Nuclear-Powered Cruise Missiles: Burevestnik and its Implications

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Executive Summary: In recent years the world has seen the greatest modernization of nuclear weapon arsenals since the end of the Cold War. This emergence of new weapon systems and new technologies comes at the same time that longstanding arms control agreements are faltering Much of the innovation has been coming in the form of new weapon delivery systems, promising improved range, payload, speed, and stealth capabilities. With the US, China and other countries developing hypersonic missiles and Russia pursuing nuclear powered delivery systems, the world is entering a new era of nuclear weapons. ICBMs (Intercontinental Ballistic Missiles) changed the dynamics of the Cold War with their promise of global reach in under an hour. Hypersonic missiles could cross the world in mere minutes. Recent years have seen the development of a new Russian nuclear-powered cruise missile that would be able to cause serious casualties and environment damage even without a nuclear payload.

I. Introduction

Russia's nuclear-powered cruise missile, 9M730 Burevestnik, and other similar nuclear-powered delivery system designs are a product, not a cause, of the current tense state of global affairs. Russo-American relations have reached a point of tension not seen since the end of the Cold War. Recent years have seen the breakdown of several key arms control agreements between the US and Russia, namely the Intermediate-Range Nuclear Forces Treaty (INF) and the Conventional Armed Forces in Europe Treaty (CFE). The various SALT (Strategic Arms Limitation Talks) and START (Strategic Arms Reduction Treaty) agreements that were instrumental in stabilizing the Cold War and post-Cold War order have been allowed to expire or will expire soon (Countryman 2019). During this time, Russian aggression in Eastern Europe, most notably with its annexation of Crimea and conflict in Ukraine, and its confrontational moves in information warfare, especially Russian interference in the 2016 US election, have caused concerns across the international community.

It is in this environment that Russia is looking to upend the status quo of nuclear deterrence with weapon systems that are increasingly difficult to counter or detect once launched. These delivery systems also pose a serious threat to the fragile stability of deterrence. The design of these systems means that their testing alone is incredibly threatening to people and to the environment. Their deployment would be disastrous, their use, catastrophic.

This assessment is not based on pure hypotheticals. There has already been a deadly accident that has been attributed to nuclear powered cruise missile 9M730 Burevestnik, NATO codename "Skyfall". Russia has not hidden its pursuit of this weapon, providing videos of tests and footage of its supposed construction. Nuclear powered cruise missiles are not a new concept. In the 1960s the US experimented with its own design of a nuclear-powered delivery system, but this line of experimentation was abandoned before the actual missile design was ever tested. The source material for this assessment comes from the numerous reports made after the 9M730 Burevestnik accident in August of 2019, the well documented Cold War-era US program to make a similar delivery system, and information that the Russian government has made public in recent years.

Certain assumptions have been made in this paper. As deterrence is dependent on adversaries having a solid understanding of an opponents' capabilities (Jervis 1982), it is not unusual that Russia has given such information about 9M730 Burevestnik. The information should be taken as credible, though with the understanding that it is in Russia's interest to exaggerate how far advanced the design is and how the system performs in tests. There has been no official confirmation by the Russian government that the accident in Nyonoska was the 9M730 Burevestnik. The majority of American Russia analysts and experts believe it was the 9M730 Burevestnik, and that is the official view of the United States government and of the American President (Restuccia 2019). As will be further discussed, there is significant evidence pointing to 9M730 Burevestnik as the cause of the August accident.

II. 9M730 Burevestnik and new Russian weaponry

In August of 2019, news broke of a nuclear accident in Russia sending the international community into a state of concern and speculation. On August 8 of 2019 the Russian Defense Ministry put out statement saying that that day a liquid-propellant rocket engine blast had caused the death of two scientists and had injured six but that no radiation had been released This deadly accident occurred at Nyonoska test site, in Northern Russia, that has been used since the 1950s for missile testing by the Soviet and then Russian navy (Isachenkov 2019).

