VERIFYING DISARMAMENT IN THE TREATY ON THE PROHIBITION OF NUCLEAR WEAPONS

Edited by Pavel Podvig

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Abbreviations and acronyms

CSA	Comprehensive Safeguards Agreement
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
CTR	Cooperative Threat Reduction (programme)
DOE	Department of Energy
DPRK	Democratic People's Republic of Korea
GGE	Group of Governmental Experts
HEU	Highly enriched uranium
IAEA	International Atomic Energy Agency
ICBM	Intercontinental ballistic missile
IPNDV	International Partnership for Nuclear Disarmament Verification
JCPOA	Joint Comprehensive Plan of Action
LEU	Low enriched uranium
MPC&A	Material Protection, Control and Accounting
NATO	North Atlantic Treaty Organization
NDV	Nuclear disarmament verification
NNC	National Nuclear Center
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NTI	Nuclear Threat Initiative
SALT	Strategic Arms Limitation Treaty
START	Strategic Arms Reduction Treaty
STS	Semipalatinsk Test Site
TPNW	Treaty on the Prohibition of Nuclear Weapons
WMD	Weapons of mass destruction

Introduction *Pavel Podvig*

Nuclear weapons occupy a special place in international power politics. In addition to being weapons of mass destruction in the fullest sense of this term, nuclear weapons have long been considered a legitimate instrument of power in international affairs. Over the years, nuclear weapons have become embedded in many international institutions through a system of treaties, alliances and rivalries as well as through their constant presence – often implicit – in policies, academic discourse and public consciousness. Unlike most other kinds of weapon, nuclear weapons exist not only as material objects with tremendous destructive power but also as a social phenomenon that reflects the relationships between people, societies and states and their ideas about national identity, power and hierarchy.

These relationships and these ideas are in a state of constant evolution, and the legitimacy of nuclear weapons has never been universally accepted. It is, however, only recently that a group of states negotiated the 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW). This seeks to delegitimize nuclear weapons by committing its parties not to develop, possess, use or threaten to use nuclear weapons. While none of the current nuclear-armed states have signed the Treaty, the TPNW contains provisions that allow such a state to join if it eliminates its nuclear weapons and its nuclear weapon programme. Given how deeply embedded nuclear weapons are in the existing structures of power, it is hardly surprising that most nuclear-armed states openly opposed the TPNW, and many states and experts have expressed doubts about the ability of the Treaty to support nuclear disarmament. These doubts in part reflect the fact that nuclear disarmament is much more than the elimination of weapons as physical items: it is a process that will affect some of the key elements of the current international security system. For some states, this generates concern over the loss of the special status that nuclear weapons seem to secure for them. Others are concerned about potential consequences of the change.

Nevertheless, the change is already under way. The fact that the TPNW was negotiated and entered into force is a dramatic development in its own right. More recently, Russia's invasion of Ukraine and the rhetoric regarding nuclear weapons that has surrounded this conflict drew renewed attention to these weapons, their role and the consequences of their use. If anything, the war in Ukraine showed that nuclear weapons are far from being a stabilizing force in international relations and that their existence carries an enormous risk of a nuclear confrontation with potentially catastrophic consequences.

In this context, it is extremely important to develop a positive vision of a world without nuclear weapons and to strengthen institutions that can turn this vision into reality. This is a challenging task as these institutions must demonstrate their credibility even in the face of non-participation or, in some cases, active opposition from some nuclear-armed states. Overcoming these obstacles requires building capacity and assembling a critical mass – economic, institutional, bureaucratic and maybe military as well – to support a world that does not rely on nuclear weapons. This will certainly be a long process and the TPNW is only one of its elements. However, it is important that the TPNW states parties are seeking to advance this process through consolidating the efforts of those who believe that nuclear weapons have no place in the international security system.

One of the core issues that the TPNW will need to address as part of this process is how to achieve and sustain a nuclear-free world. In the end, even though nuclear disarmament is a political undertaking, it must include the physical elimination of nuclear weapons and the dismantlement of nuclear weapon programmes. It must also create mechanisms that would guard against the reconstitution of nuclear arsenals. This is a difficult task especially since it must be achieved in a verifiable manner that ensures confidence in compliance. It is understandable that nuclear disarmament verification became one of the points of contention in the political debate about the TPNW.

Report summary

Like disarmament, verification is more than a set of technical tools and procedures; it is also a political concept, the meaning of which can change in different circumstances. This report explores the concept of nuclear disarmament verification in the TPNW context and outlines how various TPNW verification issues can be addressed. The authors do not attempt to develop a set of step-by-step instructions (and indeed argue that the TPNW has enough flexibility to accommodate different approaches), but rather present a framework for thinking about disarmament verification under the TPNW and its various aspects. These include the importance of cooperation and transparency; the role of technical tools and procedures; and approaches to handling sensitive weapon-related information. The key points that can be drawn from this analysis are outlined below.

As Sébastien Philippe and Zia Mian argue in chapter 1, the depth to which nuclear weapons are embedded in the internal structures of the state means that a decision to relinquish nuclear weapons and join the TPNW would necessarily be accompanied by a deep transformation of the state. This transformation will affect the state's core views on national security as well as its perceived place in the international community. A state would not join the TPNW to bolster its defence or to secure a balance between its military capabilities and those of other states. As Togzhan Kassenova shows in chapter 4, the decision not to seek nuclear weapons is very closely linked to the identity of a state, and this link helps sustain the disarmament process. That process is further supported by the emergence of institutions that define national interests in terms that align with the core principles of the TPNW.

The transformation that would be required for a state to commit to the principles of the TPNW would therefore be a highly visible process. The disarming state would be actively seeking cooperation with the international community to demonstrate its commitment to the obligations it assumed by joining the Treaty. Kazakhstan, which actively cooperated with the International Atomic Energy Agency (IAEA), the United States and the Russian Federation to eliminate its Soviet nuclear legacy and remove weapon-grade fissile materials from its territory, is a case in point. Another example is the openness in some nuclear weapon states in the 1990s; this was when the end of the Cold War led to a significant shift in the security climate, and these states sought to demonstrate the depth and importance of this transformation. Among the steps taken at the time were on-site inspections, the elimination of missiles and aircraft, the shutdown of fissile material production facilities, and ambitious declassification efforts. As those examples show, a record of transparency and cooperation is probably the strongest indicator of the strength of a state's commitment to its disarmament obligations (or, for that matter, of its limits).

The view of disarmament as a cooperative process also significantly expands the set of tools that can be used to verify compliance with the TPNW. The traditional highly technical approach of IAEA safeguards is an extremely important element of the verification toolbox, but it is far from the only one. Indeed, the most important role of technical verification measures is their ability to give states a mechanism for positively proving their compliance by following a well-defined procedure and cooperating with the verification body. This mechanism could also be complemented by other political steps, such as an effort to secure or remove all weapon-usable fissile materials or a decision to forgo development of certain technologies. Taken together, these measures create an environment in which the judgement about compliance no longer relies solely on an outcome of a certain technical procedure.

Indeed, as Nick Ritchie convincingly argues in chapter 2, the idea of the primacy of technical verification procedures is rooted in the understanding of disarmament as a deeply adversarial or even coercive process. It is also closely linked to the idea that nuclear weapons retain considerable value to a state, a notion that the TPNW states explicitly reject. The framing of verification as a purely technical and politically impartial process is in fact a political move that shapes the disarmament discourse in a way that questions the feasibility of nuclear disarmament. In reality, verification is a political process that works best when it focuses on cooperation, transparency, problem-solving and consultation. Technical procedures and precise legal definitions are still important, but mostly to the extent that they support this "managerial" approach to verification.

Secrecy is another concept that plays a prominent role in nuclear disarmament verification. In chapter 3, Alex Wellerstein follows the history of nuclear secrecy back to the early years of the nuclear age. He shows that the idea of secrecy has changed over time with changes in the international environment and the development of institutions that have been created to protect nuclear secrets. For the most part, these secrets are a product of the adversarial environment of the Cold War, and most of them would be irrelevant in the TPNW context. Some information related to weapons would still have to be carefully managed and protected, but this in no way impedes reliable verification of nuclear disarmament. As scientists have argued since the early years of the nuclear age, the most reliable way to prevent nuclear proliferation is to control access to fissile materials. In the end, this was the approach adopted by the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT). It also means that it is possible to build a TPNW disarmament process in a way that would not require inspectors to access nuclear weapons or any sensitive information about them.

The elimination of the nuclear weapon-related infrastructure in Kazakhstan, described by Togzhan Kassenova in chapter 4, illustrates many of the above points about nuclear disarmament verification. Although Kazakhstan never had its own nuclear weapon programme, it hosted a significant number of Soviet nuclear facilities on its territory. Having made an early strategic decision not to retain any weapon-related facilities or materials, Kazakhstan actively cooperated with the IAEA, the United States and Russia to demonstrate in practice its commitment to that choice. In addition to joining the NPT as a non-nuclear weapon state, Kazakhstan signed an additional protocol to its safeguards agreement with the IAEA, worked to remove all weapon-grade material from its territory, and actively participated in eliminating all legacy nuclear facilities. While compliance with the IAEA safeguards obligations is, of course, critically important, it is this record of cooperation that provides the most reliable proof of Kazakhstan's commitment to its non-nuclear future.

The prospect of a nuclear-armed state joining the TPNW may seem remote at present, yet this possibility cannot be and should not be ruled out. As mentioned earlier, this would not be an easy process, since nuclear weapons are deeply embedded in the structure of political institutions, domestic as well as international. Nevertheless, it is important to outline the course of action that a disarming state would follow. The TPNW correctly leaves open that issue of specific disarmament and verification activities. However, the contours of the technical part of the verification programme are very clear – it would include dismantlement of nuclear weapons, placement of all fissile material production under international control and establishment of appropriate IAEA safeguards. None of these steps requires knowledge of nuclear weapons (other than that already possessed by the disarming state) or access to any sensitive information about weapon-origin materials. The most important part of the disarmament process is the political commitment of a state and its cooperation with the competent authorities designated by the TPNW states parties in the course of implementing the disarmament programme. None of this is unprecedented, and there is nothing that cannot be accomplished.

1. The TPNW and nuclear disarmament verification: shifting the paradigm *Sébastien Philippe and Zia Mian*

The 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW) represents a major shift, long in the making, in how states organize themselves and the international order on the issues of the prudential and moral risks associated with nuclear weapons, as well as the responsibilities for their elimination. The preamble to the treaty and its core obligations reflect the states parties' recognition of the "catastrophic humanitarian consequences that would result from any use of nuclear weapons" and that "any use of nuclear weapons would be contrary to the rules of international law applicable in armed conflict, in particular the principles and rules of international humanitarian law". It makes clear that, for states parties, "the risks posed by the continued existence of nuclear weapons" for "the security of all humanity" outweigh any possible benefits, and there are thus "ethical imperatives for nuclear disarmament", which is "a global public good of the highest order, serving both national and collective security interests".[1]

By joining the Treaty, states signal to their national populations and institutions, to each other and to the broader international community that they fully adhere to these principles. This would also be the case for a nuclear-armed state acceding to the Treaty. In publicly preparing itself to join the Treaty, a nuclear weapon state would need to go through transformative processes involving its national decision-making to confront and renounce its nuclear weapon status, as well as the related steps involved in complying with the Treaty's core prohibitions and disarmament obligations. It is in this context of high-level political debates and decisions to remake national identity, national priorities, and national security institutions, practices and ideas, and to cultivate a sense of belonging to a trusted international political community that a former nuclear weapon state would need to cooperate with other state parties and a TPNW-designated competent authority or authorities for "the purpose of verifying the irreversible elimination of its nuclear weapon programme".[2]

This essay reflects on the nature, significance and implications of this approach to disarmament and the paradigm shift in verification it allows. It outlines a perspective on what the Treaty describes as "irreversible, verifiable and transparent" disarmament leading a state through to the "elimination of its nuclear weapon programme". It outlines how TPNW verification processes could reflect this paradigm of irreversible and transparent disarmament that focuses on the nuclear weapon programme level, rather than copying verification measures from agreements to restrain or limit nuclear weapon numbers – the latter being shaped by ideas and practices of distrust, opacity and secrecy involved in protecting weapon stockpiles, nuclear deterrence policies and related programmes.

Unlike past nuclear weapon agreements, TPNW disarmament-verification arrangements would not be the result of a bargaining process for the purpose of regulating the nuclear weapon capabilities and competition relationship between competing adversarial states. On the contrary, the purposes of verification would be to demonstrate the profound ongoing reforms – political, legal, military, institutional, social and technological – that a state is undertaking to demonstrate adherence to the Treaty's core principles

1 Treaty on the Prohibition of Nuclear Weapons, A/CONF.229/2017/8, 7 July 2017, https://undocs.org/en/A/CONF.229/2017/8, Preamble.
2 Treaty on the Prohibition of Nuclear Weapons, Article 4.

and prohibitions at home and abroad. Such arrangements may be different whether a nuclear weapon state disarms first and then joins the Treaty, or vice versa. In the latter case, the disarming state is required to play a proactive role in the verification process by submitting the first version of "a legally binding, time-bound plan for the verified and irreversible elimination of that State Party's nuclear-weapon programme, including the elimination or irreversible conversion of all nuclear-weapons-related facilities" to a competent authority designated by the state parties.[3] The Treaty requires the International Atomic Energy Agency (IAEA) to be involved in monitoring the enduring non-nuclear status of states that had nuclear weapons and that disarmed before or after joining the Treaty.

Here we understand verification as the combination of national political, institutional and technical arrangements and mechanisms that are leveraged to demonstrate – domestically as well as internationally – a state's transformation into one that is transparently and irreversibly in compliance with the obligations it undertakes as part of the TPNW. This is similar to the model of verification as "active reassurance" regarding disarmament commitments through public voluntary unilateral steps described by Bruce Larkin.[4] The emphasis in such active reassurance measures would be showing to all concerned the scope of the public renunciation and transformation of the particular policies, institutions, technologies, investments and capabilities that constitute a nuclear weapon programme and allow a state to be a nuclear-armed state.

As we will discuss, beyond familiar approaches that focus on nuclear weapons and nuclear weapon material, disarmament verification can leverage these profound political, institutional and legal transformations that are expected to take place as a state renounces nuclear weapons. We will then show how important these transformations can be in shaping the judgement of others who must decide on the adequacy of this disarmament process in terms of the TPNW goals and obligations. Understanding the implications of this paradigm shift is useful for the future institutionalization of the Treaty and the development of disarmament-verification arrangements that would best fit its goals and purpose. It is also a chance for TPNW state parties to offer a new practical path towards disarmament, rather than swait for the nuclear-armed states to continue stumbling along the stop–start, one step forward two steps back journey of adversarial arms control put in place 50 years ago, in May 1972, with the first US–Soviet Strategic Arms Limitation Treaty (SALT I) and the Anti-Ballistic Missile Treaty.

Putting disarmament and verification in context

The notion of nuclear disarmament here is not simply as a policy goal to be reached, but disarmament as processes of profound state transformation involving the unmaking of deeply entrenched and embedded national identity, policy, priorities, and political and institutional commitments and capabilities attached to nuclear weapons and the threat of their use. William Walker has observed that,

> The anchors of nuclear weaponry are to be found more within states than in their external relations—in the preoccupation with identity, in vested interests, in entrenched loyalties and bureaucratic processes, in material "facts on the grounds" and weapon succession processes, in cultures of conformity and in factional struggles among other things.[5]

These anchors are what sustain the "thrust of exterminism" in nuclear-armed states, identified by E.P. Thompson as a configuration "whose institutional base is the weapons system, and the entire economic, scientific, political and ideological support system to that weapons system, the social system

3 Treaty on the Prohibition of Nuclear Weapons, Article 4, paragraph 2.
4 B.D. Larkin, Designing Denuclearization: An Interpretive Encyclopedia, 2008.
5 W. Walker, "On Nuclear Embeddedness and (Ir)Reversibility", Program on Science and Global Security", Working paper, Princeton University, February 2020, https://sgs.princeton.edu/sites/default/files/2020-02/walker-2020.pdf.

which researches it, 'chooses' it, produces it, policies it, justifies it and maintains it in being".[6] It is these "internal sources of embeddedness" and this "exterminist" structure that will need "disembedding" as part of a disarmament transition from nuclear-armed state to nuclear weapon-free state in the TPNW. To echo William Walker, "nuclear disarmament and significant steps in its direction must always involve, beyond the traditional effort in persuasion, negotiation and regulation, an exercise in disembedding an enterprise and set of beliefs, attitudes and ideas that have deep and resilient foundations."[7]

The context in which nuclear-armed states decide to disarm and the political judgements and narratives that are at work to make and justify this decision matter.[8] Policymakers in nuclear-armed states will need to argue for and justify a shift to disarmament as part of their internal policy debates, to domestic public audiences, to rival states and allies, and to the broader international community. They will need to shift away from long-standing official narratives of national security that have served to justify a role for nuclear weapons. The role of national identity and national narratives will be as important for disarmament as it seems to have been for states seeking nuclear weapons and for such states working to maintain their nuclear weapons and status.[9]

In the past, important disarmament debates have been framed in a security-first perspective, with great weight attached to the need to restrain adversaries, the possibility of technological and strategic substitutes for nuclear weapons, and options for keeping or gaining strategic and military advantage.[10] In 1999, the US Secretary of State, Madeline Albright, argued that the 1996 Comprehensive Nuclear-Test-Ban Treaty (CTBT) served to create a major US advantage: "Under the CTBT, America would gain the security benefits of outlawing nuclear tests by others, while locking in a technological status quo that is highly favorable to us. We have conducted more than 1,000 nuclear tests—hundreds more than anyone else."[11]

For the TPNW, however, the argument for disarmament aims to break the link between nuclear weapons and security and to reject claims about the utility, morality and legality of using and threatening to use nuclear weapons. It relies on making the case that nuclear weapons are intrinsically a crime against humanity and should be seen and treated as immoral, illegal and illegitimate. This allows policymakers in nuclear weapon states to frame arguments for joining the TPNW in ways other than managing national and international security. They could for instance highlight the 1961 United Nations General Assembly resolution that "any state using nuclear and thermo-nuclear weapons

6 E.P. Thompson, "Notes on Exterminism, The Last Stage of Civilization", New Left Review, no. 121, May/June 1980, p. 22.
7 Walker, "On Nuclear Embeddedness and (Ir)Reversibility".
8 Z. Mian, "Beyond the Security Debate: The Moral and Legal Dimensions of Abolition", in G. Perkovich and J. Acton (eds.), Abolishing Nuclear Weapons: A Debate, Carnegie Endowment, 2009, https://carnegieendowment.org/2009/02/13/abolishing-nuclear-weapons-debate-pub-22748.
9 M.J. Sherwin, A World Destroyed: Hiroshima and the Origins of the Arms Race, 1975; D. Holloway, Stalin and the Bomb, 1994; S.D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb", International Security, vol. 21, no. 3, 1997, pp. 54–86; J.E.C. Hymans, The Psychology of Nuclear Proliferation: Identity, Emotions and Foreign Policy, 2006; W. Walker, A Perpetual Menace: Nuclear Weapons and International Order, 2011; B. Heuser, Nuclear Mentalities?: Strategies and Beliefs in Britain, France and the FRG, 1998; N. Ritchie, "Valuing and devaluing nuclear weapons", Contemporary Security Policy, vol. 34, no. 1, 2013, pp. 146–173; J. Baylis and K. Stoddart, The British Nuclear Experience: The Role of Beliefs, Culture and Identity, 2015; B. Pelopidas, Repenser les Choix Nucléaires [Rethinking Nuclear Choices], 2022.
10 Z. Mian, "The American Problem: The United States and Noncompliance in the World of Arms Control and Nonproliferation", in E. C. Luck and M. W. Doyle (eds.), International Law and Organization: Closing the Compliance Gap, 2004.
11 M. Albright, "A Call for American Consensus", Time, 22 November 1999.

is to be considered as violating the Charter of the United Nations, as acting contrary to the laws of humanity and as committing a crime against mankind and civilization".[12]

Humanitarian arguments have the benefit of being about people and not being about "enemies". These arguments are universal in application and available equally to all states and all audiences. They can be used consistently both at home and abroad. They also serve both to expand the elite policy process and to mobilize domestic constituencies for a policy of disarmament that can help counter opposition from existing entrenched and vested interests. Finally, these arguments serve to strengthen a way of thinking, a set of values and national self-images that allow states to break with the embedded security-dilemma sensibility that today shapes their interpretation of the intentions and actions of others, and their responses to such interpretations. This break and the new structure of feeling it allows can create a particular kind of political community with embedded "properties of trust" that would help restrain states from building nuclear weapons and taking other kinds of hostile action, including resorting to war.[13]

Security-dilemma thinking has been key to approaches towards both arms control and verification in existing nuclear arms control and non-proliferation agreements. As US arms control theorist Thomas Schelling observed, the need in the Cold War nuclear arms race was to find ways to "tranquilize relations… while hating and distrusting".[14] During the Cold War, verification was often designed as a technical remedy for the absence of US political trust in the Soviet Union and for the lack of transparency that the United States associated with the Soviet political regime. As Arvid Schors has noted, "The history of nuclear arms control negotiations during the Cold War was, if nothing else, a history of the US government openly flaunting that it could not and would not trust the Soviets under any circumstances."[15]

In a classic analysis of the US politics of verification as part of arms control, Alan Krass has argued that,

> On the US side the almost total absence of trust in the Soviet Union is generally asserted as the foundation of US compliance policy… To the USA, verification must be based on the premise of distrust, that is, the assumption that states (or at least the Soviet Union) sign treaties while maintaining the option, if not the conscious intent, of secretly violating the agreements if an opportunity presents itself in the form of either complacency or irresolution on the other side.[16]

For Krass, "this almost ritualistic incantation" of mistrust and thus verification "serves the purpose of demonstrating that the speaker is not a sentimental disarmer or unwitting dupe of Soviet trickery. To some extent it is a "credibility ritual" which US actors have come to expect of anyone with pretensions to expertise in arms control verification". Krass also notes that there is also a practical constraint posed by the nature of nuclear arms control, since "Arms control agreements are limited instruments which regulate only relatively narrow aspects of the military and political competition. It is assumed that the competition continues unabated in all areas not covered by the agreement. Anything not forbidden is permitted."[17]

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12 General Assembly Resolution 1653, "Declaration on the Prohibition of the Use of Nuclear and Thermo-Nuclear Weapons", 24 November 1961, https://undocs.org/en/A/RES/1653(XVI).
13 K. Booth and N.J. Wheeler, The Security Dilemma: Fear, Cooperation and Trust in World Politics, 2008.
14 T.C. Schelling, "Reciprocal Measures for Arms Stabilization", Daedalus: Proceedings of the American Academy of Arts and Sciences, vol. 89. no.4, fall 1960, p. 894.
15 A. Schors, "Trust and Mistrust and the American Struggle for Verification of the Strategic Arms Limitation Talks, 1969–1979", in M. Klimke, R. Kreis and C. F. Ostermann (eds.), "Trust, but Verify": The Politics of Uncertainty & the Transformation of the Cold War Order, 1969–1991, 2016; N.J. Wheeler, Trusting Enemies, 2016.
16 A. S. Krass, Verification: How Much is Enough?, SIPRI, 1985, p. 161.
17 Ibid., p. 162.

In the Soviet Union, arms control was seen as much more of a political process to address security concerns than a technical approach to managing strategic stability.[18] Technical verification arrangements and, in particular, on-site inspections were often painted as unnecessary and intrusive and providing little benefit as long as both states agreed politically in principle on arms reductions and limitations.[19] This inherent tension could only be resolved through protracted negotiations, which under some circumstances can constitute and reflect practices of trust-building.[20] Even with a view supporting the primacy of reaching political agreement and direct negotiations, the trust is clearly partial since nuclear weapons and adversarial postures remain.

Another clear expression of the intrinsically distrustful dynamics built into arms control and related verification processes can be seen in one particular feature of existing nuclear arms control and non-proliferation agreements: the explicitly or implicitly privileged role of national technical means and intelligence gathering that exists outside and separate from negotiated verification processes. The lead US negotiator of the 2010 US–Russian New Strategic Arms Reduction Treaty (New START), Rose Gottemoeller, has highlighted that,

> From the earliest days of negotiated nuclear arms control in the 1970s, non-interference with national technical verification has been a basic principle to which both sides can agree … Non-interference with national technical verification was one of the earliest and easiest points of agreement in the New START negotiations. [21]

This probably reflects how, in both the United States and the Russian Federation, there is a prevailing view that national technical means and intelligence are a more trusted basis for domestic political judgement about treaty compliance by a treaty partner than the mechanisms under the treaty's agreed verification regime. This reliance on national technical means carries the implicit assumption that a state that has agreed to a treaty and its verification measures is still not to be trusted to comply and that the agreed verification may prove inadequate.

