ARTICLE TEMPLATE

History of and Aftermath from the Withdrawal of the Intermediate-Range Nuclear Forces Treaty

Aaron J. Berliner^a, Jake Hecla^{a,*}, Michael Bondin^a, Austin Mullen^a, Kelsey Amundson^a, Elena Osorio Camacena^a, Alex Droster^a, Dinara Ermakova^a, Tyler Scott Nagel^a, Nicole L. Nappi^b, Katherine J. Oosterbaan^c, Sarah R. Stevenson^a, Chelsea D. Willett^d, Eric F. Matthews^a, Manseok Lee^e, Karl Van Bibber^a, Michael Nacht^e

^aDepartment of Nuclear Engineering, University of California Berkeley

^bDepartment of Political Science, University of California Berkeley

^cDepartment of Chemistry, University of California Berkeley

^dDepartment of Earth and Planetary Science, University of California Berkeley

^eGoldman School of Public Policy, University of California Berkeley

*Corresponding Author: jhecla@lbl.gov

ARTICLE HISTORY

Compiled December 16, 2020

Author Information

Aaron J. Berliner

Aaron Berliner is a graduate student at the University of California Berkeley in the Departments of Nuclear Engineering and Bioengineering. Helping to establish the NASA-funded Center for the Utilization of Biological Engineering in Space (CUBES), his primary research is in the design of mission architectures that leverage biotechnology for long-term human space exploration. Anticipating the increasing importance of nuclear science in space exploration, Aaron is interested in the mathematical and physical modeling of the impact of high-energy radiation distant galaxies on shielding, secondary particle cascades, and astronaut countermeasures.

Jake Hecla

Jake Hecla is a graduate student at the University of California Berkeley in the Department of Nuclear Engineering. He earned an undergraduate degree in nuclear engineering at MIT, where he worked on techniques for zero-knowledge warhead verification. Today, his research includes 3D coded aperture gamma-ray imaging and antineutrino detection for reactor monitoring. In pursuit of his interest in nuclear policy, he has worked with Berkeley's Nuclear Policy Working Group (NPWG) to analyze emerging technologies and understand their impact on strategic stability. In his spare time, he works with Clean Futures Fund, a nonprofit which provides support to communities near the Chernobyl exclusion zone.

Michael Bondin

Michael Bondin is a PhD candidate in the Department of Nuclear Engineering at the University of California Berkeley. He earned an undergraduate degree in Nuclear Engineering and Radiological Sciences from the University of Michigan, focusing on radiation detection and nuclear nonproliferation. His research explores localized and dispersed gamma-neutron radiation mapping through the use of scintillators as structural components in UAVs. He is a member of the Nuclear Policy Working Group at UC Berkeley, and lives in a van.

Austin Mullen

Austin is a PhD student in nuclear engineering at the University of California Berkeley. His technical studies focus on antineutrino detection for nonproliferation purposes, and he is deeply interested in arms control, nonproliferation, and broader nuclear weapons policy. He is currently serving as the deputy director of the Nuclear Policy Working Group at Berkeley and hopes to help bridge the divide between technical experts and policymakers in the nuclear field.

Kelsey Amundson

Kelsey Amundson holds a B.S. in nuclear engineering from the University of Wisconsin Madison and a M. Eng from the University of California Berkeley. From August 2016 to June 2020 she worked at the Defense Nuclear Facilities Safety Board, performing safety oversight of the U.S. defense nuclear complex. Starting in June 2020 she has been working at Los Alamos National Laboratory, focusing on critical and subcritical experiments. Her contributions to this paper are related to her work at UC-Berkeley and are her personal views, not those of any of her employers.

Elena Osorio Camacena

After receiving her undergraduate degree, Elena Osorio Camacena explored her interests and found she was more drawn to the technicalities that her studies encompassed. This motivated her to continue her education at UC Berkeley in nuclear engineering where she received her master's. Elena continues her exploration for the sciences as a researcher and hopes to continue her education in the following years.

Alex Droster

Alex Droster is a graduate student at UC Berkeley who studies direct detection of low-mass dark matter. His research interests include quantum metrology and nuclear nonproliferation.

Dinara Ermakova

Dinara is a graduate student at the University of California Berkeley in the Departments of Nuclear Engineering. Prior to UC Berkeley, she worked in the Russian Nuclear Industry. She earned her M.Sc. degree in Russia and B.Sc in Kazakhstan. Dinara's research interests are in international security, nuclear energy, and nuclear waste policy. Starting in January 2019 she has been working as a graduate student researcher at Lawrence Berkeley National Laboratory, focusing on the modelling of radioactive con-

taminant transport in a deep geologic repository. She is a member of the Nuclear Policy Working Group at UC Berkeley.

Tyler Scott Nagel

Tyler Nagel is a graduate student in the Department of Nuclear Engineering at UC Berkeley. His research focuses on experimental nuclear physics using ion traps. Prior to attending UC Berkeley he was a submarine officer in the US Navy.

Nicole L. Nappi

Nicole L. Nappi is an undergraduate student at the University of California Berkeley in the Political Science Department. Her specialization is in International Relations and Comparative Politics with an emphasis on U.S. foreign policy in North and South-east Asia. As a research assistant under doctoral candidate Deborah W. Powers in Human Development and Education, Nicole's research interests include a broad range of interdisciplinary topics such as the domestic and foreign policy implications of the U.S.' Human Capital Approach to education, domain based moral education and superpower geopolitics in the Cold War Era and the implications on present day global affairs. After her undergraduate degree Nicole will be applying to graduate schools to continue her studies in the field of International Relations.

Katherine J. Oosterbaan

Katherine Oosterbaan is a fifth-year PhD candidate in Theoretical Chemistry, with a Designated Emphasis in Computational Science and Engineering. Her work focuses on developing new ways of simulating x-ray absorption spectra.

Sarah R. Stevenson

Sarah is pursuing her PhD in Nuclear Engineering from the Univ. of California, Berkeley. Her research involves developing a novel ion beam degrader and studying radiation damage in bulk-scale nuclear materials. Sarah Stevenson received her B.S. in Mechanical and Nuclear Engineering at Kansas State Univ. (KSU) in 2018. From 2014-2018, Sarah worked as a licensed Reactor Operator and Senior Reactor Operator at the KSU TRIGA nuclear test reactor. From 2016-2018, she joined the Idaho National Laboratory as an intern where she developed in-core fission chambers and worked at the French Atomic Energy Commission (CEA-Cadarache) in 2017. Sarah worked as an intern at the Primary Standards Lab at Sandia National Laboratories, NM in 2018. She also worked at the Lawrence Berkeley National Laboratory in 2019 as an intern developing accelerator technologies.

Chelsea D. Willett

Chelsea Willett holds a Ph.D. in Earth and Planetary Science from the University of California, Berkeley. Her dissertation focused on the role of radiation damage in apatite crystals in geologic dating methods and data interpretation. She is currently a Postdoctoral Researcher at Lawrence Livermore National Lab, where she applies noble gas geochemistry to problems of nuclear non-proliferation and planetary science.

Eric F. Matthews

Eric is a PhD Candidate in Nuclear Engineering at UC Berkeley. His thesis studies focus on the physics and nuclear data of fission. He developed a method to calculate covariance matrices for fission yields from evaluated nuclear data libraries. He also developed the Fast Loading User Facility for Fission Yields at LBNL's 88-inch cyclotron, a pneumatic system that allows the rapid transport of actinide samples for the measurement of short-lived (<1 s) fission yields. Eric was a 2018-19 NNSA NGFP Fellow and has been a fellow of UC Berkeley's Nuclear Science and Security Consortium since 2017. It is anticipated that he will graduate with his PhD in May of 2021. Eric served as the graduate student instructor of the course that organized this publication.

Manseok Lee

Manseok Lee is a Ph.D. student in the Goldman School of Public Policy at the University of California Berkeley. Previously he was an assistant researcher at the Center for Global Security Research in the Lawrence Livermore National Laboratory. His latest article was published in Strategic Studies Quarterly. Manseok served as the graduate student instructor of the course that organized this publication.

Karl Van Bibber

Karl van Bibber received his BS and PhD from MIT in physics. He subsequently served as an Assistant Professor at Stanford, Chief Scientist for Physics and Space Technology at Lawrence Livermore National Laboratory, and Vice President and Dean of Research of the Naval Postgraduate School. In 2012 he joined the faculty of UC Berkeley as Professor and Chair of Nuclear Engineering, serving also as Executive Director of the Nuclear Science and Security Consortium, a DOE Office of Non-Proliferation center-of-excellence. In July 2017, he was appointed Associate Dean for Research and in July 2019 as Executive Associate Dean for the College of Engineering. His research focuses on basic and applied nuclear science, particle astrophysics, and accelerator science and technology. He is the recipient of an Alfred P. Sloan Research Fellowship, the DOE Deputy Secretary Award, and the Navy Superior Civilian Service Award. He is a Fellow of the APS and AAAS. Dr. Van Bibber served as the professor of the course that organized this publication.

Michael Nacht

Michael Nacht holds the Thomas and Alison Schneider Chair in Public Policy at the U.C. Berkeley Goldman School of Public Policy. He has been on the UC Berkeley faculty since 1998 and served as Aaron Wildavsky Dean of the Goldman School from 1998 to 2008. During his tenure as Dean, U.S. News and World Report ranked the School for the first time #1 in the United States among schools of public policy analysis. Nacht is the author or co-author of six books and more than eighty refereed journal articles and book chapters on nuclear weapons policy; security issues in U.S.-Russia and U.S.-China relations; Middle East policy; counter-terrorism; international education; and public management. From 2009-2010 he served as Assistant Secretary of Defense for Global Strategic Affairs, after unanimous U.S. Senate ratification, for which he received the Distinguished Public Service Medal, the highest award granted by the U.S Department of Defense for a civilian appointee. Dr. Nacht served as the professor of the course that organized this publication.

History of and Aftermath from the Withdrawal of the Intermediate-Range Nuclear Forces Treaty

ABSTRACT

On February 1, 2019, the United States and Russia withdrew from the three-decades old Intermediate-Range Nuclear Forces (INF) treaty. Events precipitating the withdrawal were allegations by both the United States and Russia of a variety of treaty violations. Until that point, the treaty had been a centerpiece of arms control and a key agreement of the global security architecture. The absence of such a pillar has the potential destabilize the status quo of arms control, creating significant uncertainty in global nuclear stability and security. In this paper, we present a historical review as overture to an analysis on the impacts of this development on force structure. This analysis examines the changes in U.S., Russian, and Chinese nuclear forces which may occur as a result of the treaty's demise. The article concludes with commentary on potential actions to preserve stability in a post-INF world.

KEYWORDS

Intermediate Nuclear Forces Treaty, INF, Withdrawal, Violation, History

1. Introduction

On February 1, 2019, the State Department officially declared that the United States would withdraw from the Intermediate-Range Nuclear Forces (INF) Treaty, or the “Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles,” claiming Russia violated the treaty’s range limits. In response, the President of the Russian Federation, Vladimir Putin, responded by announcing plans to withdraw from the INF treaty as well. Putin accused the U.S. of violations and promised the prompt development of new weapons systems of previously proscribed range (Sokov 2019). A few weeks later, on March 13th, the United States Defense Department officials executed tests of missiles with ranges that were banned by the treaty.

