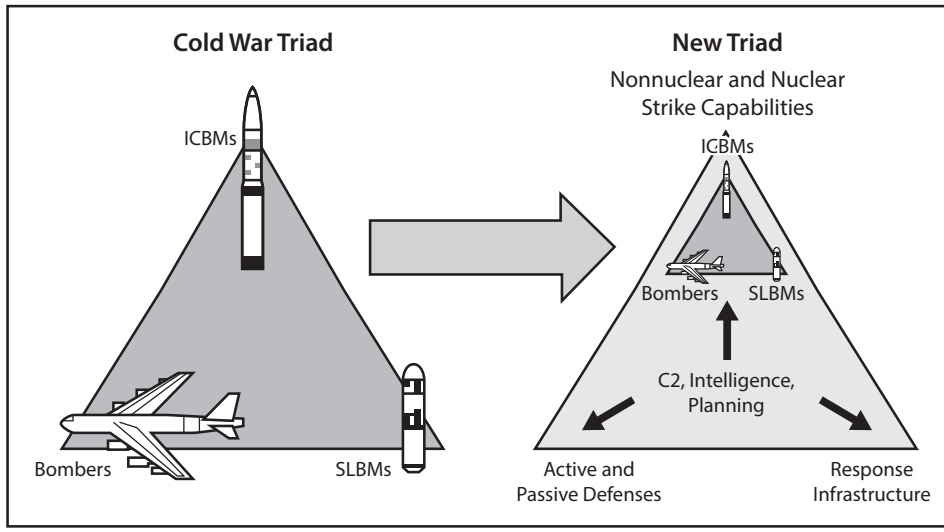


**Figure 1. The 2002 *Nuclear Posture Review* proposed that one leg of the "New Triad" would consist of a "responsive infrastructure."**
(*Source*: Air Force Doctrine Document 2-12, *Nuclear Operations*, 7 May 2009, 6.)

Under this vision, the ultimate backstop of the US nuclear deterrent would be the nation's scientific competencies, national laboratory infrastructure, and warhead production capacity rather than its reserve warheads. However, this premise is more contentious than the bland language of the *NPR* would suggest. First, there is a striking vagueness in how this model would work. The concept of a responsive infrastructure is broadly understood to mean a nuclear complex that can react swiftly to unforeseen technical or political events. Yet, the specific capabilities the complex would provide and the time frames in which it would provide them have been only loosely defined.

Of deeper significance than this conceptual imprecision are the opportunity costs in pursuing "responsiveness" as an organizing principle

for the nuclear complex. Even if the speed of its operations could somehow be radically enhanced, the investments required to achieve this capability might come at the expense of far more critical functions, such as servicing the nation's deployed warheads. Unlike the theoretical virtues of a responsive infrastructure, the contribution of these warheads to deterrence is unambiguous. More fundamentally, there is reason to doubt the wisdom of configuring the complex to quickly reverse the warhead reductions of the past two decades. Building this capability would favor a purely hypothetical need—swift rearmament, for example, or the rapid development of new warhead designs—over several existing claims on the capacity of the complex. Indeed, other elements of the administration's nuclear agenda, from dismantling retired warheads to countering nuclear terrorism, depend on an already strained nuclear infrastructure. Absent a massive infusion of capital, which is unlikely in the current budget environment, investments to achieve responsiveness would likely subtract from these other missions.

In addition to these practical considerations, the notion underlying the responsive infrastructure concept—that latent nuclear capabilities can substitute for constituted weapons—is highly controversial. This idea has been a staple of the disarmament movement for decades, but there are deep concerns about the effect of the model on strategic stability, particularly during breakdowns in relations between nuclear-armed adversaries. For example, if a state began reconstituting its reserve nuclear force during a period of high tension, its adversary might undertake reciprocal measures and thereby worsen rather than improve the security environment. Determining how the administration's vision would address these concerns is difficult because no coherent blueprint of a responsive infrastructure has been presented.

Furthermore, relying on latent capabilities for nuclear deterrence may one day extend far beyond the immediate case of the reserve force. Because this concept could be invoked to justify further reductions to the *deployed* force, its potential deficiencies must be carefully scrutinized. Indeed, in 2013 Andrew Weber, assistant secretary of defense for nuclear, chemical, and biological defense programs, reiterated the link between infrastructure investments and warhead reductions but made no distinction between reserve and deployed weapons. "A responsive infrastructure," he testified, "will provide the United States with capabilities to address

technical problems in the stockpile, or future adverse geopolitical challenges, with a substantially smaller stockpile than today's."[7]

While some officials contend infrastructure investments can enable major stockpile reductions, this assertion does not appear to have been derived from any rigorous analysis or historical analog. Yet, before undertaking such a fundamental shift in the nation's deterrence strategy, the alternative should inspire airtight confidence. Oddly, nuclear policy watchers have largely exempted this vision from critical analysis, granting its advocates latitude that exists in no other facet of the nuclear weapons debate. However, budgetary pressures increasingly demand a well-justified set of functions for the nuclear complex, with little tolerance for superfluous or ill-defined missions. The concept of a responsive infrastructure should therefore be thoroughly reexamined, as should the conditionality of future warhead cuts on its pursuit. This process should begin with identifying the specific functions the complex would perform and determining whether they are truly vital to deterrence.