The entrenchment of Cold War nuclear weapon institutions, arsenals, policies and ways of thinking extends to current discussions of the nature, role and practices of arms control and non-proliferation verification, even when it comes to global nuclear disarmament.[22] Post-Cold War agreements dealing with nuclear weapon issues include long and detailed text and annexes on verification. Examples include New START and the 2015 Joint Comprehensive Plan of Action (JCPOA) on the nuclear programme of the Islamic Republic of Iran. Without such specificity, treaties are seen as nothing but an empty shell. For decades, these Cold War arms control verification ideas and practices have served effectively as a paradigm, especially in the United States, in that they have provided shared "model problems and solutions to a community of practitioners" based on "examples which include law, theory, application, and instrumentation together" and have worked "implicitly to define the legitimate problems and methods … for succeeding generations of practitioners".[23] One attribute and function of a paradigm is to prepare each new generation to join and build on the work

18 R. Ranger, Arms and Politics 1958–1978: Arms Control in A Changing Political Context, 1979.
19 Krass, Verification.
20 N.J. Wheeler, J. Baker and L. Considine, "Trust or Verification? Accepting Vulnerability in the Making of the INF Treaty", in Kimke et al. (eds.), "Trust, but Verify"; Wheeler, Trusting Enemies.
21 R. Gottemoeller, "The New START Verification Regime: How Good is it?", Bulletin of the Atomic Scientists, 21 May 2020, https://thebulletin.org/2020/05/the-new-start-verification-regime-how-good-is-it.
22 N.E. Busch and J. F. Pilat. The Politics of Weapons Inspections: Assessing WMD Monitoring and Verification Regimes, 2017.
23 T. Kuhn, The Structure of Scientific Revolutions (2nd edn. enlarged), 1970, pp. 10–11.

of others already in the community "who learned the bases of their field from the same concrete models, [and whose] subsequent practice will seldom evoke overt disagreement over fundamentals".[24] This all works as ways of "signaling the gestalt in which the situation is to be seen".[25]

Seeing traditional arms control and its verification as a paradigm highlights the limits of the critique that the TPNW is weak with regard to verification since it does not include the familiar perspectives and arrangements related to verification (including a priori suspicion of possible cheating and requirement to deter non-compliance).[26] This of course shows only that the TPNW is not just another arms control treaty – it is not similar to the earlier models and examples familiar to nuclear arms control and is not intended to be so. The debate does highlight the importance of seeing verification and, in a broader sense, judgments about compliance, as not just the sole product of explicit treaty-specified often-technical arrangements, and of national technical means where available, that are disconnected from existing and emerging institutional, political, legal and technical contexts.

Historically, the United States has relied on its national technical means as a critical source of independent information for its assessments of treaty obligations. In contrast, many other states see such a capability as unnecessary or simply unfeasible. Such states are much more trusting in institutional arrangements between states and with third parties. For example, the non-nuclear weapon states in the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) do not inspect each other; they accept inspection arrangements negotiated with the IAEA. States within nuclear weapon-free zones accept the commitments made by their neighbours based only on arrangements that these neighbours have made separately through the NPT. It is notable that even the Brazilian–Argentinian bilateral monitoring system, the Brazilian–Argentine Agency for Accounting and Control (ABACC), has the IAEA as a third partner.

The TPNW relies first on a competent international authority (or authorities) to be designated and possibly shaped by the state parties to verify the irreversible elimination of an acceding state's nuclear weapon programme, and second on the IAEA for the post-disarmament safeguards agreement providing "credible assurance of the non-diversion of declared nuclear material from peaceful nuclear activities and of the absence of undeclared nuclear material and activities in that state [party] as a whole".[27] In this way, the Treaty recognizes that it is not operating in a vacuum and leverages existing international instruments and institutions. But it also implicitly – and significantly – recognizes the need for dedicated and possibly new institutions to facilitate a disarmament-verification process that has been largely dominated by nuclear weapon states.

The competent international authority (or authorities), whose goal is to negotiate verification arrangements related to the elimination of nuclear weapon programmes, has yet to be designated. Proposals have ranged from creating a new dedicated organization to establishing an evolutionary organization that can be adapted to be fit-for-purpose when needed, rather than a permanent set of capabilities given the material and financial constraints of state parties.[28] Whatever models

24 Ibid., p. 11.
25 Ibid., p. 189.
26 NATO, "Speech by NATO Secretary General Jens Stoltenberg at the 16th Annual NATO Conference on Weapons of Mass Destruction, Arms Control, Disarmament and Non-Proliferation", 10 November 2020, https://www.nato.int/cps/en/natohq/opinions_179405.htm; Nuclear Threat Initiative, "Treaty on the Prohibition of Nuclear Weapons (TPNW)", Fact sheet, September 2019, https://media.nti.org/documents/tpnw_fact_sheet.pdf.
27 Treaty on the Prohibition of Nuclear Weapons, Article 4, paragraph 1.
28 T. Shea, Verifying Nuclear Disarmament, 2018; T. Patton, S. Philippe and Z. Mian, "Fit for Purpose: An Evolutionary Strategy for the Implementation and Verification of the Treaty on the Prohibition of Nuclear Weapons", Journal for Peace and Nuclear Disarmament, vol. 2, no. 2, 2019, pp. 387–409.

will emerge, the implementation of the treaty is an opportunity for expanding the who (experts) and the what (institutions) that are responsible for crafting disarmament-verification approaches and methods away from existing structures of power that may act contrary to the goals of the TPNW.

Given past experiences with arms control and non-proliferation agreements, the absence from the TPNW of a detailed one-size-fits-all plan for verifying the irreversible elimination of any and all nuclear weapon programmes is more a strength than a weakness. The reason is twofold. First, because verification is political in nature, influenced by both international and domestic politics, and highly contextual, tailoring verification arrangements on a case-by-case basis is a far better strategy for the states parties that agree on the end goal. Second, the Treaty recognizes the prevalence of politics over technical and control arrangements in facilitating disarmament. By asking states to publicly commit domestically and internationally to a process of disarmament and verification upon acceding to the Treaty, rather than signing on to a fixed set of preconditions, the TPNW enables a state to model its verification arrangements as part of its own particular transition from nuclear-armed state to nuclear weapon-free state. This will allow each disarming state to put forward the most appropriate "active reassurance" measures in the form of public voluntary unilateral steps as part of its proposed legally binding, time-bound plan for the verified and irreversible elimination of its nuclear weapon programme.

Part of the paradigm shift enabled by the TPNW is also to change the purpose of verification and thus the relationship of goals, ends and means – the why, what for, and when, the who, and the what of the verification process. As Nick Ritchie explains in chapter 2, the adversarial framing of verification and its current focus on the dismantlement of nuclear warheads is to a large extent politically motivated. It reflects the entrenched structures of power that assume among other things that nuclear weapons have enormous value and carry very sensitive and by implication valuable and desirable information. Because the assumptions that nuclear weapons have value and are desirable are explicitly rejected in the TPNW, there is no reason to focus so intensely on these aspects when designing disarmament-verification arrangements. As Alex Wellerstein shows in chapter 3, the protection of proliferation-sensitive information is also largely a social construct and there are political and technical ways to deal with it. And, as Togzhan Kassenova discusses in chapter 4, once a state decides to become non-nuclear, it can do a lot to demonstrate that it is serious about this commitment – including by getting rid of material and infrastructure and by getting involved in cooperative verification mechanisms.

Shutting down a nuclear weapon programme

To design the verification arrangements of the TPNW, the first step is to understand the politics and context involved in shutting down a nuclear weapon programme. For disarming nuclear weapon states that would decide to join the TPNW, the Treaty offers two options: to join first, then materially disarm; or to first materially disarm and then join. While the two paths call for possibly different verification arrangements, the end goal of verification remains the same: to verify that all nuclear weapon activities and programmes have been terminated, facilities eliminated or irreversibly converted, and any

nuclear material not disposed of is in peaceful use only. There is a body of technical work and the past experiences of states parties with disarmament and non-proliferation that provide some confidence in verifying compliance with a disarmament process aimed at this goal.[29]

In sum, the treaty demands nothing more than former nuclear-armed states become non-nuclear weapon states in good standing as currently defined by existing international standards.

While nuclear weapon programmes it seems are always launched in secret, terminating them will be, to a much larger extent, a public and transparent process. For each of the current nuclear weapon states, shutting down and eliminating their nuclear weapon programme in a process of nuclear disarmament would be a major endeavour involving largely unprecedented political, economic, military and administrative processes. Important historical precedents exist but have been limited in scope and scale. Three former Soviet republics – Belarus, Kazakhstan and Ukraine – returned nuclear warheads to Russia and destroyed legacy weapons and infrastructures after the collapse of the Soviet Union.[30] South Africa unilaterally dismantled its clandestine nuclear weapon programme before revealing officially its existence.[31]

In addition to these four cases, China, France, Russia, the United States, and the United Kingdom are known to have stopped and dismantled some infrastructure associated with nuclear activities (e.g., fissile material production and nuclear weapon testing), as well as scrapped various types of nuclear weapon either unilaterally or as part of arms control agreements. None of these experiences have led to fundamental changes in the role of nuclear weapons in these states' national security strategies, but they are indicative of what public signalling can look like when eliminating weapon systems and infrastructure.[32]

The renunciation of nuclear weapons by one, several or all nine current nuclear weapon states would be likely to involve major speeches and decisions by government leaders, parliamentary votes, the enactment of new legislation, the signature of new or accession to existing international agreements, the opening of nuclear sites for visits and possible inspections, the removal of delivery vehicles from operational status, public displays of weapon destruction and dismantlement, and the closure, clean-up, elimination or conversion of facilities associated with nuclear weapon activities. The latter would include weapon deployment sites, warhead assembly and storage facilities, weapon component design and manufacturing facilities, research and development centres, and even private companies involved in the nuclear weapon enterprise.

The fact is that most facilities associated with existing nuclear weapon programmes are known through the numerous public sources that have documented these programmes over time, combined with today's information landscape and the democratization of space-based assets that allow for the global daily

29 IPFM, Global Fissile Material Report 2009: A Path to Nuclear Disarmament, October 2009, https://fissilematerials.org/library/gfmr09.pdf; H. Feiveson, A. Glaser, Z. Mian and F.N. von Hippel, Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation, 2014; Z. Mian, T. Patton and A. Glaser, "Addressing Verification in the Nuclear Ban Treaty", Arms Control Today, vol. 47, no. 5, 2017, pp. 14–22; P. Podvig, "Practical Implementation of the Join-and-Disarm Option in the Treaty on the Prohibition of Nuclear Weapons", Journal for Peace and Nuclear Disarmament, vol. 4, no. 1, 2021, pp. 34–49; J. Scheffran, "Verification and Security of Transformation to a Nuclear-Weapon-Free World: The Framework of the Treaty on the Prohibition of Nuclear Weapons", Global Change, Peace & Security, vol. 30, no. 2, 2018, pp. 1–20..

30 M.D. Skootsky, "An Annotated Chronology of Post-Soviet Nuclear Disarmament 1991–1994", Nonproliferation Review, spring–summer 1995, pp. 64–105; M. Budjeryn, "Was Ukraine's Nuclear Disarmament a Blunder?", World Affairs, vol. 179, no. 2, 2016, pp. 9–20; T. Kassenova, Atomic Steppe: How Kazakhstan Gave Up the Bomb, 2022. On the case of Kazakhstan see also chapter 4 in this volume.

31 P. Liberman, "The Rise and Fall of the South African Bomb", International Security, vol. 26, no. 2, 2001, pp. 45–86; N. Von Wielligh and L. Von Wielligh-Steyn, The Bomb: South Africa's Nuclear Weapons Programme, 2015.

32 K. Egeland, "Who Stole Disarmament? History and Nostalgia in Nuclear Abolition Discourse", International Affairs, vol. 96, no. 5, 2020, pp. 1387–1403.

(if not hourly) monitoring of the Earth's surface.[33] This suggests that most of the material steps of the disarmament process would happen in plain sight.

Some past disarmament and dismantlement experiences have shown the importance of performative behaviour and the need to publicly exhibit truthfulness when engaging in the deconstruction and destruction activities associated with disarmament measures. For example, the United States and Russia have both displayed disabled long-range strategic bombers in aircraft "boneyards" in accordance with arms control treaties for instance under the 1991 START agreement: "A heavy bomber or former heavy bomber shall remain visible to national technical means of verification during the entire elimination process", a process that can take no longer than 60 days.[34] This facilitated verification from satellite imagery. By 1992, the United States had terminated fissile material production for weapons and naval nuclear reactors and by the end of 2020 the public demolition of the Oak Ridge gaseous diffusion uranium enrichment plants was complete, with hundreds of buildings removed, and the site is now being redeveloped into an airport.[35] After France closed its fissile material production facilities, it invited international experts to witness the dismantlement of key sites.[36] It also closed down its former silo-based missile forces, filling up silos and firing missile engines on the ground.[37] After Ukraine renounced nuclear weapons in 1994, it blew up missile silos and returned nuclear warheads to Russia in front of international media and politicians.[38]

A commitment to public display and candour and the inclusion of nuclear programme workers, domestic civil society and international visitors as stakeholders in the process – rather than the current practices of secrecy and exclusion – suggests that assessing commitment to and progress towards disarmament would be straightforward for the most part once the political and material processes involved begin. If certain steps of the disarmament process were to happen behind closed doors, such as when South Africa dismantled its small nuclear arsenal, it may be important for TPNW states to make explicit that careful documentation and thorough record-keeping would facilitate post facto verification.[39] It would be even possible for a disarming state to document the entire history of its nuclear program at the onset of the disarmament process and commit to this history and associated digital records using established cryptography techniques, and make them available later as required.[40]

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33 I. Moric, "Capabilities of Commercial Satellite Earth Observation Systems and Applications for Nuclear Verification and Monitoring", Science & Global Security, 2022, pp. 1–28.

34 Protocol on Procedures Governing the Conversion or Elimination of the Items Subject to the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms", 31 July 1991, https://2009-2017.state.gov/documents/organization/27363.pdf; A.H. Rotstein, "U.S. Air Force Turns B-52 Bombers into Scrap Metal", Los Angeles Times, 11 September 1994, https://www.npr.org/2013/12/19/255551327/once-a-mighty-bomber-a-b-52-meets-its-end-in-the-desert.

35 US Department of Energy, Office of Environmental Management, "Workers Achieve Historic Cleanup of Uranium Enrichment Complex", October 2020, https://www.energy.gov/em/articles/workers-achieve-historic-cleanup-uranium-enrichment-complex; "Former US Enrichment Site Ready for Redevelopment", World Nuclear News, 9 September 2021, https://www.world-nuclear-news.org/Articles/Former-US-enrichment-site-ready-for-redevelopment.

36 Republic of France, "Dismantling the Fissile Material Production Facilities for Nuclear Weapons", France TNP 2010, https://onu.delegfrance.org/IMG/pdf_100329PM_BD.pdf.

37 Republic of France, "Le Démentèlement de la Composante sol–sol" [The Dismantling of the Ground–Ground Component], France TNP 2010, https://www.francetnp.gouv.fr/IMG/pdf/06-FR-Albion.pdf.

38 K. Oliynyk, "The Destruction of Ukraine's Nuclear Arsenal", Radio Free Europe, 9 January 2019, https://www.rferl.org/a/the-destruction-of-ukraines-nuclear-arsenal/29699706.html.

39 This was a decision implemented by South Africa when it dismantled its clandestine programme. Analysis of archival records was key in verifying the completeness of the South African fissile material declaration to the IAEA. See Von Wielligh and Von Wielligh-Steyn, The Bomb; A. Allen, Apparent Discrepancies: The Verification of South Africa's Nuclear Disarmament, Princeton University Senior Thesis, 2022.

40 S. Philippe, A. Glaser and E.W. Felten, "A Cryptographic Escrow for Treaty Declarations and Step-by-Step Verification", Science & Global Security, vol. 27, no. 1, 2019, pp. 3–14.

The more limited activities involving the destruction of nuclear weapons are required by the TPNW to be completed "as soon as possible," and it is proposed that for any weapon state this need not take longer than at most 10 years.[41] Some key facilities involved in the dismantlement of warheads, the storage of weapon-grade material and so on may take the longest to be closed and eliminated, or converted. These would be well-defined places that could be monitored from the outside and eventually safeguarded once a state has completed its disarmament processes and made the required arrangements with the IAEA.[42] National laboratories dealing with nuclear weapon research and development would need to shift the focus of their mission, giving up all nuclear weapon related capabilities, or shut down. Nuclear military commands and capabilities and sites would be reformed or terminated. Bases would shut down and be eliminated or be converted. Personnel would need to be transferred to new units or discharged from duty. National reports on the status of disarmament activities could be regularly made public and discussed openly in parliamentary bodies (or their equivalent). How long this process would take will be dependent on the scope and scale of particular programmes.

There are important terms of reference related to verification that will require working definitions to allow for the design and implementation of the TPNW verification process. These include specifying what constitutes a nuclear weapon programme (people, institutions, facilities, equipment, material, data, software and records), what the elimination or conversion of nuclear weapon-related facilities entails, and what "irreversibly" means in the context of eliminating or converting material, facilities, technologies, and institutions.

As argued above, all this institutional dismantlement and elimination of the nuclear weapon programme would be in the context of a broader national political, legislative and military "disembedding of an enterprise and set of beliefs, attitudes and ideas". New annual statements of posture or national defence white papers and national budgets would redefine national security strategies and priorities. New domestic laws would codify the TPNW prohibitions and include prohibitions and penalties for acts of commission and acts of omission, as for example in Ireland's 2019 Prohibition of Nuclear Weapons Act.[43]

Under TPNW Article 5, each state party is required to put in place national measures "to implement its obligations under this Treaty" and to "take all appropriate legal, administrative and other measures, including the imposition of penal sanctions, to prevent and suppress any activity prohibited to a State Party under this Treaty undertaken by persons or on territory under its jurisdiction or control".[44] Along with undoing the institutionalized secrecy and classification practices typical of nuclear weapon programmes, states could introduce institutional public commitments to nuclear candour. National implementation measures could include a public right to know, and a legal obligation to report any and all information and activities of concern with regard to meeting any of the Treaty obligations and establish protection for such reporting and whistle-blowing.

Such transparency and truth-telling obligations and protections would enable an active citizenry, especially scientists and technicians in the former nuclear weapon programme, to practice societal verification of the disarmament process. They would serve as "the chief guardians of the arrangement",

41 M. Kütt and Z. Mian, "Setting the Deadline for Nuclear Weapon Destruction under the Treaty on the Prohibition of Nuclear Weapons", Journal for Peace and Nuclear Disarmament, vol. 2, no. 2, 2019, pp. 410–430.
42 Podvig, "Practical Implementation of the Join-and-Disarm Option in the Treaty on the Prohibition of Nuclear Weapons".
43 See, for example, Republic of Ireland, Prohibition of Nuclear Weapons Act, 11 December 2019, https://www.oireachtas.ie/en/bills/bill/2019/60.
44 Treaty on the Prohibition of Nuclear Weapons, Article 5: National.

as proposed in 1946 by physicist Leo Szilard, who first had the idea of a nuclear chain reaction.[45] Joseph Rotblat, the Manhattan Project physicist who co-founded and for many years led the Pugwash movement of scientists against nuclear weapons, proposed in 1993 that any future nuclear disarmament treaty should include the "right and the civic duty of the citizen" to report untoward nuclear activities and this also should be "part of the national codes of law in the countries party to the treaty".[46] Since the TPNW is now in force, as part of the enduring practices of active reassurance, disarming states should include such a Rotblat clause as part of their national implementation measures.[47]

Conclusion

The traditional nuclear weapon-centred model of nuclear arms control verification is shaped by active suspicion and distrust of treaty partners and by national security imperatives to protect nuclear weapon information, arsenals, capabilities and policies. Verification in the TPNW can be distinctly different for a disarming nuclear weapon state, since it involves the presentation of the fundamental transformation of its state identity and national security perspectives, institutions, policies, practices and ideas as it joins a new community.

As a new paradigm, the TPNW opens a new political and technical space for innovation and offers opportunities for a new generation of disarmament science researchers and disarmament practitioners from around the world with different kinds of skills to identify possible disarmament-verification measures that would be significantly different from those identified as part of the existing arms control experience.

Rather than focusing solely on nuclear weapons, their delivery systems and the fissile material that make nuclear weapons possible – all of which have been wrapped in state secrecy for decades – new more holistic disarmament-verification approaches may be possible. These would aim at the TPNW-specified obligation to not just destroy nuclear weapons but to eliminate weapon programmes. This will mean disembedding the long and deeply entrenched military, scientific, political and ideological, and economic support systems that also constitute and sustain such weapon programmes.

There is work to be done in understanding the full repertoire of possible public voluntary "active reassurance" measures from which a state could choose in preparing its initial legally binding, time-bound plan for the verified and irreversible elimination of its nuclear weapon programme. States and publics will need to explore what kinds of public signalling are relevant when renouncing and eliminating nuclear weapon programmes and related infrastructures, ideas and identities. They will also need to understand the national political, institutional and technical arrangements and mechanisms available in any given state to reliably and transparently demonstrate its enduring transformation from a nuclear-armed state to a nuclear weapon-free state in the TPNW.

45 L. Szilard, "Can We Avert an Arms Race by an Inspection System?", in D. Masters and K. Way (eds.), One World or None: A Report to the Public on the Full Meaning of the Atomic Bomb, 2007, pp. 167–179.
46 J. Rotblat, "Societal Verification", in J, Rotblat, J. Steinberger and B. Udgaonkar (eds.), A Nuclear-Weapon-Free World, 1993, pp. 103–118. See also IPFM, Global Fissile Material Report 2009, pp. 114–123.
47 Mian et al., "Addressing Verification in the Nuclear Ban Treaty".

2. Constructing verification: power, politics, and discourse

Nick Ritchie

The purpose of this chapter is to open up our thinking about nuclear disarmament verification (NDV) in the context of a nuclear-armed state deciding to relinquish nuclear weapons and join the 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW). The chapter argues that, in such a context, the ways in which we currently think about NDV and the requirements this generates will change quite considerably. Specifically, the disarmament verification process will be a cooperative one given the political transformation that would accompany a strategic decision to disarm and the very significant changes in the value of nuclear weapons for the disarming state. Unpacking this enables us to see more clearly the ways in which power shapes the current debate on NDV and the importance of making ideas and practices that have become embedded as NDV "common sense" – and that inhibit the possibility of actual nuclear disarmament – seem less natural.

The chapter does not argue that verification is not needed in this context, nor does it provide a blueprint for verification. A system of verification will be a necessary part of any future nuclear disarmament process, but what that system will look like and how the politics of framing verification today shape the possibilities for nuclear disarmament tomorrow are important questions.

The first section of the chapter argues that verification is infused with politics and power and that we need to take this seriously if we are to think about NDV in the context of the TPNW. The second section looks at where prevailing ideas about NDV have come from and unpacks the contemporary logic of NDV, the power to shape the agenda and the contested ideas that underpin it. In particular, it highlights the emergence of requirements for a deeply intrusive and increasingly elaborate regime of technology-driven verification applied to a disarming state's entire nuclear complex and the challenges this poses for the possibility of actual nuclear disarmament. It argues that these were borne out of an adversarial Cold War experience of East–West nuclear arms control and the post-Cold War experience of trying to eliminate the nuclear weapon programmes of so-called rogue states and that they have become normalized in the contemporary NDV agenda.

The final section asks what happens when this NDV agenda meets the TPNW and the "competent international authority" that the Treaty specifies will have to verify the disarmament of any nuclear-armed state that decides to join. Here, the chapter argues that the difference between a disarmament process involving a state and an international organization compared to an interstate nuclear arms control process is crucial. This, combined with the likely asymmetric power relationships in favour of a disarming global or regional power, means that the NDV process will necessarily be a cooperative process in which the perceived value of nuclear weapons will have diminished significantly, if not completely. This enables a different way of thinking about the prevailing NDV agenda, its logic and the salience of its core challenges. In doing so, it draws on a distinction between a deterrence approach to verification and a management approach to verification set out by Nancy Gallagher and Antonia and Abram Chayes.[1]

1 Nancy Gallagher, The Politics of Verification, 1999; Abram Chayes and Antonia Chayes, The New Sovereignty: Compliance with International Regulatory Agreements, 1995.

Power, politics and verification

Verification is often framed as a technical process of measurement through methodologies that have been agreed by participants in the process. This generates objective conclusions about the extent of a state's compliance with agreed rules. But verification is also a political process involving political judgements. As the Nuclear Threat Initiative (NTI) describes it, "verification is a set of national and cooperative activities, tools, procedures, analytical processes, and fundamentally, judgments about what is happening with regard to specific activities defined in an agreement".[2] Understanding power and seeing it at work is essential to understanding the global politics of nuclear weapons, including current thinking on NDV.

Power takes multiple forms in world politics, and we see these at work in NDV. Examples include direct coercive power, such as the threat or use of military violence and economic harm; institutional power exercised through the capacity to shape institutional agendas, choices, practices and coalitions; discursive power to shape the identities of self and other in a verification relationship, what counts as legitimate knowledge, and what counts as possible, acceptable and meaningful action; and structural power, which describes the ways in which some actors are empowered by virtue of their place in social, economic and political structures.[3]

For the purposes of this chapter, the power to shape the ideas and institutions of nuclear order, especially ideas about what counts as "nuclear order" and how it should be realized, are really important. This power is centred on the five states recognized by the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as nuclear weapon states, which are also the permanent members of the United Nations Security Council, along with their supporters such as the member states of the North Atlantic Treaty Organization (NATO). These five states, together with US allies in Europe and East Asia, exercise considerable power to shape ideas about global nuclear order, its core institutions, its material landscape of warheads, delivery systems, fissile materials and nuclear complexes, and its practices of export controls, disciplinary actions, safeguards systems and verification regimes. These ordering ideas take the form of shared understandings about what nuclear weapons mean, what they can do in terms of security, stability and deterrence, how and why they are valued, and which nuclear actions and nuclear actors count as legitimate or illegitimate in world politics.[4] These shared understandings can become accepted, or naturalized, as a "regime of truth" about nuclear weapons and nuclear politics.