The INF treaty, long considered a pillar of diplomacy between the United States-Russian Federation (US-R.F.), and its predecessor, Union of Soviet Socialist Republics (USSR), arms control regime, was signed in December 1987 by Ronald Reagan and Mikhail Gorbachev. It was the first treaty to eliminate an entire class of nuclear delivery systems, becoming a foundation for ongoing arms control efforts (Bohlen et al. 2012). This treaty banned the development and deployment of all ground-launched missiles with ranges between 500 and 5500 kilometers (km) and possession of their associated launchers (US Department of State 1987). The agreement is widely credited with reducing tensions in the wake of the Able Archer 83 and the Raketno-Yadernoe Napadenie (RYAN) scare of the early 1980’s (Fischer 2007).

At the time of this article’s submission, only a single U.S.-R.F. arms control agreement remains: the New START treaty. This is due to expire in 2021 unless leaders of both countries agree to extend it by a period of up to five years (Reif 2019). The placement of the INF in relation to other arms control agreements is shown in Table 1.

The following work aims to provide a classical overview of the world events leading to the institution of the INF treaty, a contextual history of its shortcomings and non-compliance, and its ultimate dissolution and the destabilization of U.S.-R.F. nuclear relations. Building on this knowledge, a detailed analysis of both the historical and present-day nuclear postures and global climate conditions is presented in order to formulate an accurate understanding of the reasons for the treaty’s failure. The following

Table 1. Strategic Nuclear Arms Control Agreements(Kimball and Reif 2019)

	SALT I	SALT II	INF treaty	START I	START II	START III	SORT	New START
Status	Expired	Never Entered Into Force	In Force ^a	Expired	Never Entered Into Force	Never Negotiated	Replaced by New START	In Force
Deployed Warhead Limit	N/A	N/A	N/A	6000	3,000-3,500	2,000-2,500	1,700-2,200	1,550
Deployed Delivery Vehicle Limit	US: 1,710 ICBMs & SLBMs U.S.S.R.: 2,347	2250	Prohibits ground-based missiles of 500-5,500 kilometers range	1600	N/A	N/A	N/A	700
Date Signed	5/26/72	6/18/79	12/8/87	7/31/91	1/3/93	N/A	5/24/02	4/8/10
Date Ratified U.S.	8/3/72	N/A	5/28/88	10/1/92	1/25/96	N/A	3/6/03	12/22/10
Ratification Vote U.S.	88-2	N/A	93-6	93-6	87-4	N/A	95-0	71-26
Date Entered Into Force	10/3/72	N/A	6/1/88	12/5/94	N/A	N/A	6/1/03	2/5/11
Implementation Deadline	N/A	N/A	6/1/91	12/5/01	N/A	N/A	N/A	2/5/18
Expiration Date	10/3/77	N/A	unlimited duration	12/5/09	N/A	N/A	2/5/11	2/5/21 ^b

^aOn Feb. 2, 2019, both the United States and Russia announced they were suspending their obligations to the Treaty

^bNew START allows for the option to extend the Treaty beyond 2021 for a period of up to five years

assesses the nature of the newly formed gap in arms control policy and its impact on security force structures, and attempts to provide a skeleton outline of potential policy directions for stakeholders in future negotiations.

The key arguments described in this paper support the viewpoint that the deployment of INF-violating missiles in Russia and the U.S. is unavoidable given the security environment each nation faces and lack of political will towards disarmament. Thus, future arms treaties must take into account the existence of these technologies. While complete re-institution of the treaty terms may not be realistic, measures can be implemented to promote cooperation and potentially control escalation between these states.

1.1. *A Pre-INF Cold War*

Following the events of the 1962 Cuban Missile crisis, the United States and the Soviet Union established a direct hotline between Washington and Moscow, as a means of immediate communication in order to mitigate an all-out nuclear war. Official dialogue between the U.S. and U.S.S.R. began at the onset of the Nixon Administration in 1969. The period of 1969 to 1974 was characterized by a de-escalation of geopolitical tension between the two superpowers, otherwise known as détente period. This diplomatically strategic period would serve as the framework for the subsequent bilateral control agreements that followed, including: The Strategic Arms Limitation Talks (SALT I), Helsinki Accords and SALT II, the latter two which were negotiated, yet failed to be ratified by the United States.

A summary of over 40 years of strategic negotiations between the United States and the Soviet Union (and later Russia) to limit and reduce their nuclear warhead arsenals(Roser and Nagdy 2020), delivery systems(Johnston n.d.), and testing practices(Kristensen and Norris 2013) is shown in Figure 1.

Figure 1. Timeline. (A) Stockpile supply numbers colored by Nuclear Weapon States (NWS) distributed across time. (B) Scatterplot of Nuclear Tests from NWS in terms of Yield [kiloTons]. (C) Timeline of events from first weapon test (1945) leading to scheduled expiration of New START treaty (2021). Events are grouped into categories of “Crisis in Europe” (square), “U.S./U.S.S.R. Negotiations” (right-pointing triangle), and “INF Violations and Collapse” (diamond).

1.2. Crisis in Europe

As underscored in Figure 1, in the mid-1970s, the Soviet Union and the United States recognized the potential advantages of mobile, survivable intermediate-range ballistic missiles. At the time, the Soviet SS-4 and SS-5 and the American Pershing 1A served as the main nuclear deterrent force in Western Europe. However, due to their poor accuracy, long mobilization time, and lack of ability to be concealed, the North Atlantic Treaty Organization (NATO) did not regard medium range weapons as a significant threat to Western Europe (Bohlen et al. 2012). A paradigm shift would occur with the development of the Soviet Union’s SS-20. This successor to the SS-4 and SS-5 was more accurate, more mobile, faster to launch, carried more warheads, and was easy to conceal. Furthermore, the development of solid-fuel technology enabled these missiles to be re-positioned and launched before being detected. West German Chancellor Helmut Schmidt was the first to raise the alarm about the potential threat of such weapons. However, U.S. officials were skeptical about these concerns, as they believed shorter range nuclear delivery systems were enough to deter conventional air and land aggression from the East. In October 1977, Helmut Schmidt spoke to the International Institute for Strategic Studies in London and declared that the nuclear protection provided by the United States was no longer sufficient in the face of the threat posed by the SS20.

Under pressure from NATO, the Carter Administration published the Presidential Review Memorandum, known as PRM-38. This memorandum created a two part modernization program for American intermediate range missiles. First, the Tomahawk missiles which were unveiled in 1983 along with the GLCM (“Ground launched cruise missile”), would be modified to be launched from mobile ground based systems. To directly match the capabilities of the SS-20, the U.S. would develop the longer range Pershing II missile (Kaplan 1979).

Meeting in December 1979, NATO agreed to a “dual-track” approach for a long term strategy to reduce the threat of the U.S.S.R.’s intermediate range missiles. First, was the “deployment track” in which the U.S. would deploy both the Pershing II and the Tomahawk missiles in Europe (Davis 1987). The deployment track would serve as a basis for leverage for the parallel “arms control” track. The second was the “arms control” track in which the U.S. would pursue negotiations with the Soviet Union as a means of limiting, reducing and/or dismantling Moscow’s weapons. As early as 1981, the U.S. proposed the radical “zero-zero” option for complete elimination of intermediate-range missiles.

1.3. *Negotiations*

Reagan and Gorbachev first met at a summit in Geneva, Switzerland in November 1985 and established the four-part agenda that would form the backbone of all future summit meetings: human rights, regional issues, bilateral matters, and arms control (Diggins 2007). Chief among Reagan’s arms control desires was elimination of intermediate-range missiles. Gorbachev wanted the United States to stop developing the Strategic Defense Initiative (SDI) (Rhodes 2008). The Soviets saw Ballistic Missile Defense (BMD) as destabilizing because, in their view, it gave the United States an asymmetric incentive for a first strike. Following the summit, a joint statement on the results of the meeting was released stating that both sides should take steps toward a 50% reduction in nuclear weapons as well as an increase in INF related negotiations and measures for compliance (1985). Although the summit did not result in a formal treaty, it helped Reagan and Gorbachev arrive at the mutual conclusion that nuclear war was to be avoided at all costs. It was not “winnable,” as was suggested by some of Reagan’s generals. The other equally intangible outcome was the beginning of the Reagan-Gorbachev relationship. This relationship was the catalyst to break down the barrier of mistrust between the two sides, clearing a path to the INF treaty.

Previously, the Soviet Union had rejected strategic force reduction proposals in 1977 and 1982, as well as Reagan’s “zero-zero” option in 1981 (Reagan 1985) and had walked out of two sets of talks in 1983 due to U.S. deployment of Pershing II missiles in Europe (Drozdiak 1983). Yet, during a second meeting in October 1986 in Reykjavik, Iceland, Reagan and Gorbachev agreed to a similar agenda with the sticking point, the same as in Geneva, the SDI. This was the one topic on which Reagan would not budge. To Reagan, ending development of the SDI would betray his promise to the American people. Reagan opened the summit with the assertion that ending the SDI would indicate to Americans that “their government would not protect them against nuclear destruction.” (Reagan 1986) Reagan’s hard-line stance contributed to the early collapse of the summit.

Despite the sudden end to the Reykjavik summit, INF negotiations resumed in early 1987, and by July, Gorbachev had agreed to complete elimination of short and intermediate-range missiles as well as comprehensive verification provisions (US De-

partment of State 1987). Gorbachev saw a chance to enhance his country's international stature by agreeing to terms provided by Western countries, believing that this would eventually lead to improvements in political and economic relations with the West(Davis 1987). Simultaneously, the leadership of the U.S.S.R. recognized an approaching economic crisis, and made serious concessions during the negotiations in part to limit defense expenditures(Gaidar 2007).

In a public ceremony in Washington on December 8, 1987, President Ronald Reagan and General Secretary Mikhail Gorbachev signed the INF treaty. The seventeen-article treaty had the following major effects:

- (1) to eliminate all U.S. and Soviet intermediate-range missiles and launchers with ranges between 1,000 and 5,500 kilometers within three years
- (2) to eliminate all U.S. and Soviet short-range missiles and launchers with ranges between 500-1,000 kilometers within eighteen months
- (3) to prohibit production or flight-test of intermediate-range or shorter-range missiles and launchers,
- (4) to establish the right to conduct on-site inspection for thirteen years,
- (5) to establish the Special Verification Commission (SVC) to assure treaty compliance
- (6) to establish unlimited duration of the treaty,
- (7) to allow the right to withdraw from the treaty with six months' notice, and for amendments to the treaty.

It is important to note that the treaty did not ban air or sea launched missiles, even if their range was within the 500-5,500 kilometer limit. The inclusion of these missiles was not a priority since NATO's main concern was the SS-20s that were easy to hide and quick to launch. Moreover, such an inclusion would be impractical as most air and sea launched missiles fell into the INF treaty range. Thus, eliminating these missiles would effectively remove the entire air and sea platforms. The treaty was ratified in May and entered into force on June 1, 1988(US Department of State 1987).

2. History of Compliance

The following history of compliance between the U.S. and the U.S.S.R. begins with a review of the implementation and verification terms as prelude to a description of the alleged violations levied by both sides.