## Incoherent Definitions of "Responsiveness"

In an early invocation of the responsive infrastructure, Linton Brooks, then administrator of the National Nuclear Security Administration (NNSA), defined *responsiveness* as "the resilience of the nuclear weapons enterprise to unanticipated events or emerging threats, and the ability to anticipate innovations by an adversary and to counter them before our deterrent is degraded."[8] Then-NNSA official John Harvey was somewhat more specific, at least listing identifiable elements of a responsive infrastructure: a trained, well-managed workforce; an enhanced science and technology base; efficient, modern, "right-sized" manufacturing facilities; revamped business practices; and frequent, "end-to-end" exercise of key capabilities.[9] Yet, the link between these elements and specific outputs of the complex was elusive, and later descriptions were even more bewildering.[10] For example, when the NNSA introduced "Complex 2030," a comprehensive plan for reconfiguring the nuclear complex, it defined responsiveness as "understanding needs and having the capability to meet those needs with a defined set of capabilities and capacities."[11]

As should be clear, these descriptions are not simply variations on a theme but rather a jumble of incoherent visions for the future complex. Furthermore, where specific deadlines for achieving these requirements

have been assigned, they give the same impression of lacking analytical rigor. For example, in one of the few attempts to define requirements quantitatively, Brooks identified a set of functions and corresponding time frames that can hardly be described as responsive:[12]

- **Fix stockpile problems** (1 year). The nuclear complex relies on a rigorous stockpile stewardship process to evaluate problems with weapons and pursue fixes. Assigning a typical time interval for this process is difficult because most instances in which stockpile problems have been addressed remain classified. However, there is reason to believe that this process would require significantly more time than one year, not least because identifying a stockpile problem and devising a solution is arguably the least time-consuming step in the process. Servicing a large number of geographically dispersed warheads on intercontinental ballistic missiles, submarines, and bombers presents significant logistical demands and thus requires considerable time to complete.
- **Adapt weapons** (18 months). The process of adapting legacy weapons for new or modified missions, such as altering their explosive characteristics, will likely be more time-intensive than this timescale suggests. Recall that the development of the B61 mod 11 earth-penetrating warhead, which was an adaptation of the B61-7 model, took slightly less than two years in the mid 1990s.[13] However, this effort took place shortly after the Cold War, when the complex was much more robust than it is today. If the recent pace of warhead life extension programs (LEP) is any guide, the complex will have difficulty meeting its ongoing assignments (e.g., the B61 LEP and W78/W88-1 LEP) on time and within budget, much less taking on significant new challenges.[14]
- **Design, develop, and produce a new warhead** (3–4 years). The ability to produce new nuclear warheads in a timely manner, including completing the full joint nuclear weapons life-cycle process, is a long-standing national security imperative.[15] As a Lawrence Livermore National Laboratory study noted as long ago as 1987, "To avoid being caught by technological surprise, we must retain the capability to develop new [weapons] in response to new developments by our adversaries."[16] However, the speed with which new weapons must be developed is ambiguous. The three-to-four-year

time objective represents a steep decline in responsiveness from the Cold War era. Between 1945 and 1992, the United States produced more than 65 different warhead types, introducing one new design every nine months.[17] While the amount of time required to produce a new weapon today is unclear, it is almost certainly measured in multiple years. According to a 2012 study by the National Research Council, "Development of a weapon with new military characteristics would take significantly longer than 24–36 months."[18] Recent experience with W88 pit production seems to reinforce this assessment. The first W88 replacement pit was certified in 2006, capping an 11-year effort.[19] The RRW program of the mid 2000s also suggests a lengthy development period; the design phase of the program alone consumed roughly 10 months.[20]

- **Maintain underground nuclear test readiness** (18 months). The current test readiness posture allows the United States to be able to test within two to three years.[21] However, even if this time requirement were radically shortened, in neither of the scenarios that ostensibly demand responsiveness—fixing peacetime stockpile problems or reacting to a breakdown in the global security environment—would such a posture be useful. In the former case, the moratorium on testing forecloses this means of certifying the stockpile. In the latter, any global discord severe enough to push the moratorium aside would likely be so fast moving as to make testing irrelevant.

Two additional components of a responsive infrastructure have been identified, which were not assigned time requirements: the ability to produce new nuclear warheads in quantity and the capacity to augment the nuclear force.