Verification is part and parcel of this framework of power, politics and nuclear order; it is part of the fabric of its prevailing ideas, institutions, practices and material landscape. It is not, therefore, a depoliticized technical exercise located somewhere "beyond the politics of nuclear disarmament", and therefore outside of structures of power.[5] It is, as Wyn Bowen et al. argue, very much part of nuclear politics. In fact, denying the politics of verification is itself a political move. As Gallagher argues, the idea that verification can be depoliticized is problematic, and calls to depoliticize verification are more often than not "political strategies to obtain a desired outcome by empowering people who share one's starting assumptions".[6]

2 "Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks. Overview", Cultivating Confidence Verification Series, Nuclear Threat Initiative, July 2014, http://www.nti.org/media/pdfs/VPP_Overview_FINAL.pdf, p. 5. In the context of the TPNW, this will be a set of international activities undertaken by the Treaty's competent authority on behalf of its membership.

3 Michael Barnett and Robert Duvall, "Power in Global Governance", in Michael Barnett and Robert Duvall (eds.), Power in Global Governance, 2005, pp. 1–32.

4 Nick Ritchie, "Valuing and Devaluing Nuclear Weapons", Contemporary Security Policy, vol. 34, no. 1, 2013, pp. 146–73, https://doi.org/10.1080/13523260.2013.771040.

5 Wyn Bowen et al., Trust in Nuclear Disarmament Verification, 2018, p. 7.

6 Nancy Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough", Contemporary Security Policy, vol. 18, no. 2, 1997, https://doi.org/10.1080/13523269708404165, p. 141.

Power is exercised in the politics of verifying nuclear disarmament through the ways in which particular threats and conceptions of security are understood and how practices of verification are constructed as necessary and legitimate in response. It operates at the international level through shaping the content, priorities and resourcing of an international NDV agenda. It is exercised through decisions by states and international organizations about the structure, purpose and practices of a verification regime; that is, decisions about who and what needs verifying and about how the verification can and should be undertaken.

Power and politics are at work in the processes of interpretating and evaluating data and reaching judgements about non-compliance and responses to it. Determining non-compliance, framing an appropriate response and mobilizing support for it can be deeply political depending on the perceived severity of the transgression and the interests at stake. Drawing conclusions about non-compliance is often, therefore, an interpretive task involving political judgements in which lots of actors will have political interests in the outcome. Making these judgements appear objective and apolitical is in itself a very powerful political act.

This can be dangerous by allowing powerful actors to shape verification processes and outcomes to justify violence, as in the case of Iraq in 2003, but it can also be productive by providing political space for acceptable compromises. For example, the International Atomic Energy Agency (IAEA) reserves the right to reach its own judgements on the seriousness of cases of non-compliance with safeguards commitments brought by its member states and how to respond.[7] Similarly, the United States and the Soviet Union/Russian Federation have demonstrated flexibility and political judgement in efforts to reach mutually acceptable compromises on suspected violations of nuclear arms control agreements through consultative mechanisms established in their bilateral treaties.[8]

The power to shape the ideas and institutions of NDV is often experienced through relations of power. This is where context is very important because verification is a relational practice insofar as it only has meaning as an idea and a practice within the social and historical context of relations between a specific group of actors. Verification has particular meanings in the context of the US–Russian arms control relationship, but it would be very likely to have different meanings in the context of a disarmament relationship between the TPNW and a nuclear-armed state or states. But across most of these contexts, two foundational ideas give verification meaning: (1) the idea of mutual restraint on the means of violence for mutual benefit; and (2) the idea of building confidence for mutual benefit through demonstrable adherence to an agreement. Arms control debates during the Cold War showed just how contested these basic ideas could be and revealed the politics of privileging some meanings and ideas about verification over others. NDV is therefore not apolitical but part of a framework of power, politics and nuclear order. Interpretation and judgment lie at its heart, context is crucial and even these foundational ideas have been contested.

Where have these ideas come from?

This section unpacks the contemporary NDV agenda and its underlying logic by looking first at the origins of the prevailing NDV paradigm in the experience of Cold War nuclear arms control. Then it looks at how some of these core ideas were cemented in the challenges of dealing with the nuclear programmes of Iraq, the Islamic Republic of Iran and the Democratic People's Republic of Korea (DPRK) in the post-Cold War period. What emerges is an adversarial NDV paradigm based on a requirement for extensive

7 Olli Heinonen, "IAEA Mechanisms to Ensure Compliance with NPT Safeguards", UNIDIR, 2020, p. 25.
8 Pavel Podvig and Amy Woolf, "Monitoring, Verification and Compliance resolution in US–Russian Arms Control", UNIDIR, 2019.

surveillance through transparency and intrusiveness. This is aided by technological solutions that maximize the ability to detect non-compliance that could be militarily significant even at low levels and thereby deter transgressions through the risk of being caught. The analysis seeks to make some of what has been normalized in this NDV paradigm – and the requirements that are often read off from it – seem less natural.

Cold War arms control verification ideas and culture

The origins of the current NDV paradigm lie in the Cold War experience of East–West nuclear arms control, especially the Western experience. This saw the United States and the Soviet Union verify ceilings on the number of nuclear delivery vehicles and then reductions in various types of nuclear weapon through ever more intrusive inspections. Both sides still retained and modernized thousands of weapons deployed across their territories, Europe and parts of East Asia. The political relationship was adversarial and characterized by mutual suspicion and deep mistrust that assumed some degree of duplicity. Worst-case scenarios of the consequences of non-compliance became the norm and partial and uncertain evidence of non-compliance was often treated as sufficient proof. In this context, competing ideas about nuclear arms control verification emerged. The current agenda of nuclear disarmament verification is very much an extension of this.

Gallagher argues in her detailed study of the politics of verification that the verification of nuclear arms control was broadly understood by its protagonists as a "self-help" process in a world of zero-sum adversarial politics. This meant that neither side could be seen to gain any sort of advantage through an arms control agreement and possible non-compliance that might go undetected.[9] As the Cold War unfolded, "parity" between the strategic nuclear arsenals of the United States and the Soviet Union became a core principle for arms control.[10] The idea of parity became politically important even if it meant little in terms of the ability of either side to destroy the other with a nuclear first strike or a retaliatory nuclear attack. In the United States, security in the Cold War came to be based on the idea that only a careful military balance would deter Soviet military expansionism. Following this logic, while parity in strategic nuclear weapons could be cemented through arms control agreements, each side was vulnerable to changes in the military balance if the other did not comply and its non-compliance went undetected.

As a result of the emphasis on nuclear parity and military balance as the basis for security, a consensus emerged in the United States that a verification regime for nuclear arms control agreements would need to be sufficiently intrusive so as to detect non-compliance at a level that would not lead to an immediate military advantage and would give the United States enough time to respond with its own military programmes.[11] Such a level of verification would deter non-compliance because the gains would be low (in terms of military advantage before detection) and the costs high (in terms of recrimination, sanctions, countermeasures and the risk that the arms control regime might collapse altogether).[12]

9 Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough", p. 139.
10 David Mutimer, "From Arms Control to Denuclearization: Governmentality and the Abolitionist Desire", Contemporary Security Policy, vol. 31, no. 1, 2011, pp. 57–75, https://doi.org/10.1080/13523260.2011.556844.
11 For example, the 1990 JASON report on Verification Technology in the context of verifying the US-Soviet START treaty stated that a verification system must "meet two necessary and sufficient conditions, neither more nor less: We must be able to detect violations of a scale that could upset the military balance and threaten our security; We must be able to detect violations soon enough to enable us to respond in a timely fashion. These define the requirements of 'effective' verification." S. Drell et al., "Verification Technology: Unclassified Version", JASON Report JSR-89-100A, MITRE Corporation JASON Program Office, 1990, p. 3
12 Chayes and Chayes, The New Sovereignty, p. 176.

The result, as Chayes and Chayes put it,

> was an attitude of hypervigilance, rooted neither in military necessity nor in the requirements of normal political relationships, but in these ingrained ideological attitudes. A driving assumption was that relatively small changes in the size or structure of nuclear forces could directly affect the military balance and endanger American security.[13]

Consequently, the need for very high levels of confidence in compliance and the ability to detect low levels of non-compliance was often framed as a problem of increasing transparency through intrusiveness enabled by technological solutions.[14] Keith Krause and Andrew Latham argue that this approach to verification based on observation and empirical validation through "intrusive and detailed measures" became normalized as "virtually indispensable elements of arms control agreements" in a Western nuclear arms control and disarmament culture.[15] The embedding of this as normal is power at work.

Politically, the central questions became "how much verification is enough?" and whether arms control was worth the risks of being duped, knowing that transparency and therefore confidence in compliance could never be complete. Sceptics of arms control argued that the degree of intrusiveness required for a credible verification regime was not possible, or that it would only be possible between friendly states when it was not needed. Very similar arguments were made by Cold War realists about arms control more broadly.[16] Arms controllers assuaged critics by arguing that a verification approach based on a high degree of intrusiveness would be sufficient, because it would allow the United States to "obtain incontrovertible evidence of any violation" and thereby minimize the risk and effects of non-compliance.[17]

Uncertainties in the ability to detect non-compliance prompted more research on technological solutions for more precise monitoring or to hedge against non-compliance.[18] To that end, Chayes and Chayes argued that "the United States organized a costly system of surveillance, relying on complex advanced technology developed for both verification and intelligence purposes".[19]

Doubling down with "rogue" states

This approach to verification was moderated in the post-Cold War period insofar as the verification regimes for the 2002 Strategic Offensive Reductions Treaty (SORT) and 2010 New Strategic Arms Reduction Treaty (New START) were less extensive than those developed in the 1980s and early 1990s for START I and START II. As Amy Woolf argues, this was due in part to the long experience of verification under the START regime but also a shift in US threat perceptions about Russia that diluted immediate concerns in Washington about the military significance of potential treaty violations.[20]

Nevertheless, the Cold War culture of verification based on requirements for deep intrusiveness, empirical validation and an assumption of adversarial relations was reinforced through efforts to contain and roll back the nuclear programmes of so-called rogue states after the Cold War, notably the DPRK, Iraq and Iran. After the 1991 Gulf War, Iraq was subjected to a coercive and intrusive verification regime through the inspection

13 Ibid., p. 178.
14 Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough", p. 142.
15 Keith Krause and Andrew Latham, "Constructing Non-Proliferation and Arms Control: The Norms of Western Practice", Contemporary Security Policy, vol. 19, no. 1, 1998, https://doi.org/10.1080/13523269808404178, p. 30.
16 Colin Gray, House of Cards: Why Arms Control Must Fail, 1992.
17 Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough", p. 157.
18 Ibid., pp. 155, 165.
19 Chayes and Chayes, The New Sovereignty, p. 174.
20 Any Woolf, "Monitoring and Verification in Arms Control", CRS Report R4102, Congressional Research Service, 2011, p. 9.

processes of the United Nations Special Commission (UNSCOM) and later the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC), which enjoyed widespread support. The discovery of the extent of Iraq's clandestine nuclear programme also prompted the development of the IAEA's Additional Protocol to authorize the agency "to provide assurances as to the absence of undeclared nuclear material and activities in a State".[21] The new Model Additional Protocol was approved by the IAEA's Board of Governors in 1997 and also enjoyed widespread (although not universal) support. It enabled the agency to collect a wider set of data on state nuclear activities for a more comprehensive technical analysis than permitted under a standard Comprehensive Safeguards Agreement (CSA).

Similarly, international efforts to denuclearize the DPRK and contain Iran's nuclear prgramme centred on intrusive verification requiring very detailed knowledge of current and past nuclear activities in order to arrive at a determination of compliance with IAEA safeguards commitments and additional requirements. For the DPRK, these requirements took the form of the 1994 Agreed Framework with the United States, then a more comprehensive "complete, verifiable and irreversible dismantlement" (CVID) approach that informed the six-party talks process in the 2000s, which involved the United States, the DPRK, China, the Republic of Korea, Japan and Russia. For Iran, the additional requirements took the form of the Joint Comprehensive Plan of Action (JCPOA) negotiated between Iran and the United States, the United Kingdom, Russia, France, China and Germany along with the European Union.

In all three cases, the power asymmetries between Iran, Iraq and the DPRK on the one hand and their interlocutors on the other were considerable, and coercive verification was understood as an adversarial process. This was particularly so for the United States, given the history of conflict and open hostility with all three states. In the case of Iraq, the verification regime was imposed by the United Nations Security Council and supplemented by a sanctions regime and air strikes. In the cases of Iran and the DPRK, the verification regimes were negotiated, but in a context of punitive sanctions and threats of military violence should negotiations fail. In the Iraq and DPRK cases, the outcomes for compliance were dismal and calls for a more cooperative approach were ignored.[22] The jury is still out on Iran as participants in the JCPOA come close to piecing it back together at the time of writing following the US withdrawal from the agreement in 2018.

The experience with these three states cemented an adversarial and intrusive approach to verification that required the recovery of extensive information about each country's nuclear programme through maximum transparency and compliance monitoring to deter transgressions. It also went further, to become a form of verification-as-proof of absence of nuclear programmes, with all the challenges of proving a negative that this entailed. This was understood as necessitating a state-wide approach to verification, with unrestricted access for inspectors to sites they judge necessary in order to assure compliance, given the adversarial context.

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21 IAEA, "Model Protocol Additional the Agreement(s) between State(s) and the International Atomic Energy for the Application of Safeguards", INFCIRC/540, 1997.

22 On the DPRK, Siegfried Hecker, Robert Carlin and Elliot Serbin at Stanford University have developed a "technically-informed, risk management roadmap to 'denuclearization'" of the DPRK based on cooperation and détente. They argued that a coercive approach to denuclearization and intrusive verification "will be virtually impossible in a confrontational environment" and note its failures to date. Siegfried Hecker, Robert Carlin and Elliot Serbin, "A Technically-Informed, Risk Management Roadmap for North Korea's Denuclearization", 28 May 2018, Center for International Security and Cooperation, Stanford University, https://fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/hecker_carlin-serbin_denuc_rlc.pdf. Similarly, Pavel Podvig has developed a detailed approach based on verifying a freeze on fissile material production and slowly building from there. Pavel Podvig, "Freeze and Verify: Ending Fissile Material Production on the Korean Peninsula", UNIDIR, 2020.

The current NDV discourse

The prevailing NDV discourse therefore has a particular historical context and logic that are important to understand and problematize if we want to open up how we might think about NDV in relation to the TPNW. This discourse reflects a specific set of meanings derived from the East–West Cold War experience, the post-Cold War experience with rogue states, and largely Western ideas about verification and its requirements.[23]

The contemporary form of this discourse has moderated this logic through a focus on nuclear disarmament verification rather than nuclear arms control verification. It has also focused on capacity building and cooperation to develop verification technologies and methodologies through exercises and joint programmes. This has been developed through a number of Western initiatives, including the UK–Norway Initiative (UKNI) instigated in 2007, the International Partnership for Nuclear Disarmament Verification (IPNDV),[24] the Quad Nuclear Verification Partnership (involving the United Kingdom, the United States, Sweden and Norway) that followed on from the UKNI, and the Franco-German Nuclear Disarmament Verification (NuDiVe) exercises in 2019 and 2022 under the auspices of the IPNDV. These were complemented by the United Nations Groups of Governmental Experts (GGEs) on NDV of 2018–2019 and 2021–2022, whose members were selected on the basis of equitable geographical representation and represented a more diverse set of perspectives.[25] Nevertheless, the contemporary NDV agenda remains a very Western enterprise that encompasses many of the assumptions of nuclear arms control verification.

One of the main issues on this agenda is the challenge of intrusive verification while eliminating the possibility of deliberate or inadvertent disclosure of information deemed "proliferative" or classified. That includes information relating to warhead design, fissile material composition or operational environment that could aid other states' actual or potential nuclear weapon programmes.[26] The specific challenge is extracting sufficient information from the verified dismantlement of nuclear warheads to give inspectors confidence that the object being presented for dismantlement is, in fact, a nuclear warhead and even a warhead of a specific type, while denying access to information the disarming state considers proliferative or classified. For example, the United Kingdom and Norway stated that the research agenda for their joint project on the verification of nuclear warhead dismantlement "aimed at developing effective verification measures which protect proliferative or otherwise sensitive information whilst providing sufficient, accurate and truthful information for verification purposes".[27] Addressing

23 For an overview, see David Cliff, Andreas Persbo and Hassan Elbahtimy, "Verifying Warhead Dismantlement Past, Present, Future", Verification Research Report no. 9, VERTIC, 2010; Tim Caughley, "Nuclear Disarmament Verification: Survey of Verification Mechanisms", UNIDIR, 2016.

24 IPNDV was established in 2014 by the US State Department and the Washington-based NTI to investigate technical and procedural challenges and solutions associated with nuclear disarmament verification and monitoring. It has three working groups, led by the Netherlands and Italy, Australia and Poland, and the United States and Sweden. These are US treaty allies. Other members alongside these six states in Phase I were Argentina, Belgium, Brazil, Canada, Chile, Finland, France, Germany, the Holy See, Indonesia, Japan, Jordan, Kazakhstan, Mexico, Norway, Philippines, Poland, South Korea, Switzerland, Turkey, the United Arab Emirates and the United Kingdom, plus the European Union. Of the 26 states (excluding the United States and European Union), 12 are European and 13 are US treaty allies. Russia and China began as observers and then withdrew their participation.

25 General Assembly, "Final Report of the Group of Governmental Experts to Consider the Role of Verification in Advancing Nuclear Disarmament", A/74/90, 15 May 2019, https://undocs.org/en/A/74/90.

26 The NPT is often cited as the reason why certain information must be categorized as proliferative, but the NPT actually says very little about this. The text provides only a general proscription in Articles I and II. For example, Article I says, "Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in sany way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices" (emphasis added).

27 United Kingdom and Norway, "The United Kingdom–Norway Initiative: Further Research into the Verification of Nuclear Warhead Dismantlement", Working Paper, NPT/CONF.2015/WP.31, 22 April 2015, https://www.un.org/en/conf/npt/2015/pdf/NPT-CONF2015-WP.31_E.pdf.

this problem has led to an NDV agenda based on developing elaborate technological solutions to the political challenges of verification understood in terms of a requirement for ever more comprehensive, intrusive and technologically assured verification as a condition of disarmament. A second key issue is the fear of nuclear "breakout".

The fear of nuclear "breakout"

The mainstream logic of NDV is that it must be deeply intrusive to maximize transparency and deter non-compliance that could lead to a military advantage. In the context of verifying nuclear disarmament, this logic is underpinned by the fear of nuclear breakout. This refers to the fear that a state could violate a nuclear disarmament agreement, that the violations go undetected, and that the violator is able to reveal a small hidden nuclear arsenal or a clandestinely reconstituted nuclear arsenal, and then use this to coerce others to win political victories or to engage in territorial aggression and threaten nuclear use if others attempt a forceful return to the status quo ante.[28]

This concern reflects the ways in which a very high value is currently ascribed to nuclear weapons by nuclear-armed states and their supporters. Breakout scenarios are based on the underlying assumption that nuclear weapons will remain of very high value to a nuclear-armed state that has made a strategic decision to relinquish them.[29] Nuclear disarmament, if it ever happens, will take place under a condition of reluctance, distrust, scepticism and caution, with plans to redeploy nuclear weapons if necessary over some period of time, perhaps even rapidly.

For the nuclear-armed states, the pathways to tomorrow's disarmament therefore reflect the ways in which nuclear weapons are not only valued today, but have an enduring value that could, in certain circumstances, be outweighed by the value of collective nuclear disarmament, but not negated by it: according to this logic, the value of nuclear weapons would remain through and after a disarmament process. The requirements of a verification regime are read off from these understandings of the enduring value of nuclear weapons through the way in which the possibility of nuclear breakout is framed as a decisive, perhaps paralysing, advantage.[30] Typical of the idea is the statement by Bowen et al. that, "when it comes to monitoring nuclear warhead dismantlement, a step that is usually thought of as happening at low numbers of nuclear weapons, it is clear that more intrusive measures would need to be employed as the diversion of a single weapon could prove strategically significant".[31]

One of the working papers submitted to the GGE on NDV echoed this refrain that, "As the number of nuclear weapons decreases during the disarmament process, *the strategic value of a single nuclear warhead will increase*, as will the level of assurance required for verification on disarmament treaties".[32] This relationship between the intensity of verification and the depth of disarmament was captured as early as 1961 by Jerome Wiesner and is known as the Wiesner Curve. According to the curve, the lower the number of weapons, the greater the level of inspection.[33]

28 See Charles Glaser, "The Flawed Case for Nuclear Disarmament", Survival, vol. 40, no. 1, 1998.
29 See, for example, Thomas Shea, Verifying Nuclear Disarmament, 2019, p. 5.
29 Thomas Schelling, "A World without Nuclear Weapons?", Daedalus, vol. 138, no. 4, 2009, pp. 124–129.
30 Bowen et al., Trust in Nuclear Disarmament Verification, p. 57.
31 Michael Biontino, "Considerations on the Role of Verification in Advancing Nuclear Disarmament: Background Paper", Working Paper by Germany, GE-NDV/2018/4, 2018 (emphasis added).
32 Allan Krass, Verification: How Much Is Enough?, SIPRI, 1985, p. 168
33 Allan Krass, Verification: How Much Is Enough?, SIPRI, 1985, p. 167.

This logic, in turn, can mitigate against the very idea of nuclear disarmament because the current nuclear-armed world of imperfect nuclear deterrence, with thousands of nuclear weapons organized for rapid warfighting, is considered less risky than a world without nuclear weapons subject to an imperfect verification system. As Allan Krass put it, "Extending this argument to its logical conclusion leads to the prediction that complete nuclear disarmament is an unstable and potentially very dangerous situation, since a marginal advantage of only a few weapons could give its possessor enormous power".[34]

The logic of the current NDV discourse

What we discern from this overview is an NDV discourse dominated by four core ideas:

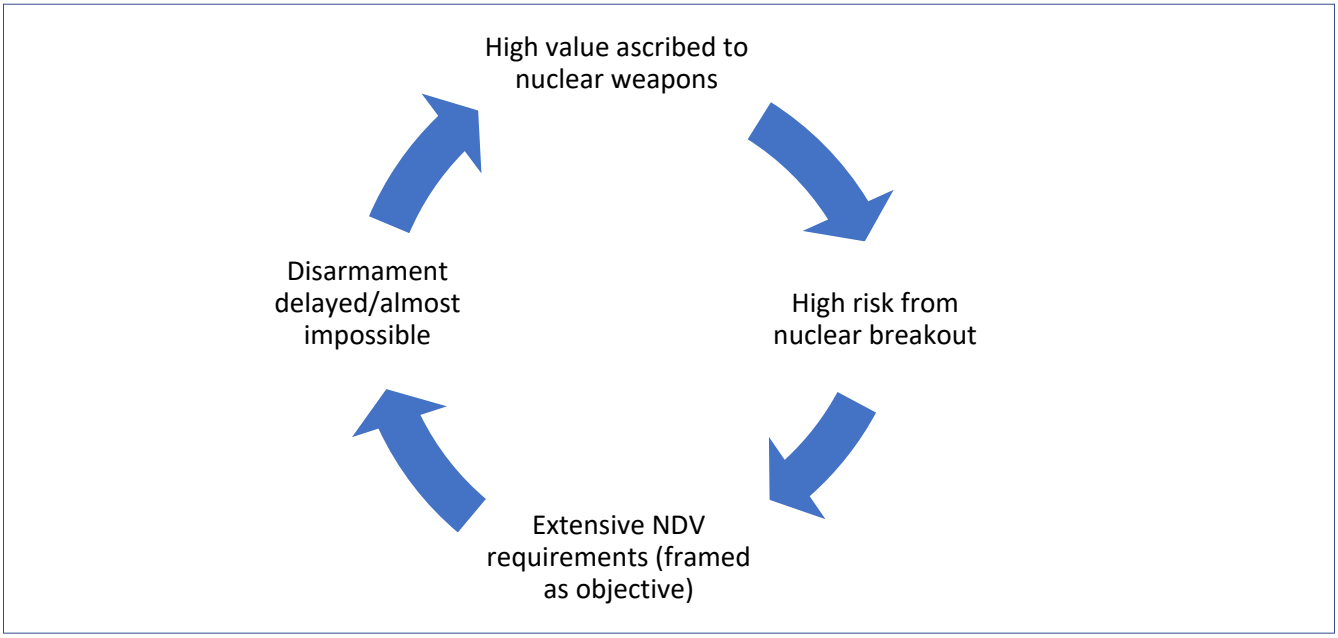
1. A broad process of nuclear disarmament will be an extrapolation of the US–Soviet/Russian nuclear arms control verification experience, and therefore shaped by its ideas, practices and adversarial character. It is based on continued US–Russia reductions extending from nuclear delivery vehicles to warheads (picking up where US and Russian discussions on a framework for START III left off in the late 1990s), expanding to include other NPT nuclear weapon states, and then all nuclear-armed states.
2. Nuclear weapons remain highly valued assets because the logic of nuclear deterrence prevails, and this will remain so during and beyond any future disarmament process. Any change in a "balance" of nuclear capabilities at very low numbers would therefore be very significant and dangerous. Effective nuclear disarmament therefore requires a very high level of intrusiveness in order to deter and, if necessary, respond in a timely manner to non-compliance and potential nuclear breakout.
3. Even if extraordinary intrusiveness becomes politically permissible, its extent is inescapably circumscribed by a requirement to contain proliferative or classified information about nuclear warheads and fissile materials. The scope of such information is determined by the nuclear-armed states, but this barrier to progress can be overcome through a series of technological solutions that could, potentially, generate very high levels of confidence in NDV outcomes.
4. This is all necessary because of the unacceptable risks of cheating that could lead to a breakout nuclear monopoly that would be unacceptably dangerous given the high value accorded to nuclear weapons. The risk of breakout (in terms of its probability and the significance of its occurrence) is considered high. Therefore, if NDV is perceived to be unable to verify to the degree of assurance required (which is subjective) in order to reduce that risk below a threshold (which is subjective), then nuclear disarmament itself will be considered too risky.