2.1. *Implementation and Verification*

The United States arsenal included four missile types set to be eliminated: the Pershing II, Pershing 1A, Pershing 1B, and the BGM-109G. The Soviet Union had six: the SS-20, SS-4, SS-5, SS-12, SS-23, and the SSC-X-4 as detailed in Table 2. Oversight of these actions was undertaken by the SVC.

The United States declared 689 intermediate-range missiles with 282 launchers, and 170 shorter-range missiles with one launcher. The Soviet Union declared 826 intermediate-range missiles with 608 launchers, and 926 shorter-range missiles with 237 launchers. To assist in the demanding task of carrying out hundreds of inspections of 2,692 missiles, Reagan created the On-Site Inspection Agency (OSIA) on January 15, 1988(Harahan 1994). The inspection teams performed five specific types of inspections: baseline, elimination, closeout, short notice, and portal perimeter(Russell

Table 2. U.S.(top) and U.S.S.R.(bottom) Missile Technical Data

	Maximum number of warheads per missile	Maximum number of missiles per launcher	Length of missile with front section (meters)	Range Type
Pershing II	1	1	10.61	Intermediate
BGM-109G	1	4	6.4	Intermediate
Pershing IA	1	1	10.55	Shorter
Pershing IB	1	1	8.13	Shorter
SS-20	3	1	16.49	Intermediate
SS-4	1	1	22.77	Intermediate
SS-5	1	1	24.3	Intermediate
SSC-X-4	1	6	8.09	Intermediate
SS-23	1	1	7.53	Shorter
SS-12	1	1	12.38	Shorter

2001). During the thirteen-year period allocated for on-site inspections, the United States conducted 540 inspections and the Soviet Union conducted 311. By the deadline of June 1, 1991, all 2,692 declared missiles were verified as destroyed as detailed in Table 3.

Table 3. U.S.(top) and U.S.S.R.(bottom) Missile Eliminations

	1988-1989	1989-1990	1990-1991	Total
Pershing II	34	72	128	234
BGM-109G	130	90	223	443
Pershing IA	169	-	-	169
			total:	846
	1988-1989	1989-1990	1990-1991	Total
SS-20	192	262	200	654
SS-4	149	0	0	149
SS-5	1	5	0	6
SSC-X-4	80	0	0	80
SS-23	0	239	0	239
SS-12	600	118	0	718
			total:	1846

The verification process became difficult following the collapse of the Soviet Union in December of 1991. The newly independent countries of Belarus, Kazakhstan, Turkmenistan, Ukraine, and Uzbekistan all had INF missiles within their borders, thus the original bilateral treaty was now a multilateral one. The SVC, established by the treaty to aid in verification matters, conducted negotiations between the U.S. and the successor states(Tennis 2017). On-site inspections formally came to end on June

1, 2001, thirteen years after the treaty entered into force. From this date until the present, all monitoring has been done by “national technical means,” which consists primarily of overhead imaging using space assets.

2.2. *Violations and Withdrawal*

The United States offered allegations of Russian misconduct in 2014, claiming that the INF treaty was violated by testing a ground-launched cruise missile to intermediate range (500-5,500 km)(Gordon R. 2014). Every year since then, the State Department’s annual report on “Adherence to and Compliance with Arms Control, Non-proliferation, and Disarmament Agreements and Commitments” has cited Russian violations of the INF treaty(Service 2018). In 2017, Washington claimed Russia had begun to deploy a 9M729 missile that violated the treaty.

Moscow has remained firm in denying their alleged violation of the treaty, labeling reports as false and offered an exhibition of 9M729 missiles, but U.S. officials claimed that it did not satisfy their concerns(MacFarquhar 2019). Likewise, no U.S. personnel were made available to inspect the claimed missile, as the display was clearly inadequate if not entirely falsified. In addition, Russia has also accused the United States of violating the INF treaty by the development of the Aegis Ashore Ballistic Missile Defense system (first tested 2014, SM-3 interceptor range is 900km) and ballistic target missiles, along with the U.S. use of armed unmanned aerial vehicles (UAVs)(Panda 2018). These claims are in spite of the fact that the INF contains specific clauses to deal with air defense missiles and BMD target systems. UAVs, if counted, would represent violations on both sides. Viktor Bondarev, chairman of the Federation Council Committee on Defense and Security (a portion of the Russian parliament), added that the U.S. has violated the treaty about 95 times(RIA News 2018), but has not provided a list of what those violations consist of.

A more defensible objection is that the Mk-41 launcher system used on U.S. warships can hold a variety of missiles, including cruise missiles. The United States never replied to these allegations and did not offer the exhibition of Mk-41 launchers(RIA News 2019), but claimed that they do not represent a threat, even when installed in an Aegis Ashore configuration. It is conceivable that such a system could be used to hold INF-violating cruise missiles, although no such tests had been carried out before the INF withdrawal. Objections also center on the contention that the Aegis ashore system may offer little direct missile-defense capabilities against long-range missiles. However, this ignores the fact that the radar can be used as a portion of an integrated BMD solution which provides information on the missile during midcourse(Lewis 2016).

While the U.S. Department of Defense has published unclassified studies that reported highly inadequate radar and questioned the Aegis system capability to engage long-range missiles(Fallon and Lyles 2011), Russia has expressed concerns about the presence of U.S. combat unmanned aerial vehicles (UAVs) with an operating range of 1,100 kilometers. These UAVs have capabilities and characteristics that are close to the definition of a cruise missile, but UAVs are not part of the treaty(Mosesov 2018). Since 2014, U.S. officials have not provided any proof of Russian violations or information to substantiate their charges(RIA News 2019). However, the U.S. government believes that Russia had violated the treaty. In 2014, the Obama administration claimed that Russia violated the treaty, which led to criticism from Republicans, and called the desire to reduce nuclear arms “naïve.” It has been argued, however, that if there was no evidence of a violation, it is unlikely the Obama Administration would

have confronted Russia in a public manner(Pifer 2019).

In 2018, U.S. Secretary of State Mike Pompeo warned that Moscow had 60 days to comply with the terms of the agreement. In response, President Vladimir Putin argued that many other countries are likely producing weapons that would be banned by the INF, so Russia should be able to produce these weapons too. Putin also pointed out that Washington started these accusations of Moscow as an excuse to exit the treaty, and to make the global community believe that the Russians were at fault(Clinton 2010). The Chief of the General Staff of the Armed Forces of the Russian Federation, Valery Gerasimov, said that the United States, which had already left the Anti-Ballistic Missile (ABM) treaty in 2001, had destroyed another agreement and “blamed Russia for allegedly violating obligations(Mosesov 2018).”

Today the situation is different as more countries show interest towards acquiring their own nuclear arsenal, putting the signatories of the INF treaty into conflicting positions. While the United States and Russia are blaming each other for violations of the INF treaty, China, Iran, and North Korea are making efforts to acquire intermediate-range missiles. Moscow has already expressed concerns regarding this matter and is supporting the expansion of the INF treaty to include more states. China’s intermediate-range ballistic missiles now constitute “approximately 90%” of the People’s Liberation Army missile force. As China’s nuclear stockpile continues to grow, a bilateral INF treaty may no longer be beneficial for the United States and Russia(201 2018). The United States also shared the concern in 2014 that the INF treaty jeopardizes its ability and readiness to counter the missile threat from China and other actors. On October 22 2019, Trump remarked that “China is not included in the agreement. They should be included in the agreement”(201 2019a).

Taking the above mentioned facts into account, “To some extents the treaty has outlived its initial purpose,” said Malcolm Chalmers, Deputy Director General of the Royal United Services Institute. Experts have said that the collapse of the INF treaty and the loggerheads over the missile verification were also a symptom of the broader breakdown in U.S.-R.F. relations(Pifer 2019).

3. Impact on Force Structure

3.1. *The United States*

The U.S. laid out its responses to Russia’s violations of the INF treaty, and considered the implications of withdrawing from the INF treaty in the 2018 Nuclear Posture Review. The report highlights developments in three key areas: the development of low-yield submarine launched ballistic missiles (SLBM), the development of a modern nuclear-armed sea-launched cruise missile (SLCM), and research into a ground-launched intermediate range nuclear-armed cruise missile (GLCM)(Chapman 2018). Of these, the GLCM is unique as the only system banned from development and testing by the treaty – research into this area, however, is still allowed¹. The other two systems were not addressed by the INF treaty, but new developments in these systems can be interpreted as a response to the changing security and political environment created by the end of the INF treaty.

The manufacturing of low-yield warheads for the existing SLBM fleet is not outlawed by the INF treaty. The decision to add this capability to the U.S arsenal is nonetheless a response to the treaty’s end and the United States’ perception of Russian non-

¹Although it would not be a display of good faith.

strategic nuclear weapon superiority. In reference to developing the new low-yield warhead, the Nuclear Posture Review specifically states that “Moscow’s perception that its greater number and variety of non-strategic nuclear systems provide a coercive advantage in crises and at lower levels of conflict” is what largely motivates the new developments(Chapman 2018). Existing Trident D-5 missiles in the U.S.arsenal could be modified with a low-yield warhead in the short term, without excessive cost or political efforts. A concern amongst United States defense strategists is the perceived imbalance of nuclear forces between the United States and Russia(Sokov n.d.; Spring and Bendikova 2012; Legge 1983). Russia has a number of low-yield and non-strategic nuclear weapons at its disposal . Without the INF Treaty, a further increase in these systems could be possible. In order to maintain defense credibility, some analysts postulate that the United States must maintain an arsenal of low-yield weapons of its own, as the threat of high-yield strategic nuclear weapons against a Russian low-yield use is not seen as credible. A low-yield SLBM would help to close this “deterrence gap”(Chapman 2018). The continuation of the New Strategic Arms Reduction Treaty (New START) between the U.S.and Russia brings about a possible secondary effect of further SLBM development. Under the treaty, both countries are limited to only 1,550 nuclear warheads on deployed ICBMs, SLBMs, and heavy bombers. If the United States desires to continue low-yield SLBM development, and thus deploy an increased number of missile systems, the limits imposed by New START may incentivize the United States to not continue with the treaty when its current terms end in 2021.

A nuclear-armed SLCM provides much the same effect as a low-yield SLBM, but remains a longer-term goal. The United States’ previous SLCM fleet, the TLAM-N variant of the Tomahawk cruise missile, was retired in 2010. The Tomahawk missile is still operational with conventional warheads in the U.S.arsenal (Center for Strategic and International Studies 2018d). The development, manufacturing, and deployment of a new SLCM fleet will take a longer time than modifying existing SLBM’s with lower-yield warheads. A new SLCM also has major implications in East Asia, where China’s Anti-Access Area Denial tactics and non-strategic nuclear arsenal threaten U.S. interests in the region. China uses its own GLCM’s and ground-launched ballistic missiles (GLBM’s) to target U.S. naval bases and fleets in the Pacific, as they are not signatories to the INF and thus are not banned from intermediate-range forces (McCarthy and Force 2010). Much like with the Russian non-strategic weapons, the U.S. deterrence against Chinese low-level nuclear use may not be credible without non-strategic forces of their own for response.

