4 Nuclear infrastructure, strategic hedging, and the implications for disarmament

Michal Smetana

In the 2001 US Nuclear Posture Review (NPR), the George W. Bush administration put a special emphasis on the need for substantive investments in the nuclear weapons infrastructure of the USA. Understood as a complex of national laboratories, production plants, and an expert workforce, this infrastructure was portrayed as a key supportive component of the country's strategic arsenal, but also as a component that had severely deteriorated since the end of the Cold War. The perceived urgency to improve US capabilities in this area led to the prominent position of "revitalized defense infrastructure" as one of the three legs of the "New Triad" concept, along with offensive strike systems and strategic defenses (US Department of Defense 2001).

Although the rhetoric employed by the following administration of Barack Obama in relation to nuclear issues could have been initially seen as a radical break with the past decade, a number of its policies in this area soon showed a remarkable pattern of continuity with the previous years. In relation to nuclear infrastructure in particular, many analysts were caught by surprise by the extent of the multi-billion dollar investments allocated by the new administration to upgrade major nuclear weapons plants and laboratories.[1] Interestingly, Obama's own NPR in 2010 defended these investments not only on the grounds of near- to medium-term plans, but also as one of the prerequisites for a long-term agenda to achieve a world free of nuclear weapons. The document notes that one of the goals of the new US nuclear posture should be to:

> … improve nuclear physical infrastructure and human capital to position the USA to safely reduce nuclear weapons, and if international conditions allow, eliminate them altogether. In a world where nuclear weapons had been eliminated but nuclear knowledge remains, having a strong infrastructure and base of human capital would be essential to deterring cheating or breakout, or, if deterrence failed, responding in a timely fashion.
>
> (US Department of Defense 2010: 48)

This short statement represents one of the rare instances in which the Obama administration officially commented on how the world after nuclear abolition should actually look from a US perspective. It has sometimes been pointed out that the term "nuclear disarmament" may represent very different realities in terms of the military capabilities of states and their deployment status (Lodgaard 2009: 142; Ford 2010: 9–10). In the 2010 NPR, the Obama administration implicitly subscribed to the conception of nuclear disarmament based on so-called "virtual nuclear arsenals" – that is, the elimination of existing nuclear warheads and bombs, but the maintenance of a robust capability to quickly rebuild an effective nuclear arsenal if needed.[2]

The idea of nuclear-armed states keeping their respective infrastructures in a ready-state close to and beyond the point of abolition as a hedge against potential threats is not new. In the 1980s, Jonathan Schell made a famous case for a "weaponless deterrence" provided by virtual arsenals, in which, instead of actual weapons, "factory would deter factory, blueprint would deter blueprint, equation would deter equation" (Schell 1984: 119). Many other authors subsequently acknowledged that the assurance of the existence of virtual (or "latent") arsenals and their inherent security benefits might well be the only way to convince the current nuclear weapons states to take the final steps on the road to "global zero" (see, for example, Mazarr 1995; Cohen and Pilat 1998). This claim spurred further theoretical discussions over reconstitution-based deterrence dynamics in a hypothetical nuclear weapons free world (see, for example, Mazarr 1997a; Ford 2010; Drell and Jeanloz 2011; Acton 2016, this book).

In this chapter, I will try to unpack the paradoxical double-edged nature of nuclear infrastructure in relation to the goal of global nuclear disarmament. On the one hand, a robust nuclear infrastructure does give the nuclear-armed states confidence in their remaining arsenal in the sensitive final stages of nuclear abolition; it provides them with the tools for complex verification activities, enables them to efficiently dismantle the remaining stockpiles, and facilitates the political decision to do so. On the other hand, the maintenance of a responsive infrastructure beyond the point of abolition as a latent virtual arsenal represents a serious threat to the stability of the disarmament regime on both military–strategic and normatively political grounds. Paradoxically, what is often portrayed as a way to enable the ultimate goal of the abolition of nuclear weapons may well create a world that is still de facto nuclear and most likely even more inequitable, unstable, and dangerous than the one in which we live right now.