Krause and Latham describe this discourse as "a socially constructed 'script'… embedded in a specific cultural context" rooted in the Cold War experience.[35] The discourse establishes a set of requirements for the verification of nuclear disarmament that have been established by nuclear-armed states for nuclear-armed states. They are framed as objective and therefore a justifiable reason for delaying disarmament until the requirements can be demonstrably met, along with other disarmament conditions beyond verification.

34 Allan Krass, Verification: How Much Is Enough?, SIPRI, 1985, p. 167.
35 Krause and Latham, "Constructing Non-Proliferation and Arms Control", p. 46.

The problem is that this logic of NDV and its requirements then make actual nuclear disarmament seem almost impossible. This is because these requirements are derived from the ways in which nuclear weapons are currently valued very highly by nuclear-armed states. This NDV discourse and its requirements then reproduce and naturalize this value through the ways in which non-compliance and breakout from a disarmament process are framed as an unacceptable risk. Moreover, the challenge of meeting these requirements reinforces a perception of nuclear disarmament as impossible and idealistic. The practical impossibility of nuclear disarmament then reinforces the value ascribed to nuclear weapons in a permanently nuclear-armed world, generating a cyclical logic (figure 2.1). In that way, the main discourse of NDV circulating at the centre of nuclear order reproduces the idea that nuclear disarmament is, in fact, just not possible, despite repeated statements by nuclear-armed states that they do eventually intend to disarm. Requirements for ever more demanding verification processes becomes an effective means of endlessly delaying progress on actual disarmament while claiming to work towards it.

Figure 2.1. *The cyclical logic of the dominant discourse on nuclear disarmament verification*



The assumption that verification will take place in an adversarial context that requires a deep level of intrusiveness sits at the heart of the current discourse. This has led to a bet on technologies to enable such intrusiveness without giving away information considered classified or proliferative by the disarming state. As a result, the development, institutionalization and proven capabilities of an intrusive nuclear verification system have become a necessary condition for nuclear disarmament. The degree of intrusiveness for such a regime is shaped by nuclear-armed states, who then judge whether this is sufficient to tip the balance of risk in favour of nuclear disarmament at some future point. In fact, significant work has been done on intrusive arms control processes, with conclusions reached of high confidence in some of the practices and technologies developed to date and identification of a research agenda to increase that confidence. This approach has now become normalized to the extent that the politics of NDV can often recede into the background, leaving a "depoliticized" and "objective" science and technology programme as the NDV agenda.[36] It is in this sense that we see power at work in setting underlying assumptions, framing the degree of intrusiveness and normalizing a particular approach.

36 IPNDV, "Phase I Summary Report: Creating the Verification Building Blocks for Future Nuclear Disarmament", 2017.

The NDV paradigm and the TPNW

The political effects of the prevailing NDV discourse are therefore substantial: it privileges technological solutions and managed access methodologies to overcome the proliferative information problem; it normalizes increasing intrusiveness to mitigate the problem of breakout; and it assumes a broadly adversarial context in which nuclear disarmament is an extension of nuclear arms control. Power therefore plays a central role in the politics of verification not only in terms of how a prevailing culture of security and arms control shapes our understandings of NDV, but also in terms of the power relations between the actors involved in a verification relationship.

It is important to note, however, that verification will be necessary even in a cooperative environment. The Treaty text states that the irreversible elimination of the state's nuclear weapon programme will be verified by the "competent international authority or authorities" designated by the states parties. This does not mean, however, that the approach to verification has to follow the prevailing NDV discourse.

An asymmetry of power and the case for cooperation

A nuclear disarmament process through the TPNW will not be an extension of interstate nuclear arms control, but a different type of endeavour. Arms control is an attempt to manage and regulate a system of security based on nuclear weapons and deterrence in which nuclear weapons are very highly valued and the risk of nuclear violence must be managed since it cannot be eliminated.[37] Disarmament is an attempt to manage a system of security without nuclear weapons and nuclear deterrence, one in which nuclear weapons are of low or negative value (i.e., they are considered a serious liability) and the risk of nuclear violence must be eliminated since it cannot be managed indefinitely. The voluntary disarmament of nuclear-armed states joining the TPNW through a cooperative verification process would therefore constitute the negotiation of a new nuclear order and the dismantling of the current one, which relies on nuclear weapons. Nuclear arms control, in contrast, is about managing a nuclear-armed world in ways that reproduce it, whether with a smaller number of weapons or with different weapons. The underlying assumptions of these two approaches about cooperation and trust in the politics of NDV are therefore different.

Within this context, a power asymmetry to shape the NDV process will favour the disarming state when it is a global or regional power (e.g., the United States, China, Russia or India) in terms of preferences and costs. This stands in contrast to the comparatively equal power relationship between the United States and the Soviet Union/Russia in East–West nuclear arms control and the asymmetry of power against the disarming states in post-Cold War experiences with Iran, Iraq and the DPRK. Power, here, refers to the power to shape the discourse of disarmament verification, institutional power through the TPNW and related institutions (e.g., the United Nations Security Council, the IAEA and the NPT), and the wider structural power of major powers in world politics. Powerful nuclear-armed states will not be coerced into disarming, but in the event that such a state makes a strategic decision to willingly disarm and join the TPNW, then the verification process will necessarily have to be cooperative rather than adversarial or coercive. This has a number of implications.

37 In fact, these two approaches to nuclear weapons, risk and security are in the end incommensurable, since the logic of nuclear arms control is fundamentally incompatible with the logic of nuclear disarmament, as David Mutimer shows. Mutimer, "From Arms Control to Denuclearization: Governmentality and the Abolitionist Desire".

First, it means that the disarming state will largely define the degree of intrusiveness to which it is willing to subject its nuclear weapon complex based on its judgements of the balance between secrecy, transparency, reassurance, the domestic and international political context, and the timeline for disarmament, which could be substantial. Under the TPNW, the competent authority would, of course, play a substantial role, but the asymmetry of power would be substantial even as the disarming state is acting in good faith and cooperating fully.[38] History shows that the power to shape disarmament-verification regimes has historically resided with the world's powerful states, not least the United States and Russia. For example, the crafting of the verification regimes for the 1993 Chemical Weapons Convention (CWC) and the 1996 Comprehensive Nuclear-Test-Ban Treaty (CTBT) was driven in large part by the interests, preferences and capacities of the main chemical- and nuclear-armed states, notably the United States and Russia.[39] This is in part because those states with substantial experience of chemical or nuclear weapons and with large military-scientific complexes with centres of research expertise on verification practices were best-placed to shape verification regimes. Organizations like the IPNDV and the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) recognize this and have specific capacity-building programmes to enable a wider range of states to actively participate in verification practices.[40]

Second, an asymmetric power relationship between a global or regional power and the TPNW's competent authority will be compounded by the requirement under Article 9(3) of the TPNW for the disarming state to bear the full costs of its disarmament process, including the costs of implementing verification measures negotiated with the competent authority. The costs of a very intrusive process could be significant, given the requirement to verify the irreversible elimination of the state's nuclear weapon programme and the elimination or irreversible conversion of all of its nuclear weapon-related facilities.[41] This power dynamic means that a disarming global or regional power will probably be able to resist a preconceived NDV methodology to which it might have objections, even if it is committed to relinquishing its nuclear weapons. This suggests that the TPNW's competent authority will need to take a tailored and cooperative approach to verification that does not stick rigidly to a predetermined NDV process, particularly if a very detailed level of verification becomes prohibitively expensive.

Third, the asymmetry could be compounded if a state chooses the TPNWs "destroy-then-join" option by dismantling and eliminating its nuclear weapons and nuclear complex facilities and only then joining the Treaty and opening the residual complex to external verification. This would follow the example of South Africa, which destroyed its small nuclear arsenal prior to joining the NPT in July 1991 and then inviting the IAEA first to verify its initial declaration on nuclear facilities and nuclear material inventories under the CSA negotiated with the agency in September 1991, and then to verify the dismantlement of its nuclear weapon programme. This route works against an intrusive verification system designed to verify a disarmament process, rather than a disarmament outcome.[42]

38 Thanks to Pavel Podvig for this point.

39 Rebecca Johnson, Unfinished Business: The Negotiation of the CTBT and the End of Nuclear Testing, UNIDIR, 2009, chapter 7.

40 International Partnership for Nuclear Disarmament Verification, "Working Group 1: Deliverable 3. The Skills, Areas of Expertise and Resources Needed, and the Ways Forward for Building these Capacities", November 2017, http://ipndv.org/wp-content/uploads/2017/11/WG1-Deliverable-Three-Final-.pdf; Mao Sato, "Advancing Nuclear Test Verification without Entry into Force of the CTBT", Journal for Peace and Nuclear Disarmament, vol. 4, no. 2, 2021, pp. 251–267.

41 Shea, Verifying Nuclear Disarmament, p. 6.

42 Pavel Podvig and Joseph Rodgers, "Deferred Verification: Verifiable Declarations of Fissile-Material Stocks for Disarmament Purposes", Nonproliferation Review, vol. 26, nos 3–4, 4 May 2019, pp. 209–217, https://doi.org/10.1080/10736700.2019.1628414; Zia Mian, Tamara Patton and Alexander Glaser, "Addressing Verification in the Nuclear Ban Treaty", Arms Control Today, June 2017, https://www.armscontrol.org/act/2017-06/features/addressing-verification-nuclear-ban-treaty.

However, the power relationship will not be entirely one-way. There is a weight of expectation among non-nuclear-armed states that a disarming state must be subjected to a sufficient level of verification to assure non-nuclear-armed states that it has, in fact, dismantled and destroyed its nuclear weapons and dismantled or repurposed its nuclear weapon complexes. Moreover, non-nuclear-armed states have shown increasing interest in active participation in NDV through the GGE and the IPNDV.[43] The context of the TPNW is important here insofar as the Treaty emerged as an exercise of collective agency by comparatively disempowered non-nuclear-armed states to push the disarmament agenda forward at the international level.[44] The TPNW is, in part, about the democratization of the global politics of nuclear weapons and disarmament, and a right to have a say, including in NDV through the TPNW's competent authority. This is supported as a matter of principle in a report of the United Nations Disarmament Commission that set out 16 principles of verification. These included that "all States have equal rights to participate in the process of international verification agreements to which they are parties", which was reaffirmed by the 2018–2019 United Nations GGE on NDV.[45] In the event that a nuclear-armed state is prepared to relinquish its nuclear arsenal, there will be pressure from the non-nuclear-armed states to have a clear say on the scope and process of verification through the competent authority.

For these reasons, both the disarmed/disarming state and the TPNW's competent authority will seek a cooperative, rather than a coercive, approach to NDV. A verification process is therefore more likely to look like what Gallagher and Chayes and Chayes describe as a cooperative managerial approach to NDV and less like an adversarial deterrence or enforcement approach.[46] Gallagher sets out a verification-as-management approach in contrast to a verification-as-deterrence approach based on adversarial relationships and worst-case assumptions. Verifiction-as-management is based on a cooperative approach to security in which verification is a form of regulatory management through "consultation, clarification, and dispute resolution that are increasingly multilateral and managerial despite conflicts of interest and lingering doubts about motivations".[47] She draws on the experience of the US–Russian Cooperative Threat Reduction (CTR) programme established in the early 1990s as a prime example.[48] The experience of Kazakhstan in dismantling the nuclear infrastructure it inherited form the Soviet Union also testified to the value of cooperative approach to verification (see chapter 4 of this report).

Chayes and Chayes draw a similar distinction between an "enforcement model" and a "managerial model", drawing on their professional experiences in US nuclear arms control. For them, a managerial approach to verification focuses on cooperation, transparency, dispute settlement, capacity building, persuasion, problem-solving and

43 VERTIC, "Exploring Multilateral Verification of Nuclear Disarmament: Scenarios, Modelling and Simulations", VERTIC Research Reports no. 12, 2015, p. 15.
44 Nick Ritchie and Kjolv Egeland, "The Diplomacy of Resistance: Power, Hegemony and Nuclear Disarmament", Global Change, Peace and Security, vol. 30, no. 2, 2018, pp. 121–141, https://doi.org/10.1080/14781158.2018.1467393.
45 Disarmament Commission, "Review of the Implementation of the Recommendations and Decisions Adopted by the General Assembly at Its Tenth Special Session", Report of the Disarmament Commission, A/SI/182/Rev.1, 2 June 1999. This is also supported in practice by the democratization of nuclear verification through the CTBTO's International Monitoring System (IMS). This has established over 300 facilities across the globe with 130 governments able to receive data from the organization, making verification "a highly collaborative endeavor". Lassina Zerbo, "Attracting a Crowd: What Societal Verification Means for Arms Control", Bulletin of the Atomic Scientists, vol. 69, no. 3, 2013, https://doi.org/10.1177/0096340213485932, p. 11.
46 Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough"; Gallagher, The Politics of Verification; Chayes and Chayes, The New Sovereignty.
47 Gallagher, "The Politics of Verification: Why 'How Much?' Is Not Enough", p. 164.
48 Ibid., pp. 164–166.

consultation to address non-compliance concerns, rather than enforcement through an adversarial process of threats and punishment.[49] Their analysis of treaty regimes shows that, "For the most part, compliance strategies seek to remove obstacles, clarify issues, and convince parties to change their behaviour. The dominant approach is cooperative rather than adversarial. Instances of apparent non-compliance are treated as problems to be solved, rather as than wrongs to be punished."[50] They challenge the efficacy of a coercive, accusatory and adversarial approach to compliance and verification and conclude that it is "as misguided as it is costly".[51] In these studies, a managerial approach frames verification and compliance as an evolving and iterative process of learning "in which not only national positions but also conceptions of national interest evolve and change".[52] The iterative nature of a cooperative and managerial NDV process is illustrated by the South African experience as well as that of Kazakhstan.[53]

This sort of cooperative managerial approach is likely to be the only plausible pathway for a NDV process between a disarmed/disarming nuclear-armed state and the TPNW's competent authority. From this starting point, we can unpick the prevailing logic of NDV set out above and look again at the requirements it generates for deeply intrusive verification based on elaborate technological solutions to questions of political judgement rooted in fear of nuclear breakout.

Rethinking the problem of nuclear breakout in a TPNW disarmament process

A nuclear disarmament-verification system under the TPNW must balance assurance of compliance with the Treaty's prohibitions with enabling actual elimination of nuclear weapons and the dismantling of nuclear weapon complexes.[54] The perfection of a NDV process must not become the enemy of good (or "good enough") nuclear disarmament. The main driver of "perfection" has been the fear of non-compliance leading to a military advantage through the idea of nuclear breakout. Reducing this risk requires a deeply intrusive and elaborate verification system according to the logic of NDV set out above. For some, this risk would be so great that nuclear disarmament must not be entertained.

The breakout narrative is powerful, but its power would wane considerably in the context of a disarmament process through the TPNW because of the necessarily significant change in value and legitimacy assigned to nuclear weapons through and after disarmament. Specifically, the argument that a state with a new-found nuclear monopoly could coerce other states is speculative and contested.[55] The notion that this would be so significant as to require so extensive a verification system as to practically preclude disarmament is based on a set of assumptions about what nuclear weapons mean and what states can actually achieve through

49 Chayes and Chayes, The New Sovereignty, pp. 25–26.
50 Ibid., p. 109.
51 Ibid., p. 22.
52 Ibid., p. 4.
53 See Olli Heinonen, "Lessons Learned from Dismantlement of South Africa's Biological, Chemical, and Nuclear Weapons Programs", Nonproliferation Review, vol. 23, nos 1–2, 2016, pp. 147–162, https://doi.org/10.1080/10736700.2016.1182685.
54 Proponents of the TPNW rejected an alternative proposal from Seth Baum to reduce the total number of nuclear weapons to 50 worldwide on the basis that if they were to be simultaneously detonated, the risk of severe nuclear winter catastrophe would be very unlikely to occur. Seth Baum, "Winter-safe Deterrence: The Risk of Nuclear Winter and Its Challenge to Deterrence", Contemporary Security Policy, vol. 36, no. 1, 2015, pp. 123–148, https://doi.org/10.1080/13523260.2015.1012346.
55 Mathew Fuhrman and Todd Sechser, Nuclear Weapons and Coercive Diplomacy, 2017.

nuclear threat-making. If a nuclear-armed state considers a single nuclear weapon, or perhaps a handful, clandestinely concealed from a verification regime to be revolutionary, then it is likely to be placing sufficiently high a value on nuclear weapons as to forgo the strategic decision to disarm in the first place.

The validity of the Wiesner Curve that captures the prevailing logic of NDV has been challenged on precisely this basis.[56] Richard Falk and Richard Barnett show that this logic is based on the premise that the degree of mistrust will remain constant in a disarmament process, such that the closer we get to disarmament the more verification is required because our security is at more risk from the military significance of violations. They unpack the problems with this logic and argue that

> If the process of disarmament, once commenced, were to continue, it would almost necessarily transform both the attitudes of states toward one another and the general character of international society. It seems implausible to postulate as constant the political atmosphere that exists today during the course of disarmament from beginning to end. Either trust and harmony would emerge to a much greater extent than they exist today, or the disarmament process would not proceed very far. That is, we must accompany the idea of disarmament with an expectation of political transformation, the nature of which cannot be anticipated with any precision.[57]

Unpicking this logic (and at the risk of being tautological), if a political context permissive of disarmament is one in which nuclear weapons have been devalued perhaps to the point of obsolescence (and potentially also delegitimized and stigmatized), then the political and military significance of a state acquiring or reacquiring a small number of nuclear weapons would be serious but not revolutionary. Consequently, the requirement for so intrusive a verification system as to preclude the possibility of this type of breakout can be questioned, thereby opening up other ways of thinking about a verification process. Moreover, evidence suggests that the United States did not gain much leverage from its nuclear monopoly in the late 1940s.[58] Scott Sagan and others have argued that there would be a shared interest in mobilizing forcefully against a state that did breakout with a clandestine nuclear weapon capability.[59]

In sum, the current high value ascribed to nuclear weapons that generates requirements for very intrusive verification-as-deterrence in order to preclude dangerous breakout scenarios. This in turn undermines the possibilities for actual nuclear disarmament because the requirements are so onerous.

Rethinking the problem of proliferative information in a TPNW disarmament process

Moderating requirements for deeply intrusive verification also moderates requirements for increasingly elaborate technological solutions. These are intended to eliminate the possibility of accidental or deliberate transfer of information relating to warhead design, fissile material composition or operational environments considered proliferative or classified. The context of a disarmed/disarming state joining the TPNW in a cooperative NDV process will allow more room for political judgement and generate fewer requirements for a deeply intrusive and elaborate technological process of systematic verification derived from the largely adversarial logic set out above. Chapter 3 of this report covers the issues around handling

56 Krass, Verification, pp. 167–171.
57 Richard Falk and Richard Barnett, Security in Disarmament, 1965, p. 47.
58 McGeorge Bundy, "Atomic Diplomacy Reconsidered", Bulletin of the American Academy of Arts and Sciences, vol. 38, no. 1, 1984.
59 Scott Sagan, "Shared Responsibilities for Nuclear Disarmament", Daedalus, vol. 138, no. 4, 2009, p. 166; Muller, "Icons off the Mark", p. 555.

nuclear weapon related information and associated secrecy in more detail. This section describes the aspects of the problem that are linked to the power dynamics in the verification process.

The level of intrusiveness in the verification process will be limited by the power of the disarmed/disarming state. Here, the power to decide what counts as proliferative or classified information in a verification process negotiated with the TPNW's competent authority will lie largely with the joining state. The power to define these categories circumscribes the availability of information and therefore the shape of the NDV process, and that power will reside far more with the disarming party than the inspectorate.[60] This would pertain even if the inspectorate comprised inspectors from one or more nuclear-armed states given their different classification and security regimes. The boundaries of these categories of information are open to debate, but it is difficult for non-nuclear-armed states, international organizations or even other nuclear-armed states to challenge the basis upon which a nuclear-armed state categorizes certain information as proliferative or classified because of this power–knowledge asymmetry.

In this way, a disarming state occupies a powerful structural position in the politics of nuclear disarmament because it can set the parameters for a NDV process that will not, in its judgment, disclose what it categorizes as proliferative or classified information. For example, in its peer review of the United Kingdom's NDV programme in 2011, the British Pugwash Group noted that "The main basis for the UK's uncompromising stance on the release of proliferation-sensitive information has been *its interpretation* of the provisions of the NPT – i.e. that there should be no disclosure of information to any party which would assist anybody in designing a weapon".[61] A disarming state could even use this position to deny the TPNW and non-nuclear-armed states from playing any part in an NDV process. For example, Russia stated unequivocally at the United Nations GGE on NDV that "without authorized access to highly classified and proliferation-sensitive information pertaining to actual nuclear weapons and their delivery means, [external] scientific and technical experts will be unable to make any relevant contribution to shaping future nuclear arms control agreements and regimes".[62]

Deeply intrusive verification methodologies based on a suite of technological solutions might be possible in the future, but requirements for such methodologies are currently read-off the prevailing NDV discourse derived from an adversarial nuclear arms control context. The very different context of a disarmed/disarming state joining the TPNW presupposes a degree of political transformation that has sufficiently devalued and perhaps delegitimized nuclear weapons as to warrant disarmament. This, coupled with the power to decide what counts as proliferative or classified information, is very likely to dilute current verification requirements and open up different methodologies in which the challenges of revealing proliferative information are moot, such as those developed by Pavel Podvig and others.[63] This is important, because an NDV regime based on intrusive verification that also protects proliferative

60 As the final report of the United Nations' high-level expert preparatory group for a fissile material cut-off treaty (FMCT) noted in relation to fissile material, "the determination of what is in 'non-sensitive form' remains primarily a national prerogative". General Assembly, "Report of the High-Level Fissile Material Cut-Off Treaty Expert Preparatory Group", A/73/159, 13 July 2018, https://undocs.org/en/A/73/159, p. 16 fn 5.

61 Brian Anderson et al., "Verification of Nuclear Weapon Dismantlement: Peer Review of the UK MoD Programme", Research Report, British Pugwash Group, 2012, p. 10 (emphasis added).

62 Vladimir Leontiev, "Establishment of Group of Scientific and Technical Experts on Nuclear Disarmament Verification (GSTE-NDV)", Working Paper by the Russian Federation, GE-NDV/2019/2, 2019.

63 Pavel Podvig and Joseph Rodgers, "Deferred Verification"; Pavel Podvig, "Practical Implementation of the Join-and-Disarm Option in the Treaty on the Prohibition of Nuclear Weapons", Journal for Peace and Nuclear Disarmament, vol. 4, no. 1, 2021.

and classified information is often framed as a prerequisite for moving close to nuclear disarmament when the need to do so might be of limited necessity for an actual disarmament process.

Conclusion

This chapter has explored some of the politics and power relationships shaping nuclear disarmament verification in relation to the TPNW. Drawing on previous work, it has argued that NDV sits within the wider structures of a global nuclear order and is part of its fabric of prevailing ideas, institutions, practices and structures of power. At the centre of power of this nuclear order are the five NPT-defined nuclear weapon states, which exercise considerable power over the ideas and practices of NDV. It is in this context that the chapter argues that the prevailing discourse of NDV reflects a specific set of meanings derived from the East–West Cold War experience, largely Western ideas about verification and its requirements that were cemented in the post-Cold War experience with Iran, Iraq and the DPRK.

However, the verification context of a nuclear disarmament process through the TPNW will differ from a verification context of interstate nuclear arms control, not least because nuclear weapons will have necessarily been considerably devalued and perhaps also delegitimized. Also, the power asymmetry in favour of the disarming state will necessitate a cooperative rather than coercive approach. A more cooperative and managerial process will open up more room for political judgement and reduce demands for a deeply intrusive elaborate technological process of systematic verification.