The United States development of a new GLCM, previously outlawed by the INF treaty, has less obvious direct military applications. In a way, it can be used to fulfill the same roles as the low-yield SLBM’s and SLCM’s, but with a major drawback. Unlike sea-based variants, an intermediate-range GLCM must be based in areas near potential adversaries. This raises difficulties in deploying this capability in Europe and especially in Asia, where all potential defense partners have currently refused nuclear basing rights in their territory(Woolf and Chanlett-Avery 2017; Tim Kelly 2017). The United States has historically deployed nuclear weapons in Europe as a counter to Russia, but future deployments will likely be very contentious in today’s security and political environment. Possible locations include Poland and Romania, where the United States currently bases an anti-ballistic missile defense (ABM) system. This, however, would be seen as very aggressive by Moscow, who has already voiced multiple concerns over the possibility of using ABM launch sites in the countries to base offensive warheads(Kramer 2016).

Until recently, the deployment of a new GLCM was outlawed by the terms of the

INF treaty. During this time period, the United States has conducted INF-compliant research as a hedge against Russian violations (Chapman 2018). With the end of the treaty, the U.S. has begun to manufacture parts needed to assemble and test a GLCM system, thus signaling its intent to move forward with the project (Ali and Mohammed 2019). More recently, in August 2019, the United States has completed a successful test of an intermediate-ranged ground launched cruise missile (Mehta 2019). It has also maintained that, if Russia is willing to return to arms-control negotiations or abide by the terms of the INF treaty, the United States will roll back development on the project (Chapman 2018). It is thus likely that the GLCM development is a political tool more than a vital component of the U.S. arsenal.

3.2. *Impact on Russian Forces*

The Russian federation has not supplied an exact accounting of how they intend to respond to the termination of the INF treaty. However, insight into their response may be gained by analyzing trends in Russian foreign policy and missile development programs.

Given the Russian government’s demonstrated willingness to use force to coerce states in its near vicinity², it is possible that the Russian Ministry of Defense (MoD) seeks to be able to credibly threaten states within its imagined sphere of influence with nuclear-armed ballistic and cruise missile platforms. The INF-range missile capability would be a credible threat against these states.

These intermediate range systems offer an option for attack targeted purely at states in Russia’s periphery. This serves both as a means of intimidation and of creating restraint within NATO when considering involvement in states along Russia’s border. In the following sections we will explore how we anticipate the Russian state will deploy these INF-ranged systems and the role they serve in the MoD toolkit.

3.2.1. Historical Precedent

The missile system that led to the INF, the SS-20, was explicitly conceptualized as a means of assuring a survivable theater nuclear force which could be deployed rapidly. According to statements made by General-Colonel Andrian Danilevich, the development of the SS-20 and related systems was spurred by radical changes in military strategy which came about in the late 1960s in response to changes in U.S. posture³. These changes were characterized by the consideration of conventional induction of nuclear war and slow (day-to-week scale) escalation in a European land conflict. This was in direct contradiction to the “nuclear euphoria” of the early 60s, in which Soviet official doctrine posited that all superpower direct conflict would immediately escalate to the strategic level. This view was espoused by Khrushchev (and a great number of Strategic Rocket Forces personnel), but strongly questioned by Brezhnev, resulting in changes in official doctrine (Cant 1998).

These changes necessitated a force which would attempt to eliminate adversary theater nuclear forces using conventional forces, but could use nuclear weapons to hold massed troops and material at risk as well as be able to engage larger theater-scale targets in a survivable manner.

The Russian military currently faces a very different threat landscape. However,

²specifically in the cases of Georgia and Ukraine.

³flexible response and the Schlesinger doctrine, in particular.

they have nonetheless developed systems which reprise the roles of pre-INF systems. It is unlikely they are considering a return to Cold War-era plans of fighting a nuclear war to the Rhine river (?). Instead, it is likely that the new INF-ranged systems will be deployed as a tool of nuclear blackmail: they will be used to threaten states in the near vicinity and as a means of inculcating restraint in NATO when considering intervention. As these systems are distinct from ICBMs intended to target the “main adversary,” there may be a perception that the threshold for use is lower⁴. This may aid in pressuring those in the near-abroad to accept Russian demands when involved in a high-level conflict.

Likewise, the presence of such systems serves as a visible reminder of Russian power, which may have psychological impacts on adversaries. INF-ranged systems provide a means of striking NATO targets throughout a sizeable portion of Western Europe. Due to short warning times, quick deployment timelines and high survivability, the road-mobile INF-ranged systems being deployed enhance Russian deterrence against these states, and may cause leaders to reassess their opinions on the credibility of U.S. extended deterrence.

While the authors feel that there is little practical difference between threatening European states with an ICBM or a theater ballistic missile/intermediate-range ballistic missile (TBM/IRBM), the publicity associated with “unstoppable” and “short warning time” missile systems will likely have a large psychological impact on the general public. This may cause political pressure to deploy defenses or offensive systems to placate domestic audiences who feel more threatened. If such comes to pass, it is likely that the portion of the European public opposed to U.S. nuclear weapons will apply political pressure, resulting in increased internal polarization and inter-alliance tension. Such an outcome would fit squarely within Russian interests. If historical precedent is any indicator, the backlash against U.S. weapons deployment in Europe could be considerable⁵, and have long-term impacts on the transoceanic partnership.

3.2.2. 9M729

The withdrawal of the United States from the 1987 INF treaty is centered around Washington’s claim that Russia has developed and is currently developing intermediate range cruise missiles in direct violation of the treaty(Reif 2019). The missile in question is the Novator 9M729, claimed to be an upgrade of the existing, INF-legal 9M728 missile(Center for Strategic and International Studies 2018c).

The 9M728 missile is a short range cruise missile capable of delivering a conventional or nuclear payload at a maximum range of 500 km. To circumvent missile defenses, it has a “sprint-to-target” capability, in which it accelerates to Mach 6 on approach to the target(Pike 2018a). System development began in 1996 and first tested in 2007. Since then, Russia has presented its development of the 9M729 missile as an effort to modernize its missile arsenal, essentially upgrading the 9M728 by fitting a higher-yield warhead and an improved guidance system. Russia claims the 9M729 missile has a reduced range from its predecessor, due to the increased weight of the new components(200 2000). U.S. open-source missile experts strongly contest this(Lewis 2014).

The range of the new system has been a source of contention. The U.S. Air Force National Air and Space Intelligence Center has estimated the missile’s maximum range at 2,500 km(201 2017a). If true, this was in direct violation of the INF treaty banning

⁴Use of a long-range strategic system would suggest escalation to general thermonuclear war.

⁵Consider the scale and duration of the 1980s era antinuclear protests.

ground launched cruise missiles with range between 500 and 5,500 km. Russia has stated the booster, engine, and fuel tank of the 9M729 are identical to its predecessor's, and the only way to increase the missile's range is by increasing the size of the canister (Woolf 2017; Podvig 2019).

However, the size of the existing 9M728/9M729 canister is only 6 inches shorter than that of the RK-55 missile discontinued in 1987 due to its INF-non-compliant range of 3,000 km (Center for Strategic and International Studies 2018b). It is therefore entirely plausible the 9M729 could have been redesigned to significantly increase its range.

For this reason, the United States has called for the complete elimination of both the 9M729 missile and its associated launch vehicles, which in effect would require Russia to nearly completely overhaul its broadly interchangeable missile systems. Russia has not tested its missile beyond a 500 km range from a mobile launcher, but has used a clause in the INF treaty allowing sea- and air-based missiles to be tested from a fixed ground launcher to a range well above 500 km (Coates 2018). A missile of this specification has the ability to pose a threat to all of Eastern and Western Europe, most of Asia, and targets as far as Los Angeles (Pike 2019). Since the 9M729 is posited as an upgrade of Russia's existing ground launched cruise missile (GLCM), its demonstrated range capability places it in clear violation of the INF treaty.

Ground-launched cruise missiles, especially ones with low-yield warheads, are typically recognized as tactical weapon systems. The use of a strategic weapon would be inappropriate for relatively small-scale, regional conflicts. Developing a low-yield, medium-range missile may in effect raise credibility of Russia using this weapon to assert its regional dominance over neighboring states seeking to align themselves with the West. Russia has already used cruise missiles in its conflicts in Syria, albeit only non-nuclear variants.

3.2.3. 9M723/*Iskander*

This single-stage, road-mobile solid-propellant missile with an inseparable warhead has become a linchpin of Russia's rocket forces. The 9M723/*Iskander*-M SRBM system, while legally an INF compliant system, has been tested to significantly beyond 500 km after withdrawal from the INF (Maksimov 2020), a development which was widely anticipated based on technical and policy analysis.

The first evidence of testing to beyond INF-compliant range occurred in January 2018 when crash debris from a 9M723 was photographed⁶ by rural residents in Kazakhstan approximately 650 km from the borders of the Russian Federation. Nearly a decade earlier, analysis of the missile system by Stefan Forss of the Finnish National Defense University suggested that the range of the missile may exceed 1000 km in some configurations. Official statements suggest the missile can be armed with conventional warheads (480-700 kg) or a single nuclear warhead (Forss 2012). The missile uses advanced terminal guidance to avoid missile defense (including claimed terminal maneuvering exceeding 30 G), and claims a circular error probable (CEP) of 5-7 m using combined optical and GLONASS (*Globalnaya navigatsionnaya sputnikovaya sistema*) guidance (20-30 meters (m) in autonomous mode). Missile mass is approximately 3800 kg, and overall length around 7 m (SS- n.d.). The system has been acknowledged to be based on a heavily modified version of the OTR-23 Oka system, which was eliminated under the INF.

In terms of its operational role, the 9M723 missile has seen successful battlefield usage since being fielded in 2006 and later used in the Russo-Georgian war. A variant

⁶<https://mod.gov.kz/rus/press-centr/novosti/?cid=0&rid=7427>

designated 9M723K1 with unspecified improvements was deployed in 2012, which has yet to see battlefield use.

The Iskander system seems to loom large in the consciousness of the Russian MoD as a primary pillar of both defense and deterrence. Language around the deployment of the 9M723/Iskander system suggests that the Russian leadership treats it as something more akin to a strategic system than a tactical or operational weapon. In a speech regarding NATO BMD in 2008, Medvedev specifically invoked the system by name as a means of responding to the system deployments in Eastern Europe (Medvedev 2009). Signaling from the armed forces has been similar: Nikolai Makarov, Chief of the General Staff of the Russian Armed Forces, referred to the Iskander system as being on the forefront of the modernization and rearmament of the Russian state, an odd role for a supposedly short-range system.

Emplacement of the Iskander system began officially in 2010 in the Leningrad Military District (2010a), although evidence from the Russo-Georgian war strongly suggests their use in 2008 (RTL n.d.). Various reports suggest their deployment near Armenia, in Syria, across the western border of Russia as well as in Kaliningrad. Assuming a range of 750 km, the missile system has the ability to target a variety of Baltic and European capitals from the Russian exclave, as threatened by Medvedev in 2012 (Stubbs and Osborn 2018).

Going forward, it can be anticipated that the Iskander will be formally tested to long range and will receive an “upgrade package” to account for this improvement. Messaging surrounding the system, which has already cast it in a role as an intermediate-range system will likely continue. Current basing is more than sufficient to act as a deterrent against Baltic states, and will likely not be significantly modified as a result of the upgrade. It is likely NATO has already planned for the actual range of the system, and that the eventual “upgrade” will have little to no impact on the status quo.