The chapter proceeds as follows. First, I focus on the facilitating role of effective nuclear infrastructure on the "road to zero," linking it to the logic of established arms control practices that increase the political acceptance of nuclear abolition at the national level. Second, I review the theoretical arguments in relation to the strategic dynamics of reconstitution

races, pointing out the destabilizing factors inherent in the maintenance of nuclear reconstitution capabilities. Third, I focus on the normative issues resulting from the unequal distribution of capabilities in the international system and the aims of particular states to revitalize their respective infrastructures. I argue that these factors would contradict the logic of normative strategies to stigmatize nuclear weapons and, in effect, delegitimize the disarmament regime. This would further reinforce the destabilizing dynamics of reconstitution races, potentially causing the collapse of the disarmament regime, with far-reaching consequences. In the final section, I make the case for the "virtual irreversibility" of nuclear disarmament, reflecting on the common claim that reconstitution capabilities represent an inevitable fact instead of a choice.

The role of nuclear infrastructure on the road to zero

The technical capability and scientific expertise of national nuclear enterprises[3] may be seen by the current possessors of nuclear weapons as indispensable during the transition to a world without nuclear weapons. There are several reasons why the retention or even significant expansion of the nuclear infrastructure may facilitate the political decision to engage in deep cuts in the respective nuclear arsenals, eventually reaching the zero state. First, an effective responsive infrastructure corresponds to the logic of "strategic hedging" practices against geopolitical or technical surprises. Second, it provides decision-makers with a high level of confidence in the reliability of their diminishing arsenal. Third, it is used for the dismantlement of decommissioned warheads and the disposal of the remaining fissile material and other proliferation-sensitive components. Finally, it provides states with the tools and expertise for verification activities that increase confidence in other actors' compliance with arms reduction agreements.

The underlying logic of strategic hedging is based on the connection between the quantitative limitations of one's nuclear arsenal, which reflects the respective security environment, and the simultaneous aim of maintaining an option to reverse this decision in a timely manner if new threats suddenly appear. In the case of the USA, strategic hedging has become an established practice within its post-Cold War nuclear posture. Early 1990s studies of the US Strategic Command stressed the importance of secure hedging and a reconstitution/upload capacity maintained through the preservation of thousands of non-deployed warheads outside the arms control regimes (Kristensen 2001). This eventually became one of the building blocks of the Clinton administration's "lead but hedge" posture and has since remained a constant feature of US nuclear policy (cf. Ritchie 2009: 96–97).[4] The explicit maintenance of the capability to manufacture nuclear weapons and their respective delivery systems represents a mere extension of this hedging logic to adapt it to a situation when

even non-deployed weapons become a subject of arms control agreements. The incorporation of this concept into US planning had already started during the Bush administration (Ford 2010: 8). Reconstitution capability in the form of a responsive infrastructure subsequently gained a prominent position in Obama's NPR, which noted that it "will allow the USA to shift away from retaining large numbers of non-deployed warheads as a hedge against technical or geopolitical surprise, allowing major reductions in the nuclear stockpile" (US Department of Defense 2010: 30).