- **Quantity production of new warheads.** The ability to produce new warheads in quantity under a responsive infrastructure is similar to a paradigm known as "capability-based deterrence," or "weaponless deterrence." Under this system, states derive deterrent value from the ability to produce nuclear weapons rather than maintaining a stockpile of weapons-in-being. According to Joseph C. Martz, a nuclear materials scientist at Los Alamos National Laboratory (LANL), the essential questions for a capability-based nuclear deterrent are "timing (agility) and capacity." He notes there is "no consensus on either of these issues at present, nor is there a ready answer to

'how fast' and 'how many' weapons or components should be reconstituted should the need arise."[22] Moreover, even if these quantities were known, the US capacity to produce new warheads is sorely lacking. In a 2012 essay on deterrence in the twenty-first century, ADM Richard Mies, former commander of US Strategic Command, noted that in contrast to Russia, the United States has had "virtually no warhead production capability for the past two decades and little likelihood of developing a robust one within the coming decade." This lack of capacity led Mies to conclude that "promises of a responsive infrastructure remain largely unfulfilled."[23]

Central to the capacity to produce new warheads in quantity is the ability to manufacture plutonium pits. With the closure of the Rocky Flats Plant in 1989, the United States lost this large-scale production capability for almost two decades. Beginning in 2007, the NNSA again began to manufacture pits to replace those destroyed in the surveillance process, and the LANL manufactured roughly 10 pits per year for the W88 warhead.[24] Increasing pit production rates is supposed to be a key element of infrastructure modernization—the long-term Department of Energy/Department of Defense requirement for pit manufacturing is to produce 50–80 newly manufactured pits per year. However, given the deferral of the Chemistry and Metallurgy Research Replacement-Nuclear Facility at LANL, the NNSA will at best have the capacity to manufacture 20 pits per year in five years.[25] Various options are being explored to compensate for the decline in pit manufacturing capacity, including the reuse of stored pits in future LEPs. Yet, these are stopgap solutions that do not begin to provide the capacity envisioned for a responsive infrastructure.

- **Support for force augmentation.** US officials often overstate the speed with which hedge warheads can be uploaded to the deployed force, as former secretary of defense William Perry did when he testified that the United States has "the capability of rapidly uploading thousands of nuclear weapons onto our strategic forces if we choose to do so."[26] The Commission on the Strategic Posture of the United States made a similar allusion to "a stockpile of nondeployed weapons that can quickly be uploaded in the event of a rapid deterioration of the international situation."[27] In reality, given various logistical constraints (e.g., the limited number of trained personnel,

> vehicles, and equipment needed to perform this uploading), it is doubtful hedge warheads can be uploaded quickly enough to have a meaningful effect on international crises that are measured in weeks or even several months.[28]

Whether unforeseen events are technical or geopolitical, it is difficult to imagine that even a radically enhanced nuclear infrastructure could respond in the time that history suggests would be necessary. Consider Brooks' statement that the United States could go much farther in reducing the stockpile if it could produce new warheads "on a timescale in which geopolitical threats could emerge."[29] This statement mirrors the *NPR*, which stated that a "surge production" capacity would be put in place to respond to "significant geopolitical 'surprise.'"[30] Yet, crises of world historical significance can unfold with astonishing speed, as numerous twentieth-century events attest. To wit, Nazi Germany and the Soviet Union transitioned from signing a nonaggression pact and jointly dismembering Poland in 1939 to full-scale, existential warfare in the space of just 20 months. For countries locked in a persistent state of low-grade hostility, such as the United States and the Soviet Union during the Cold War, relations can deteriorate far more rapidly.

The Cuban missile crisis is a case study in this phenomenon. After beginning to suspect that the Soviets were constructing ballistic missile sites in Cuba in August 1962, the United States first captured aerial images of the sites on 14 October. Just one week later, President Kennedy publicly announced the discovery and explicitly acknowledged the prospect of nuclear war over the incident. Similarly, the most obvious scenario requiring a swift surge in US nuclear capabilities would be the discovery of an adversary's secret buildup of nuclear weapons. But unless this discovery occurred very early in the process, an adequate response would likely require too much time to complete.

Another concern in relying on the infrastructure to respond to geopolitical surprise is the influence of uncertainty on decision making. Recall the definition of *responsiveness* that stressed the "ability to anticipate innovations by an adversary and to counter them before our deterrent is degraded." This statement takes for granted that the geopolitical event in question would be unambiguous. Yet, if history is any guide, sharply divergent assessments of a foreign threat can exist within a single government agency, much less the larger bureaucracy.[31] What level of confidence would be required to set in motion an expensive and possibly

destabilizing response by the nuclear complex? Absolute certainty? Near certainty? Mere suspicion? The Cold War precedent of worst-case-scenario planning would seem to suggest the latter. But if this response turns out to be in error, chastened government leaders might then be strongly disinclined to relax US capabilities again. Alternatively, they might relax US capabilities even further.

Yet, even if ambiguity did not exist and drastic improvements could be made in the speed with which the complex responds, there would still be ample reasons to question the wisdom of this model. Chief among these is whether a deterrence model based partly on latent capabilities can provide the strategic stability of an arsenal made up exclusively of constituted warheads.