Two days later, Rosatom's, Russia's nuclear agency, first statement on the accident stated that five Rosatom scientist had died during work on a "an isotope power source in a liquid-propulsion system" (Scollon 2019). The death toll would rise to seven and the Kremlin would attribute the accident to a "nuclear-propelled missile" (Webb 2019). Rosatom would go on to say that the test was conducted from a sea platform and to say that it involved a "nuclear battery" (Rudnitsky and Arkhipov 2019).

There is strong consensus amongst US intelligence officials that the August accident most likely involved the testing of the 9M730 Burevestnik (RFE/RL 2019). The NATO codename for this weapon is "Skyfall." Skyfall is a Russian military missile project that came to the attention of the broader international community in Vladimir Putin's 2018 State of the Nation (Putin 2018). President Putin used this address to unveil the next phase in Russian defensive and offensive posture in anticipation of continued tensions with the United States. In the address, President Putin discussed a pair of nuclear-powered nuclear weapon delivery systems, Poseidon and Burevestnik, alongside other innovative weapon systems, including a hypersonic glider "Avangar" and a nuclear missile that can be launched from the seabed. Poseidon is a nuclear-powered torpedo that could be released from a submarine and cross the ocean to hit a US navy base or a coastal city (Peck 2019). This nuclear torpedo has been rumored for a long time, after a strategic leak by the Kremlin in 2015, where a diagram of Poseidon (then named Status 6) appeared in news broadcast capturing President Putin's meeting with his generals. However, it is Burevestnik that has come to the attention of the public more recently. The project involves an airborne nuclear-powered missile, which would be able to fly at low altitudes, allowing it to evade missile defense, a goal helped by the fact that it would also fly at less predictable trajectories, from less obvious approaches, than ICBMs (Smith 2019). This missile would be able to carry a nuclear weapon payload and would have a much greater range than existing systems as the nuclear engine would power it for longer than conventional fuel (Roblin 2019).

III. Motivations in pursuing nuclear-powered delivery systems

Russia has historically had high risk -tolerance when it comes to nuclear weapons and nuclear technology. This willingness to take high risks is enabled by the state's control over the media and scientists, making it difficult for unflattering information to leak out and making it easy to control a narrative for domestic audiences when accidents occur (Vitkovskaya 2016). The post-Soviet Union defense industry landscape has also had a significant influence on Russia's rollout of new technologies. Expensive and unconventional weapon systems are pitched to Russian defense leaders as necessary by the Russian defense industry so as to push the government towards greater military spending. Hostile relations with the West and the perceived need to bridge the parity gap with the US are often used as justification for increased defense spending. These proposed systems are often based on old technologies or plans from the Soviet era, and while grand in theory, they often prove to be incredibly costly and difficult to produce in actuality (Cooper 2018).

The perceived gap with the US is mainly based on longstanding Russian concerns about Missile Defense and US Global Strike Capability reducing Russian deterrence. Although the US left the Treaty on Anti-Missile Defense in June 2002, Russian fears of US missile defense date back to days of the Soviet Union and Reagan's embrace of the Strategic Defense Initiative, which looked to create a missile defense system of space lasers and ground and space-based missiles to take out incoming enemy missiles (US Department of State 1983). More recent US initiatives in pursuing global strike capabilities have also concerned the Russians (Boese 2008). US Global Strike Capability is the ability pursued by the US to conduct precise conventional strikes anywhere in the world within an hour—the reach of ICMBs but with conventional weapons.