The extension of strategic hedging practice through a responsive infrastructure is directly connected with an assumption that the closer the countries get to zero, the higher will be the tendencies of other actors in the international system to proliferate and obtain a strategic advantage over the disarming/disarmed states (Lodgaard 2011: 179–180). The nuclear reconstitution capability of the ready-state national infrastructures would be considered a prudent option, with the aim of deterring such moves or responding to them quickly and effectively. Indeed, the 2010 NPR notes that a "revitalized infrastructure" would "dissuade potential competitors from believing they can permanently secure an advantage by deploying new nuclear capabilities" (US Department of Defense 2010: 41). There are two important features of this particular conception of the role of nuclear infrastructure: first, the strategic stability on a nuclear level of potential conflict as a prime goal of the policy; and second, the indispensable role of nuclear weapons in deterrence, albeit in a different form than through physical (existing) capabilities. As such, these proposals operate primarily in the "arms control paradigm," which is based on the notions of strategic stability and the normative acceptance of nuclear weapons as a legitimate policy tool, as opposed to the "disarmament paradigm," in which nuclear weapons are stigmatized as illegitimate weapons of terror that should be completely absent from the strategic discourse. The logic of the arms control paradigm has been an integral part of US nuclear policy since the 1960s, guiding the negotiations of all strategic treaties between Washington and Moscow. The continuity embedded in the arms control paradigm therefore makes deep reductions in nuclear stockpiles less controversial and, in principle, even the zero option politically more feasible than the revolutionary, pacifist discourse of the disarmament paradigm.[5]

Another critically important task for the national nuclear enterprise is connected with the need to assess the proper functioning of the dynamically shrinking stockpile and the effective management of its ongoing safety, security, and reliability (cf. Drell and Goodby 2009: 25, 27). From the strategic point of view, the smaller the weapon stock the country possesses, the more assured it will have to be that the weapons will still function properly if used for military purposes. In the case of the USA, since the termination of the production of new nuclear weapons and the declaration of the testing moratorium at the beginning of the 1990s, the major

goal of the US nuclear complex has been to ensure that the constantly diminishing nuclear stockpile will remain safe and reliable without the need to resume underground testing (Woolf 2006: 36). This has been achieved primarily through the use of sophisticated computer simulations within the Stockpile Stewardship Program, as well as through the refurbishment of the components of the warheads under the Life Extension Program.[6]

In the context of deep cuts in the nuclear stockpile, the nuclear complex will have to be in charge of the dismantlement of retired warheads as well as the disposal of fissile materials and other proliferation-sensitive components. This is generally a lengthy (and expensive) process. To illustrate this point, there are still thousands of old US warheads waiting to be dismantled at an average rate of about 330 warheads per year (Weiner 2012). The current National Nuclear Security Administration goal to dismantle the remaining warheads that were retired before 2009 by the financial year 2022 (National Nuclear Security Administration 2013) is probably going to fail unless there are significant investments to accelerate this process (Alvarez 2014). It is also worth noting that, in addition to the non-trivial requirement for a very specialized industrial capacity, dismantlement also has additional security risks, especially in the context of the aims of non-state actors to acquire some of the remaining weapons or the fissile material. It will be both an expensive and technically complex endeavor to ensure that the remaining global stockpiles of nuclear weapons are dismantled in a safe and effective manner, as was the case with the aim to safely dispose of the exceeding nuclear weapons after the dissolution of the Soviet Union in the 1990s (cf. Bunn and Holdren 1997; Perkovich and Acton 2009: 59–60).

There is also the distinct role of nuclear enterprise in verifying the disarmament process. The scope of the verification activities carried out by national complexes will depend largely on the "division of labor" between states and international organizations – that is, whether the individual states will be themselves monitoring their counterparts (as is the case with all bilateral nuclear arms limitation/reduction agreements), or whether the International Atomic Energy Agency or some newly established international body will (partly or completely) take on this task (cf. Reppy 2010, 2011). In either case, there will be a need for both unprecedented political will and considerable scientific expertise to design and properly execute mechanisms to verify that no warhead or weaponizable fissile material has been kept in secret by the particular state. No arms control treaty has yet established a system to account for individual warheads or fissile material. The use of rather challenging activities such as nuclear forensics – a kind of "nuclear archeology" to reconstruct the history of production of fissile material – may be some of the daunting tasks for the verification experts in the final stages of disarmament (Fetter 1993; Acton 2011).[7] Some authors also stress that nuclear laboratories and their expert

workforce will still serve as active agents in counter-proliferation efforts targeting potential new proliferators (whether state or non-state) in a role seen by the states as indispensable during the transition phase as well as beyond it (Drell and Goodby 2009).