## Parallels with "Weaponless Deterrence" and its Deficiencies

The concept of weaponless deterrence has been at the intellectual core of the nuclear disarmament movement for more than a generation. Also known as "countervailing reconstitution" and "virtual nuclear arsenals," this concept holds that states may be able to deter adversaries with the latent capability to produce nuclear weapons even without possessing constituted "weapons in being." As one advocate famously described it, the present paradigm in which "missile deters missile, bomber deters bomber, submarine deters submarine" would be replaced by one in which "factory would deter factory, blueprint would deter blueprint, equation would deter equation."[32]

Noting the intellectual lineage of weaponless deterrence from the 1980s to the present day, Martz argues that "in support of the Global Zero vision, the [2010 *NPR*] has embraced the idea that the reconstitution of nuclear forces can serve as a growing portion of deterrence in an environment of stockpile reductions."[33] While the *NPR* makes no explicit reference to capability-based deterrence, the similarity between this decades-old concept and the administration's vision of a responsive infrastructure should be obvious. Both models involve replacing constituted warheads with infrastructure-based capabilities and are distinguished from one another only by degree.[34] The obvious difference is that under weaponless deterrence, the nuclear complex would represent the entirety of a nation's strategic deterrent, while under the Obama

administration's vision, the nuclear infrastructure would merely complement the deployed arsenal. Nonetheless, there is sufficient similarity between the two models that traditional concerns surrounding weaponless deterrence might very well apply to the current incarnation of the concept. Foremost among these concerns is the destabilizing potential of capability-based deterrence. Others center on the questionable ability of the model to extend deterrence to one's allies and to actively compel an adversary to act (as opposed to simply deter the adversary from attacking). A final concern is whether latent nuclear capabilities are sufficiently survivable to be valuable as a deterrent.

**Strategic Stability**

US officials have frequently alluded to the role of a responsive infrastructure in reacting to global ferment. For example, then-NNSA deputy administrator for defense programs Thomas D'Agostino suggested that "adverse change in the geopolitical threat environment . . . could require us to manufacture and deploy additional warheads on a relatively rapid timescale."[35] Yet, even if this capability could be achieved, its advocates appear to have given little thought to the concern that made the original concept of weaponless deterrence so controversial—that responding to global tumult by rapidly building up nuclear arms may be inherently destabilizing.

Illustrating this concern, George Perkovich and James Acton describe a scenario in which a virtual nuclear weapons state under perceived threat "might try to signal its resolve by beginning to reconstitute its nuclear arsenal, which might then provoke a capable adversary, or a belligerent state's security patron, to race to balance it."[36] There are obvious differences between this scenario and any that might occur under the responsive infrastructure model; their example implies an action over weeks or months, while under the responsive infrastructure vision the response might occur over several years. Further, transitioning from zero nuclear weapons to *n* weapons would be far more consequential than simply adding warheads to an already substantial arsenal. Nonetheless, there are unmistakable parallels between Perkovich and Acton's hypothetical scenario and the vision of an agile complex springing into action. In both cases, the result may be a classic "security dilemma" in which a state's actions to increase its own security may induce its enemy to answer with reciprocal measures, causing a spiral of ambiguous actions that increase the odds of

conflict even if neither side actively desires it.[37] Whatever efficiencies are to be gained by eliminating thousands of reserve warheads cannot come at the expense of strategic stability. Concerns about the destabilizing nature of this model must therefore be firmly laid to rest before it could be realized responsibly.

**Extended Deterrence and Compellence**

An additional consideration is whether a responsive infrastructure would be capable of performing two other functions of US nuclear weapons aside from deterring a direct attack on the United States. The first, extending deterrence to US allies is publicly acknowledged; the second, exercising nuclear "compellence," is implicit in the nation's declaratory policy.

Before significantly reducing the number of US warheads, policymakers must verify that any alternative arrangement is fully capable of extending the "nuclear umbrella" to US allies and partners. This arrangement involves a pledge by the United States to risk an attack on its own homeland in defense of a foreign ally. Nuclear strategists have long wrestled with the credibility of extended deterrence, even with huge arsenals at hand. Ironically, reassuring allies of the sincerity of this commitment has generally been more difficult than signaling resolve to adversaries. As one European leader famously commented, the difference between extended deterrence and assurance is that "it takes only five percent credibility of American retaliation to deter the Russians, but ninety-five percent credibility to reassure the Europeans."[38]

It seems logical, therefore, that this assurance would be further called into question if much of the US nuclear force consists of hypothetical rather than actual weapons. The United States maintains a number of forward-deployed nuclear weapons in Europe, in part to underscore its commitment to NATO.[39] Both the United States and its allies appear to attach significance to the *physical* presence of these weapons, preferring this arrangement to security assurances backed by US strategic weapons. Given the emphasis on physical weapons, this policy implicitly undercuts the idea that deterrence can be extended with virtual nuclear capabilities.

Another function where the efficacy of a responsive infrastructure is uncertain is that of nuclear compellence, which is conceptually distinct from "central" deterrence. Whereas deterrence involves a passive threat to punish an adversary if it takes a particular action (e.g., attacking one's

homeland), compellence involves an active threat to induce the adversary to take an action (e.g., withdrawing from an occupied territory) that it otherwise would not take absent the threat.[40] Though historically less common than threatening to retaliate if attacked, the ability to exercise nuclear compellence is one of the conceivable "uses" of nuclear weapons.[41] However, it is generally understood to be more difficult to accomplish than central deterrence. While a latent nuclear capacity might prove adequate to deter a direct attack on one's homeland, it may be insufficient to enable compellence, in part because the infrastructure cannot respond quickly enough to have an impact on fast-moving developments.

