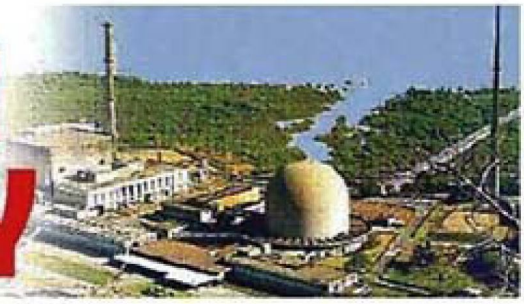
NUCLEAR SECURITY



A FORTNIGHTLY NEWSLETTER ON NUCLEAR DEFENCE, ENERGY AND PROLIFERATION FROM CENTRE FOR AIR POWER STUDIES

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OINNION – Tara Kartha

Pakistan's Shaheen II Test an Attempt to Project Strength, but Fails to Account for Post-Balakot Realities

With the results finally in, and congratulatory messages pouring in from all over the world, exhausted politicians and their supporters are likely to take a while to discern some notable developments next door. Not that at least one wasn't really 'in your face'. But the point is the assessment of all the obvious and the not so obvious issues that are like to arise, and soon.

The first was the obvious test of a two stage Shaheen II missile, said to be 'Medium Range' of 1,500 kilometres and based on a Chinese design. That missile can cover most of India, and unless Pakistan is looking to hit Turkey, that's all the range it needs to make it into a strategic weapon. Missile tests are usually planned well in advance with notices issued for all flight activity and ships in the vicinity. Pakistan had, at any rate, extended the over flight ban till end May, apparently as a cautionary measure till the end of elections.

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But the firing of this missile into the Arabian Sea, just a day before elections were to end seems to be far too much of a coincidence. The press release issued by Major General Asif Ghafoor DG (ISPR) carefully mentioned that the missile could carry both "conventional and nuclear warheads" which is an interesting point. Apparently, Islamabad wants to convey that it is ready to use these missiles during war: a fallout of the story run by Reuters that India was planning to launch some six missiles at Pakistan, and that Islamabad threatened to launch three times as many. That story quoted "sources" in Islamabad, including a western diplomat. Clearly there are some 'strategic' moves being made here, by not just Pakistan, but also others.

A second development was the appointment of a new high commissioner, Moin-ul-Haq, to New

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Delhi just recently. Not just that, the outgoing High Commissioner Sohail Mahmood has been elevated to foreign secretary. The New Delhi post is a coveted one, despite or probably because of the difficulties attached to it. Unsurprisingly, past high commissioners generally went on to become foreign secretaries. Riaz Khokkar and Salman Bashir come readily to mind, while others were favoured political appointees.

What is the likely deliverable of a resumption of talks? Certainly files of more than a decade ago — when the "composite" talks last took place — can be dusted off and pored over. The composite dialogue at the time had a 'basket' of issues to be discussed, which included among other confidence building measures, an end to terrorism and the Kashmir issue.

The outgoing ambassador would certainly have had enough opportunity to showcase his ability to defuse the volatile situation. Just weeks after being summoned to the Foreign Office in Delhi and issued a demarche, Pakistan was making specific gestures to bring down tensions. It quickly announced its intention of releasing some 360 prisoners, most of whom are fishermen. That kicked off on 7 April, with these catspaws to a bilateral game being sent back through Wagah.

Prime Minister Imran Khan was considering appointing a new national security advisor to resume back channel diplomacy. Earlier, under Nawaz Sharif, Lieutenant General Naseer Janjua as NSA held several rounds of quiet dialogue with his counterpart Ajit Doval. It seemed that the Pakistani prime minister was serious about talks, since getting the army to talk to the (entirely civilian) establishment in New Delhi was vital.

And two weeks after the terrorist strike, the two sides were talking about the modalities of setting up the corridor between Kartarpur in Pakistan and Gurdaspur in Punjab. All this despite the posturing and clamour was continuing on social media as well as on election platforms. Islamabad simply walked around the Pulwama strike and came up with a passage to Delhi. The Rashtriya Swayamsevak Sangh could not have been more nonplussed.