3.2.4. RS26-Rubezh

While the Rubezh system is not currently deployed and is officially on hold until 2027 due to budgetary constraints, trends in Russian armament suggest that a return to this program could be imminent. Due to the vigorous pursuit of this program until 2016, it is a strongly desired capability of the R.F. military.

The RS26 was developed under the regulatory framework of New START, but is likely designed as an INF-ranged system. Under development, the system was regulated under the New START treaty as a prototype system. The missile itself consists of the upper 3 stages of the RS24 (“Yars”), a heavy-lift, solid-fueled road-mobile ICBM first tested in 2007. This missile is similar to a Topol-M with modifications to allow increased warhead upload capacity. As a result, the missile is referred to using NATO designations as either the SS-29 (if one accepts the assertion that it is a new system) or the SS-27 mod 2 (if one does not). As is common across the current generation of Russian nuclear delivery systems, the intent of this upgrade is improved evasion of missile defense systems using maneuvering re-entry vehicles, decoys and/or a large numbers of warheads (Pike 2018b).

Notably, the RS26 was developed alongside the “Avangard/Yu-74” hypersonic glide vehicle. According to MoD reports, the missile will be able to carry multiple Avangard boost-glide vehicles. MoD statements have also indicated that the RS26 is intended to carry maneuverable reentry vehicles (MARV) as well as conventional, non-maneuvering reentry vehicles (RV), although public information on the capacity has not been made available (Pike 2018c).

The claimed operational role of the RS26 is to replace the aging RS-12M (“SS-25 Sickle”), a road-mobile, single-warhead ICBM (Center for Strategic and International Studies 2018a). However, presenting the RS26 as a stand-in for the aging RS-12M is suspect, as the maximum tested range currently stands at 5800 km. Open source intelligence analysis (Lewis 2014) suggests this launch was performed with a “very light or nonexistent” payload. To avoid violating START, Russia would have to bring back the RS26 program as a TBM/IRBM. However, considering the fluidity of missile model designations in the Russian armed forces, this is not a significant impediment.

Alternatively, the system can be viewed as a modern parallel to the creation of the SS-20 Saber IRBM. Like the SS-20, the RS26 consists of a long-range ICBM with a stage removed, keeping development costs low and parts interchangeability high. The RS26 most likely has a fully-loaded effective range of a few thousand kilometers, making it useful for delivering payloads in Russia’s near-abroad. This is similar to the use-case of the SS-20-10, which was deployed as a means of threatening European capitals with a highly-survivable system.

For maximum psychological impact in Western Europe, Russia may make a show of placing these missiles in Kaliningrad, as they have indicated they intend to do with the 9M729 and have done with the 9M723. People’s Republic of China (P.R.C.) may be targeted as well (with forces deployed in the east), but this is a more provocative move. Given the current state of the R.F-P.R.C. relationship, this action seems unlikely. Russia may desire to use this capability to hedge against a rising China, but this is secondary to its utility in threatening NATO.

With the RS26 and other INF-ranged nuclear weapons systems, Russia will be able to threaten areas protected by theater BMD with improved credibility. This places pressure on a number of European states. Likewise, states in Russia’s near-abroad will feel immensely vulnerable, even if they have existing BMD installations. The psychological impact of these weapons on adversaries is therefore significant, and may be of use in driving divisions within NATO as elaborated above.

4. Moving Forward

The demise of the INF is likely an irreversible development. Neither the geopolitical or the physical conditions exist to create a successor treaty which would appeal to any constituency currently in power in any of the original party states. Arms control relies on the existence of favorable political conditions, and the current state of renewed great-power competition is not conducive. Further, the former INF states have taken steps in missile development which make a reversal far more difficult than the initial implementation (see discussion of Iskander FRODs, SM6). China, a proposed third signatory for an “expanded” INF, has made it clear it maintains no interest in joining such an agreement. Further, the structure of the People’s Liberation Army Rocket Forces (PLARF) and the threat model posed by the U.S. are not conducive to a reduction in intermediate ranged missiles.

The current structure of the Russian armed forces places an additional barrier in the way of reviving the INF. Any potential arms limitation treaty must have a scope acceptable to both parties. Today, with the revelation of the 9M723 as an intermediate-range system, the Russian armed forces would have to be dramatically remodeled in order to comply with such a treaty. The Iskander is a much-hyped fundamental capability and has been invested in heavily, with 13 launch complexes known as of April 2020. The elimination of such a system, alongside other INF-ranged systems,

would be nearly unthinkable from a budgetary and propaganda standpoint.

If one was to limit the elimination to simply Iskander-M systems, a major problem would still remain in identification of 9M728 vs. 9M729 armed systems. If claims about the canister being interchangeable are correct, the systems would lack any functionally-related observable differences (FRODs). This would render the INF-compliant and INF-violating systems indistinguishable using aviation and space assets. This creates issues in verification that would likely require on-site investigation.

4.1. *Salvaging a Bilateral Treaty*

Increasing global nuclear security is likely best achieved when more nuclear-capable parties join and conform to one treaty. However, the negotiations required to form such a multilateral treaty may be prohibitively time-consuming or politically impossible. Based on the duration and outcome of the original INF treaty, this section contains the broad suggestion that a revised bilateral treaty be pursued by the U.S. as it provides the greatest net benefit to the signatories and international nuclear security if signed and implemented quickly. Furthermore, this section provides specific recommendations for the treaty terms that most require renegotiation. Given the history of the INF treaty and the implications of withdrawal, the most efficient and safest path forward for international arms control may be to focus U.S. energy on pursuing a revised bilateral treaty with the Russian Federation.

4.1.1. INF in the context of existing treaties

The downfall of the INF treaty suggests the larger disintegration of the U.S.-R.F. arms control relationship. If a bilateral INF-like treaty is to be salvaged, it must be done with an eye towards more modern arms control agreements between the United States and Russia and the modern relationship between the U.S. and the R.F.

The New Strategic Arms Reduction Treaty, or New START, is the primary context in which an updated INF Treaty must be viewed. Set to expire in early 2021, New START set limits on both the number of deployed warheads and the total (deployed and non-deployed) number of launchers. It also allows for 18 yearly on-site inspections, and contains provisions on the use of national technical means (NTM) for remote compliance verification(201 2010b).

Arms control agreements like the INF Treaty and New START help the United States to maintain strategic stability. In a March 2017 congressional testimony, U.S. General John Hyten stated, “I’m a big supporter [of the treaty]... When it comes to nuclear weapons and nuclear capabilities, that bilateral, verifiable arms control agreements are essential to our ability to provide an effective deterrent”(201 2017b). The verification terms of such agreements, like the now-defunct Special Verification Committee of the INF and the 18 on-site inspections per year provided by New START, provide the United States with valuable intelligence on Russian weapons systems that cannot be gathered by NTM. Salvaging an INF-like treaty is integral to supporting the United States continued goal of strategic stability. A revised INF treaty would ameliorate the reliance on New START as the only arms control agreement between the two states, and shore up the credibility of U.S. and Russian commitment to nuclear non-proliferation as stated in the The Nuclear Non-Proliferation Treaty (NPT), as well as increase the probability of the extension of New START and agreement to future arms-control treaties.

4.1.2. International support for the INF Treaty

Some political scientists have suggested that downfall of the bilateral INF treaty is linked to the need for multilateralization to prevent changes in China’s force structure undermining the incentives constraining U.S. and Russian missile forces (Stokes and Blumenthal 2011). This multilateralization was proposed to the United Nations in 2007, when Russia and the United States submitted a joint proposal that would “convert the INF Treaty into a multilateral treaty that could be signed by all states with intermediate-range and shorter-range missiles” (Woolf 2017). However, no support for this change was garnered in the past, and is unlikely to be garnered in the immediate future. INF-range missiles serve as the backbone of national defense for a variety of proposed partners for the multilateralization effort, and little political will exists for broad-ranging disarmament, as it does not serve the defense interests or political goals of these partners.

The difficulties with multilateralization have only grown since the 2007 proposal. China strongly supports a revised bilateral INF treaty while vehemently denying the possibility of a multilateral treaty. China’s nuclear program has been developed largely outside of nuclear arms control agreements. Roughly 90% of China’s current nuclear weapons arsenal fall under the weapon classes banned by the INF (Panda 2019a). It would remain in China’s interests to maintain a ban on these weapons from the world’s two largest nuclear powers while not being required to drastically downsize its own capabilities, as it would draw its opponents nearer to parity. Geng Shuang, the Chinese Foreign Ministry Spokesperson, summed up China’s views on the INF when he stated, “The multilateralization of the INF treaty involves a series of complex issues covering political, military and legal fields, which draws concerns from many countries. China opposes the multilateralization of this treaty. What is imperative at the moment is to uphold and implement the existing treaty instead of creating a new one” (Taheran n.d.). In theory, it may be beneficial for both the U.S. and Russia to include China and other states with INF-range missiles in a multilateral INF revision, but the negotiations required to form a multilateral treaty will be time consuming and will likely yield no progress under the current regime. Therefore, a revised bilateral INF treaty provides the fastest path to restored arms control for the signatories and increased global security in the short term.

The European Union and NATO were supportive of the INF treaty during its tenure (Taheran n.d.). Like much of the international community, NATO acknowledges that a total loss of the INF treaty alone will not motivate Russia to move towards compliance, and takes away the means (within the treaty itself) by which to pressure Russia to comply (Kubiak 2018). While not a signatory, NATO benefits from the treaty, given its close relationship with the United States and proximity to Russia. While NATO supported U.S. withdrawal based on Russian violations, it would likely support any efforts to create a new bilateral treaty between the two states.

4.1.3. Weapons Technology

According to the Russian Federation, one factor for the demise of the INF treaty is the concern that it “unfairly prevents it from possessing weapons that its neighbors, such as China, are developing and fielding” (Kimball and Reif 2019), which it implies puts the nation at a strategic disadvantage. Furthermore, both the United States and Russia have expressed concerns that the other has maintained and planned military programs that are out of compliance with the INF treaty, which in turn has led both parties to initiate modernization efforts. As a revised bilateral treaty is negotiated, the

United States and Russia will need to discuss these emerging technologies and their relationship to the revised treaty terms to ensure that each party can trust the other to comply in the future. Transparency in developing technologies should foster trust between the two parties, and should be backed by adequate verification. Transparency and diplomacy between the United States and Russia will also have a stabilizing effect on global nuclear security.

The INF treaty requires the elimination of intermediate and short-range missiles (ballistic and cruise missiles) with ranges from 500 to 5,500 kilometers, and does not include air-launched or sea-launched missiles. These terms have given some leeway for the parties to acquire a nuclear arsenal with capabilities that come close to the banned weaponry but are not in violation. In the light of modern technology, the 1987 treaty falls short in encompassing the different existing missiles. For example, in the past, one of the charges that Russia brought against the United States is that armed unmanned aerial vehicles (UAVs) are, in effect, ground-launched cruise missiles and thus banned by the treaty. When the INF Treaty was negotiated, neither Russia nor the United States had armed UAVs.