In summary, there are a number of issues on the road to zero that will serve as arguments for nuclear-armed states to maintain and, most likely, even expand the capability of their national nuclear infrastructures. A large, modern nuclear enterprise able to carry out the tasks outlined here with high confidence and efficiency would undoubtedly facilitate the political will to engage in the final stages of disarmament and eventually proceed to the zero state. Nevertheless, as demonstrated in the following two sections, as soon as the threshold to a world free of nuclear weapons is crossed, the national nuclear infrastructures will become more of a liability than an asset for the global disarmament regime.

Strategic logic of the reconstitution race

As noted earlier in this chapter, the maintenance of a responsive nuclear infrastructure beyond the abolition point indicates that nuclear weapons would remain present in international politics, albeit in a virtual or latent state. A number of authors have challenged Schell (1984) and Mazarr (1995) and their case for the establishment of a virtual/latent deterrence order through national reconstitution capabilities. The counter-arguments have so far been elaborated primarily on the grounds of the strategic logic, which uncovers the escalation tendencies embedded in such systems.

In a disarmed world, a small number of clandestinely produced nuclear weapons would upset the strategic balance more significantly than in a world where the major powers possessed hundreds of such weapons (Sagan 2009: 166). To stop a reconstitution race taking place in response to a nuclear breakout, a state with at least a small nuclear arsenal would be strongly tempted to exercise the option to engage in a preventive strike to hinder the build-up of an adversary's arsenal (cf. Kahn 1960: 230–235; Schelling 2009). A temptation to strike first would be further enhanced by the fact that the maintenance of the reconstitution capability would require the survival of a very complex production system (Ford 2010), as opposed to the survival of a small number of retaliation-capable weapons in hardened silos or in submarines in a world with physically assembled weapons.

Through this logic, the nuclear threat would be at least tacitly present in every serious conflict situation between states with ready-state nuclear infrastructures. In Thomas Schelling's words, "[e]very crisis would be a nuclear crisis, any war could become a nuclear war" (Schelling 2009: 127). There is good reason to believe that this would be even more true in an era free of nuclear weapons than in today's world of relative "nuclear quiet" (Schelling 2009). In principle, the threat of nuclear reconstitution

is inherently much more credible and politically more acceptable to carry out than the threat of nuclear use. The threshold to engage in such activities would therefore be comparatively much lower. Consequently, the escalation dynamics would push those who were ahead in the reconstitution race to take advantage of the quickly closing window of opportunity and strike critical components of their opponents' infrastructures before the threat of the balancing nuclear arsenal materialized (Waltz 1997: 157). The famous "use it or lose it" thinking that the Cold War strategists were so worried about would be even more prominent in the case of incomparably smaller, hastily developed nuclear arsenals.

As relatively fast reconstitution becomes a part of the security strategies of all states with effective nuclear infrastructures in place, the decision to accept the repercussions and to make elaborate plans for the rapid build-up and eventual use of nuclear weapons will be seen as necessary and indeed prudent (Lodgaard 2011: 179–80).[8] At the very least, a "responsible" government will be expecting that other "responsible" governments will take these decisions; with this image in mind, the government will ensure that it does not lag behind others in case the reconstitution race takes place. During the crisis or even in a conventional war – something that a world free of nuclear weapons will surely not be able to eliminate – the states will not only be tempted to take steps to rebuild their arsenal to protect their vital interests, but will also assume that *others* have already taken these steps and therefore it would be far too risky not to do the same. It should be noted that the dynamics of reconstitution races do not necessarily involve only former nuclear-armed states. Unless the issue of the dual-use nature of nuclear technology is effectively addressed in a world free of nuclear weapons, there is a serious risk of the "virtual" (Mazarr 1997b) or "wildfire" (Roberts 1997) proliferation of reconstitution capabilities, potentially leading to a horizontal hedging race (Lodgaard 2009: 142). The result would be an unstable, escalation-prone international system where nuclear war would be an outcome of international crises with a higher probability than today (for further conceptual elaborations of this argument, see Waltz 1997; Glaser 1998; Quinlan 2007; Schelling 2009; or Müller 2009).