The threat of nuclear breakout, which shapes most current approaches to NDV, will be quite different because of changes in the perceived value of nuclear weapons by nuclear-armed states by virtue of their participation in a voluntary and cooperative disarmament process. The salience of this fear and the power of this narrative will change in relation to the declining value and legitimacy of nuclear weapons in an actual nuclear disarmament process under the TPNW.

This, of course, is not an argument against the development of a suite of NDV technologies and methodologies that could prove to be essential to further arms-reduction treaties and disarmament steps. And this does not suggest that political judgement should or can replace technical verification procedures. But it is important to ask questions about whether and how a traditional arms control verification-as-deterrence approach serves or inhibits actual nuclear disarmament as imagined under the TPNW. A nuclear disarmament-verification system, or system of systems, will be essential to enable, support and sustain a world without any nuclear weapons. However, there is an ongoing process whereby the high value ascribed to nuclear weapons generates requirements for very intrusive verification-as-deterrence. These requirements undermine the possibilities for actual nuclear disarmament that would, by definition, shift the meanings of nuclear weapons in the direction of devaluing and delegitimizing them. This will enable a nuclear disarmament process to be initiated in such a way that the requirements for very intrusive verification-as-deterrence are reduced or displaced by something like a verification-as-management approach.

Finally, when we ask "how–possible" questions about a phenomenon like the current political configuration of the NDV agenda, we can foreground some of the core assumptions that make that phenomenon make sense in its political context. Here, the chapter argues that this agenda is underpinned by a particular set of power relations and a discourse of nuclear value that ripples through the assumptions, agendas and logic of NDV, something that the TPNW actively seeks to challenge. This discourse of requirements and the science and technology agenda to try

and find solutions to political problems is rarely contested. From one perspective, then, the technological NDV agenda is seeking solutions to a particular framing of the problem; from another, it reproduces the value and legitimacy of nuclear weapons in ways that inhibit nuclear disarmament through its production of very difficult requirements that are framed as objective and necessary.

3. Secrecy and verification in nuclear disarmament

Alex Wellerstein

Since their invention, nuclear weapons have existed within extensive regimes of state secrecy. Historically, this began within the context of their origins within state-run programmes often developed clandestinely out of a fear of attempted pre-emption, sabotage or negative pressures imposed by both enemies and allies.[1] Once established, the secrecy mindset quickly spread to nearly all aspects of the development of such weapons and their deployment.

If history is any indication, it is incredibly hard to scale back this secrecy, even when there are serious attempts at reform. Two main official rationales are typically given for this: that knowledge of nuclear weapon design information can enable both proliferation and innovation of nuclear weapons abroad; and that intimate knowledge of a state's nuclear weapon systems could lead an enemy state to increased aggression. Against this background, there have been arguments that the aforementioned secrecy concerns can and have been used by nuclear-armed states as a means to discourage the development of and participation in a total disarmament treaty – such as the 2017 Treaty for the Prohibition of Nuclear Weapons (TPNW) – by non-nuclear-armed states, as discussed by Nick Ritchie in chapter 2. This chapter gives an overview of potential issues posed by secrecy, and discusses their possible resolutions.

Historical overview

The problem of secrecy and arms control has been a prominent one since the very dawn of the nuclear age. The first discussions about "international control of atomic energy" – what we would today call total, verifiable nuclear disarmament – began within the United States Government even before the bombing of Hiroshima, centred around questions of secrecy. Specifically, arms control was the antithesis of nuclear secrecy. To facilitate a world without nuclear weapons, the scientist Niels Bohr argued that what was necessary was an openness, at least among scientists. Only through the ability to go anywhere and ask anything could it be established that another state was not trying to become a clandestine nuclear power. Other versions of international control sometimes included some secrecy for hard-won and very applied "manufacturing details", but generally saw their effectiveness as being about creating a regime of inspection (a form of openness) as the core to their work.

Both the Acheson–Lilienthal Report and the Baruch Plan of 1946 saw an opposition to state secrecy – notably the state secrecy associated with the Soviet Union – as absolutely core to their approaches to nuclear regulation. The scientific advisors who helped create both emphasized that nuclear secrets were at best only temporary, because other states could independently discover the same principles through their own research, if not espionage, whereas arms control based on material substances (e.g., the production of fissile material) would necessarily be far more secure. In these schemes, what secrets the United States currently possessed would be released to the world upon the establishment of a treaty that would guarantee against nuclear arms races.[2]

It was recognized by those in favour of international control that this was a very radical proposition for several reasons. One is that the Soviet Union, which most saw as a primary

1 See, e.g., Jeffery Richelson, Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea, 2007.

2 See Alex Wellerstein, Restricted Data: The History of Nuclear Secrecy in the United States, 2021, especially chapter 4.

contender for the next nuclear power and the main antagonist in a future nuclear arms race, was a notoriously closed society that operated under extreme secrecy, especially under Joseph Stalin. Bohr in particular was well aware that this was not only the means of avoiding an arms race, but would amount to "a revision of the relationship between sovereign nations so radical that it would hardly be feasible unless there were a question of unprecedented common dangers which can be averted only by cooperation in true confidence".[3] It was hoped that the end of World War II, the creation of the United Nations and the emergence of a new category of possibly civilization-destroying weapons could serve as an impetus for such a radical reorganization of global power. The fact that this did not come to pass makes it easy, in retrospect, to dismiss such advocacy as either idealism or naivete, but it interesting to note that, especially in the early post-war period, before the Cold War power relations had calcified, there was considerable popular support for such ideas.

The second problem was that it would require both the United States to abandon its new capabilities and the Soviet Union to foreswear them. The United States was willing to make earnest proposals for international control in the United Nations, which itself is somewhat surprising in retrospect. But it is not clear that, even if it had been supported by the Soviets, it would have been politically capable of following through on the proposals for domestic reasons. As it was, the Soviet Union in retrospect gave these proposals no sincere support; it did offer up a counterproposal, the Gromyko Plan, which simply declared that nuclear weapons were banned but had no verification measures. This was understandably rejected by an untrusting United States. Similarly, the Soviet Union did not trust the aspects of the Baruch Plan which would require total cooperation from the Soviet Union before the United States would itself be subjected to disassembling its own nuclear weapons. The arguably justified lack of mutual trust between the two superpowers at the end of World War II was an apparently insuperable obstacle towards a working disarmament treaty.

Secrecy was core to this discussion, as noted. Aside from the questions of sovereignty that international control proposals brought up, the US representatives were under the impression that their nuclear secrets should be preserved in the short term as a sort of incentive for Soviet participation in a control agreement: if the Soviet Union signed an agreement, it would get information that might have important economic implications (e.g., for the creation of nuclear power plants). This approach appears in retrospect to have been badly miscalculated, not only because the possible peaceful incentives did not balance the security concerns that the Soviets had, but also because, as became known a few years after the international control debate had essentially died, the Soviets had an impressive espionage network throughout parts of the US nuclear programme, and had already acquired enough information to jumpstart their own nuclear infrastructure. The Soviet Union was also, it turned out, entirely willing and capable of doing its own costly research.[4]

Despite this initial failure, it is important to note that the approach taken by the Acheson–Lilienthal Report and the Baruch Plan, with their focus on fissile material monitoring and other non-information-based approaches to halting nuclear weapon development, is the

3 Niels Bohr, "Addendum to Memorandum of July 3, 1944", 24 March 1945, copy in Correspondence ("Top Secret") of the Manhattan Engineer District, 1942–1946, microfilm publication M1109, National Archives and Records Administration, 1980, Roll 3, Target 5, Folder 20, "Miscellaneous".

4 On the very limited value of "secrets" to the Soviet nuclear programme, see Michael D. Gordin, Red Cloud at Dawn: Truman, Stalin, and the End of the Atomic Monopoly, 2009. Gordin emphasizes that ultimately the Soviet nuclear accomplishment was not a product of "information" so much as creating the material infrastructure necessary for bomb development. He further argues, following work by Alexei Kojevnikov, that espionage information was of less value to the Soviet programme than has been traditionally thought because the Soviets deliberately did not use the information as efficiently as they might have since they did not fully trust it.

primary approach used today by the International Atomic Energy Agency (IAEA) regarding compliance with the safeguards regime of the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Modern non-proliferation efforts at the international level are less about the monitoring or control of secrets, and more about the monitoring and control of material goods, which are both easier to actually monitor and control and are what makes the difference between a state with nuclear weapons and one without them. This material-based approach to non-proliferation and arms control presents the major cogent alternative to secrecy as a model for the control of nuclear weapons, and has done so since the 1940s despite very public obsessions with "secrets".[5] This view does not argue that information about, say, weapon design cannot be of use to other states, only that it is of much less use than many nuclear weapon states estimate (i.e., it is not as big a barrier to nuclear acquisition as is often believed), and it is a much less productive vector along which to target non-proliferation than, say, the production of fissile materials.

Despite international control not coming to pass, these issues would return again in the attempts to create new arms control agreements in the 1950s, notably the US Atoms for Peace initiative. One of the proposals offered by the United States was that it and the Soviet Union ought to offer up a large quantity of fissile material as part of a pool that would be made available for global, peaceful nuclear research. The Soviets objected that, because the United States already had such a large accumulation of fissile material, this proposal would not affect its ability to simultaneously produce nuclear weapons, and would thus not be a meaningful arms control measure. The United States countered that it would take the fissile material for its contribution from existing weapons that it was dismantling, thus tying the issues together. A difficulty immediately presented itself: how could the United States reasonably prove to a sceptical Soviet Union that it was actually dismantling weapons, and vice versa? This "adversarial" approach to verification occupies a considerable amount of the energy and attention of the existing verification literature and is the sort of work that generated many internal studies from the 1950s onward.

Several of the arms control treaties between the United States and the Soviet Union of the détente period, notably the Strategic Arms Limitation Treaties (SALT I and SALT II), included verified limits on deployments of weapons. A core concept of these verifications was that states could use "national technical means" without hinderance: things like overflights, satellite photography, telemetry and other aids to remote intelligence gathering. SALT I notably prohibited any "deliberate concealment measures" that might impede verification by these means. This approach of remote verification, as opposed to the more intrusive safeguards and inspection regime eventually developed for non-nuclear weapon states as part of the NPT, was clearly a balance between the demands of verification and the desire for secrecy, as remote verification could only give broad indications of compliance for large scale deployments of missiles, sub-marines and bombers, but would avoid the intrusiveness of on-site inspections.

Later treaties, notably the 1991 Strategic Arms Reduction Treaty (START), added on-site inspections and on-site monitoring systems as parts of a broader verification regime. It has often been noted that these kinds of activity, separate from whatever specific intelligence they may give, are also valuable as cooperative measures that indicate a good-faith approach to treaty compliance. These kinds of interaction are generally considered to be increasing "transparency", tacitly framed as in opposition to the traditional secrecy associated with such categories of arms.[6]

5 See Wellerstein, Restricted Data, chapters 4, 8 and 9; and David Kaiser, "The Atomic Secret in Red Hands? American Suspicions of Theoretical Physicists During the Early Cold War", Representations, vol. 90, no. 1, 2005, pp. 28–60.

6 Amy Woolf, "Monitoring and Verification in Arms Control", Congressional Research Service, R41201, 23 December 2011, https://sgp.fas.org/crs/nuke/R41201.pdf.

Moving away from the superpowers, the NPT and the safeguards regime created by the IAEA in the 1960s offer some instructive guidance on how secrecy and safeguards can coexist. INFCIRC/26, the policy establishing the IAEA's pre-NPT safeguards system in 1961, specifically prohibited IAEA staff from disclosing "any industrial secret or other confidential information" that they learned in the course of their inspection duties.[7] Subsequent policies strengthened this language, instructing the agency to take "every precaution to protect commercial and industrial secrets" in particular.[8]

Similar language was part of the later, NPT safeguards policy, that would also be used for nuclear weapon-free zone regimes. Safeguards agreements between the IAEA and states would, again, provide for the protection of "commercial and industrial secrets and other confidential information" that the IAEA might acquire through its safeguards inspections, and the IAEA itself was prohibited from publishing or communicating "to any State, organization or person" any information that it acquired from an inspected state with the exceptions of information specifically related to implementing the safeguards themselves and summarized information about "nuclear material" being safeguarded. A further provision makes clear that the issue is that the IAEA inspectors could come into the knowledge of "industrial secrets and … other confidential information" in the course of their duties, and that they must "ensure [its] protection".[9]

The framing of all of these agreements is instructive: the IAEA is acknowledging that states have their own internal regimes for both proprietary and military classified information. It also acknowledges, tacitly, that any safeguards regime it might impose will be likely to expose its inspectors to information that a state might consider confidential for one of these reasons. The agency is thus charged to make sure that such information does not leak out. In other words, this is an approach that acknowledges that there are multiple reasons that states might have information controls, but in principle that ought not to prohibit inspections.

The NPT itself says nothing specifically about secrecy. However, Article I – in which every nuclear weapon state party to the treaty agrees "not in any way to assist, encourage, or induce" non-nuclear weapon states to manufacture nuclear arms – has, at times, been interpreted by nuclear weapon states as implying that part of their treaty obligations is to maintain secrecy over nuclear weapon design information. For example, in the late 1990s, the United States and the Russian Federation, as part of their increased transparency measures and arms reductions in the post-Cold War, agreed to endeavour to find "technical methods" that would "protect sensitive nuclear weapons information and to prevent its disclosure", as part of their interpretation of Article I.[10]

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7 IAEA, INFCIRC/26, 30 March 1961, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1961/infcirc26.pdf.

8 IAEA, INFCIRC/66, 3 December 1965, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1965/infcirc66.pdf.

9 IAEA, INFCIRC153 (Corrected), June 1972, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1972/infcirc153.pdf. The only other acknowledgement that "classified knowledge" might be relevant to safeguards inspections is a short section on "non-peaceful" activities, in which states are allowed to use special nuclear materials for military activities that do not involve the production of nuclear weapons (presumably including things like fuels for military propulsion reactors). In such cases, the IAEA is tasked with issuing quick "agreements" acknowledging that this material has been taken out of the safeguards regime legally, but said agreements "shall not involve any approval or classified knowledge of the military activity or relate to the use of the nuclear material there".

10 Dirk Schiefer, "Evolution of IAEA Verification in Relation to Nuclear Disarmament", IAEA-SM-367/02/06, https://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF files/Session 2/Paper 2-06.pdf.

It is worth very briefly noting the case of the one fully nuclear-armed state that transitioned into a former nuclear-armed state: South Africa. The South African nuclear programme was kept in in a state of "absolute secrecy", where even its existence was itself a secret. When it was decided in the early 1990s to dismantle the programme, President Frederik de Klerk is said to have ordered the destruction of "sensitive documents" relating both to technical developments as well as strategy and policy.[11] This was, one source reports, done in order to prevent future post-apartheid governments from reconstructing the weapon prgramme.[12] Some records were, however, deliberately preserved, in part to demonstrate that dismantlement had taken place.[13]

In recent years, considerable attention has been given to the question of verifiable warhead dismantlement in the context of hypothetical future treaties that might put a cap on total warheads, and not just deployments of weapons. Verifying warhead dismantlement is of especial interest regarding secrecy because (as discussed in the next section) nuclear warhead design information is usually one of the primary categories of nuclear secrecy desired to be maintained by nuclear-armed states. How, then, can an inspector confirm that an object to be dismantled is a warhead without learning proprietary information about warhead design? Since the 1960s, various solutions have been proposed based either on a trade-off between classified information released and confidence in verification, or on novel "zero-knowledge proof" approaches that use technical means to achieve verification without any design information possibly being used.

These approaches are all interesting in their own right, but, for the purposes of this chapter, they can probably be put to the side. They are dismantlement approaches that rest very heavily on both adversarial assumptions about what a potential "cheater" might be attempting, and with an "arms control" mindset that assumes that some number of weapons and their systems will be maintained. This is, as Sébastien Philippe and Zia Mian argue in chapter 1, probably the wrong framework for thinking about a total disarmament treaty like the TPNW. The details of warhead dismantlement in such a regime are less important than accounting for fissile material quantities and a dismantlement of delivery systems, as has been argued at length elsewhere.[14]

In summarizing the above capsule history, a few things stand out. One is that nuclear secrecy is fairly exclusively a creation of national nuclear programmes. It is not imposed at an international level, except inasmuch as NPT states parties interpret Article I as potentially including avoiding the transfer of sensitive weapon information as part of its non-proliferation expectations.[15] As the next section will discuss,

11 David Albright with Andrea Stricker, Revisiting South Africa's Nuclear Weapons Program: Its History, Dismantlement, and Lessons for Today, Institute for Science and International Security, 2016, pp. 204–206.

12 Mitchell Reiss, Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities, 1995, pp. 18–19.

13 Albright and Sticker, Revisiting South Africa's Nuclear Weapons Program, pp. 206–207.

14 Pavel Podvig, "Practical Implementation of the Join-and-Disarm Option in the Treaty on the Prohibition of Nuclear Weapons", Journal for Peace and Nuclear Disarmament, vol. 4, no. 1, 3 June 2021, pp. 34–49, https://doi.org/10.1080/25751654.2021.1936993.

15 I have only found one example, as an aside, of an NPT state party being cited as infringing its Article I responsibilities on the basis of the widespread publication of information that another state party regarded as sensitive (as opposed to the clandestine transfer of classified information to a non-nuclear weapon state). Apparently, following the publication of Dalton E.G. Barroso's *A Física dos Explosivos Nucleares* ("The Physics of Nuclear Explosives"), the IAEA requested that Brazil "recall" the book. The Brazilian Government reportedly refused. Barroso's book is a self-described independent analysis of the physics behind both fission and thermonuclear weapons, with detailed equations and results from computer models used to analyse nuclear weapon designs, including the classified US W88 nuclear warhead. The Brazilian Defence Minister, in his rebuttal of the IAEA's request, indicated that he believed the open publication of the book indicated Brazil's commitment to non-military uses of atomic energy. Presumably, the IAEA complaint, however, was not about Brazil's status as a nuclear aspirant, but on the basis that such a book could "assist" or "encourage" a non-nuclear weapon state to design nuclear weapons. Such censorship attempts on already-published books, it should perhaps be noted, tend only to draw attention to the works – even in the past, much less in our information age, recalling information already released is requently impossible, and censorship efforts only validate that the book contains information of interest to a potential proliferator or terrorist. On the Barroso case, see Steven Aftergood, "Brazil Book on Nuclear Weapons Draws Scrutiny", Secrecy News (Federation of American Scientists), 21 September 2009, https://fas.org/blogs/secrecy/2009/09/brazil_nuclear. On the validating effect of mismanaged censorship attempts, see Wellerstein, Restricted Data, chapter 8.

what exactly might be considered "sensitive weapon information" has been historically contingent and hotly debated – there is no apparent international standard for this. Initially, disarmament proposals, like the post-war "international control" proposals, assumed that verified disarmament would require an almost totalizing rejection of secrecy and embrace of transparency and openness. Arms control proposals of the Cold War, however, found ways to accommodate verification and secrecy simultaneously, both by choosing carefully what to verify and with agreements on the specific means of doing verification. Lastly, one looking at this might conclude that secrecy is primarily a concern only of active or former nuclear-armed states. There is some truth to this, but, as the next section will outline, there are places where one might imagine secrecy to be a potential component of international disarmament regimes.

What are nuclear secrets?

The attempt to control the spread of and innovation in nuclear weapons by limiting access to putatively sensitive information about them – nuclear secrecy – has a long and complex history. It is worth considering a few classes of "secrets" before continuing, both in the effort to demystify the concept (and make it more tangible) and to illustrate several aspects of nuclear secrecy that may not be obvious when viewed from afar.

Historically, what has been a nuclear secret has varied dramatically in scope and scale over the years, ranging from the measurement of specific physical properties (e.g., the average number of neutrons released per fission of a given isotope, which was arguably the first nuclear secret), all the way up to the details of plans for nuclear war. For our purpose, it is worth considering the following as a list of the sorts of "secret" about which at least the United States has indicated (more through its actions than through explicit acknowledgment) concern about being able to keep in the context of disarmament verification. The following descriptions also indicate whether the information would potentially be seen as something that would need to remain a secret under a regime of total nuclear disarmament.

- *The specific design principles used to create a nuclear explosion.* The gun-type design, the implosion design, the Teller–Ulam design, the principle of core levitation, the principle of boosting and so on are examples of broad classes of secret which have been declassified in the United States. Beyond the broad concepts, however, are a wealth of secret details. For example, on thermonuclear weapon design, only the following statement is officially declassified, with any further elaboration officially secret: "The fact that, in thermonuclear weapons, radiation from a fission explosive can be contained and used to transfer energy to compress and ignite a physically separate component containing thermonuclear fuel".[16] The exact substances, geometrical arrangements, and so on for achieving this end are classified, as are the variety of ways that it can be put into practical engineering effect. Over time, a vast number of scientific and technical facts have been kept by states in this class of secret, although it is relatively rare that states coordinate on which facts are so designated. A consequence is that it is not uncommon for some nuclear-armed states to regard different scientific and technical information as being classified, with some being able to publish openly on it, and some restricted by their national legislation and regulations.[17]

16 Item V.C.1.e. in "Restricted Data Declassification Decisions 1946 to the Present (RDD-7)", 1 January 2001, https://sgp.fas.org/othergov/doe/rdd-7.html.

17 Examples of this, historically, have included a wide variety of things, including the possibility of peaceful nuclear fusion at all, which was classified in the United States until 1958, but was published quite openly by many other countries prior to this point. See Wellerstein, Restricted Data, chapter 6.

- *The specifics of any given weapon design in the United States arsenal, past or present.* This includes the internal geometries of the various materials (including, but not exclusive to, the fissile material). While considerable information has leaked out over time about several specific warheads (e.g., the weapons dropped on Hiroshima and Nagasaki, or some of the principles used in modern warheads like the W88),[18] the official US position is that details of even historically antiquated warhead designs, much less ones presently in use, pose grave risks for proliferation or (depending on their simplicity) nuclear terrorism. Note that this does not mean that all information about actual weapons, especially previous ones, is necessarily classified secret – but, generally speaking, the assumption is that the bulk of such information is and should be classified, and any disclosures should be careful exceptions to that. With present weapons, it is worth noting that the fear extends to the possibility of defeat mechanisms as well: that if an enemy state understood a weapon's internal workings to a high level of precision and confidence, they could devise strategies to mitigate their effects or even disable them before detonation.[19] In the event of a total disarmament treaty, this would only be still secret to the extent that it gave away very practical design knowledge. It might be considered an even more sensitive class of secret than the "general principles" class, because copying a specific design is potentially easier than designing a new weapon from scratch, especially for very simple weapon designs. The problem of warhead vulnerabilities would disappear generally in the event of total disarmament.
- *The specific amounts and types of fissile material used in the primaries and secondaries of warheads.* This is a subset of weapon design information, but one worth drawing specific attention to in the context of verification and disarmament since inspecting some amount of fissile material at the end of the dismantlement process is a likely outcome. Historically, the sensitivity of this kind of information derived largely from the fact that knowing this could allow an enemy state to extrapolate production capacity and stockpile size. Presently, in states where fissile material supplies are abundant, that is less of a concern, but it would still be a concern in states where there is presumably a close relationship between the active production of fissile material and their arsenals (such as India, Pakistan and the Democratic People's Republic of Korea). There are indications that the United States views this information as sensitive in part because modern weapons can use very small amounts of fissile material (far lower than the "significant quantity" figures used by the IAEA). The reasons why this is a concern seem unarticulated, but one might speculate that, if acknowledged, this fact could create greater regulatory difficulties or could spur a less-advanced nuclear-armed state towards new design work that would greatly expand its arsenal size. Under a treaty for total disarmament, there would be great

18 See, for example, John Coster-Mullen, Atom Bombs: The Top Secret Inside Story of Little Boy and Fat Man, self-published manuscript, 2002, rev. 2020; Dan Stober and Ian Hoffman, A Convenient spy: Wen Ho Lee and the Politics of Nuclear Espionage, 2001; and Chuck Hansen, The Swords of Armageddon: U.S. Nuclear Weapons Development since 1945, 1995, updated 2007.