**Survivability**

Among the greatest challenges of relying on a responsive infrastructure in place of constituted weapons is to ensure that the former, like today's nuclear arsenal, is not vulnerable to preemptive attack. Because the facilities that would comprise the infrastructure would present a small handful of "aim points," their vulnerability to a first strike would be high. Like the location of US intercontinental ballistic missile silos, the placement of these facilities would be known to adversaries. Ensuring their survivability would require an extensive system of deeply buried underground facilities, which would have to be designed to satisfy two seemingly contradictory requirements: they would have to be impervious to the most advanced earth-penetrating warheads, yet be open to international inspections. (The logic behind the second requirement is that neither the United States nor its adversaries would unilaterally adopt a posture of latent deterrence; this paradigm would only be entertained as part of an international agreement that tightly restricted the number of constituted weapons each side could possess. Such a system would require stringent verification protocols, in turn requiring considerable access to sensitive sites.)

However, even with these requirements satisfied, there is reason to be skeptical that burying the nuclear infrastructure underground provides an adequate solution. As Christopher Ford notes, the nation's requirements would demand the survival and functionality of a complex system and not merely "disaggregated component elements entombed and isolated from each other in deep caverns."[42] This system would include "the entire panoply of capabilities that . . . would be necessary to have intact if one wished to rebuild, deploy, and potentially use a nuclear

arsenal: production and assembly facilities; warhead component and fissile material storage depots; delivery systems and the institutions and processes by which they are loaded with warheads, managed, and employed; and the logistics and communications linkages that tie together the system of arsenal reconstitution and enable it to function."[43] Each of these capabilities would have to be safeguarded.

## Unexamined Questions

Another set of questions concerns the actual mechanics of implementing the responsive infrastructure, especially with respect to the bilateral relationship with Russia. In particular, would US reductions in reserve warheads require Russian reciprocity? US nuclear policy seems to place great emphasis on the importance of rough numerical parity with Russia, with the 2010 *NPR Report* stipulating that "large disparities in [US-Russian] nuclear capabilities . . . may not be conducive to maintaining a stable, long-term strategic relationship, especially as nuclear forces are significantly reduced."[44] Strangely, advocates for the responsive infrastructure seem to ignore the possibility that unilateral stockpile reductions may be destabilizing.[45] When Russia's numerical superiority in *nonstrategic* warheads is raised in the arms control debate, US officials often note the US advantage in nondeployed strategic weapons, implying that these forces balance each other.[46] Would reducing the US hedge force thus cede a destabilizing advantage to Russia in nonstrategic weapons?

Another question centers on verification. Advocates of a responsive infrastructure envision a complex that is capable of almost heroic feats of agility. Yet, this vision coexists with the long-term ambition to eliminate nuclear weapons entirely. Given that the potential for swift and stealthy rearmament is arguably the biggest obstacle to nuclear disarmament, there is a certain tone-deafness in the call for these capabilities. That is, it might not be intuitive to US adversaries that strengthening the infrastructure, in particular the speed with which it can produce new nuclear weapons, is consistent with enabling warhead *reductions*. Indeed, the opposite conclusion seems more logical.

Allowing intrusive inspections of the complex may therefore be necessary to avoid hostile counter investments by Russia and other states. Under current US-Russian treaties, only deployed weapons are subject to inspections. However, under the proposed vision of the infrastructure, the

complex itself may need to be subject to the same scrutiny that deployed weapons face, a prospect the US nuclear weapons establishment may find distinctly unappealing.

## Linking Warhead Reductions to Infrastructure Modernization

A final consideration is the wisdom of tethering strategic warhead reductions to the modernization of the nuclear complex. Both advocates and opponents of nuclear cuts have made this linkage over the last decade for different reasons. The Obama administration, like its predecessor, may have done so for political reasons. By offering assurances that a responsive infrastructure could compensate for the shrinking arsenal, policymakers provided themselves some degree of cover as they went about cutting warheads. Meanwhile, congressional Republicans extracted a pledge to modernize the complex in exchange for the New START ratification. Their motive presumably was to increase the political cost of warhead reductions in the long term by assigning to them a hefty "price tag." Or they may have simply wished to solidify the nuclear establishment in an era of abolitionist fever. Yet, a crucial pitfall exists for both sides in this approach.

Policymakers have long acknowledged the relationship between investments in the nuclear complex and the strength of deterrence, and many have predicted dire consequences if the US nuclear infrastructure is not modernized. In 2008, for example, then–secretary of defense Robert Gates argued that "*there is absolutely no way* [the United States] can maintain a credible deterrent and reduce the number of weapons in our stockpile without either resorting to testing our stockpile or pursuing a modernization program" (emphasis added).[47] This rhetorical linkage creates the possibility of a self-inflicted wound to the technical credibility of the US stockpile if these investments do not occur. Indeed, since Gates made this unqualified statement, the pace of infrastructure modernization has slowed considerably, with the construction of new facilities deferred for several years. This shift begs the question: Would policymakers now be willing to concede the logical corollary of Gates' statement that the credibility of the US arsenal has begun to degrade?