Reconstitution capabilities and the normative order

It may be argued that it would be an analytical mistake to portray a hypothetical world free of nuclear weapons as simply today's world without nuclear weapons, all other things being equal. In addition to the need to create general political conditions that would make the disarmament vision feasible (Perkovich and Acton 2008: 15–40; Paul 2016, this book), some authors have also been promoting the idea that there is a need for normative development that stigmatizes, devalues, and delegitimizes nuclear weapons so that international society no longer accepts them as

usable and therefore useful tools (see, for example, Tannenwald 2015; Harrington de Santana 2009; Berry *et al.* 2010). If the norm against the possession of nuclear weapons indeed reaches this level of internalization, then disarmament should be a realistic task and the idea of even considering rebuilding nuclear arsenals would be akin to building gas chambers today.

The logic of robust nuclear infrastructures with explicit reconstitution capability, however, is exactly the element that would effectively erode such a normative order and prevent the norm from becoming a standard of appropriateness. The fact that states would require a strategic hedge is the prime signal that nuclear deterrence is a useful concept and that there are situations in which the reacquisition of nuclear weapons may be considered. If we assume that the ownership of nuclear weapons for deterrent purposes is useful, then we also implicitly acknowledge that, under some circumstances, nuclear use would be an act of choice (otherwise the deterrence would lose all its meaning). In consequence, it would be impossible to establish and maintain this kind of normative order and create a "security community" that would allow the abolition in the first place (Müller 2009: 175).

It should also be noted that in the case of some nuclear-armed states – including the USA – the functional reconstitution capability is not based on a mere maintenance of the current infrastructure, but implies a significant upgrade of today's nuclear complex. Some analysts point to the fact that the US nuclear enterprise does not currently possess even a modest capability to produce new nuclear weapons and that massive investments (well beyond even the current revitalization plans) would be necessary to change this course (Martz 2011; Boyd 2014). Dramatic investments in industrial capacities and in the human personnel directly connected with new weapons manufacturing contradicts the normative calls for decreasing the role of nuclear weapons in particular security strategies, as is often mentioned in the context of the disarmament pillar of the nuclear Non-Proliferation Treaty (NPT) (Kane 2013).

Another important normative issue related to nuclear infrastructures is linked to the notion of distributive justice, based on the distribution of rights and obligations within the hypothetical disarmament regime.[9] The international regime that would be established in a world free of nuclear weapons may be seen as a fulfillment of the 1968 NPT bargain between nuclear weapons states (NWS) and non-nuclear weapons states (NNWS). Although interpretations of Article VI of the NPT vary (cf. Ford 2007; Joyner 2011; Müller 2010), delegates at the NPT Review Conferences have repeatedly concluded that there is a binding obligation for NWS to pursue nuclear abolition. In principle, the NPT regime has been constructed as a transformative regime, the justice foundations of which were based on "microjustice" principles (Brickman *et al.* 1981), with different obligations and rights related to the different, but temporary, status of the two groups

of states. As such, the justice within the regime was supposed to be maintained by upholding the principle of nuclear *equity* for an unspecified, but principally limited, amount of time, with the goal to move beyond nuclear equity and to reach nuclear *equality* as the final, "macrojustice" goal of the regime.

The persistent equity-framed conflicts within the regime are based primarily on the notion that NWS do not take active steps toward nuclear disarmament and therefore do not fulfill their end of the bargain. During the Cold War, this issue was of limited salience due to the perceived *need* – another justice-building concept – to retain nuclear arsenals in the context of bipolar conflict and the politics of alliance. However, in the post-Cold War period the perceived slow motion toward nuclear disarmament has become a major source of normative clashes within the NPT regime. Although the USA and Russia, as the major nuclear possessors, point to the massive reductions in their arsenals since the early 1990s, a number of NNWS – in particular those who do not benefit from the US "nuclear umbrella" – stress that the input/output ratio of mutual rights and obligations is not being upheld within the regime and that there is no longer any justification for this stasis. In this context, the NWS are often accused of aiming to conserve the NPT regime as a status quo instead of as a transformative regime (see, for example, Tannenwald 2013).