19 A very simple and historically out-of-date example of this: the weapons dropped on Hiroshima and Nagasaki had small radar devices that could detect their altitudes and begin the detonation sequence once they were at their desired height above the ground. If the Japanese had had exact knowledge of how these worked and were tuned, they could have potentially developed technology to cause the radar devices to send their detonation signals prematurely, leading to a less effective weapon. More modern concerns involve what have historically been labelled as "warhead vulnerability" issues, which include things like whether a given warhead or its components will fail under certain induced conditions (e.g., high amounts of heat, X-rays, neutrons (which in some historical designs, could induce premature detonation), or electromagnetic pulse). Such information is of relevance to designing anti-ballistic missile systems, for example, or knowing how much accuracy a given yield of weapon would need for counter-force targeting.

incentive to release this kind of information as it would be necessary for an effective fissile material regulation regime. Arguably, even without such a treaty, it should be disclosed for exactly this reason – if regulations and safeguards are based on erroneous ideas of what a militarily significant amount of fissile material is, then that is potentially quite dangerous.[20]

- *Nuclear capabilities for active weapons. These include explosive yields and accuracy of delivery vehicles, but also things like failure rates*. Some information on these characteristics is published by some nuclear-armed states. However, as they can relate very directly to nuclear strategy and credibility (e.g., how many warheads would need to be targeted at a given target to guarantee some decree of destruction, etc.), they can be very sensitive indeed, especially if the information is surprising in one direction or another (surprisingly accurate, surprisingly inaccurate, etc.).
- *Information relevant to the production of fissile material and 'special nuclear materials" like tritium*. Historically, this meant that all information relating to isotopic enrichment and nuclear reactor design and operation was originally classified. Starting in the early 1950s, the United States began to declassify many theoretical and some practical aspects of these technologies as part of its effort to stimulate a domestic nuclear industry. Some of these older tech-nologies (e.g., gaseous diffusion enrichment) and newer technologies (e.g., laser isotope enrichment) remain heavily classified. The Zippe-type gas centrifuge, having been developed outside the United States, is an interesting counter-example to the norm.[21]
- *The specific technological developments, capabilities, countermeasures, and so on.* These could relate to a variety of nuclear delivery systems, command and control systems, early warning systems, and so on.
- The specifics of nuclear war planning, policies and procedures.
- Proprietary information that might related to industrial secrets of the commercial corporations that are involved as producers or contractors for nuclear weapons. In many states, the manufacture and even design of nuclear weapons is handled not exclusively by central governments, but in various kinds of public–private hybrid arrangements that may involve complex intellectual property regimes as well as their state secrecy regimes. This aspect is frequently overlooked in discussions of nuclear infrastructure and secrecy. It is easy to overlook such things as comparatively minor when stacked up against the previous items on the list, but historically such concerns have added significant complications to some state secrecy regimes, and, as indicated above, are accommodated by existing the IAEA safeguards regime. [22]
- Information acquired either through cooperation or intelligence operations about the nuclear programmes of other states, or information that would have diplomatic consequences if it were to be released. For example, the United States undoubtedly has information about the Israeli nuclear programme that it would not want to release because it would endanger US–Israeli relations and could compromise sources and methods of intelligence acquisition. Also, during the Cold War, the United States was often hesitant to release infor-

20 As an example of where this could be an issue, IAEA regulations allow for amounts of up to 1 kilogram of plutonium to be exempted from certain safeguards. But, as Pavel Podvig has noted, there is evidence that at least one Soviet test in 1953 involved a core of only 0.8 kg of plutonium, which apparently achieved a yield of over a kiloton of TNT equivalent. Pavel Podvig, "Interesting Document about Soviet Nuclear Tests in 1953", Russian Strategic Nuclear Forces, 1 October 2012, https://russianforces.org/blog/2012/10/interesting_document_on_soviet.shtml.

21 See Wellerstein, Restricted Data, chapters 6 and 7.

22 For a discussion of how this worked in the early US Manhattan Project as an example of the historical complexities involved, see Wellerstein, "Patenting the Bomb: Nuclear Weapons, Intellectual Property, and Technological Control", Isis, vol. 99, 2008, pp. 57–87. For further examples of how intellectual property in the late Cold War, notably with gas centrifuges and laser fusion, complicated US secrecy goals, see also Wellerstein, Restricted Data, chapter 7.

mation about the foreign basing of US weapons because it did not always inform the host countries of the details of such arrangements (and the governments of the host countries did not always want to know, because plausible deniability was considered a more politically acceptable way to deal with deployments that might be unpopular to their citizens).

- *Derivative secrets.* From these chief "secrets", there is an almost endlessly long list of what we might think of as "derivative" secrets: information that is secret inasmuch as it can indicate (often through considerable effort or combination with other secrets) one of the above secrets. The most straightforward example of this is the shape of the warhead or weapon itself, which can be secret inasmuch as someone with experience can derive certain aspects about internal design choices from analysing it. Historically, this has been considered very sensitive information by the United States (e.g., the casings of the World War II weapons were not declassified until 1960 because they are extremely revealing about the basic principles behind each). Today, however, nearly all US warhead shapes are declassified.
- *Misuses of secrecy.* The previous classes of official secret are all "justified", but there are also "misuses" of secrecy: places where secrecy is used to withhold information that might be embarrassing, scandalous, compromising, illegal, unethical, hazardous, or used exclusively for bureaucratic or institutional advantage. As one example, during the early Cold War, the US Atomic Energy Commission opted to keep classified records of human experimentation done during the Manhattan Project as part of its health physics programme because it worried that the records would have an adverse political impact on the organization.[23] These misuses are never part of the official justifications for secrecy, and it is difficult to judge what proportion of secrecy orders might fall under this class of secret if given external scrutiny. However, there are enough cases of such abuses of secrecy that it should be considered a possible class of its own, irrespective of its legitimacy.[24]

The above list is, of course, not likely to be comprehensive. But it gives a sense of the variety of uses to which secrecy has been put in nuclear weapon contexts. On many of these topics, a total disarmament treaty like the TPNW would be mute: early warning systems, bureaucratic disputes, war planning and so on. This does not mean that these classes of secret are irrelevant for thinking about disarmament. In fact, some of them, like bureaucratic advantage, are so core to the history of secrecy and the organizations that maintain it that they may present some of the most difficult hurdles to overcome. We will deal with that later in this chapter.

We can, perhaps, divide these classes of secret into three major categories of relevance to a treaty like the TPNW: proliferation-relevant secrets; secrets that have no relevance to the TPNW; and secrets that might interfere with implementation of the TPNW.

Proliferation-relevant secrets

The first category relates to information that the possessing state (and perhaps international organizations, like the IAEA, or other states) believes is important to keep hold of in order to discourage the proliferation of nuclear weapons. These could include things like warhead design and the production of fissile material, although, as noted above, different states have at times regarded the sensitivity of these topics differently over

23 Wellerstein, Restricted Data, p. 188.

24 For more on secrecy abuse, see especially William Burr, Thomas S. Blanton and Stephen I. Schwartz, "The Costs and Consequences of Nuclear Secrecy", in Stephen I. Schwartz (ed.), Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940, Brookings Institution, 1998, pp. 433–483.

time. Looked at historically, this category has been a "sliding scale" of release from the Manhattan Project through to the present day, with some concepts (e.g., the construction of nuclear reactors, or the implosion design for nuclear weapons) that are initially considered among the most important secrets eventually being declassified either because they were judged significantly compromised or because their declassification served some other end (in the case of reactors, it was Atoms for Peace and a desire for a civilian nuclear power industry; in the case of implosion, the US Atomic Energy Commission declassified the concept in order to enter it into evidence in the espionage trial of Ethel and Julius Rosenberg in 1951).[25]

A key point about this category of "secrets" is that in theory (if not in practice) they do not "expire". If one believes that these forms of information are vital steps in the proliferation and creation of nuclear weapons (as the classification officers and weapon designers who create and enforce these categories do) and if one is worried about the proliferation of weapons in a world where one doubts that all fissile material is under rigorous safeguards, then they will forever be risks.

Whether these kinds of "secret" are actually important to the spread of nuclear weapons (or, at least, whether the efforts made to control them are worth the costs) has been historically a hotly disputed question. Since the 1940s, there has been an explicit belief in the United States that the denial of certain categories of weapon design information played a chief role in inhibiting the acquisition of nuclear weapons by non-nuclear weapons states and inhibiting innovation in nuclear weapon designs by existing nuclear-armed states. There have been, it is worth noting, objectors to this article of faith all along, including many of those who helped develop said weapons. The argument against "secrets" being important, which is so alien to the modern rhetoric of arms control that it is worth just briefly outlining, is twofold.[26]

One is an argument that explicit information – that is, the kind of information that can be written down – is not the primary vector along which nuclear acquisition or innovation occurs. This is particularly the case for new nuclear states; what holds them back is not their lack of ability to design a viable nuclear weapon (which has arguably only become easier over time, both with the amount of information about nuclear science and technology that is globally available, and with the dramatic increases in computational technology that allow for the easy simulation of ideas), but their access to fissile material. All efforts should thus be focused on the latter, which is also a much more practical and tangible vector to focus on than ever-diffusive "information".[27]

The second argument, which has been noted above, is that, because the essential information is based on scientific and engineering facts, any secrecy must be temporary since it can be rediscovered by any other state with a sufficient technical infrastructure. Moreover, given the nature of global science and technology, nearly every state today has sufficient technical infrastructure to develop a viable nuclear weapon design. Furthermore, in a world where espionage occurs, one should never have any confidence that any of these "secrets" are not already known widely anyway (as cases of known nuclear espionage make very clear).

The counterarguments to these are that sensitive information, especially certain types of very specific sensitive information, may indeed be core stumbling blocks in a state's nuclear ambitions. Moreover, even if secrecy does not offer an absolute possibility of discouraging foreign nuclear development,

25 See Wellerstein, Restricted Data, chapter 6.

26 "Secrets" here is in quotes because historically there has been a gap between what is formally classified and what is actually unknown to a broader population (much less the nuclear programmes of other states). On the general argument about the shifting barrier of secrecy, see Wellerstein, Restricted Data. As a whole, that book seeks to characterize this activity, but chapters 6 and 7 in particular illustrate this action through numerous case studies of declassified fields.

27 For a historical overview, see Wellerstein, Restricted Data, especially chapters 4 and 7.

its presence adds to the difficulty, and that translates into additional resources spent on the nuclear programme that cannot be spent on other programmes, as well as additional time, and time is valuable.

For our purposes, these considerations may not matter because if these states or entities believe (or profess to believe) that that these secrets "matter", then they will insist on treating them in a controlled fashion, and indeed will see such treatment as core to the success of a treaty like the TPNW, rightly or wrongly. In practice, the "forever" status of even things in this category has historically been much more limited, as changing political contexts and perceptions of what is known publicly have led, over time, to many of these "secrets" becoming formally declassified. This chapter largely takes for granted that these beliefs about the importance of secrecy exist among the nuclear-armed states, and are unlikely to change soon, even if they undergo a "paradigm shift" of the sort that accession to the TPNW would require.

But it is important not to see secrecy as an absolute, all-or-nothing state of affairs. Historically, the categories of what is a secret have changed dramatically and sometimes quickly, and how important any given secret (or all secrets) are for nuclear outcomes has waxed and waned in the official imagination. The goals of secrecy themself have also changed over time. For one simple example, only in the early 1970s did denial of nuclear weapons to non-state actors become a major US classification priority, and that can result in very different sorts of decisions on declassification questions than if the only imagined enemy is a state actor.[28] While it is certainly too much to imagine the existing nuclear-armed states abandoning all secrecy (if that was even a good idea, which it clearly may not be), it is not historically unjustified to imagine that they could, in a relatively short period of time, rearrange their thinking on some of the core issues that may be stumbling blocks for warhead dismantlement (e.g., whether there is still utility in keeping the exact fissile material masses in existing weapons classified).

Secrets that have no relevance to the TPNW

A second category of secrets might be secrets that have no relevance to the TPNW and should not interfere with it. This would include things like nuclear war planning and policy, details about and capabilities of specific warheads and delivery systems, details about command and control and early warning, and so on. Although these may have historically been among the most closely held and valued secrets of a nuclear-armed state, they are irrelevant for the concerns of the TPNW as that state transitions into being a former nuclear-armed state. They do not have an impact on verification, inasmuch as they do not impinge on the accounting and safeguarding of special nuclear materials.

Secrets that might interfere with TPNW implementation

Finally, a third category might be secrets that in principle should not have relevance to the TPNW but might interfere with its implementation. In this category we might include general military secrecy, which is always an issue with nuclear-specific verification treaties that do not infringe on the ability to have other categories of secrecy. This has apparently been an issue with Iranian verifications, when sites of interest to the IAEA are declared by the Iranians to be military sites but not nuclear sites, and thus out of their jurisdiction. This category also includes general bureaucratic secrets that impinge on verification activities. In principle, implementing a verifiable TPNW would not care about either of these types of secret; in practice, they may create enough uncertainty to promote fears of covert operations.

The most tricky of the above three categories is likely to be the first: the proliferation-relevant secrets. It is difficult to judge, from first principles, how much of a problem they should be seen as because it depends on how

28 Discussed in Wellerstein, Restricted Data, chapter 7.

serious one takes the threat of proliferation-by-information (as opposed to proliferation-by-materials or proliferation-by-facilities). It is possible to imagine that, in a world where the TPNW was being implemented, we may exit the mindset that is so focused on "secrets" as the vector of proliferation, or at least become less convinced that they are worth as much effort as has historically been committed to them. The United States in particular will find it quite hard to go in this direction: for over 70 years, the idea of "secrets" has been core to its ideological and rhetorical concepts of non-proliferation, even if most of its practical tools of non-proliferation focused on other vectors of technological transmission. Institutional cultures, as will be discussed in the next section, matter.

Discussions with nuclear practitioners suggests that they do not hold these beliefs cynically: they truly believe that small, transmissible bits of information (e.g., the equation of state of plutonium under many megabars of pressure, the exact ways of manufacturing and operating centrifuges) could, in the wrong hands, encourage a state to pursue nuclear weapons when it might not otherwise, could increase the speed or likelihood of proliferation, and could generally lead to very bad outcomes. Again, one can debate or reject this; there have been, since 1945, different perspectives that were not uninformed, and not all critiques of this come from people outside the nuclear weapon system (e.g., J. Robert Oppenheimer and Theodore B. Taylor are two prominent weapon designers who ultimately believed that material safeguards were much more effective than secrecy).

Non-nuclear-armed states could go either way on this issue. One could see them rejecting these claims as attempts by the nuclear-armed states to maintain a paternalistic control over the field of nuclear science and technology. One could, just as easily, see them embrace the opposite idea, wanting to show their utter lack of interest in nuclear weapons and their disdain of proliferation by trying to keep these matters more controlled than they even have been. It seems reasonable to suspect that whatever one thinks about this category, if the nuclear-armed states are going to treat it as important to them, then anyone wanting them to accede to the TPNW must also allow them to treat it that way.

Institutions and cultures of secrecy

The discussion above has been primarily concerned with the technical applications of secrecy, and the official justifications and arguments in favour of it. But even secrecy of technical things is always more than just technical: it is also political, either through its use to reinforce hierarchical relations, or through its ability to obscure or derail various political efforts. It is also organizational, sociological and psychological: it is a practice implemented by institutions and people within them, and secrecy practices have long been noted, even before nuclear weapons, to be endemic to bureaucracies in general for a variety of reasons that surpass whatever official justifications are given for their existence. Acknowledgment of this is likely to be an important aspect of dealing with and understanding institutions and cultures of secrecy in the context of the TPNW, and it likely to be considered part of the overall institutional and cultural shift that would be necessary for a nuclear-armed state to disarm.

There have been many different analyses of the psychological and sociological aspects of secrecy of organizations, including government bureaucracies and "secret societies". This scholarship ranges from the early 20th-century sociology of Max Weber and Georg Simmel, through to the more recent work of nuclear anthropologists like Hugh Gusterson and Joseph Masco. The Weber and Simmel approaches appear in retrospect to identify secrecy as having particularly trans-historical and transcultural effects. For

Weber, for example, secrecy in bureaucracies is an inherent property that emerges as individual bureaus struggle for resources and power, and find that their ability to limit access to information is a potent weapon towards this end.[29]

For Simmel, secrecy is a core aspect of human behaviour. Its manifestation in secret societies (e.g., the Freemasons) provides a psychological benefit to the individuals within the society (who are united in their knowledge) and is part of the constitution of the identity of the society as a whole (i.e., in some kind of opposition to the broader world).[30]

Where the work of Weber and Simmel take on an air of spacious theorizing, the more recent nuclear anthropologists reinforce their study of weapon laboratories with ethnographic observation and specific historical inquiry. Gusterson, in his classic ethnographic study of weapon scientists at the Lawrence Livermore National Laboratory towards the end of and immediately after the Cold War, argues that secrecy is "an anvil on which the identity of new weapons scientists at the laboratory is forged". Its practices shape every interaction they have within the laboratory, and shape their interactions with the world outside the laboratory, even to the point of personal ruin (e.g., the inability to communicate about their daily work with their wives and children is a point of particular long-term psychological and familial harm). In general, the impression one gets from Gusterson's approach is that the institutional culture of secrecy within US nuclear weapon laboratories is one of constant reinforcement about the value of secrets, the need to keep secrets and the gradual warping of a practitioner's world into one that is almost entirely defined by the presence of a secrecy regime.[31]

Masco's interests, in contrast, are in the ways in which places like the Los Alamos National Laboratory interact with the broader context in which they exist. This includes sites that help to generate the political and ideological needs for large, secretive weapon complexes, and their impact on the people and locales in which they are situated. The ways in which, by the end of the Cold War, secrecy had been internalized as a national security norm, taken for granted and endlessly extended, with bouts of "hypersecurity" in the wake of real or perceived national security failures, all appear to indicate to Masco that nuclear secrecy in particular is a self-perpetuating, deeply rooted aspect of at least US political discourse.[32]

One last perspective is valuable here, that of a critical insider. Daniel Ellsberg, the famous *Pentagon Papers* whistle-blower and one-time RAND Corporation nuclear security expert, has written eloquently on the pernicious social effect of secrecy on people who come into organizations that require it. In his memoirs on his time as a whistle-blower, Ellsberg recounts a meeting in which he discussed with Henry Kissinger the latter's status as someone who was rapidly getting access to large amounts of classified information in 1968. First, Ellsberg says, Kissinger will feel like a fool, because he will see how much had been kept from him. Then there will be a time in which he forgets he ever did not have such information, and think that everyone without similar status are the fools. Over a much longer period of time, he will become familiar with the limits of the secret information, but before then, it will become very difficult for him to learn anything from anyone without similar access. Ultimately, he will start to see people outside the secrecy regime as essentially dupes to be manipulated towards his own ends.[33]

29 Max Weber, "Bureaucracy [1920]", in Guenther Roth and Claus Wittich (eds.), Economy and Society: An Outline of Interpretive Sociology, 1978, pp. 956–1005.
30 Georg Simmel, "The Sociology of Secrecy and of Secret Societies", American Journal of Sociology, vol. 11, no. 4, January 1906, pp. 441–498.
31 Hugh Gusterson, Nuclear Rites: A Weapons Laboratory at the End of the Cold War, 1996, especially chapter 4.
32 Joseph Masco, Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico, 2006, especially chapter 6.
33 Daniel Ellsberg, Secrets: A Memoir of Vietnam and the Pentagon Papers, 2003, pp. 237–238.

The sum of all of these accounts – just a few of the many takes on secrecy and organizations that are out there – is that secrecy is more than just the content of the secrets. It is an organizational technique that, even when applied to control information that all might agree is unambiguously in need of such control (which as we have already discussed is rarely the case), has intense effects on institutions, individuals and the broader societies they are in. Secrecy is a mindset, it is an ideological enabler, it is a paradigm. It is something that confers power and status on those who have access to it. Again, this is not to say that secrecy exists only to these sorts of ends; the arguments above are that these kinds of ends will happen in any system that relies on large amount of secrecy, including "legitimate" ones protecting "legitimate" secrets. The consequence is that secrecy regimes are very difficult to unravel because nearly all psychological, sociological and political forces are in favour of their strengthening and reconstitution, and not their dissolution.

There are at least two historical examples that may be of particular utility in thinking through some of the possibilities of secrecy reform on national levels: South Africa in the early 1990s, and the Openness Initiative by the US Department of Energy (DOE) in the immediate post-Cold War United States.

South Africa in the 1990s

South Africa disarmed unilaterally in the early 1990s. Because the disarming apartheid government of South Africa anticipated being replaced by a very different post-apartheid government, there was a curious mixture of transparency (an accounting of the disarmament process) and permanent secrecy (destruction of records). This seemingly paradoxical outcome is potentially one model for what a full disarmament might look like. The transparency is necessary, of course, to allow for some level of verification that disarmament actually occurred. However, it is interesting to note that, in the case of South Africa, a sceptic could easily suggest that verification was necessarily incomplete on a technical level, and that the acceptance of South Africa into the NPT regime was in part an act of faith and political trust. In this way, South Africa is an example of a practical disarmament regime that might not meet all of the imagined demands one would have on a hypothetical disarmament regime, but has, apparently, been accepted as legitimate by the world community (inasmuch as there are apparently no serious allegations that South Africa remains a nuclear-armed state).

Permanent secrecy is a very different state of secrecy than the regimes discussed in this chapter generally. Most secrecy regimes require the secrets to be, in principle, accessible and usable. The degree to which this is possible in practice depends on the regime and depends on the secrets, but officially most secrets are intended to be used in some way, especially in regards to a weapon programme. Permanent secrecy of the sort associated with the destruction of records means that whatever information was once known is now, in principle, totally lost, with the exception of whatever remnants remain in the heads of those who once knew the secrets. This does not mean that such information could not be "rediscovered" later – there are certainly examples of "lost" explicit and tacit knowledge being reconstructed at great cost by later generations and institutions. Yet, destroying the knowledge does to some degree increase the difficulty of its reconstitution.[34] The sociologists Donald MacKenzie and Graham Spinardi have used the fact that knowledge (especially "tacit

34 On recovering "lost" knowledge, the common example is Fogbank. This exotic substance was apparently used in the interstage of several thermonuclear weapons. The United States nuclear complex lost the ability to produce it by the post-Cold War period and had to develop, at some cost, new production methods for a substitute, which then had to be validated as having acceptably physical properties similar to the original. For one account, see "Fogbank: Lost Knowledge Regained", Nuclear Weapons Journal (Los Alamos National Laboratory) no. 2, 2009, https://www.lanl.gov/orgs/padwp/pdfs/nwj2_09.pdf, pp. 20–21.

knowledge", which is to say, the individual experience gained through long hands-on interactions which is hard to write down) can be destroyed and lost in this way to argue that, contrary to the usual assertion, it is possible to functionally "uninvent" nuclear weapons. This may only be true for a certain sense of "uninvent", but it does highlight the notion that information that has to some degree been actually kept secret may be more destructible as a result, in a way that might, unintuitively, help disarmament efforts like the TPNW.[35] There is some irony in the idea that, if one believes that certain information obtained by nuclear-armed states is proliferation relevant and has been successfully kept secret, then a necessary consequence of that is that its destruction would be the next natural step once a state has decided to disarm.

The post-Cold War United States

In the early 1990s under the administration of US President Bill Clinton, there was an effort by the Department of Energy and its Secretary of Energy, Hazel O'Leary, to reconstitute a new institutional outlook that was based around "openness" instead of the traditional secrecy. The Openness Initiative was a broad-ranging set of policies that sought to declassify pertinent information, increase the number of stakeholders involved in DOE decision-making in general, and acknowledge Cold War sins committed by the US nuclear complex, including the non-consensual exposure of people to various kinds of radiological hazard. It included many attempted re-evaluations of the entire classification system itself, and involved many reformers and harmed parties in discussions about the corrosive effects of secrecy.

Tellingly, it was not an unambiguous success, although some of its releases and changes have held up over time. The difficulties came from several quarters. One was that reforming secrecy from the inside was incredibly difficult because there were institutional stakeholders who genuinely saw secrecy as an important part of US national security interests. Laboratory heads and weapon scientists were not particularly enthusiastic about openness, and saw it as a political imposition to be resisted. Another is that the Clinton administration was beginning to come under sustained political attack along a number of different venues (as was O'Leary), and blaming it for being lax on secrecy and security was a particularly fruitful mode of attack by its opponents. The allegation in the late 1990s that China had, over a period of decades, stolen advanced US nuclear warhead designs was deployed as a political weapon against the administration, and the DOE in particular. The accusation that the Openness Initiative had anything to do with this work is specious (the alleged espionage happened before it began), but the political liability of being seen to have lost "nuclear secrets" was still potent. It was also the case that the revelation of past US nuclear infrastructure failures (e.g., human radiation exposures and experiments) appears to have decreased public faith in said institutions – even though they were the ones doing the revealing as part of a reconciliation process. This is what I have in the past identified as one of the paradoxes of secrecy reform: releasing once-secret information seems like it ought to increase trust in institutions, but it can easily produce the opposite because it reveals to what lengths the institutions of the past were willing to go. All major attempts at nuclear secrecy reform in the United States have led to their champions being easy targets for allegations of being lax on secrecy, with the result being a pendulum swing in the other direction of more secrecy, either in the same administration or the next one.[36]

The sum of these two case studies is not some simple directive, but it does show some of the difficulties involved with institutional secrecy reform. In the case of the South Africa,

35 Donald MacKenzie and Graham Spinardi, "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons", *American Journal of Sociology*, vol. 101, no. 1, July 1995, pp. 44–99.

36 See Wellerstein, Restricted Data, chapter 9.

it was successful, but only because the institutions keeping the secrets were (secretly) planning for their own destruction, and thus were able to tidy affairs to the degree that they (and not an external auditor) preferred. In comparison, the case of the Openness Initiative shows how difficult self-reform is for institutions of secrecy. This is the case even if it is genuinely desired (and again, not all of the stakeholders in the case of the Openness Initiative probably genuinely desired this) because of the vulnerable position it puts the institution in to do this publicly and to try to continue to operate. It is tempting to suggest that the South African case, however unsatisfying it is for those who would prefer to know more about the operation of the South African nuclear programme (and the potential for cover-ups and lost opportunities for reconciliation) is perhaps the more viable and realistic model. But these two examples no doubt do not encompass the variety of possibilities available.[37]

Conclusions

As national nuclear secrecy regimes necessarily reinforce the divisions between the nuclear-armed states and the non-nuclear-armed states, it is easy to make the claim that their primary impact on arms control historically has been to hinder it. The degree of legitimacy one assigns to this critique depends on how seriously one takes the comitments of the nuclear-armed states to progress towards disarmament, and how seriously one takes them when their experts and institutions claim that certain information must remain secret without direct consequences to follow.[38] Even the fact that a great quantity of the secrets is necessarily unknown to external, impartial observers presents a problem of asymmetry and trust.