Much of the disagreement between the two INF parties stems from the development of recent weapons technology that are near the INF range limitations. In the 2014, 2015, 2016, 2017, and 2018 editions of the U.S. State Department report titled, “Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments,” the United States declared that “the Russian Federation is in violation of its obligations under the INF Treaty not to possess, produce, or flight-test a ground-launched cruise missile (GLCM) with a range capability of 500 to 5,500 kilometers, or to possess or produce launchers of such missiles” (201 2019b). The report specified the 9M729 as violating the treaty terms, and stated that Russia has deployed several battalions of the missile. Russia, on the other hand, has listed similar concerns with the United States, particularly in regard to the Mk-41 anti-ballistic missile launcher.

The possibility of crafting a new bilateral INF treaty will hinge on the negotiation of mutually acceptable terms to updated weapons technology. The agreement will require that the parties put a halt on their INF treaty-relevant technology development or, at best, modify their arsenals to comply with the updated terms of the treaty. It also implies renewed trust between the parties owing to transparency which is forged with a more efficient verification scheme. The benefit to international security includes diffused security concerns for countries in the E.U (especially at its eastern periphery). A return to a bilateral agreement may also lead to an increased support for a multilateral treaty, contingent on compliance from both parties.

4.1.4. Verification Terms

The mutual compliance concerns between the United States and Russia can be attributed to insufficient verification methods, but it is notable that this was not always the case. In fact, “at the time of its signature, the Treaty’s verification regime was the most detailed and stringent in the history of nuclear arms control” (US Department of State 1987). The verification terms included a 3-year period allowing short-notice on-site inspections, as well as a 13-year period of on-site inspections. By the end of these inspections in 2001, they were falling out of favor due to high cost and logistical complexity (Ritter 2015). Since then, the United States and Russia have relied on NTM to verify compliance (Ritter 2015).

The INF treaty has a Special Verification Commission clause intended to bring

leaders from both parties together to resolve questions relating to compliance. This Commission met in 2018, without success in resolving the prior five years of concerns. To craft a new bilateral treaty, experts believe that the United States should more effectively use the Special Verification Commission to resolve compliance issues (Brown 2018; Wolfsthal 2018; Ritter 2015). Specifically, the Special Verification Commission should demand a return to on-site inspections. Previous on-site inspections were historically effective, and their terms are well defined in the original INF treaty.

Furthermore, in order to reintroduce an INF-like treaty, Russia would be required to make an example of the 9M729 available for the United States, and its technical terms would need to be agreed upon in advance. If the missile system is found to have been in violation, then Russia would be forced to modify or remove it from service and development. After an initial on-site inspection of the 9M729, the United States and Russia can produce a plan for future monitoring, which could include recurring on-site inspections. In return, the United States would also have to reassure Russia that the anti-ballistic missile systems in Europe are not in violation of INF treaty terms. This could be done with reciprocal on-site inspections, showing that no offensive missiles are deployed alongside the MK-41 launchers. Furthermore, the United States could agree to modify the system so that the Tomahawk launch capability is removed.

Ultimately, a return to on-site verification on both ends is viewed as the most likely resolution to salvage the INF Treaty's verification terms. It is a historically effective clause, and would allow both the United States and Russia to address their concerns with the other party, as well as force any violators to return to compliance. This can be implemented with the authority of the Special Verification Commission, whose exact roles and powers can be renegotiated as the treaty is revised.

4.1.5. Policy Options for U.S. Leadership

Accusations of treaty violation lodged by both parties largely came to light after the scheduled conclusion of routine inspections. As such, it would be challenging to unequivocally prove past violations without explicit admission from Russia, the United States, or both. Future bilateral negotiations ought to incentivize the United States and Russia to come to the table by including, if needed, discussion of the alleged past violations without requiring a party to confirm or deny past actions. By renegotiating the terms of the treaty in the context of past violation allegations, the two signing parties will be able to more explicitly define what does and does not constitute a violation, and updates to the treaty policies that each party desires. Enforcement and verification will also be facilitated by the aforementioned updated inspection terms. The following list provide two possible options for treaty renegotiation and re-signing, also summarized in Table 4.

Plan A

In Plan A, Russia is invited join the United States at the negotiation table for an opportunity to update treaty terms to account for new technology and a return to verification. To make the negotiations politically palatable, it is important that neither side is required to admit to past violations. With this caveat, the possibility of Russia returning to bilateral negotiations is promising, although the ability of the two states to come to an agreement on the complete ban of certain missile classes remains in question. Plan B may provide a more palatable option.

Table 4. Analysis of Consequences for Salvaging INF Plans A and B

		Plan A	Plan B
	Conditions	<p>Invite Russia to join negotiations, providing incentive of no admission of past wrong-doing, if needed.</p> <p>Update treaty to include new technology and renewed on-site verification terms</p>	<p>Propose an INF-style bilateral treaty that does not completely forbid missiles in the 500-5500 km range</p> <p>Places limits on number and deployment locations</p>
United States	Possible positive consequences	<p>Promotes global stability</p> <p>Limits Russian weapon types, verification to assure compliance</p> <p>Russian acknowledgement of wrongdoing and return to compliance was a goal of Obama and Trump administrations. Succeeding in this goal would receive domestic support.</p>	<p>Promotes the assessment and reassurance that U.S. national security interests are not compromised</p> <p>Helps global stability, sets some limits on Russian systems (better than no limits), verification to assure compliance</p> <p>Allows U.S. to develop missiles that compete with non-INF nations, e.g. China</p>
	Possible negative consequences	<p>Strain on U.S.-R.F. relations if Russia admits past violation</p> <p>May be viewed as weak domestically/abroad for not punishing Russian violations</p> <p>Non-INF parties can still develop INF-banned missiles, a threat to U.S. and global security interests</p>	<p>Threat of appearing weak for not punishing Russian wrongdoings, and instead rewarding it with a more accommodating treaty, thereby setting a bad precedent for future arms control agreements</p> <p>May cause tension or receive pushback from states outside of the bilateral agreement</p>
Russia	Possible positive consequences	<p>Promotes global stability</p> <p>Limits U.S. weapons types, verification to assure compliance</p> <p>Willingly renegotiating arms control agreement viewed positively and may improve relationships between Russia and other countries</p>	<p>Promotes the assessment and reassurance that Russian national security interests are not compromised</p> <p>Helps global stability, sets some limits on U.S. systems (better than no limits), inspections assure compliance</p> <p>Allows Russia to develop missiles that compete with non-treaty nations, including China</p>
	Possible negative consequences	<p>Strain on U.S.-R.F. relations if Russia admits past violation</p> <p>Non-INF parties can still develop INF-banned missiles, a threat to Russian and global security interests</p>	<p>May cause tension or receive pushback from states outside of the bilateral agreement</p>
	Plan Analysis	<p>Success probability: low. Unwillingness of either side to admit to a treaty violation.</p> <p>If successful, may set a poor precedent for future arms control agreements.</p>	<p>Success probability: medium. The U.S. runs the risk of appearing weak, there are minimal negative consequences for Russia, and it might set a poor precedent for future arms control agreements.</p>

Plan B

If an outright ban on the INF-dictated range of missiles is determined unacceptable to the U.S. and/or Russia, given changes in geopolitical and nuclear powers since the Treaty's original drafting, then an INF-style treaty that instead allows limited numbers of missiles in the 500- to 5,500-kilometer range may bring the parties to the negotiating table. Importantly, allowing limited development of previously forbidden weapons gives both Russia and the United States opportunity to counter INF banned weapons development by states outside of the bilateral INF agreement, some whose distance from the signatories are of particular relevance to the 500- to 5,500-kilometer range. As of this work's publication, the only arms control agreement still in force, New START, is based on limiting the number of deployed weapons and establishes detailed monitoring and verification procedures; mirroring these aspects of New START may be a selling point for efficient negotiation and ratification of a modified INF Treaty. Allowing for a small number of previously banned weapons may lead signing parties to propose a feasible composition of offensive arms, providing flexibility in treaty terms negotiation as well as an opportunity to incorporate new technology into the proposed limits. As mentioned above, explicit acknowledgement of past wrongdoing is likely to hamper negotiations, and ought not to be a prerequisite of a revised treaty. Given

the historical unwillingness of either side to admit to a treaty violation, and national security concerns regarding outside parties with INF-banned missiles, the probability of Plan B seems promising.

4.1.6. Concluding Remarks on Salvaging a Bilateral Treaty

The demise of the original 1987 INF treaty began following concerns over each parties' compliance and whether the treaty served the national security interests of either party. A lasting, renegotiated INF treaty will be updated with clear delineations regarding new technology and a return to on-site inspections. Signing a revised bilateral treaty will prevent New START from standing alone as the only limit on the world's two largest strategic nuclear arsenals, provide improved global nuclear stability, and improve U.S.-R.F. relations. As such, this chapter has included policy options to salvage a bilateral INF-like treaty, as would be best for global nuclear security in the short term. If these options fail, then the United States must emphasize the importance of renewing New START in 2021 and focus its energy on furthering arms control wherever else possible.

4.2. Towards a New and Improved INF

While the United States and Russia agreed to halt production and remove all ground launched missiles proscribed by the INF, other countries were able to build up arsenals of these delivery systems. The presence of multiple regional powers wielding INF-ranged systems indicates that a multilateral treaty may be necessary to prevent regional missile competition from undermining global security through arms racing.

This mechanism is evident in the U.S.-China strategic competition and its impact on those nations' force structures. In response to the presence of U.S. Naval assets in its perceived zone of influence, China has developed an extensive arsenal of INF-class missiles (Panda 2019a) to counter these assets. The presence of these systems has led to Russian claims that this creates security concerns for them. They go on to state that this is an example of why participation from additional countries in an INF-like treaty is necessary. Creation of a multilateral treaty would require additional incentives for countries to join by reducing the threat posed by other states' missile arsenals, which is a challenging proposition. Furthermore, a multilateral treaty would necessarily provide a means of communications to discuss the current security environment and address concerns individual countries may have. This is difficult when several proposed partner countries do not recognize the legitimacy of the other regimes. A serious discussion of the requirements for a multilateral treaty is needed, although this discussion is made unlikely by the current political climate.

We therefore examine the difficulties constructing a new multilateral treaty through the simplified case of the addition of China alone. As news of U.S. withdrawal from the INF Treaty broke out, China's Foreign Ministry Spokesperson released the following statement, "China is opposed to the U.S. withdrawal and urges the U.S. and Russia to properly resolve differences through constructive dialogue" (200 2002). As other countries like Germany encouraged a multilateralization treaty, the Chinese government made it clear through an official statement that they were opposed to joining the INF Treaty. One of China's primary concerns involves U.S. deployment of ground-launched missiles in Asia and U.S. missile defense capabilities if the U.S. were to withdraw from the treaty (Panda 2019b). This would trigger China to further increase their missile arsenal and accelerate development of missiles in China. It could also mean that China

would be pressured into possibly abandoning its no-first-use policy. Currently, China's military strategy consists of having nuclear and conventional missiles that would hold U.S. massed forces at risk if they were to be involved in a regional conflict, as well as targeting high-value assets like carriers. This is not only a problem for the U.S. but for their allied military power in Asia. Threats of punishment against South Korea and Japan were made to have them reconsider hosting U.S. ground-launched missiles. China warned neighboring states that they should carefully consider whether their security is dependent on improving relations with a neighbor or standing with a geographically distant ally(Stokes 2019).