The outgoing ambassador did not leave without a cue to this successor. In his final interaction with Indian media he noted, "Sustained engagement and structured dialogue would enable the two countries to understand mutual concerns and differences, resolve outstanding disputes and build the edifice of durable peace, security and prosperity in the region." This diplomatic mouthful is supposed to indicate that Pakistan wants to restart engagement whatever the odds. It will be the new ambassador's job to make that push palatable. That's not going to be easy.

Apart from the fact that the recent elections focused rather heavily on Pakistan and its terror tendencies, the bureaucrat sitting in the foreign ministry is ask a fundamental question: what is the likely deliverable of a resumption of talks? Certainly files of more than a decade ago — when the "composite" talks last took place — can be dusted off and pored over. The composite dialogue at the time had a 'basket' of issues to be discussed, which included among other confidence building measures, an end to terrorism and the Kashmir issue.

In the four years that this dialogue took place (2004 to 2008) a rather surprising number of issues were successfully dealt with, including the beginning of the train and bus service, revival of long extinct trade routes, and the setting up of a judicial commission to look into the humanitarian issues with respect to the arrests of fishermen and other civilians. The whole was pulled up short by the Mumbai attacks of 26 November, 2008. That was the end of the formal talks. During the UPA period, a second track dialogue took place intermittently to no discernible effect. Now it seems the decks are being cleared — in Pakistan — for a fresh dialogue process with India.

Into this comes another report and a rather quick denial. On 19 May Pakistani media reported that Prime Minister Imran Khan was considering appointing a new national security advisor to resume back channel diplomacy. Earlier, under Nawaz Sharif, Lieutenant General Naseer Janjua

as NSA held several rounds of quiet dialogue with his counterpart Ajit Doval. It seemed that the Pakistani prime minister was serious about talks, since getting the army to talk to the (entirely civilian) establishment in New Delhi was vital.

Two days later, however, another rather curious report not only denied that any NSA was being appointed, but also chose to state that the entire NSA apparatus had been dismantled, with its 27 or so officials repatriated back to their units or cadre. Whether this means that the Pakistan Army is refusing to get involved in the talks, or whether it is Imran making a push for independence in foreign policy is unclear. It could equally be that the army is letting the civilian government do the talking, while they pull the strings from behind. It could even be a little of all three.

So here's the thing. Pakistan is undoubtedly girding itself for talks, with the missile test intended to send a signal of resolve and strength. Or so it thinks. The new government under a revitalised BJP is likely to view that with annoyance. Modi is not one who likes grandstanding in others. Second, talking to Pakistan means investing political capital rather heavily, and no politician — however barrel-chested — want to go on a risky path, when he has so much more on his plate.

Third, a spanking new foreign secretary and high commissioner however well intentioned, can't inspire confidence unless there is a definite signal of the army's acquiescence. That's the reality. Else, it will be partial walk back to another phase of desultory talks, followed by the inevitable terrorist attack: with one difference.

The Balakot strikes pushed the force envelope to a new frontier. Any talks have to deal with the reality of that new line in the snow. The Pakistani Army knows this. But for dialogue to start, it needs to find a way to communicate this to India. In simple words, Pakistan has to acknowledge that things have changed, and deal with it: and not use missiles as flag bearers. That calls for a rare degree of diplomacy not seen yet. One can but hope.

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Source: https://www.firstpost.com, 25 May 2019.

OPINION – Aaron Miles

Is the Air Force Really Testing an 'Earth-Penetrating' Nuclear Bomb?

Eryn Macdonald repeated the stubbornly persistent misconception that the Air Force is developing a new earth-penetrating nuclear bomb. Similar analysis last summer followed a drop test of the B61-12 nuclear bomb—or "mod 12," meaning twelfth modification or variant—from a stealth bomber. Drop tests verify the operation of various weapon subsystems, but do not include the nuclear components. The Defense and Energy Departments are developing the B61-12 to replace several old B61 variants that are slated for retirement, but the new weapon is not an earth penetrator.

Currently, the United States deploys four B61 variants. The B61-7 is considered a strategic weapon because it is carried by the B-2 bomber and can, therefore, travel intercontinental distances. Two nonstrategic variants are carried by shorter-range fighter aircraft and are deployed in Europe as part of the U.S. security commitment to NATO. The fourth existing variant, the B61-11, does actually possess an earth-penetration capability, and in this respect is unique within America's nuclear deterrent force.