By accepting the idea that the current owners of nuclear weapons would retain their ready-state nuclear infrastructures and therefore their capability for nuclear weapons reconstitution, we would also accept the institutionalization of nuclear inequality for an indefinite future. The states would once again be divided into two distinct groups: those that possess a reconstitution capability and those that do not. This time, however, there would be no further obligation on the side of the "virtual" NWS; they would maintain their reconstitution capability indefinitely. The disarmament regime in a world free of nuclear weapons would therefore become an *explicitly* status quo regime, something that the current NNWS could hardly see as a fair, just, or even acceptable solution (Lodgaard 2009: 148).

Some realist scholars – including Elbridge Colby (Colby 2016, this book) – would argue that issues such as equity are not in the forefront of states' motivations in international politics and they are merely a "cheap talk" to cover the actual interests of individual actors. Nevertheless, there is abundant literature that unpacks the notions of equity and equality – as well as the resulting justice and fairness – as issues that have a major impact on negotiations in international relations, including security-related issues (see, for example, Albin 2001; Müller and Druckman 2014; Tannenwald 2013). From the regime perspective, the prime concern is the effect of (a lack of) perceived justice on the legitimacy of the given international regime. As equity, equality, and need are concepts closely linked to the notions of justice and fairness, distributive and procedural justice

are the building blocks of both substantive and procedural legitimacy (for the difference between these two concepts, see Barnett 1997: 539). The level of legitimacy that a particular regime wields is a critical component of the efficiency of the given regime. Aside from coercion and the application of the self-interest principle, legitimacy is a major tool in the maintenance of order in the given area of social interaction (Hurd 1999).

"Compliance-pull" resulting from the regime's legitimacy (Franck 1990) should be seen as a critical component of a world free of nuclear weapons. Following the basic strategic logic outlined here, the social order embedded in the disarmament regime will be under strong pressure from within. The international community will therefore be forced to build an effective system to assure compliance with, and enforcement of, the core regime norms. The application of double standards and the resulting lack of legitimacy of the given regime, along with the strategic logic outlined in this chapter, will be major factors contributing to norm violations and crises of non-compliance (Perkovich and Acton 2009: 16). A social order based solely on coercion and the self-interest of actors would be increasingly difficult, and costly, to maintain in the long term – and perhaps completely impossible to uphold in cases of major conventional conflict, which cannot be ruled out in a world free of nuclear weapons.

This suggests that states will potentially perceive the rule not to acquire nuclear weapons in a crisis as illegitimate and the system will therefore lack a normative barrier to proliferation. Moreover, it will be increasingly difficult to maintain collaboration between the former NWS and NNWS on initiatives to develop new non-proliferation tools, limit the use of dual-use technologies, and enforce compliance. In particular, the NNWS will hardly be willing to accept the limitations of their own dual-use nuclear capabilities if the NWS explicitly retain them on an inequitable level (Perkovich and Acton 2009: 92). A similar dynamics is already present in the current NPT regime (cf. Rathbun 2006).

As demonstrated here, the retention of reconstitution capabilities beyond the point of abolition will have a negative impact on the stability and maintenance of the normative order embedded in the disarmament regime. Instead of creating normative barriers to non-compliance, this development would further feed the destabilizing strategic logic outlined in the previous section. These dynamics would contribute to the spiral of mistrust and further hedging, with an inherent risk of nuclear reconstitution and the use of nuclear weapons in major crises.