US leaders have created for themselves an untenable position: they cannot decouple warhead reductions from the transformation of the

infrastructure without nominally sacrificing credibility, yet there are no realistic mechanisms to force this revitalization. The continued allusions to the nuclear weapons complex of the future therefore bear less and less resemblance to reality.

## Conclusion

Modernization of the nuclear infrastructure, broadly defined, will certainly be necessary in the medium to long term as US weapons continue to age and maintaining them becomes correspondingly more difficult. Yet, configuring the nuclear infrastructure to serve as a substitute for the hedge force would likely represent a costly, infeasible, and potentially destabilizing diversion from more pressing missions. In particular, the complex should be oriented to sustain the legacy stockpile and support other elements of the administration's nuclear agenda, including warhead dismantlement, nonproliferation, treaty verification, nuclear counterterrorism, and nuclear forensics.

The first of these missions is self-evident given the president's pledge to maintain US warheads for as long as nuclear arms exist anywhere. Furthermore, because any additional reductions beyond New START levels will likely require ironclad faith in the deployed stockpile, ensuring the health of these weapons—and not retiring the hedge force—should be the overwhelming priority of the abolitionist camp. That the other nuclear missions would require a substantial infrastructure is perhaps less obvious, yet each depends on a finite pool of scientific expertise and research and development capital. Balancing these priorities will require skillful management, and the challenge will be made all the more difficult by the increasingly scarce resources available to the task. Above all, this will require a coherent set of requirements for the entire complex so that both their desirability and feasibility can be properly assessed.

Aside from its bewildering presentation, perhaps the most puzzling feature of the responsive infrastructure concept is the inherent contradiction it embodies. Advocacy for sharp cuts in the US nuclear arsenal, which has come from diverse and often surprising quarters, has been premised on two developments: the improved security landscape following the Cold War and heightened confidence in US legacy warheads stemming from the Stockpile Stewardship Program.[48] Yet, advocates for a responsive infrastructure have argued, perhaps unwittingly, that either

of these achievements may be so brittle as to require a nuclear complex that is configured to rapidly reverse warhead reductions. This message is hardly a ringing endorsement of the cuts that have already occurred, much less future reductions to either the deployed or the reserve force.

Hedging nuclear deterrence—that is, maintaining the capacity to respond to technical problems within the stockpile or to unexpected geopolitical developments—is an appropriate function of the nuclear enterprise. Whether this responsibility is most effectively discharged through a large hedge force, a combination of reserve warheads and infrastructure functions, or some alternative model remains unclear. However, any substantial departure from the status quo must be demonstrably superior in cost, efficacy, and impact on strategic stability. Making this determination will require the abandonment of stock terminology as a substitute for critical thinking on what the complex should look like and what it should deliver. SSQ

**Notes**

1. *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* (Washington: Department of Defense [DoD], 5 January 2012), 5.

2. Remarks by President Obama at Hankuk University, Seoul, Republic of Korea, 26 March 2012.

3. This uploading capacity is a legacy of the Clinton administration's "lead and hedge" strategy. First introduced in the 1994 *NPR*, this strategy called for the United States to take the lead in cutting its deployed forces and encouraging arms control but also to hedge against adverse developments by maintaining a sizable inventory of nondeployed warheads. See Samuel W. Bodman and Robert M. Gates, "National Security and Nuclear Weapons in the 21st Century," US Department of Energy/Department of Defense, September 2008, i. For a discussion of the use of nondeployed warheads as a hedge against technical problems or sudden adverse geopolitical developments, see *Nuclear Posture Review Report* (Washington: DoD, 2010), 38.

4. Various permutations of the term include *responsive infrastructure*, *responsive defense infrastructure*, and *responsive industrial infrastructure*.

5. *Nuclear Posture Review Report* (Washington: DoD, 2002), i–iii.

6. The 2010 *NPR* did not limit the vision of a responsive infrastructure to a "technical hedge" only; elsewhere it suggested that modernization would "enable further arms reductions by allowing us to hedge against *future threats* without the need for a large non-deployed stockpile" (emphasis added). *Nuclear Posture Review Report* (2010), 40.

7. Andrew Weber, testimony before the Senate Armed Services Subcommittee on Strategic Forces, 17 April 2013. While the Department of Energy (DoE) and the DoD remain committed, at least rhetorically, to the responsive infrastructure vision, they have also endorsed another strategy that ostensibly would allow for reductions in the hedge force. In November 2012, the Nuclear Weapons Council ratified a stockpile life extension plan that would implement

the "3+2" vision, in which the stockpile would be consolidated to three ballistic missile warheads and two air-delivered warheads. This vision is touted as enabling "a reduction of the number of warheads required in the technical hedge by balancing the deployments in the submarine-launched ballistic missile and intercontinental ballistic missile legs." *Fiscal Year 2014 Stockpile Stewardship and Management Plan* (Washington: DoE, June 2013), 2–16.