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The misperception that the B61-12 will also be an earth penetrator took root with a 2016 article that Hans Kristensen and Matthew McKinzie published shortly after an earlier drop test. Video footage from the test shows the bomb impact a dry lake bed in the Nevada desert. Rather than bouncing or fragmenting in any way that is visible to the camera, the bomb disappears into the soft ground. Based on this footage, Kristensen and McKinzie concluded that the new variant is an earth-penetrating weapon designed to go after underground targets.

It is true that a pointy metal object will tend to bury itself in the dirt when dropped from an airplane. However, that does not mean that its internals are capable of surviving the impact. Analogously, the fact that the bomb would sink if dropped into the ocean does not imbue it with anti-submarine capability. Designing and building an earth-penetrating bomb is a challenging engineering endeavor that requires special measures. In particular, such weapons generally incorporate an extra heavy case to shield electronics and explosives until they penetrate below the surface and reach the requisite depth. The weight of such a case may be hundreds or even thousands of pounds. For example, the penetrating B61-11 weighs more than 400 pounds more than the non-penetrating B61-7. According to the NNSA, which manages nuclear warheads for the DoE, the new B61-12 weighs about 825 pounds. This is quite close to the weight of the non-penetrating B61-7 (about 760 pounds), and still more than 400 pounds less than the penetrating B61-11 (about 1245 pounds).

The Defense and Energy Departments have been fairly open about the actual purpose and role of the modernized B61-12. Some of the older variants include components that have been in the stockpile since the 1960s, and without replacement, all will become too old to remain reliable. Following the Cold War, the United States eliminated all of its nonstrategic nuclear weapons except for the B61. Modernizing the B61 is therefore critical to ensuring that the United States can still deploy nuclear weapons abroad as a tangible element of its nuclear umbrella. Extending deterrence in this way serves not only to defend America's allies in Europe and Asia, but also to help assure them that they do not need to develop nuclear weapons of their own.

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The Obama Administration developed a warhead modernization plan under which the B61-12 would eventually become the only nuclear gravity bomb in the U.S. stockpile. This required giving it greater accuracy so that it can fill the role of existing variants with higher as well as lower explosive yields. Greater accuracy offsets lower yield because a bomb that can get closer requires a smaller explosion to destroy its target.

The B61-12 cannot, however, replace the B61-11 because fulfilling that role would require an earth penetration capability. For years, official reporting and documents carefully noted that the B61-12 will consolidate and replace all existing variants except for the earth-penetrating B61-11, but that the United States would also retire the B61-11. More recently, the Trump administration's 2018 Nuclear Posture Review left the door open to delaying the retirement of the B61-11 precisely because it provides a capability that the B61-12 does not.

As both the Obama and Trump administrations have explained, the B61-12 is necessary to sustain a gravity bomb in the U.S. nuclear deterrent force.

However, the new variant is not an earth penetrator and therefore cannot deliver all the capability that existing variants afford. Sustaining such a capability benefits deterrence, but relying on other means of holding hard and deeply buried targets at risk might nonetheless be preferable. If America would be better off without an earth-penetrating nuclear bomb, then the B61-12 is not the problem. If earth penetration capability is worth retaining, then the upgrade now underway is not the solution.

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Source: https://nationalinterest. org, 18 May 2019.

OPINION – Sebastien Roblin

Step Aboard USS United States: An Aircraft Carrier with Nuclear Armed Bombers

In the wake of the mushroom clouds that blossomed over the Japanese cities of Hiroshima and Nagasaki, it swiftly dawned on political and military leaders across the globe that warfare between superpowers would never again be the same. But what exactly were the implications of nuclear weapons when it came to planning military force structure?

The Air Force touted it soon-to-be operational fleet of ten-thousand-mile-range B-36 Peacemaker nuclear bombers as the only vital war-winning weapon of the nuclear age. This logic resonated conveniently with the postwar political program mandating sharp cuts to U.S. defense spending and force structure—which the Air Force naturally argued should fall upon the Army and Navy.

In the United States, it was assumed that nuclear weapons would be widely employed in future conflicts, rendering conventional land armies and fleets at sea irrelevant. The newly formed Air Force particularly argued that carrier task forces and armored divisions were practically obsolete when (ostensibly) just a few air-dropped nuclear bombs could annihilate them in one fell swoop.