China's military build-up threatens important American interests in the Pacific. Besides Chinese militarization, China claims sovereignty over much of the South China Sea. The South China Sea accounts for approximately 20% of global trade with \$3 trillion of goods transiting its waters annually. Aside from the trade, there are concerns that Beijing placed anti-ship cruise missiles on several of its artificial islands in the South China Sea, which are thought to exceed INF-compliant ranges(Brookes 2019). This means that U.S.-China relations could see the emergence of friction in strategic stability in addition to other issues such as trade, Taiwan, and maritime disputes.

Another threat for China comes from the China-Russian border. China is concerned that with the demise of the INF treaty, Russia will deploy missiles on their border with China. Russian President Vladimir Putin stated the treaty to be unsuitable for Russia since countries like China, Pakistan, and Israel possessed missile systems that are restricted by the INF(Luhn and Borger n.d.). Russia's main concerns about security include China's possession of missiles restricted by INF and their proximity to its borders while China has the same concerns when it comes to Russia's withdrawal from the INF treaty. China's current nuclear-capable short- and intermediate-range missiles are the deterrence strategy toward Russia, Japan, India, Pakistan, and North Korea. It poses a strategic threat against regional countries and U.S. military bases in Asia, Taiwan, and islands in the East or South China seas. The fact that China remains outside the INF treaty creates an asymmetry of arms control regimes that it leverages to its advantage. This is something China aims to maintain since their accession to the INF treaty would mean that over 90% of their inventory would be subject to restrictions. As a result, China is more interested in the continuation of the existing treaty instead of creating a new one. They oppose the multilateralization of the INF treaty.

Given these and other difficulties of adding a single new signatory, it is likely that roads towards a new and improved, multilateral INF-like treaty would be even more challenging to navigate. Regardless of the outcome, the development of a new multilateral INF treaty is not a short-term solution to the collapse of the original INF treaty. It is therefore recommended that the New START be renewed to preserve the arms control regime while negotiations for a multilateral INF treaty progress.

5. Conclusions and Remaining Questions

A new INF-like treaty provides the least overall ambiguity for the future of the global nuclear nonproliferation regime. However, despite our best estimate of success for implementing Plan B, success such an outcome is exceedingly unlikely, given current U.S.-R.F. relations.

Now that the United States has withdrawn from the INF treaty, New START remains as the only limit on the world's two largest strategic nuclear arsenals. If New

START is also allowed to expire, there will be no limit on U.S. or Russian nuclear weapons for the first time since 1972. Washington has, at the time of this writing, remained noncommittal on the extension of New START past its 2021 expiration date, citing concerns of novel Russian weapons systems that may not be covered by the treaty. Washington has also expressed a desire to include China in any future arms control agreements.

President Trump's statement of intent to withdrawal from the Treaty on Open Skies further demonstrates the decline of arms control between the United States and Russia. The two states have again failed to resolve noncompliance issues within the confines of the treaty, instead allowing the agreement to terminate.

In terms of the Nonproliferation Treaty (NPT), there are other significant implications involved with withdrawal from the INF, such as weakening the nonproliferation status quo. Scrapping the INF Treaty instead of addressing claims of noncompliance sets a bad precedent, demonstrating that noncompliance will lead to the abandonment of the treaty rather than actions to bring a state back into compliance. In general, arms control treaties like the INF and New START help the United States to maintain strategic deterrence. While it may be impossible to bring back the INF treaty, the maintenance of bilateral arms control more broadly is vital for strategic stability. It is too dangerous to return to U.S.-R.F. relations that feature unregulated and clandestine nuclear programs.

Because most of the issues surrounding the continuation and renewal of these nuclear arms control treaties are compliance allegations, a return to on-site verification is viewed as the most likely resolution to prevent future treaties from meeting this same fate. With fears of noncompliance lessened, the terms of the current INF can be recreated and modified according to modern needs.

That being said, the authors confess to being of two minds concerning our Options A and B above, i.e. updating the INF to account for new technology, with rigorous limits and strict verification, vs. a more flexible treaty allowing for new technology and limited numbers of missiles in the 500-5,500 km range. While rigorous exclusion of missiles within the INF range and strict verification is the ideal, the authors favor Option B which possesses some compelling advantages. First, as mentioned, from a pragmatic perspective, we see this as the most realistic path to secure an INF treaty. Second, it would mark the beginning of rebuilding of dialog and trust with the Russia Federation. Without a significant degree of trust, even the most hermetic treaty from a verification standpoint is deficient, President Reagan's famous dictum notwithstanding. Third, the deliberate porosity of Option B works in favor of both the R.F. and U.S. to maintain and develop systems responding to China's intermediate range assets. Last, in recent years, the U.S. position has driven the Russian Federation and China into a much closer mutual relationship, including joint naval exercises conducted in both the Indian Ocean, and the East China Sea and Yellow Sea. A treaty giving space to both the R.F. and U.S. to protect their own and international security interests on China's western border and maritime region could help unwind and perhaps even reverse that dynamic.

It is desirable for the United States to expand a future treaty to include more countries; China, with their entirely unregulated nuclear arsenal, is a prime candidate. However, due to China's smaller arsenal size and reliance on intermediate ranged missiles for their defense posture, multilateralization of the INF treaty is simply not feasible in the near future. Instead, a modified bilateral INF treaty is the best option to ensure strategic stability in the short-term. After initial concerns are met through smaller modifications to the treaty, the development of a multilateral INF-style treaty

that addresses the concerns of all parties is an advisable long-term goal. Until then, taking steps bilaterally with Russia, such as extending New START past its upcoming end-date and engaging in negotiations for a replacement of the INF treaty, is necessary.

Acknowledgements

The authors thank Lance Kingsbury, Scott Hart, Vanessa Goss, Nkiruka Menankiti, and Fiona Bock for their help for the initial NE-C285 class report and for the opportunity to learn and participate in nuclear security/policy offered the joint efforts of the UC Berkeley Department of Nuclear Engineering and the Goldman School of Public Policy. This material is based upon work supported by the Department of Energy National Nuclear Security Administration through the Nuclear Science and Security Consortium under Award Number(s) DE-NA0003180. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

References

- n.d. "RTL Nieuws - Onderzoek in Gori: De dood van Stan Storimans." <https://www.rtl.nl/video/530b1ab9-9bfd-4135-9969-462733c91274/>.
- n.d. "SS-26 Stone Iskander 9M72 9P78E Ballistic missile system." https://web.archive.org/web/20100725054913/http://www.armyrecognition.com/derni_res_news/bienvenue_sur_joomla__3.html.
1985. "Joint Soviet-United States Statement on the Summit Meeting in Geneva." <https://www.reaganlibrary.gov/research/speeches/112185a>.
2000. "Doctrine - Russian / Soviet Nuclear Forces." <https://fas.org/nuke/guide/russia/doctrine/intro.htm>.
2002. "Foreign Ministry Spokesperson Geng Shuang's Remarks on the US Suspending INF Treaty Obligations and Beginning Withdrawal Process." https://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/t1635268.shtml.
- 2010a. *ITAR-TASS, First Iskander system accepted for service in Leningrad mil district*. Technical Report. Moscow: Moscow ITAR-TASS.
- 2010b. *Treaty Between The United States Of America And The Russian Federation On Measures For The Further Reduction And Limitation Of Strategic Offensive Arms*. Technical Report. <https://www.state.gov/documents/organization/140035.pdf>.
- 2017a. *2017 Ballistic and Cruise Missile Threat Report*. Technical Report. Defense Intelligence Ballistic Missile Analysis Committee. <https://fas.org/wp-content/uploads/media/NASIC2017.pdf>.
- 2017b. "Military Assessment of Nuclear Deterrence Requirements." <https://republicans-armedservices.house.gov/legislation/hearings/military-assessment-nuclear-deterrence-requirements>.
2018. "Statement Of Admiral Harry B. Harris Jr., U.S. Navy Commander, U.S. Pacific Command Before The House Armed Services Committee On U.S Pacific Command Posture."
- 2019a. "Remarks by President Trump Before Marine One Departure — The White House." 4. <https://www.whitehouse.gov/briefings-statements/remarks-president-trump-marine-one-departure-18/LB-CpVh>.
- 2019b. "Report to Congress on Russian Compliance with INF Treaty." <https://news.usni.org/2019/01/21/report-congress-russian-compliance-inf-treaty>.
- Ali, Idrees, and Arshad Mohammed. 2019. "U.S. to start making parts for ground-launched cruise missile systems." <https://www.reuters.com/article/us-usa-russia-inf/u-s-to-start-making-parts-for-ground-launched-cruise-missile-systems-idUSKBN1QS1W8>.
- Bohlen, Avis T, William F Burns, Steven Pifer, and John Woodworth. 2012. *The Treaty on Intermediate-Range Nuclear Forces: History and Lessons Learned*. Brookings Institution.
- Brookes, Peter. 2019. "The INF Treaty—What It Means for the U.S., Rus-

- sia, and China Today.” <https://www.heritage.org/arms-control/report/the-inf-treaty-what-it-means-the-us-russia-and-china-today>.
- Brown, Zack. 2018. “The Helsinki Move That Could Save the INF Treaty.” <https://www.defenseone.com/ideas/2018/07/helsinki-move-could-save-inf-treaty/149862/>.
- Cant, James Farquhar. 1998. “The development of the SS-20: a case study of Soviet defence decision making during the Brezhnev era.” .
- Center for Strategic and International Studies. 2018a. “SS-25 (RS-12M Topol).” <https://missilethreat.csis.org/missile/ss-25/>.
- Center for Strategic and International Studies. 2018b. “SS-N-21 ”Sampson” (RK-55).” <https://missilethreat.csis.org/missile/ss-n-21/>.
- Center for Strategic and International Studies. 2018c. “SSC-8 (Novator 9M729).” <https://missilethreat.csis.org/missile/ssc-8-novator-9m729/>.
- Center for Strategic and International Studies. 2018d. “Tomahawk — Missile Threat.” <https://missilethreat.csis.org/missile/tomahawk/>.
- Chapman, Bert. 2018. “2018 US Nuclear Posture Review.” .
- Clinton, Hillary Rodham. 2010. “Remarks at press availability.” *Hanoi, Vietnam, July 23*. <https://www.state.gov/secretary/remarks/2019/02/288712.htmLB-cMiZ>.
- Coates, Daniel. 2018. “Director of National Intelligence Daniel Coats on Russia’s Intermediate-Range Nuclear Forces (INF) Treaty Violation.” <https://www.dni.gov/index.php/newsroom/speeches-interviews/item/1923-director-of-national-intelligence-daniel-coats-on-russia-s-inf-treaty-violation>.
- Davis, Lynn E. 1987. “Lessons of the INF Treaty.” *Foreign Aff.* 66: 720.
- Diggins, John P. 2007. *Ronald Reagan: Fate, freedom, and the making of history*. WW Norton & Company.
- Drozdiak, William. 1983. “Soviets Halt Strategic Arms Talks.” 4. <https://www.washingtonpost.com/archive/politics/1983/12/09/soviet-halt-strategic-arms-talks/5ec90e4c-8b95-4be0-9265-1e622f706176/LB-0eug>.
- Fallon, William, and Lester Lyles. 2011. *Science and Technology Issues of Early Intercept Ballistic Missile Defense Feasibility*. Technical Report. <https://apps.dtic.mil/docs/citations/ADA552472https://apps.dtic.mil/dtic/tr/fulltext/u2/a552472.pdfLB-7KmD>.
- Fischer, Benjamin B. 2007. “A Cold War Conundrum: The 1983 Soviet War Scare — Central Intelligence Agency.” 3. <https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/a-cold-war-conundrum/source.htm>.
- Forss, Stefan. 2012. “The Russian operational-tactical Iskander missile system.” *Julkaisusarja 4: työpapereita No 43* .
- Gaidar, Egor Timurovich. 2007. *Collapse of an Empire: Lessons for Modern Russia*. Brookings Institution Press. https://market.android.com/details?id=book-PPZoAAAAAAAJhttps://books.google.com/books/about/Collapse_of_an_Empire.html?hl=&id=PPZoAAAAAAAJLB-gF4F.
- Gordon R., Michael. 2014. “U.S. Says Russia Tested Cruise Missile, Violating Treaty - The New York Times.” 7. <https://www.nytimes.com/2014/07/29/world/europe/us-says-russia-tested-cruise-missile-in-violation-of-treaty.html>.
- Harahan, Joseph P. 1994. *On-site Inspections Under the INF Treaty: A History of the On-Site Inspection Agency and INF Treaty Implementation, 1988-1991*. Diane Publishing Company. https://market.android.com/details?id=book-0IktAAAACAAJhttps://books.google.com/books/about/On_site_Inspections_Under_the_INF_Treaty.html?hl=&id=0IktAAAACAAJLB-7x0a.
- Johnston, Robert. n.d. “Johnston’s Archive.” <http://www.johnstonsarchive.net/>.
- Kaplan, Fred. 1979. “Warring Over New Missiles for NATO.” *The New York Times Magazine* 9: 46ff.
- Kimball, Daryl, and Kingston Reif. 2019. “U.S.-Russian Nuclear Arms Control Agreements at a Glance.” <https://www.armscontrol.org/factsheets/USRussianNuclearAgreements>.