The need for "virtual irreversibility"

It is a common argument against a world free of nuclear weapons that the *irreversibility* of nuclear disarmament is merely a rhetorical figure and not a practically achievable goal. The critics of nuclear abolition often point to the supposedly obvious fact that nuclear weapons can be dismantled, but

can never be "dis-invented." In the words of one scholar, "[u]nless societies revert to an agropastoral mode of production, every advanced industrial nation will retain, in the future as today, at least a theoretical capability to build nuclear weapons" (Zaluar 2009: 199). In this context, it is commonplace to recall a famous Schelling quote: "[s]hort of universal brain surgery, nothing can erase the memory of weapons and how to build them" (Schelling 1962). This suggests that the capability to reconstitute nuclear weapons is an inevitable fact instead of a choice.

Such claims are, however, only partially true. There are two main factors that define a state's capability to rebuild its nuclear arsenal: first, the technological and industrial base; and second, the human expertise and relevant knowledge. The first factor is not necessarily equal to the general technical and industrial capability that the state possesses; as noted earlier, even the USA does not currently maintain a nuclear infrastructure that would provide it with fast production rates for new nuclear weapons. The legal limitations of nuclear infrastructures with a sophisticated verification system in place would further reduce a state's ability to produce nuclear weapons in a timely manner (e.g., to make them relevant in an ongoing, weeks- or months-long international crisis). As for the second factor, the claim that the scientific community will retain a knowledge of the science behind nuclear weapons does not mean that the knowledge to build nuclear weapons will be possible to maintain at the same level without practice. Even today, it is a common complaint of US nuclear laboratories that the knowledge necessary to rebuild a nuclear arsenal is progressively waning after two decades without nuclear testing. In this context, Mackenzie and Spinardi (1995) elaborated the concept of "tacit knowledge," suggesting that there are certain skills relevant to nuclear weapons production that may simply disappear over time and will have to be "reinvented" if a nuclear arsenal is to be rebuilt. Taking these factors into account, restarting a nuclear enterprise and eventually rebuilding a nuclear arsenal may be a long, expensive, and arduous process, and progressively more so as time goes by.

The disarmament debate should therefore turn to arrangements related to nuclear infrastructures that would make the effective reconstitution not theoretically impossible, but technologically challenging, lengthy, costly, and visible. There should be a clear plan with agreed schedules to get rid of the activities, as well as the physical facilities, that may be relevant to the production of nuclear weapons (cf. Müller 2009: 176; Reppy 2010: 53). Some of the obvious challenges in this direction relate to the dual-use nature of enrichment and reprocessing technologies, a problem that may be at least partially solved through an internationally controlled fuel cycle.[10] With respect to human capital, there will be a need – especially in the sensitive stage immediately after abolition – to carefully manage the occupations of expert personnel so that their skills cannot be misused for proliferation-relevant activities, as occurred with the A.Q. Khan network (Reppy 2010: 50).

In addition to these practical steps, further barriers will be created by normative strategies that limit the motivations of states to proliferate under the logic of appropriateness. The combination of all these factors would ensure the "virtual irreversibility" of nuclear disarmament. Strongly influencing both the cost–benefit and normative components of the decision to reconstitute nuclear arsenals, this concept would clearly represent a realistic answer to the calls for irreversibility in the context of deliberations about Article VI of the NPT.[11]

Conclusion

In this chapter, I have focused on the role of nuclear infrastructure – defined as a complex of nuclear laboratories, industrial facilities, as well as the relevant expert workforce – in relation to nuclear disarmament. I claim that although the maintenance of robust nuclear infrastructures by the current nuclear powers as a strategic hedge against future uncertainties may serve as both a political and practical facilitator of nuclear disarmament, it would also make the resulting disarmament regime incredibly fragile and prone to instability, non-compliance, and eventual nuclear conflict. I outlined the strategic, normative, and political factors that, taken together, represent an explosive, perilous dynamics that poses a grave threat to global security. Hence I argued that in order to embrace nuclear disarmament as a serious goal – something that may be necessary for the further existence of the global nuclear non-proliferation regime – there is a need to abandon the idea of keeping "virtual arsenals" through responsive nuclear enterprise. A prudent route to a world free of nuclear weapons should instead be guided by the logic of "virtual irreversibility" based on the interplay of practical as well as normative barriers to nuclear weapons reconstitution.