8. Linton F. Brooks, testimony before the Senate Armed Services Committee, 24 March 2004.

9. John R. Harvey, "How Can the Nuclear Weapons Enterprise Itself Reinforce 'Assurance' and 'Dissuasion?'" Presentation to 36th Annual IFPA-Fletcher Conference, Washington, DC, 15 December 2005.

10. Then-NNSA deputy administrator Thomas D'Agostino also identified a number of specific functions of a responsive infrastructure: ensuring that warheads are available to supplement the operationally deployed force; identifying and resolving technical problems with the stockpile; designing, developing, certifying, and producing refurbished or replacement warheads; maintaining the capability to design, develop, and begin production of new warheads; producing the required quantities of warheads; dismantling warheads; and maintaining readiness to conduct underground nuclear tests. Yet, these functions did not noticeably differ from the functions of the complex even at the time he articulated them. See Thomas P. D'Agostino, testimony before the House Armed Services Committee, Subcommittee on Strategic Forces, 5 April 2006.

11. *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century*, DOE/NA-0013 (Washington: DoE/NNSA, 23 October 2006), 9.

12. Brooks, testimony, 2004.

13. Greg Mello, "New Bomb, No Mission," *Bulletin of the Atomic Scientists* 53, no. 3 (May/June 1997): 28–32.

14. D'Anne Spence neatly summarizes the challenge that NNSA faces in maintaining "an increasingly dilapidated weapons complex and stockpile with maintenance funds that decrease significantly each year." D'Anne E. Spence, "Zero Nuclear Weapons and Nuclear Security Enterprise Modernization," *Strategic Studies Quarterly* 5, no. 3 (Fall 2011): 124.

15. See Appendix D: "U.S. Nuclear Weapons Life-Cycle" in *The Nuclear Matters Handbook* (Washington: Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs, 2011), 181–93.

16. George H. Miller, Paul S. Brown, and Carol T. Alonso, "Report to Congress on Stockpile Reliability, Weapon Remanufacture, and the Role of Nuclear Testing," Lawrence Livermore National Laboratory, UCRL-53822, October 1987.

17. Spence, "Zero Nuclear Weapons."

18. See National Research Council, *The Comprehensive Nuclear Test Ban Treaty: Technical Issues for the United States* (Washington: National Academies Press, 2012), 30.

19. Joseph C. Martz, "Reconstitution as Deterrence: Advantages and Challenges of the Strategy," *Actinide Research Quarterly*, no. 1 (May 2011): 1–9. The "pit" is the core of an implosion weapon—the fissile material and any neutron reflector or tamper bonded to it. Some weapons tested during the 1950s used pits made with U-235 alone or in composite with plutonium. "Restricted Data Declassification Decisions 1946 to the Present (RDD-7)," DoE, 1 January 2001.

20. The design phase consisted of a competition between Los Alamos National Laboratory and Lawrence Livermore National Laboratory which began in May 2005. By February of the following year, the teams were confident in their designs, and in March 2006 they completed their work. See Jonathan Medalia, "The Reliable Replacement Warhead Program:

Background and Current Developments," Congressional Research Service report RL32929, 27 July 2009, 16–17.

21. DoE, "Nuclear Test Readiness: Report to Congress," May 2011.

22. Martz, "Reconstitution as Deterrence."

23. Richard Mies, "Strategic Deterrence in the 21st Century," *Undersea Warfare* 48 (Spring 2012): 12–19.

24. Marisa Sandoval, "Pit Perfect: LANL Meets Plutonium Pit Production Goal," *National Security Science*, issue 3 (2011): n.p., http://www.lanl.gov/science/NSS/issue3_2011/story3full.shtml.

25. See Frank Kendall and Neile L. Miller, letter to the Honorable Howard P. McKeon, chairman, House Committee on Armed Services, 8 April 2013. Under the DoD-DoE Memorandum of Agreement, NNSA was originally required to reach the 50–80 pits per year capacity in the 2022 time frame.

26. William J. Perry, testimony before the Senate Committee on Foreign Relations, 29 April 2010.

27. William J. Perry and James Schlesinger, co-chairs, *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States* (Washington: US Institute of Peace Press, 2009), 24.

28. According to the DoD *Nuclear Matters Handbook*, "inactive near-term hedge warheads" that serve as part of the technical or geopolitical hedge can serve as active ready warheads within six to 24 months; "extended hedge warheads" that serve as either part of the technical or geopolitical hedge can serve as active ready warheads within 24 to 60 months. See *Nuclear Matters Handbook: Expanded Edition*, Section 3.4.1: Configuration Management.

29. Brooks, testimony, 2004.

30. *Nuclear Posture Review Report* (2010), 43.