It is worth acknowledging that this problem exists with all of the nuclear-armed states. The United States, perhaps unexpectedly given its long discourse on its long history of secrecy, is among the most transparent of the group. The United Kingdom has made some strides over the last several decades to increase its overall transparency, but it is still quite far behind the United States in its willingness to disclose even historical information about its nuclear programmes and policies. All other nuclear-armed states are far behind these two in this respect. Which is only to say that this problem gets even more difficult as one imagines trying to get other states involved in such negotiations, and that these asymmetries exist among nuclear-armed states as well as between the nuclear-armed states and the non-nuclear-armed states.[39] As a plan for total disarmament would necessarily be cooperative, one would imagine that some of these issues would be lessened if the parties going into it were doing so in good faith and with strict timelines for implementation. But if one of the parties suspected that other parties were not doing so, and were either trying to acquire sensitive nuclear knowledge with the goal of becoming a future nuclear state, or were attempting to use secrecy as a way to conceal a lingering nuclear capability, one can see that this would be a very tricky problem.

37 One possibility not discussed here, because it is not relevant to the TPNW discussions, is that secrecy regimes are only potentially totally removed with the total dissolution of the national political regime that enabled them in the first place. Even in such cases, however, secrecy regimes can be very persistent, such as in the case of the transition from the Soviet Union to the Russian Federation.

38 As someone who has spent a lot of time looking at the historical debates about classification questions from within the US nuclear complex, I should also note that the term "experts" here is probably overly vague. Within national nuclear complexes, there are many technical experts who possess a wide variety of opinions on what should or should not be kept secret, and the utility of secrecy in general. The ones who are specifically in charge of enforcing classification rules, however, tend to believe in their importance as a rule (or else do not stay in the job that long, historically). They also, I have found, frequently overestimate how good their secrecy efforts have been because they do not, without some special reason, keep especially abreast of developments in other countries or the worlds of science and industry outside of their classified contexts that might indicate what is already "known" outside. These experts are still yet distinct from those who are in positions of political authority (e.g., laboratory directors), who have additional considerations relating to their places within a broader political system colouring their views. All of which is to say, one should not see "experts" as a monolithic and homogenous category.

39 Annette Schaper, "Looking for a Demarcation – between Nuclear Transparency and Nuclear Secrecy", Peace Research Institute Frankfurt Reports no. 68, 2004, pp. 23–25.

It is somewhat depressingly easy to predict the kinds of dynamics likely to arise for a disarmament treaty, in part because they have already arisen in previous contexts. Nuclear-armed states will probably claim that the requirements for secrecy will mandate that they cannot accept certain arrangements. Moreover, they will not be able to explain in a level of detail that critics would find adequate why that might be as one of the difficulties of secrecy is that the person keeping the secret, even if they are entirely justified in keeping it, will have a hard time convincing others of the value of secrecy without giving up the secret itself. Those who are advocating for the TPNW may be likely to dismiss these objections as indications of bad faith negotiations, or simply paranoia. The lack of a neutral arbiter, such as a party that has access to said secrets and can evaluate their actual importance and impact, means there is no easy resolution to this scenario.

Even if a nuclear weapon state, like the United States, were able to endorse a method that it felt protected its own classification interests, it would not necessarily be sufficient to meet the requirements of other nuclear weapon states. While the classification concerns of the United States and, say, Russia, may overlap in many ways, they also no doubt differ for reasons relating to asymmetries in their nuclear forces and strategic concerns. This seems even more so when one considers the wide variety of other nuclear-armed states and their respectively different strategic situations.

Ultimately, the inherent asymmetries are likely to mean that, should the nuclear-armed states be truly interested in a total disarmament treaty, they will need to play key roles regarding problems of secrecy. They will need to endorse protocols that meet their requirements for verification and concealment or, somehow, come to agreement on how much secrecy they are willing to abandon. These will probably be a mixture of concerns relating to their own national security needs (e.g., shielding certain programmes from possible "leakage" of non-nuclear secrets), their perceived fears of adversaries who might be "cheating" (e.g., trying to make sure verification is robust) and fears about non-proliferation generally (e.g., protecting "proliferation-relevant" information). One could imagine many different perspectives on how important each of these categories might be for any given state, and there would certainly be differences of opinion about whether a given piece of information truly fits into one of these categories in a way that mattered.

Ultimately, the non-nuclear-armed states, in turn, must be willing to engage with them on this issue. They may perhaps accept that some types of secret may be worth preserving, even if there is not universal agreement on the importance of nuclear secrets to nuclear proliferation, and even if there are concerns that secrecy may inhibit peaceful nuclear developments (as has historically been argued to be the case). It may be the case that the non-nuclear-armed states might be willing to accept the destruction of secrets, despite its stink of corruption and subterfuge, if it allowed the institutions of secrecy to transition to a new disarmament footing and role. Should a total disarmament treaty like the TPNW, with strong safeguards on the facilities necessary to produce weapons themselves, be put into global effect, these issues would presumably matter less and less over time.

The insidiousness of the secrecy problem is, in the end, that it exacerbates already-existing asymmetries and tensions, by its very nature makes communication about even very seriously held concerns difficult, and is incredibly difficult to scale back or reform once it has taken root. At the core of questions about secrecy are also questions about authority: Whose judgment is valued, and whose is not? Who gets to decide what should be secret and what should not? Who even gets to decide what kinds of factors should be given weight in making that determination? These questions will not be easily resolved, but they are probably easier to resolve than the question of total disarmament more generally, and there are many indications that, although these issues are tricky, they need not be insuperable.

4. Kazakhstan's nuclear history: lessons for the future of disarmament

Togzhan Kassenova[1]

The 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW) contains provisions that make it possible for a nuclear-armed state to eliminate its nuclear weapons and nuclear weapon programme and join the treaty. Even though this would not be entirely unprecedented, a verifiable elimination of a nuclear weapons programme will certainly present a number of challenges that the TPNW states parties would have to address. From this point of view, it is important to examine how various aspects of nuclear disarmament were handled in the past. This chapter considers the case of Kazakhstan, a former Soviet republic in Central Asia and a relative newcomer on the international stage.

Kazakhstan's nuclear story began in the late 1940s when the Soviet Government chose the Kazakh steppe for its nuclear test site. As the Soviet nuclear programme developed, its reliance on Kazakhstan's resources and land grew. Kazakhstan was the main supplier of uranium and the host of several facilities that were integral to producing and testing Soviet nuclear weapons. Kazakhstan hosted intercontinental ballistic missiles (ICBMs), heavy bombers and nuclear warheads. Kazakhstan's path from being an integral part of the Soviet nuclear programme and an inheritor of nuclear weapons, material and infrastructure to a nuclear-free country provides unique insights into how nuclear disarmament works in practice.

Before looking at lessons from Kazakhstan's case, let us address its limitations. Kazakhstan, Belarus and Ukraine – three former Soviet republics that dealt with a nuclear inheritance – are less straightforward cases for understanding disarmament than, for example, the case of South Africa. Unlike South Africa, Kazakhstan, Belarus and Ukraine were part of a large state – the Soviet Union, with Moscow serving as the central decision maker. Local leaders of Soviet republics did not choose to develop nuclear weapon programmes. Instead, Moscow brought these republics into the Soviet nuclear weapon programme and used their land and resources. While the nuclear weapons were not under the command and control of Belarus, Kazakhstan or Ukraine, when the Soviet Union collapsed and they gained independence, the weapons' legal status was not clear and it was not predetermined that those weapons must be moved to the Russian Federation or dismantled.

From a practical standpoint of denuclearization, the case of Kazakhstan (as well as Belarus and Ukraine) provides important insights and lessons, which could be relevant in the TPNW context. First, even if the government of Kazakhstan did not have access to the command and control of Soviet nuclear weapons, the weapons remained on its territory when it became a sovereign state. The fate of those weapons could not be decided without Kazakhstan. Second, nuclear infrastructure, nuclear material, space- and missile defence-related infrastructure remaining in Kazakhstan were even more consequential than the weapons themselves. They could have provided a foundation for a latent capability or an indigenous nuclear programme. But above all, Kazakhstan's case offers practical lessons how to implement denuclearization and how a state that has made a commitment to denuclearize can prove it through specific actions.

1 This chapter is based on Togzhan Kassenova, Atomic Steppe: How Kazakhstan Gave Up the Bomb, Stanford University Press, 2022.

The framing questions of this chapter are: Why did Kazakhstan decide to give up its nuclear inheritance? How did Kazakhstan implement its decision to become a nuclear weapon-free country? How did it deal with the technical and political challenges along the way? Which actions helped Kazakhstan demonstrate its commitment to denuclearization?

The chapter will take the reader on a journey stretching from the first step in Kazakhstan's anti-nuclear path – the closure of the Semipalatinsk Test Site (STS) during the Soviet period – on to the removal of nuclear warheads, missiles and heavy bombers, the dismantlement of nuclear testing infrastructure, and the removal and securing of nuclear material.

Closure of the Semipalatinsk Test Site

The Soviet Government chose the Semipalatinsk region of eastern Kazakhstan to build its first nuclear test site. Thousands of soldiers, construction workers and prisoners toiled for two years, over 1947–1949, to build the testing grounds. STS stretched across 18,500 square kilometres – a territory equivalent in size to Belgium. A complex infrastructure was built under and above the ground with special buildings to house hundreds of measuring devices and equipment. Kilometres of electric cables ran underground. Later, the Soviet Union built dozens of tunnels and boreholes for underground nuclear explosions.

On 29 August 1949, the Soviet Union carried out its first atomic test at STS. Forty years of nuclear tests that followed devastated the local environment and the health of tens of thousands of people who lived in the vicinity. The Soviet military conducted more than 450 nuclear tests at the site – in the atmosphere, on the ground and underground. For a brief period, the military also experimented with radiological weapons and devices. In addition to STS, the Soviet Union built another test site at Novaya Zemlya in Russia – two islands in the Arctic Ocean. Unlike Semipalatinsk, Novaya Zemlya was far from any population centres, and its 400 inhabitants – mostly a Samoyedic ethnic group native to northern Arctic Russia – were moved to the Russian mainland.

The undeniable health consequences of radiation for Semipalatinsk locals became apparent in the 1950s, but the tests continued undeterred. The atmosphere of secrecy, lack of truthful information, prioritization of national security interests above public health and complete control of the narrative surrounding the testing programme by the state meant that, for decades, local people had no say in their own fate. The central Soviet Government suppressed several attempts by local Semipalatinsk regional governors to bring attention to the plight of their fellow countrymen and women. The Kazakh Government appointed by Moscow was powerless.

By the late 1980s, the situation changed, and several external and internal factors created a perfect storm. A new reform-oriented leader, Mikhail Gorbachev, introduced greater political freedoms. The monopoly of the Communist Party was broken, and political movements, including environmental groups, were now allowed. In Kazakhstan, the anger with the nuclear tests reached its peak amid the general push of the Soviet republics for greater autonomy from Moscow.

A breaking point came on 12 February 1989, when an underground nuclear explosion resulted in radioactive release. "Partially contained" explosions with a radioactive release had happened in the past, but this time, the information became public. A military commander from a base hosting heavy bombers confirmed to the Semipalatinsk local governor, Keshrim Boztayev, that the base's radiation safety devices showed elevated levels of radiation. The STS leadership tried to suppress the information, but it was too late. The news of confirmed radioactive contamination spurred action at several levels in Kazakhstan: on the ground in Semipalatinsk region under the leadership of Boztayev, nationwide led by Kazakhstan's famous writer

Olzhas Suleimenov, who created a public anti-nuclear movement named Nevada-Semipalatinsk, and at the level of the republic, which was still part of the Soviet Union.

During 1989–1991, the fight for the end of nuclear tests raged on the ground, with massive protest rallies and in the tug of war between Soviet and Kazakh officials. Gorbachev was in favour of slowing down the arms race, but the powerful Soviet military-industrial establishment pressured for at least a few more years of testing at STS.

Finally, on 29 August 1991, 42 years after the first Soviet atomic test and days after conservative hardliners in Moscow attempted to overthrow Gorbachev, Kazakhstan's President Nursultan Nazarbayev, backed by a powerful anti-nuclear movement, signed a decree to shut down the test site. This was Kazakhstan's first step to withdraw itself from the Soviet nuclear weapon programme and a conscious effort to reclaim agency over its own land. It provided the foundation for its anti-nuclear identity as an independent country. Shortly after, the Soviet Union collapsed, and Kazakhstan found itself with a nuclear inheritance it did not seek.

The decision to give up the nuclear arsenal

The young state inherited 104 ICBMs (SS-18 in NATO classification), 40 heavy bombers and as many as 1,400 nuclear warheads associated with them. Tactical nuclear weapons were removed from Kazakhstan to Russia by early 1992 and were not part of the post-collapse nuclear deliberations. ICBMs sat in 122 silo launchers in two locations – Derzhavinsk and Zhangiz Tobe. Both towns, not identified on any maps for secrecy reasons, hosted divisions of the Soviet Strategic Rocket Forces. Another 14 test silo launchers were located at the Balapan site at the Semipalatinsk Test Site, and 12 more in Leninsk near the space-launching site at Baikonur. Heavy bomber divisions were stationed in a military airbase called Chagan, not far from STS.

In addition to warheads, missiles and bombers, the nuclear test site, and the space-launching pad Baikonur, Kazakhstan hosted facilities involved in the production of nuclear material (i.e., uranium mining and milling, production of fuel pellets, plutonium breeding), scientific experiments with nuclear material and nuclear systems, and testing grounds for anti-missile defence at Sary-Shagan.

The decision to give up its nuclear weapon inheritance came relatively soon after the leadership considered Kazakhstan's security interests and its economic, political and diplomatic priorities. A fortunate combination of Kazakhstan's priorities and the responsiveness of the international community to Kazakhstan's needs created a conducive environment.

Kazakhstan's leadership recognized that trying to keep nuclear weapons and nuclear infrastructure was incompatible with how it wanted to present itself to the outside world. Even more importantly, Kazakhstan's decision makers understood that attempts to push its way into a nuclear club would preclude access to what the new country needed the most: security guarantees of its sovereignty and territorial integrity, foreign direct investment, and access to international institutions and markets.

The international community, in its turn, was ready to offer Kazakhstan all that, as well as technical and financial resources for the actual denuclearization.

The number one concern for a young state was its security – its sovereignty and territorial integrity. Kazakhstan was a newly independent state in a geopolitically challenging environment bordering on two nuclear powers – Russia and China. Nationalist politicians in Russia, struggling to accept the new post-collapse reality, laid claims to northern parts of Kazakhstan. As for China, Kazakhstan inherited Sino-Soviet border disputes, and there were concerns that China could also claim some parts of Kazakhstan's land. The

Central Asian region was unstable. In those circumstances, receiving security guarantees from the nuclear powers, especially the United States, was very important for Kazakhstan's leadership.

In 1992, Kazakhstan signed the Collective Security Treaty, an alliance of several former Soviet states that in 2002 became the Collective Security Treaty Organization (CSTO) – this meant that Kazakhstan and Russia were now part of a collective defence mechanism. In November 1993, Kazakhstan and the United States finalized the language of security assurances that would be codified in early 1994 as part of the US–Kazakhstan Charter on Democratic Partnership. Later in 1994, Kazakhstan – like Belarus and Ukraine – signed the Budapest Memorandum in which Russia, the United Kingdom and the United States provided security assurances in recognition of Kazakhstan joining the NPT as a non-nuclear weapon state.

Attracting foreign direct investment was another priority. Following the dissolution of the Soviet Union, Kazakhstan's economy collapsed. Abundant natural resources were Kazakhstan's best hope to get itself back on a firm footing, but it needed investments and technical resources to help develop oil fields and produce other minerals for export.

As a new country on the international scene, Kazakhstan was eager to join the international community – international organizations and markets – as soon as possible. The Government of the United States provided explicit support for Kazakhstan joining the United Nations, the World Bank, the International Monetary Fund and other key institutions.

Kazakhstan's leadership was concerned with the financial resources and technical expertise required for safe denuclearization. Thanks to the Nunn–Lugar Cooperative Threat Reduction (CTR) programme, which authorized assistance to the former Soviet Union to reduce nuclear risks, the US Government could offer both. Assistance also came from other countries and international organizations. This practical assistance played a direct role in the eventual denuclearization of Kazakhstan.

The domestic political situation in Kazakhstan was also conducive to a non-nuclear path. The trauma of the Soviet nuclear tests meant that Kazakhstan's society was strongly anti-nuclear. Centralized decision-making and the absence of any strong pro-nuclear interest groups meant that Kazakhstan's president and a handful of advisors did not face the same degree of opposition to denuclearization as, for example, the leadership of Ukraine faced in a more politically diverse environment.

The normative aspect of Kazakhstan's decision-making process deserves special mention. Foreign policy advisors who worked on nuclear issues in the early days of Kazakhstan's independence argued that, should Kazakhstan attempt to go nuclear, it would undermine the NPT.[2] Decades later, a former senior Kazakh official described this by saying, "We did not want to become a Central Asian North Korea."[3]

Based on the favourable combination of Kazakhstan's priorities and the readiness of the international community to offer Kazakhstan what it sought, in December 1993, Kazakhstan's parliament voted for Kazakhstan to join the NPT as a non-nuclear weapon state, and the country was ready to free itself of the nuclear arsenal.

2 Oumirserik Kassenov, "The Fragile Future of the NPT", memorandum, 1992.
3 Author's interview with Tulegen Zhukeev, Almaty, 2018.

Removal of the nuclear arsenal

Removal of nuclear warheads, missiles and heavy bombers

The formal status of the nuclear arsenal in Kazakhstan remained unclear until March 1994. The first two documents that addressed the status of the nuclear weapons in the non-Russian republics to a limited extent were the agreements on strategic forces signed as part of the Alma-Ata Declaration and the Minsk Declaration. Both documents were signed in December 1991 by 11 former Soviet republics that decided to become part of the Commonwealth of Independent States (CIS) – a loose union created in place of the Soviet Union. The agreements noted that Belarus and Ukraine committed to join the NPT as non-nuclear weapon states. Interestingly, the documents did not include a reference to Kazakhstan on that matter. A statement that any decision on the necessity of using nuclear weapons will be taken by the Russian president in consultation with the leaders of Belarus, Kazakhstan and Ukraine was political in nature.[4] There were no technical means for these three non-Russian republics to stop the launch of nuclear weapons from their territory.

In March 1994, Russia and Kazakhstan signed more than 20 bilateral agreements, two of which specifically dealt with nuclear weapons on Kazakhstan's territory – "On Strategic Nuclear Forces Temporarily Located on the Territory of the Republic of Kazakhstan" and "On Military Cooperation". The two countries agreed that nuclear weapons on Kazakhstan's territory belonged to Russian strategic nuclear forces, and Russia committed to removing them. That finally removed the ambiguity over the fate of ICBMs and warheads, which throughout the period of ambiguity of their legal status remained in the custody of Russian forces.

By early 1994, the Russian military flew heavy bombers out of Kazakhstan. Removing ICBMs from their silos and transporting them to Russia was a more complicated endeavour. Each missile, with a launch weight of almost 200 tonnes, had to be de-fuelled, lifted from an underground silo and put on special rail transporters. The Russian military did all this without the participation of Kazakhstan's forces. By April 1995, Kazakhstan and Russia announced that all ICBMs and nuclear warheads had been removed from Kazakhstan to Russia. But in fact, one nuclear device (not a weapon) remained buried at STS.

The unexploded nuclear device

The Soviet military placed a nuclear device in one of the tunnels at STS in May 1991, hoping that they could carry out a test. This was despite no tests having been conducted at STS since 1989 due to pressure from the Kazakh anti-nuclear movement. In August 1991, Kazakhstan's government shut down STS, and the nuclear device was left sitting underground.

Meanwhile, as Kazakhstan banned nuclear tests on its territory and joined the NPT as a non-nuclear weapon state in December 1993, the unexploded device presented a serious political and technical problem. The Kazakh Government wanted to get rid of the device as soon as possible, not least because it was worried about the radioactive contamination of underground waters should the device remain indefinitely. At the same time, Kazakhstan did not have the technical expertise to deal with it on its own.

Kazakh officials were adamant that they would not permit anything that would even remotely resemble a nuclear test.[5] The Kazakh Government appealed to the Russian Ministry of Defence and the Russian Ministry of Atomic Energy, asking them how the

4 Agreement on Joint Measures with Respect to Nuclear Weapons, Alma-Ata, 1991, https://www.venice.coe.int/webforms/documents/?pdf=CDL(1994)054-e, pp. 152–153; Agreement on Strategic Forces, 30 December 1991, https://www.bits.de/NRANEU/START/documents/strategicforces91.htm.

5 Letter from S. Tereshchenko, Prime Minister of the Republic of Kazakhstan to S. Abdildin, Chair of the Supreme Soviet, 30 November 1992, f. 5H, o. 1, d. 1958, Archive of the President of the Republic of Kazakhstan.

device could be destroyed, how soon, and how to prevent damage to people and the environment.

Finally, by March 1994, when Russia and Kazakhstan finalized agreements on the status of nuclear weapons on the territory of Kazakhstan, they also agreed on how to proceed with the emplaced device. Russia agreed to pay for the dismantlement of the device and, more importantly, promised that, if the engineers could not extract it, they would use a chemical explosive to detonate it to avoid a nuclear explosion.[6]

It would take another year for the device to be destroyed. When the engineers opened the tunnel, they discovered that water had seeped inside in the four years that the device was sitting underground, making their task even harder. Nevertheless, they succeeded, and on 30 May 1995, a month after all ICBMs and warheads were removed from Kazakhstan, a chemical explosive obliterated the last remaining nuclear device.[7]

Nuclear material in Kazakhstan

Whether a young state would give up Soviet nuclear weapons attracted the most attention from the international community. But in practical terms, the availability of nuclear material and nuclear material production facilities could be considered even more consequential. Kazakhstan did not have access to command and control of the Soviet nuclear weapons even when they remained on its territory. Practically no ethnic Kazakhs served in the Soviet Strategic Rocket Forces due to an unofficial policy of a hierarchy of ethnicities in the Soviet Union.[8] Kazakhstan had neither access nor expertise when it came to Soviet strategic nuclear weapons.

With the nuclear material, the story was different. In theory, Kazakhstan, with its natural uranium reserves, nuclear material production facilities, and significant amounts of already produced nuclear material, could turn its inheritance into a foundation for a nuclear programme if it was ever interested in it, or keep material as an important symbolic step and a nuclear hedge.

As Kazakhstan's actions demonstrated, the country had no interest in nuclear weapon-related infrastructure or nuclear material. Instead, it was keen to dismantle or convert infrastructure relevant to weapons of mass destruction (WMD), and to minimize and secure nuclear material – by removing it from a country altogether, making it unusable in a weapon or, as was the case with the spent fuel, placing it in long-term secure storage.

Project Sapphire

In 1993, Kazakhstan was preparing to join the NPT as a non-nuclear weapon state. To comply with the NPT, the next step would be putting its nuclear material and nuclear facilities under International Atomic Energy Agency (IAEA) safeguards. Nuclear facilities conducted internal housekeeping before opening to the international inspectors. As a soon-to-be non-nuclear weapon state with no plans or ambitions to build a nuclear weapon or have a latent nuclear capability, Kazakhstan had to demonstrate that whatever nuclear material it kept was necessary for peaceful nuclear purposes, such as nuclear science or a civilian nuclear programme. Any material that Kazakhstan kept, it had to ensure was safely and securely stored.

In that context, more than 2 tonnes of fuel elements containing almost 600 kilograms of highly enriched uranium (HEU) stored at the Ulba Metallurgical Plant was a major headache for the Kazakh Government. Fuel elements containing beryllium and uranium enriched to 90 per cent were left from the Soviet Alfa-class nuclear submarine project. The project was folded in the 1980s, but the fuel remained at Ulba.

6 Deputy Chair of the State Committee of the Russian Federation on Economic Cooperation with CIS (M. Khusnutdinov) to the Council of Ministers of the Republic of Kazakhstan, 23 December 1993, f. 75H, o. 1, d. 602, Archive of the President of the Republic of Kazakhstan.
7 André Grabot, "Kazakhstan Officially Non-nuclear but Legacy Remains", Agence France-Presse, 6 June 1995.
8 Mariana Budjeryn and Togzhan Kassenova, "Nuclear Shades of Red Racism", Inkstick, 24 September 2020, https://inkstickmedia.com/nuclear-shades-of-red-racism.