- Kramer, Andrew E. 2016. "Russia Calls New U.S. Missile Defense System a 'Direct Threat'." <https://www.nytimes.com/2016/05/13/world/europe/russia-nato-us-romania-missile-defense.html>.
- Kristensen, Hans M, and Robert S Norris. 2013. "Global nuclear weapons inventories, 1945–2013." *Bulletin of the Atomic Scientists* 69 (5): 75–81.
- Kubiak, Katarzyna. 2018. "The INF Treaty: European Perspectives on the Impending U.S. Withdrawal." <https://www.armscontrol.org/act/2018-12/features/inf-treaty-european-perspectives-impending-us-withdrawal>.
- Legge, J Michael. 1983. *Theater Nuclear Weapons and the NATO Strategy of Flexible Response*. Technical Report.
- Lewis, Jeffrey. 2014. "An Intercontinental Ballistic Missile by any Other Name." *Foreign Policy* 25.
- Lewis, Jeffrey. 2016. "Russia's Nuclear Paranoia Fuels Its Nuclear Propaganda." https://foreignpolicy.com/2016/08/22/russias-nuclear-paranoia-fuels-its-nuclear-propaganda/?fbclid=IwAR2E6phim21M43ezxqoR_3hmi0KoxE9_zyI0PYJUrs-E-wLlyip151-vFI.
- Luhn, Alec, and Julian Borger. n.d. "Moscow may walk out of nuclear treaty after US accusations of breach." <https://www.theguardian.com/world/2014/jul/29/moscow-russia-violated-cold-war-nuclear-treaty-iskander-r500-missile-test-us>.
- MacFarquhar, Neil. 2019. "Russia Shows Off New Cruise Missile and Says It Abides by Landmark Treaty." 4. <https://www.nytimes.com/2019/01/23/world/europe/russia-inf-cruise-missile.htmlLB-dG0q>.
- Maksimov, Evgeniy. 2020. "The INF Treaty ended in time. The wreckage of the Iskander launched from the Russian Federation fell on the territory of Kazakhstan outside the missile range, this is +620 km from the border of the Russian Federation." 1. <https://twitter.com/PararamTadam/status/1216099179677831169>.
- McCarthy, Christopher J, and U S Air Force. 2010. "Anti-access/area denial: The evolution of modern warfare." .
- Medvedev, Dmitry. 2009. "Presidential address to the Federal Assembly of the Russian Federation." *Archive. kremlin. ru* .
- Mehta, Aaron. 2019. "Watch the Pentagon test its first land-based cruise missile in a post-INF Treaty world." 8. <https://www.defensenews.com/pentagon/2019/08/19/pentagon-tests-first-land-based-cruise-missile-in-a-post-inf-treaty-world/>.
- Mosesov, Alexander. 2018. "Why Russia and the United States accuse each other of violating the INF Treaty (translated)." <https://tass.ru/mezhdunarodnaya-panorama/4816794>.
- Panda, Ankit. 2018. "The Uncertain Future of the INF Treaty." *Council on Foreign Relations* <https://www.cfr.org/background/uncertain-future-inf-treatyLB-R0R0>.
- Panda, Ankit. 2019a. "China Won't Join the INF Treaty—But Can It Forever Dodge Arms Control?" <https://thediplomat.com/2019/02/china-wont-join-the-inf-treaty-but-can-it-forever-dodge-arms-control/>.
- Panda, Ankit. 2019b. "Why nuclear arms talks between China and the US are inescapable." <https://www.scmp.com/news/china/diplomacy/article/2187188/why-nuclear-arms-talks-between-china-and-us-are-inescapable>.
- Pifer, Steven. 2019. "The blame game begins over the INF Treaty's demise, and Washington is losing." 4. <https://www.brookings.edu/blog/order-from-chaos/2019/01/25/the-blame-game-begins-over-the-inf-treatys-demise-and-washington-is-losing/LB-qQJ0>.
- Pike, John. 2018a. "R-500 Iskander-K 9M728 (SS-C-7) 3M-80MVE Coastal ASCM, GLCM, LACM." <https://www.globalsecurity.org/wmd/world/russia/iskander-k.htm>.
- Pike, John. 2018b. "RS-26 Rubezh / Avangard - Program." <https://premium.globalsecurity.org/wmd/world/russia/rs-26-program.htm>.
- Pike, John. 2018c. "RS-26 Rubezh / Avangard - Western Views." <https://premium.globalsecurity.org/wmd/world/russia/rs-26-west.htm>.
- Pike, John. 2019. "9M729 - SSC-X-8." <https://www.globalsecurity.org/wmd/world/russia/ssc-8.htm>.

- Podvig, Pavel. 2019. "Moscow shows the 9M729 missile and its launcher." *Russian Strategic Nuclear Forces* http://russianforces.org/blog/2019/01/moscow_shows_the_9m729_missile.shtml.
- Reagan, Ronald. 1985. "Address to the Nation on the Upcoming Soviet-United States Summit Meeting in Geneva." 4. <https://www.reaganlibrary.gov/research/speeches/111485dLB-DazR>.
- Reagan, Ronald. 1986. "Address to the Nation on the Meetings With Soviet General Secretary Gorbachev in Iceland." 4. <https://www.reaganlibrary.gov/research/speeches/101386aLB-ZIqw>.
- Reif, Kingston. 2019. "As INF Treaty Falls, New START Teeters." <https://www.armscontrol.org/act/2019-03/news/inf-treaty-falls-new-start-teeters>.
- Rhodes, Richard. 2008. *Arsenals of folly: The making of the nuclear arms race*. Vol. 3. Vintage.
- RIA News. 2018. "In the Federation Council told how many times the United States violated the INF (translated)." <https://ria.ru/20181204/1543475194.html>.
- RIA News. 2019. "The United States does not respond to the requirements of Russia on the MK-41, said Ryabkov (translated)." <https://ria.ru/20190131/1550168479.html>.
- Ritter, Scott. 2015. "U.S., Russia should return to on-site inspections for treaty claims." <https://www.latimes.com/opinion/op-ed/la-oe-ritter-nuclear-weapons-inspections-20150127-story.html>.
- Roser, Max, and Mohamed Nagdy. 2020. "Nuclear Weapons." *Our World in Data*.
- Russell, John. 2001. *On-site Inspections Under the INF Treaty: A Post-mortem*. Verification Technology Information Centre. http://www.vertic.org/media/Archived_Publications/Briefing_Papers/Briefing_Paper_01_2.pdfLB-zVOU.
- Service, Congressional. 2018. *Russian Compliance with the Intermediate Range Nuclear Forces (Inf) Treaty: Background and Issues for Congress*. Independent Publishing Platform.
- Sokov, Nikolai. n.d. "Russian nuclear strategy: Background, current status, future." *Center for Nonproliferation Studies presentation* www.nonproliferation.org/wp-content/uploads/2016/06/Nikolai-Sokov-Russian-Nuclear-Strategy.pdf.
- Sokov, Nikolai. 2019. "The INF Treaty Crisis: Filling the Void With European Leadership." *Arms Control Today* 49 (2): 20–24.
- Spring, Baker, and Michaela Bendikova. 2012. "The United States Must Not Concede the Russian Position on Tactical Nuclear Weapons." *Heritage Foundation WebMemo* (3491).
- Stokes, Jacob. 2019. *China's Missile Program and US Withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty*. US-China Economic and Security Review Commission.
- Stokes, Mark, and Dan Blumenthal. 2011. "Can a treaty contain China's missiles?" <http://www.washingtonpost.com/wp-dyn/content/article/2010/12/31/AR2010123104108.html?noredirect=on>.
- Stubbs, Jack, and Andrew Osborn. 2018. "Russia deploys Iskander nuclear-capable missiles to Kaliningrad: RIA - Reuters." <https://www.reuters.com/article/us-russia-nato-missiles/russia-deploys-iskander-nuclear-capable-missiles-to-kaliningrad-ria-idUSKBN1FP21Y>.
- Taheran, Shervin. n.d. "Select Reactions to the INF Treaty Crisis." <https://www.armscontrol.org/blog/2018/select-reactions-inf-treaty-crisis#IR2019>.
- Tennis, Maggie. 2017. "INF Dispute Adds to US-Russia Tensions." *Arms Control Today* 47 (5): 29.
- Tim Kelly, Nobuhiro Kubo. 2017. "Allowing nuclear weapons in Japan could defuse North Korean threat, say some policy makers." <https://www.reuters.com/article/us-northkorea-missiles-japan/allowing-nuclear-weapons-in-japan-could-defuse-north-korean-threat-say-some-policy-makers-id>
- US Department of State. 1987. "Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Elimination Of Their Intermediate-Range And Shorter-Range Missiles (INF Treaty)." <https://www.state.gov/t/avc/trty/102360.htm#>.
- Wolfsthal, Jon. 2018. "It's Not Too Late to Save the INF Treaty." <https://foreignpolicy>.

[com/2018/12/07/its-not-too-late-to-save-the-inf-treaty/](https://www.congressionalresearchservice.com/2018/12/07/its-not-too-late-to-save-the-inf-treaty/).
Woolf, Amy F. 2017. *Russian Compliance with the Intermediate Range Nuclear Forces (INF) Treaty: Background and Issues for Congress*. Technical Report.
Woolf, Amy F, and Emma Chanlett-Avery. 2017. *Redeploying US Nuclear Weapons to South Korea: Background and Implications in Brief*. Congressional Research Service.