It is clear from public statements (such as the 2018 State of the Nation) that the Russian military and Vladimir Putin are interested in pursuing doomsday weapons that can stay in the air or sea for prolonged periods of time. These types of weapons ensure true second-strike capabilities: the ability to retaliate after having absorbed a nuclear strike. These weapons also provide other significant strategic advantages. Undetectable delivery systems like Poseidon and Burevestnik provide the Russian military with plausible first strike capabilities. These capabilities exist when a state can attack an opponent and take out their ability to strike back, which is facilitated by systems that evade detection so as to reduce the chance of launch under attack. Burevestnik and Poseidon take aim at any US confidence in missile defense. Though there is general agreement that US missile defense is unable to promise protection (Burbach 2019) from a nuclear attack, in a world with Burevestnik even those most convinced of the protection provided by missile defense must acknowledge that it is not infallible. This means that the US has no choice but to accept that missile defense will not protect from a Russian strike, which in the eyes of Russia, increases deterrence. However, these weapons cannot be said to be stabilizing. The aim of Burevestnik and her sister weapons is to eliminate early warning, so that an opponent lacks the time or opportunity to retaliate fully, or even at all. When other countries know that there is so little time, rash decisions must be made, which can prove devastating in the case of false alarms.

IV. The difficulties of engineering Burevestnik

It is incredibly difficult to make nuclear engines to power a cruise missile. According to Russian military experts, there have been fourteen suspected tests related to Burevestnik, with each ending in failure. President Putin has claimed that Burevestnik would be able to reach hypersonic speeds, which would most likely require a nuclear-powered ramjet engine (though this would probably bring the speed to Mach 4, just under hypersonic speed) (Scollon 2019). Given that this type of engine has never been mounted on a missile and tested, there are serious obstacles to its development and deployment. A ramjet engine on a missile would pull in cool air, expand it with heat generated by the nuclear reactor and use that expanded air to propel the missile.

V. A Cold War parallel

A nuclear-powered cruise missile is not a new invention. In the 1960s, the United States explored the development of a similar missile in a top-secret program called Project Pluto. Project Pluto was focused on the creation of a missile known as SLAM – Supersonic Low Altitude Missile. The project was undertaken at Lawrence Livermore National Laboratory (then Lawrence Radiation Laboratory). The design featured a rocket booster for the initial launch after which propulsion would be taken over by a ramjet engine. The low altitude part of the name came from the fact that the missile would fly at around 1000 ft of altitude, with the aim that it would fly under radar and evade detection. SLAM most likely would have been used in the worst-case scenarios of nuclear war; it carried fourteen to twenty-six nuclear warheads which it could drop at different parts of its flight path. It would have a preprogrammed flight path to drop the bombs and after dropping the last one, it would crash itself into the final target (Mizokami 2019). However, SLAM was deemed too dangerous to test, due to risk of putting a nuclear reactor on a missile. Though no test of SLAM was ever conducted, in 1961 enough progress had been made on the nuclear ramjet engine that a test was planned. Since the engine was so volatile and testing it in the air was deemed too dangerous for fear of crashing, it was put on a rail car for testing. A first test ran the engine for only few seconds, while a second test was able to run the ramjet on the train car for five minutes. The tests showed a functioning engine but the risks of placing it on a missile and the dangers associated with the system would lead the US government to shut down the program (Krzyzaniak 2019).

Other major issues confounded the American efforts in Project Pluto. Designing a nuclear reactor that can bear the stresses put on it by being placed on a cruise missile is challenging. A nuclear reactor on top of a cruise missile would have to contend with extreme variations in pressure over the body of the reactor, with high pressure at the front and low pressure at the back as the missile takes off and enters the upper atmosphere. The stresses of flight, extremely high temperatures needed for the nuclear reaction, and the rapid heat loss due to air stream cooling of the reactor represent challenging design and construction problems. Project Pluto sought to fulfill these requirements by designing and building a 500-megawatt nuclear reactor that could withstand over 2,500 degrees Fahrenheit when in operation (Tucker 2019).