In the early 1990s, Ulba, which in its heyday produced almost half of all fuel pellets used in Soviet-type nuclear reactors, struggled to keep itself afloat. With the collapse of the Soviet economy and the dissolution of the Soviet Union, it stopped receiving orders from the formerly powerful Soviet ministries.[9] In these conditions of socio-economic crisis, the facility managers and the government had to decide what to do with the valuable but dangerous contents of its warehouses.

The questions that the Kazakh Government faced were not trivial: How high was the risk of theft? Did Kazakhstan want to keep this material? If not, to whom should it be offered?

Kazakhstan decided that it wanted to remove the material and reached out to the United States. While the decision to disclose the presence of a HEU stockpile was made at the highest political level, the very first communication on the subject started informally in 1993. Ulba's director, Vitalii Mette, first communicated with the chief of the US Embassy's political-military section in Almaty, Andy Weber. Later the same day, Weber, now joined by the US ambassador to Kazakhstan, William Courtney, met with Mette again. Mette revealed to the US diplomats that there was uranium at his facility without disclosing the level of enrichment or the quantity.

In December 1993, the vote on Kazakhstan's accession to the NPT as a non-nuclear weapon state coincided (but not by coincidence) with the visit of US Vice President Al Gore to Kazakhstan. During that visit, the United States and Kazakhstan signed an umbrella agreement on the CTR programme that authorized US non-proliferation assistance. Against the backdrop of elevated US–Kazakhstan cooperation in the nuclear field, Mette disclosed to Weber that the material in question was "U_{235}, 90 percent, 600 kilos".[10]

There is no clarity on whether the HEU at Ulba was forgotten by top Russian nuclear officials, or the information was compartmentalized and that those who knew had moved on. Russia's Minister of Atomic Energy, Viktor Mikhailov, initially referred to the material as "waste". After some back and forth, the Russian Prime Minister, Viktor Chernomyrdin, told his US counterpart, Al Gore, that the United States could have the HEU.[11] Kazakh President Nazarbayev also reached out directly to Russian President Boris Yeltsin. According to Nazarbayev, Yeltsin told Nazarbayev that Kazakhstan could keep the HEU but added: "Why would you need it?" The bottom line, according to Nazarbayev, was that Kazakhstan was "left alone with the United States [to deal with it]".[12] Once both Kazakhstan and the United States were sure that Russia was not interested in the material, the two governments started planning the operation – known as Operation Sapphire – in earnest.

In October 1994, gigantic US military cargo aeroplanes landed in Ust-Kamenogorsk. The planes carried a team of technical experts and all the equipment necessary to carry out the work. It took the team four weeks to handle 2,200 kg of material that included 600 kg of HEU. Three military cargo aeroplanes carried the team and the HEU to the United States. The governments of Kazakhstan and the United States carried out the operation in conditions of high secrecy.[13]

9 Vitalii Mette, footage from 1992, in "Operatsiia Sapfir" [Operation Sapphire], documentary, Khabar TV, 2015, https://youtu.be/kjHIj9K-4jc.
10 Author's interview with Andy Weber, by email, Washington, DC, 2020.
11 William C. Potter, "Project Sapphire: U.S.–Kazakhstani Cooperation for Non-Proliferation", in John M. Shields and William C. Potter (eds.), Dismantling the Cold War: U.S. and NIS Perspectives on the Nunn-Lugar Cooperative Threat Reduction Program, 1997, pp. 345–362; William C. Potter, "The Changing Nuclear Threat: The 'Sapphire' File", Transitions Online, 17 November 1995.
12 Operatsiia Sapfir" [Operation Sapphire], Khabar TV.
13 US Defense Threat Reduction Agency, "Project Sapphire After-Action Report", National Security Archive, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB491/docs/01 - After Action report DTRA.pdf.

The United States paid for the operation and offered compensation for the removed material. Cobbling those funds together required creative thinking. The US Department of Energy and Department of Defense covered their involvement from their budgets, and the Department of State reimbursed Ulba for the SWU value of the HEU (SWU is a separative work unit, a standard measure of the effort required to separate isotopes of uranium during an enrichment process). Compensation also included in-kind assistance for nuclear facilities and government agencies – medical equipment, computer equipment, transport vehicles, as well as funding for inspection at nuclear facilities and funding via the International Science and Technology Center (ISTC) for projects dealing with Kazakhstan's immediate nuclear challenges (e.g., analysis of the radioactive contamination at the Semipalatinsk nuclear test site; strengthened controls on nuclear material; etc.).[14]

Kazakhstan's lack of interest in keeping the HEU at Ulba was another important indicator that the country had no interest in building a nuclear programme of its own. As the first operation of its kind to remove a large amount of nuclear material from one country to another, it required political will and mutual trust from Kazakhstan and the United States. In practical terms, the success of Project Sapphire required innovation – both in meeting the technical challenges but also in terms of securing the necessary funding.

Nuclear material at other nuclear facilities

Ulba was not the only location that stored nuclear material. The Mangyshlak Atomic Energy Combine (MAEK) in Aktau, the Institute of Atomic Energy in Kurchatov, and the Institute of Nuclear Physics in Almaty all had varying quantities of nuclear material. The US-funded Material Protection, Control and Accounting (MPC&A) programme paid for security improvements at all nuclear facilities in Kazakhstan, ranging from improving the physical security of facilities to establishing computerized accounting systems for the material. Other international partners helped Kazakhstan as well.

The Mangyshlak Atomic Energy Combine, built on the shore of the Caspian Sea, hosted a fast breeder reactor, BN-350. Since 1973, BN-350 had provided heat, electricity and fresh water. The reactor ran on HEU fuel and could breed more than 100 kg of plutonium per year.[15] Like Ulba, MAEK used to be an important Soviet nuclear industry facility, but it fell on hard times in the 1990s. As with the rest of its nuclear inheritance, Kazakhstan faced a problem on how to proceed. In MAEK's case, the main question revolved around spent reactor fuel that contained three tonnes of "ivory-grade" plutonium (i.e., plutonium in which the amount of less desirable isotopes is extremally low, making it attractive for use in a weapon).

Starting from 1995, Kazakhstan began cooperation with the United States on securing MAEK and its material. Initial MPC&A efforts focused on material characterization and accounting.[16] Once inventory work was complete, the material was placed under IAEA safeguards. US–Kazakh technical teams analysed, categorized, accounted and packaged all spent fuel assemblies into 480 stainless steel casks. Still, they could not be stored at the facility indefinitely and had to be moved to a secure location. The Kazakh Government decided to move the spent fuel to the Baikal-1 reactor site at Kurchatov, near STS, for long-term storage.

14 K.K. Tokayev and V.S. Shkolnik (eds.), CTR v Kazakhstane [CTR in Kazakhstan], unpublished manuscript, p. 23.
15 "Nuclear Successor States of the Soviet Union: Status Report on Nuclear Weapons, Fissile Material, and Export Controls", Monterey Institute of International Studies and Carnegie Endowment for International Peace, no. 5, March 1998, pp. 38–42.
16 R. Case et al., "Nuclear Material, Control, and Accounting Program at the Mangyshlak Atomic Energy Complex, Aktau, Republic of Kazakhstan", Sandia National Laboratories, 1998.

Moving the spent fuel from MAEK to Baikal-1 was an arduous task. It required political trust between Kazakhstan and the United States, financial resources, and technical innovation. Every stage of the removal demanded technical solutions – from what type of cask to choose for transport to where to procure cranes that could lift 100-tonne casks.

By 2010, the moving operation began in earnest. The casks filled with spent fuel travelled from Aktau to Kurchatov in five special railcars accompanied by two security railcars. From Kurchatov, casks continued by heavy-haul trucks to the Baikal-1 reactor complex. Hundreds of Kazakh troops helped with the safe transfer. It took 12 runs, with the last casks reaching Baikal-1 in November 2010, and the site was immediately connected to the IAEA safeguards monitoring system.[17]

In addition to the spent fuel, MAEK also housed almost 3 tonnes of fresh HEU fuel. A US non-governmental organization, the Nuclear Threat Initiative (NTI), helped Kazakhstan move fresh fuel to Ulba and downblend it to low-enriched uranium (LEU).[18]

Aside from significant quantities of material stored at MAEK and Ulba, sites with Kazakhstan's four nuclear research reactors stored spent and fresh HEU fuel. The Institute of Atomic Energy in Kurchatov hosted three nuclear research: two reactors at the Baikal-1 complex (IVG-1M and RA) and the IGR. From 1996 to 1998, 138 kg of spent HEU fuel from Baikal-1 were shipped to Russia, followed by RA's reactor core with 10 kg of HEU.[19] The remaining IVG-1M reactor was converted to work on LEU fuel. Spent HEU fuel from the third nuclear research reactor in Kurchatov – the IGR – was moved to Ulba and downblended into LEU there. By 2020, the final 2.9 kg of fresh HEU fuel from the reactor was transported to Ulba and converted to LEU.[20] By 2014, the United States had helped to remove 158 kg of spent HEU fuel from the Institute of Nuclear Physics in Almaty. Almost 50 kg of the Institute's fresh HEU fuel was downblended to LEU at Ulba. By 2017, the nuclear research reactor was converted to LEU fuel.[21]

Securing nuclear material at the Semipalatinsk Test Site

From the international non-proliferation point of view, the Semipalatinsk Test Site presented two broad risks: (1) the weapon infrastructure could theoretically be used for testing again, by Kazakhstan or Russia – an unlikely scenario, although this fear was shared by some international observers; and (2) state or non-state actors could get access to nuclear and radiological material remaining from various experiments at STS.

The Kazakh Government was concerned with both safety and security. As the sprawling site stood unprotected in the early 1990s, people and animals roamed freely. Driven by dire economic conditions, locals came to the site searching for scrap metal to collect and

17 "Moving Kazakh Nuclear Cache a Massive Undertaking", All Things Considered, National Public Radio, 17 November 2010.
18 Author's interview with Laura Holgate, by phone, 2020.
19 NTI, "Baykal-1 (Baikal) Research Reactor Complex", https://www.nti.org/learn/facilities/453/; Second National Report of the Republic of Kazakhstan on Compliance with Obligations Subsequent upon the Convention on Nuclear Safety, Astana, 2016, https://www.iaea.org/sites/default/files/kazakhstan_nr-7th-rm.pdf.
20 US National Nuclear Security Administration, "Kazakhstan and U.S. Cooperate to Eliminate Highly Enriched Uranium in Kazakhstan", 22 September 2020, https://www.energy.gov/nnsa/articles/kazakhstan-and-us-cooperate-eliminate-highly-enriched-uranium-kazakhstan.
21 "Kazakhstan Removes Research Reactor HEU", World Nuclear News, 3 October 2014, https://www.world-nuclear-news.org/RS-Kazakhstan-removes-research-reactor-HEU-03101401.html; US National Nuclear Security Administration, "Kazakhstan and U.S. Cooperate to Eliminate Highly Enriched Uranium in Kazakhstan", 22 September 2020, https://www.energy.gov/nnsa/articles/kazakhstan-and-us-cooperate-eliminate-highly-enriched-uranium-kazakhstan; US National Nuclear Security Administration, "NNSA Partners with Kazakhstan Research Institute to Remove All of its Highly Enriched Uranium", 19 September 2017, https://www.energy.gov/nnsa/articles/nnsa-partners-kazakhstan-research-institute-remove-all-its-highly-enriched-uranium; International Panel on Fissile Materials, "Russia Prepares to Accept Spent Fuel of Kazakhstan's VVR-K Reactor", 29 September 2016, http://fissilematerials.org/blog/2016/09/russia_prepares_to_accept.html.

sell. In addition to amateur scrap metal scavengers, at some point, entrepreneurial individuals started showing up with mining equipment. Metal hunters could access tunnels and boreholes built for nuclear tests, not fully aware that some parts of STS were still highly contaminated and presented a health hazard.

Unknown to those who came to collect metal, the tunnels and boreholes contained unvaporized nuclear material from the Soviet tests and experiments. As would become known later, Kazakhstan's nuclear inheritance included special large containers – *kolbas* and end-boxes – used for experiments with nuclear material. Those containers, abandoned by the Soviet Union, still held some leftover material. What if it not only entrepreneurial metal scavengers, but also determined non-state actors or state agents seeking nuclear material showed up at an unprotected site?

Lack of information on what exactly remained at STS presented the main challenge for the Kazakh Government. This information could only come from Russia. Kazakhstan also did not have information on the radioactive contamination – on which parts of the enormous site presented health dangers.

From the very start, the Kazakh Government reached out to the international community for help. In 1993, after the withdrawal of the Russian military, Kazakhstan received full control of STS and the town of Kurchatov. In 1993–1994, the IAEA conducted two preliminary radiological surveys of the territory.[22] In November 1993, a joint team of Kazakh and US scientists conducted their radiological survey and briefed their findings to scientists from Kazakhstan, the United States and Russia who gathered in Kurchatov for a scientific conference.[23]

In 1995, Kazakhstan and the United States signed an agreement, "Concerning the Elimination of Nuclear Weapons Infrastructure". Under this agreement, the United States committed to funding the sealing of tunnels and boreholes at the test site, under the provisions of the CTR programme.

Kazakh and US technical specialists, mainly from Kazakhstan's National Nuclear Center (NNC) and the US Defense Threat Reduction Agency, worked together. Over 1995 and 1996, the NNC team surveyed the tunnels and boreholes and assessed the radioactive contamination of each. In some areas, the team discovered radionuclides, including strontium-90, cesium-137 and plutonium.[24] Each tunnel and borehole required a tailored approach, as some had accumulated water and required special handling.[25] This took the labour of almost 200 local experts over three years.

Experiments with nuclear material and explosives had been conducted in giant steel containers called *kolbas*. Each kolba weighed close to 30 tonnes and could hold the equivalent of 200 kg of dynamite. Kazakhstan did not possess full information on which parts of the enormous territory required attention: how many *kolbas* there were, where they were buried and where else nuclear material remained. In 1997, Kazakhstan and Russia signed an agreement on *kolbas*. It was Kazakhstan's second major STS-specific agreement, following the 1995 US–Kazakhstan agreement on dismantling the STS infrastructure.

For a while, Kazakhstan's cooperation with Russia and the United States proceeded on parallel tracks under bilateral agreements. But soon, those bilateral tracks merged into trilateral cooperation between Kazakhstan,

22 IAEA, "Radiological Conditions at the Semipalatinsk Test Site, Kazakhstan: Preliminary Assessment and Recommendations for Further Study", 1998, pp. 1, 10.

23 Joseph P. Harahan, "With Courage and Persistence: Eliminating and Securing Weapons of Mass Destruction with the Nunn–Lugar Cooperative Threat Reduction Cooperative Threat Reduction Programs", Defense Threat Reduction Agency, 2014, p. 195.

24 N. Nazarbayev et al., "Provedenie kompleksa nauchno-tekhnicheskih i inzhenernyh rabot po privedeniiu byvshego Semipalatinskogo ispytatel'nogo poligona v bezopasnoe sostoianie" [Scientific-Technical Measures and Engineering Work to Transform the Former Semipalatinsk Polygon into a Safe State], vol. 1, National Nuclear Center, 2016, pp. 39, 70.

25 Ibid., pp. 39, 197.

Russia and the United States. That convergence became possible to a large extent thanks to scientists from the three countries, who pushed their respective governments to cooperate in the sensitive field.[26] By 2000, a meeting between high-level officials from Kazakhstan, Russia and the United States helped to move the process forward.[27]

By 2000, all tunnels and 13 unused boreholes were sealed, and the trilateral scientific teams focused on securing the remaining boreholes by building a sarcophagus to cover them. The construction began in August 2000, but two developments stalled it: in the United States, the new administration of President George W. Bush requested a review of all CTR programmes; and in Kazakhstan, the original CTR umbrella agreement expired, and a new agreement was pending ratification in the parliament. The attacks on the United States of 11 September 2001 and Al-Qaeda's expressed interest in acquiring WMD, as well as the information that scrap metal hunters had breached up to 70 per cent of previously sealed tunnels, reinforced the urgency of securing the former nuclear test site.[28]

By 2003, the sarcophagus, more than 70 metres in length, rose above the boreholes. The engineers used more than 1,000 plates made of cement as a foundation. The dome was made of steel, with the cement poured on top. The construction appeared to blend into the landscape as a low hill.[29]

In 2004, the trilateral teams secured three *kolbas* stored above the ground in a bunker by filling them with a mixture of cement and sand.[30] By that time, Russian scientists had persuaded the Russian Ministry of Atomic Energy to release information about three more *kolbas* sitting in one of the tunnels.[31]

Securing these *kolbas* was a more challenging task. They could be taken out of the mountain tunnels and filled with cement, but they would be too heavy to insert back into the tunnel. Plus, the US partners were not keen on re-opening the previously sealed tunnels. The Russian side agreed to provide information on the precise location of *kolbas* to allow the engineers to drill into the tunnels at those exact points. They punctured one kolba and filled it with sand and cement. With the other two, they filled the space around *kolbas* with the same sand–cement mixture to prevent access.[32]

The work on *kolbas* was completed in 2005. Yet again, thanks to Russian scientists, the Russian Government disclosed additional information to Kazakhstan and the United States. This time, it concerned so-called end-boxes – less secure containers than *kolbas* – with almost 100 kg of plutonium.

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26 For first-hand accounts of scientists who worked at STS, see Siegfried S. Hecker (ed.), Doomed to Cooperate: How American and Russian Scientists Joined Forces to Avert Some of the Greatest Post-Cold War Nuclear Dangers, vol. 1, 2016.

27 Siegfried S. Hecker, "Semipalatinsk Project: A Trilateral Cooperation to Secure Fissile Materials at the Former Soviet Semipalatinsk Nuclear Test Site", in Hecker (ed.), Doomed to Cooperate, vol. 1, p. 466.

28 Nazarbayev et al., [Scientific-Technical Measures and Engineering Work to Transform the Former Semipalatinsk Polygon into a Safe State], vol. 1, p. 207.

29 Ibid., p. 112–114, 117; Viktor S. Stepanyuk, "Liquidation of the Consequences of Nuclear Tests at the Semipalatinsk Testing Site (STS) in Trilateral Cooperation (Russian Federation, Republic of Kazakhstan, United States)", in Hecker (ed.), Doomed to Cooperate, vol. 1, p. 492.

30 Eben Harrell and David Hoffman, Plutonium Mountain: Inside the 17-Year Mission to Secure a Legacy of Soviet Nuclear Testing, Belfer Center, 2013, p. 25.

31 Stepanyuk, "Liquidation of the Consequences of Nuclear Tests at the Semipalatinsk Testing Site (STS) in Trilateral Cooperation", p. 495.

32 Nazarbayev et al., [Scientific-Technical Measures and Engineering Work to Transform the Former Semipalatinsk Polygon into a Safe State], vol. 1, p. 150; Stepanyuk, "Liquidation of the Consequences of Nuclear Tests at the Semipalatinsk Testing Site (STS) in Trilateral Cooperation", pp. 493–94.

Three sites, referred to as Special Projects X, Y and Z, were categorized as the highest risk among the newly disclosed locations. As with the earlier endeavours, trilateral teams worked with complex technical tasks. In one of the tunnels, rock formations had been encased in ice. Mountain rescuers helped cut a passage through.[33] Teams manually removed metal from the frozen rocks. Debris removed from two of the tunnels, referred to as "special technical equipment", was taken back to Russia.[34]

Over the next few years, the trilateral teams properly secured and sealed all tunnels. By 2012, they had secured additional sites identified as low risk and eliminated all manholes. In March 2012, at the Nuclear Security Summit in Seoul, the presidents of Kazakhstan, Russia and the United States shared with the world that the work to make the former nuclear test site safe and secure was almost complete.[35]

Conclusion: lessons for the future of disarmament

As we look into the future, hoping that other countries will give up on nuclear weapons and join the TPNW, we can draw lessons from Kazakhstan's case.

Kazakhstan made a strategic decision to give up nuclear weapons, their supporting infrastructure and nuclear material. Kazakhstan's leaders understood that attempts to enter the nuclear club were not commensurate with its national strategic interests and its national identity. Kazakhstan's leadership carefully weighed its security situation in the context of nuclear decision-making. It was clear that a nuclear weapon programme would not help with the types of security vulnerability it faced. On the contrary, trying to embark on a nuclear path would be detrimental to its security and sovereignty. Kazakhstan would not be able to build itself up as an independent state if it cut itself off from access to international institutions, markets and foreign direct investment. A non-nuclear choice aligned with the national identity of Kazakhstan, a country that suffered from the Soviet nuclear tests and a newly independent state that wanted to enter the world on good terms, as a responsible member of the international community. Based on its security interests and an understanding of what kind of state it wanted to become, Kazakhstan made a strategic decision to get rid of its nuclear inheritance.

At almost every stage of denuclearization, Kazakhstan faced informational, technical, financial and sometimes political challenges. The fundamental challenge was the lack of information on the nuclear activity that had transpired on its territory during the Soviet period. Kazakhstan relied on Russia for this information. Technical challenges, such as the destruction of a remaining nuclear device, dealing with flooded tunnels at STS or removing tonnes of spent fuel from one location to another, required innovative technical approaches and financing. Kazakhstan would not be able to deal with them on its own without Russia and the United States. The United States especially played a decisive role: technical expertise and financial resources made available thanks to the Nunn–Lugar Cooperative Threat Reduction programme and other funding streams made Kazakhstan's denuclearization possible.

33 Nazarbayev et al., [Scientific-Technical Measures and Engineering Work to Transform the Former Semipalatinsk Polygon into a Safe State], vol. 1, pp. 184, 170.

34 Philip H. Hemberger, "The Semipalatinsk Project: A Los Alamos Scientist's Perspective", in Hecker (ed.), Doomed to Cooperate, vol. 1, p. 479.

35 Joint Statement of the Presidents of Kazakhstan, the Russian Federation and the United States of America Regarding the Trilateral Cooperation at the Former Semipalatinsk Test Site, White House, 26 March 2012, https://obamawhitehouse.archives.gov/the-press-office/2012/03/26/joint-statement-presidents-republic-kazakhstan-russian-federation-and-un.

On the political level, Kazakhstan balanced equally well its relationship with Russia and the United States, two partners it needed the most for successful denuclearization. Despite the unclear status of the nuclear weapons on its territory during the first years of independence, the negative impact of the Soviet nuclear tests on its people and the environment, and general points of tension between the former metropole and a former republic, the Kazakh Government maintained a close relationship with Russia as it dealt with the Soviet nuclear legacy. Similarly, Kazakhstan proved to be a reliable partner for the United States, fully open to cooperation in the nuclear field.

The trilateral cooperation at STS required flexibility from all parties. It can be cited as a success story of cooperation between nuclear weapon states and non-nuclear weapon states. When Kazakhstan, Russia and the United States together dealt with reducing nuclear risks at STS, some information could only be shared between Russia and the United States (as nuclear weapon states), some information could only be shared between Russia and Kazakhstan (as Russia, like the United States, still held on to its nuclear weapon programme and protected sensitive data from rivals). For every challenge, the three countries managed to find a solution.

The fundamental role in the success of Kazakhstan's denuclearization belongs to scientists and technical experts from Kazakhstan, the United States and Russia. They are the ones who not only found solutions to every technical problem they encountered but also built the trust between the countries that made political breakthroughs possible. The high-stakes trilateral cooperation at STS was a fine example of how scientists pushed their governments towards closer collaboration.

What does Kazakhstan's case teach us in terms of disarmament verification, especially as applied to the TPNW? Why is the international community confident that Kazakhstan does not bear nuclear ambitions? Part of Kazakhstan's denuclearization relied on bilateral verification built into the US–Russian arms control framework, specifically the 1991 Strategic Arms Reduction Treaty (START). ICBMs located in Kazakhstan fell under START limitations. The rest of Kazakhstan's denuclearization credentials were built on the combination of its circumstances (no visible drivers for a nuclear option), its strategic decision not to pursue a nuclear weapon programme and trust accumulated thanks to its actions in support of its strategic decision.

The IAEA safeguard procedures played an important role. Once Kazakhstan joined the NPT, it understood that nuclear material should be accounted for and put under safeguards. Despite the unique complications of Kazakhstan's case (centred mostly around lack of full information and unique challenges of securing nuclear material at a former nuclear test site, etc.) and necessity to improvise on the go, Kazakhstan and its international partners found ways.

Once Kazakhstan made the decision, its actions helped to build trust with the international community. Two factors are especially significant. The first is a policy of transparency. As the historical record shows, Kazakhstan did not try to hide the details of its nuclear inheritance from the start. If anything, it faced the opposite problem – it lacked full information and tried to obtain it. The second important factor is Kazakhstan's policy on nuclear infrastructure and nuclear material. Agreeing to join the NPT as a non-nuclear weapon state and support moving nuclear weapons from its territory to Russia was an important first step. Taking action to dismantle all weapon-related infrastructure and removing nuclear material truly demonstrated the commitment to its non-nuclear choice. Transparency and the consistency of Kazakhstan's policy played key roles in removing any doubts about Kazakhstan's commitment.

This report explores the concept of the verification of nuclear disarmament in the context of the Treaty on the Prohibition of Nuclear Weapons. The authors show that disarmament in this case will be a cooperative process accompanied by a deep transformation of the disarming state. While technical tools and procedures will continue to play an important role, their primary purpose will be to allow the disarming state to demonstrate its commitment to its disarmament obligations.

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