31. Consider the case of Team B, a 1976 "competitive analysis" exercise in which an independent panel was tasked with reviewing US intelligence assessments of the Soviet military threat. The panel produced assessments of Soviet strength and strategic intentions that were wildly at odds with conventional intelligence estimates of the time. See Anne Hessing Cahn, "Team B: The Trillion-Dollar Experiment," *Bulletin of the Atomic Scientists* 49, no. 3 (April 1993): 22–27.

32. Jonathan Schell, *The Abolition* (New York: Alfred A. Knopf, 1984), 119.

33. Martz, "Reconstitution as Deterrence." Former Bush administration official Christopher Ford also contends that the 2010 *NPR* "enthusiastically embraced" the essential elements of weaponless deterrence. See Christopher A. Ford, "Nuclear Weapons Reconstitution and its Discontents: Challenges of 'Weaponless Deterrence,'" Hudson Institute, November 2010.

34. Several policy documents have made this link more explicitly. For example, the NNSA document *Complex 2030* asserted that a responsive infrastructure "facilitates a reduction in the size of the stockpile and greater reliance on deterrence by capability." See DoE/NNSA, *Complex 2030*. A 2008 NNSA strategy document, "Complex Transformation" also alludes to deterrence via infrastructure: "The purpose of a reliable and responsive infrastructure is to deter adversaries from trying to seek advantage, i.e., an attempt to seek advantage would be detected and negated by a quick response. A more responsive infrastructure is expected to permit further reductions in the nuclear weapons stockpile." See "Final Complex Transformation Supplemental Programmatic Environmental Impact Statement," National Nuclear Security Administration, DOE/EIS-0236-S4, October 2008, S-15. As of 2014, the NNSA website confirms that "NNSA continues to assure the safety, security, and reliability of the existing stockpile as it progresses towards a newly responsive nuclear weapons infrastructure

*as called for in the 2001* Nuclear Posture Review *and described in the vision for Complex Transformation*" (emphasis added), http://nnsa.energy.gov/aboutus/ourprograms/defenseprograms/futurescienceandtechnologyprograms/productiontechnology.

35. D'Agostino, testimony, 5 April 2006.

36. See George Perkovich and James M. Acton, eds., *Abolishing Nuclear Weapons: A Debate*, Adelphi Paper 396 (London: International Institute for Strategic Studies, 2009), 120–24.

37. Robert Jervis, "Cooperation under the Security Dilemma," *World Politics* 30, no. 2 (January 1978): 167–74.

38. See Keith Payne, "Future of Deterrence: The Art of Defining How Much Is Enough," *Comparative Strategy* 29, issue 3 (2010): 220.

39. The United States also stores nuclear weapons in CONUS that are available for global deployment in support of extended deterrence. See *Nuclear Posture Review Report* (2010), 27.

40. See Thomas Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 1966).

41. For a partial list of instances in which nuclear threats have been issued, see Samuel Black, *The Changing Political Utility of Nuclear Weapons: Nuclear Threats from 1970 to 2010* (Washington: Henry L. Stimson Center, August 2010).

42. Ford, "Nuclear Weapons Reconstitution and its Discontents."

43. Ibid.

44. *Nuclear Posture Review Report* (2010), xi.

45. For example, the Strategic Posture Commission report stated that "substantial stockpile reductions need to be done bilaterally with the Russians." Yet, the report also suggested that "some potential reductions in non-deployed weapons need not await Russia. The United States could reduce its reliance on, and thus supply of, reserve warheads if it were to refurbish the nuclear infrastructure." See Perry and Schlesinger, *America's Strategic Posture*, 25.

46. Former defense secretary William Perry, for example, has noted that "the asymmetry in tactical nuclear weapons is primarily in favor of the [Russian Federation], but the asymmetry in strategic weapons in reserve is primarily in the favor of the United States and is a very sore issue with the Russians that I speak to." Perry, testimony, 29 April 2010.

47. Robert M. Gates, remarks at the Carnegie Endowment for International Peace, Washington, DC, 28 October 2008.

48. Sustaining nuclear deterrence with the minimum number of warheads in the stockpile is a principle with broad currency in the nuclear policy world. Some of the more surprising advocates of this position include retired general James Cartwright, former commander of US Strategic Command, who in 2012 outlined a proposed nuclear posture consisting of only 450 deployed warheads. See James Cartwright, chair, "Modernizing U.S. Nuclear Strategy, Force Structure and Posture," Global Zero US Nuclear Policy Commission Report, May 2012. Likewise, Air University scholars Gary Schaub Jr. and James Forsyth Jr. have noted, "America's nuclear security can rest easily on a relatively small number of counterforce and countervalue weapons totaling just over 300." See James Wood Forsyth Jr., et al., "Remembrance of Things Past: The Enduring Value of Nuclear Weapons," *Strategic Studies Quarterly* 4, no. 1 (Spring 2010): 74–89. Finally, in June 2013, President Obama announced his conviction that the United States could reduce its deployed nuclear stockpile by one-third while still maintaining the credibility of US deterrence and ensuring the security of US allies. See "Remarks by President Obama at the Brandenburg Gate," Berlin, Germany, 19 June 2013.

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