VI. Implicit flaws and operational instability

In a system so complex, so tightly coupled and so small in scale (relative to a normal nuclear reactor), there is no way to mitigate operational accidents. This creates a product that is prone to accidents, yet any malfunction would most likely not be seen as problems as long as they occurred on enemy territory. This is not a missile that is designed with precision in mind, rather, it is a doomsday weapon. Though the path would be preprogramed as it flew across enemy territory, everything in its path would be destroyed or irradiated. By embracing a delivery system that is so devasting in its design, it is clear that the concern is not mitigating human and environmental casualties. The value of this doomsday missile would be its instability. In a war, its failure could be as devastating to the enemy as its success.
However, as has been shown in other high profile Russian military technologies (Gady 2020), expensive Russian hardware is never manufactured in large amounts, just enough to create an atmosphere of fear and raise the stakes of confrontation. It is highly unlikely that the world will ever see a fleet of Burevestniks, but one is enough to cause a lot of damage. This a weapon that cannot be tested without serious damage to the environment and people (as seen in the deadly August test). A failed test can lead to casualties but so can a successful one.

VII. The risk to the global order and potential solutions

There are no easy solutions to this concerning proliferation trend. There is an implicit perilousness in running a delivery system that also works as a dirty bomb. There are also proliferation concerns. It is possible that the world could see other countries pursue these weapons in order to preserve parity. This would be incredibly consequential for the global population and the environment. The testing of one such weapon causes enough damage. If other nuclear powers were testing these weapons, it would be a serious environmental and human health concern. If a reactor on a missile were to explode, a missile test would quickly have the ramification of a nuclear test. Even without an accident, radiation is released. One cannot expect other countries to realize the danger and refuse to test in the air, like the US did with Project Pluto. Russia has already flouted this safety concern.

In an ideal world, arms control agreements would be drafted or amended to address this new technology. A clause could be appended to the Nuclear Test Ban treaty to specifically ban the testing of military systems involving nuclear reactions. A discussion should be had over whether a nuclear-powered missile carrying a conventional weapon should be considered a nuclear weapon. Given that these usually consist of a self-destructing finale, they should be considered as nuclear weapons (or at minimum, radiological weapons) even when equipped with a conventional warhead. There should at the very least be arms control discussions about this threat. There should be a stated international goal to limit proliferation of like systems. One can imagine a non-nuclear power developing such a system and claiming it does not count as a nuclear weapon as long as it carries a conventional warhead and thus claim compliance with the NPT.

There are several arms control agreement options. Clauses could be appended to the Nuclear Test Ban treaty or to the NPT to specifically ban the testing and deployment of military systems involving nuclear reactions. A separate treaty could be drawn up, ideally including Russia, the US, and other countries pursuing hypersonic missile technology (notably

China, France, and India) to prevent this trend from spreading. It is concerning enough that Russia, with its inadequate safety record when it comes to nuclear accidents, is embracing this technology. It would be downright alarming to see this trend move to countries like North Korea, with no safety standards and even greater risk tolerance, or to regions with countries on the brink of war, like India and Pakistan.

However, the appetite for arms control has waned in recent years, in both Russia and the United States. As has been previously mentioned, under the current administration the United States has pulled out of a series of arms control agreements and there is little to indicate continuing Russian interest. President Putin has made a point of testing missiles banned by the INF (Collina, n.d.), which in part led to its dissolution. Additionally, a US push for an arms control on nuclear powered delivery systems would likely lead to a Russian demand to include missile defense in the agreement, which would face stiff opposition in the US Given open source information and government denials it appears that US has no nuclear-powered delivery system to barter. Arms control has to have limitations on both sides, no country would agree to an agreement that imposes restrictions on them and not other parties in the agreement. It is highly unlikely that the US would barter missile defense for a cruise missile that will likely not be operational for many years, if ever. A broader global initiative to ban these weapons, or at least their testing, would reduce the bilateral Russo-American conflict. Unless these global concerns about the environment and human costs of these weapons are translated into arms control agreements or policies to avoid proliferation, there are going to be technologies with nuclear weapon consequences that are not constrained or even addressed by the current nuclear order.

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