The virtual irreversibility of nuclear arsenals is certainly not a risk-free concept that would solve all the problems. Indeed, under such conditions the current nuclear-armed states may be more reluctant to take the final steps toward abolition and dismantle their remaining stockpiles. Nevertheless, at least on a deductive, theoretical level, virtual irreversibility offers a vision of a world free of nuclear weapons that is still realistic, but inherently more stable, just, legitimate, and secure than that portrayed by the proponents of reconstitution capabilities. Although this vision may lie far ahead in the future, its general acceptance can already bear fruits today in the bolstering of a more equitable, enlightened nuclear order.

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Notes

1 See, for example, Kristensen (2010). A recent report by researchers from the James Martin Centre for Nonproliferation Studies estimated that about US$350 billion will be spent on National Nuclear Security Administration (NNSA) activities over the next thirty years (Wolfsthal *et al.* 2014). Linton Brooks, Administrator of the NNSA during the Bush administration (and one of the contributors to this book), once mentioned that he "would have killed" for the budgets and political support currently granted to the US nuclear enterprise.

2 Ford (2010: 14) distinguishes between Tier One and Tier Two countervailing reconstitution capabilities. The former concept relates to the de facto reconstitution capability possessed by a state as a result of its civilian operation of dual-use nuclear technology. The latter denotes the possession of a virtual arsenal as a result of deliberate strategic posture and policy. In this sense, this chapter primarily deals with the issue of Tier Two capability. The common argument about the difficulty of abolishing the Tier One capability of states is briefly addressed in the last section of this chapter.

3 In this chapter, I use the terms "nuclear infrastructure," "nuclear complex," and "nuclear enterprise" interchangeably.

4 Gold and Wagner (1990: 6) discussed this conceptual change as a shift from the so-called "attack paradigm" of ready-state forces to the "mobilization paradigm," with preparation time measured in months, and, eventually, the "rearmament paradigm" of even smaller standing forces with years required to build the equipment and mobilize the army.

5 For a critical elaboration of a conceptual tension between arms control and disarmament in the context of Obama's nuclear policy, see Mutimer (2012).

6 Some critics argue that the refurbishment of nuclear warheads under the Life Extension Program is sometimes so complex that the result is de facto a new weapon design with improved military capabilities; see, for example, Kristensen (2014).

7 For a detailed discussion of verification in the context of nuclear disarmament, see Chapter 6 in this book by Andreas Persbo.

8 Many scholars have already pointed to the fact that nuclear laboratories as "arsenal keepers" have their own parochial interests in the maintenance as well as further expansion and perfection of strategic hedge in the form of robust reconstitution capabilities. As such, they follow a bureaucratic logic that may further contribute to the destabilizing dynamics in a world where nuclear infrastructures are retained. For the debate, see Reppy 2010: 45–46; Müller 2009: 175; Perkovich and Acton 2009: 118; Lodgaard 2009: 142; Lodgaard 2011: 179–180.

9 For the original conceptual elaboration of distributive justice, see, for example, Homans (1961), Adams (1965), or Eckhoff (1974).

10 There are currently several NNWS within the NPT regime that systematically refuse the aims of the NWS to put any further constraints on their right to a

civilian nuclear program under Article IV of the NPT. As argued by Sagan (2009: 162), the NNWS will eventually have to acknowledge their shared responsibility over the Article VI commitment and limit their rights to independent fuel cycle management in exchange for an unambiguous progress toward nuclear disarmament. For further discussion of the role of NNWS in nuclear disarmament, see Smetana and Ditrych (2015).

11 See, for example, the Final Document of the 2000 NPT Review Conference (United Nations 2000: 14).

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