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The Army responded by devising "Pentomic Divisions" organized for nuclear battlefields, with weapons ranging from nuclear-armed howitzers and rocket artillery to bazooka-like Davy Crockett recoilless guns. The Navy, meanwhile, sought to find a way to integrate nuclear bombs into its carrier air wings. However, early nuclear bombs were simply too heavy for World War II-era carrier-based aircraft.

In 1945, the Navy began commissioning three larger forty-five-thousand-ton Midway-class carriers which incorporated armored flight decks for added survivability. The decks were swiftly modified to angular, effectively lengthened configuration for jet operations. Neptune P2V-C3 maritime patrol planes converted into nuclear bombers could take off from Midway-class carriers using rocket-pods but would have no way landing on the carrier deck.

Therefore, the Navy decided it needed huge supercarriers from which it could operate its own fifty-ton strategic bombers. These would displace over 40 percent more than the Midway at sixty-eight thousand tons, and measure 12 percent longer at 330-meters. In July 1948, Defense Secretary James Forrestal approved plans for five such carriers, the first named USS United States with hull number CVA-58.

The naval heavy bombers (which didn't exist yet) were expected to have such wide wings that naval architects decided that CVA-58 would have a completely flush deck without the standard "island" superstructure carrying a radar and flight control tower. Instead, the carrier would feature side-mounted telescoping smokestacks that could be raised should smoke impeded flight operations, and a similarly retractable wheelhouse that could be extended to observe navigation and flight operations.

The ship's air wings would include twelve to eighteen heavy bombers that would mostly remain parked on the flight deck, exposed to the elements. Four side-mounted elevators would ferry forty to fifty-four jet fighters between the hangar and flight deck to escort the bombers. Eight nuclear bombs per heavy bomber would also be stowed in the hangar. The combined ship's company and airwing would total 5,500 personnel. The carrier's oddly-shaped deck included four steam catapults—two for use by bombers, and two axial "waist" catapults. Because the ship would be effectively blind without an elevated radar and control tower, a separate cruiser was intended to serve as the carrier's "eyes." Nonetheless, CVA-58 still incorporated eight 5-inch guns for air defense, and dozens of rapid-fire short-range cannons.

The "Revolt of the Admirals": Though theoretically capable of contributing to conventional strike and sea control missions, the heavy bomber-equipped CVA-58 was clearly an attempt by the Navy to duplicate the Air Force's strategic nuclear strike capabilities. This put giant crosshairs on the program during an era of sharp defense cuts. Following his reelection in November 1948, President Harry Truman replaced Forrestal—a naval aviator in World War I, and former secretary of the Navy—with Louis Johnson, who had fewer qualms about enforcing defense spending cuts.

In April 1949, just five days after CVA-58's fifteen-ton keel was laid down in Newport News, Virginia, Johnson canceled the mega-carrier. He also began advocating dissolution of the Marine Corps, starting by transferring its aviation assets to the Air Force strategic bombers at sea was many times more expensive than basing them on land. This upset the Navy bigwigs so much that Navy Secretary John Sullivan resigned, and numerous admirals began openly opposing the termination of a project they viewed as essential to validating their branch's existence in the nuclear age.

This "Revolt of the Admirals" developed into a crisis in civil-military relations, as the Navy's top brass defied the authority of their civilian commander-in-chief and resorted to covert methods in an attempt to influence public opinion. The Op-23 naval intelligence unit formed by Adm. Louis Denfeld secretly circulated a memo called the Worth Paper alleging that Johnson had corrupt motivations due to being a former director of Convair, manufacturer of B-36 bombers, which were also claimed to be deficient. The bitter inter-service rivalry, and the utility of land-based bombers versus carriers, was publicly litigated in congressional hearings. The Army also piled on against the Navy, and public opinion turned against the sea-warfare branch as Op-23's activities were revealed.

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As Gen. Douglas MacArthur would later discover, Truman had no qualms about squashing military leaders that questioned his authority. His new secretary of the Navy, Francis Matthews, torpedoed the career of several admirals that spoke against the CVA-58's termination despite an earlier promise that those testifying before Congress would be spared retaliation. The irony of this tempest in a teacup, which resulted in the political martyrdom of many senior Navy leaders, was how misguided both sides swiftly proved to be.

In June 1950 the Korean War broke out, and the U.S. found itself desperately short of the necessary conventional land, air and sea forces. U.S. aircraft carriers and their onboard jet fighters soon bore the brunt of the initial fighting, and continued to play a major role until the end of the conflict. And the Air Force's vaunted B-36s? They never dropped a single bomb in anger—fortunately, as they were only intended for use in apocalyptic nuclear conflicts. It turned out that plenty of wars were liable to be fought without resorting to WMD.

However, the Navy also had cause to count itself fortunate that the CVA-58 had been canceled. That's because in just a few years the size of tactical nuclear weapons rapidly decreased, while high-thrust jet engines enabled hauling of heavier and heavier loads. By 1950, nuclear-capable AJ-1 Savage hybrid jet/turboprop bombers were operational on Midway-class carriers, starting with the USS Franklin Roosevelt.

These were soon followed by nuclear-capable capable A-3 Sky Warrior and A-5 Vigilante bombers, A-6 and A-7 attack planes, and even multirole fighters like the F-4 Phantom II. Carriers with these aircraft were far more flexible than a CVA-58 full of B-36 wannabees ever could have been. Arguably, by the 1960s the Navy's ballistic missile submarines would amount to a scarier strategic nuclear weapons than any aircraft-based delivery system.

The schematics for CVA-58 nonetheless informed the Navy's first supercarriers, named rather appropriately the Forrestal-class, laid down during the Korean War. But the heavy-bomber carrying United States remains notable as the supercarrier the Navy absolutely thought it needed—but which with literally just a couple years more hindsight it discovered it truly could do without.

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Source: https://nationalinterest. org, 25 May 2019.

OPINION – Tsvetana Paraskova

Rare Earth Metals: China's 'Nuclear Option' in the Trade War

A simple visit to an obscure factory by Chinese President Xi is all it took to raise the specter that China could be contemplating cutting off supply of critical materials to the US and potentially crippling large swathes of its industries. Also, fueled by political innuendo in Xi's recent call for a new "Long March" in reference to a key founding tenet of the Chinese Communist Party, speculators are growing increasingly wary of Chinese export restrictions to the U.S., including rare earth minerals. As the world's largest producer, the Middle Kingdom has a vice-like grip on rare earths supply.

China produced more than 90 percent of the world's supply of these critical elements over the past decade, though its share was lower at 71.42 percent last year. In 2018, the U.S. Geological Survey identified 35 minerals critical to the country's economy and national security. America is heavily dependent on imports of these minerals, producing less than a tenth of the world's supplies and importing half of what it consumes.

Rare earth minerals, also known as the "vitamins of chemistry", are a group of elements used in the manufacture of a wide range of equipment in small doses to produce powerful salutary effects. These minerals are extensively used in smartphones, batteries, turbines, lasers, electromagnetic guns, missiles, advanced weapon sensors, stealth technology and jamming technology. For instance, lanthanum is used in lighting equipment and camera lenses; neodymium in hybrid vehicles; praseodymium in aircraft engines; europium in nuclear reactors and gadolinium in MRIs and X-rays. Oil refiners also use rare earth catalysts to process crude oil into gasoline and jet fuel. China produced more than 90 percent of the world's supply of these critical elements over the past decade, though its share was lower at 71.42 percent last year. In 2018, the

U.S. Geological Survey identified 35 minerals critical to the country's economy and national security. America is heavily dependent on imports of these minerals, producing less than a tenth of the world's supplies and importing half of what it consumes. It clearly highlights the U.S.' soft underbelly. Not surprisingly, rare earth minerals are some of the few products that escaped Trump's latest tariffs.

What's the Big Deal?: President Trump's executive order banned Huawei, China's largest tech company, from doing business with U.S. companies might be the final straw that forces the Asian nation into sterner action (though Huawei did get a stay of execution for 90 days). Once again, Beijing has been dealt a strong geopolitical hand and it's probably going to weigh the weapons in its arsenal that it can use to hit back—and rare earths are some of the most powerful. As usual, Beijing has maintained a deafening silence on the matter, letting its animated states media do most of the talking: "It is normal that the top leader investigates relevant industrial policies. I hope everyone can interpret it correctly." Meanwhile, the *Global Times* has gloated, "U.S.' need of rare earths is an ace on Beijing's hand". At this point it's still merely speculation, but supposing the worst actually happened and Beijing went for the so-called "nuclear option"? In the short-term, things would get pretty murky for hordes of U.S. industries.

As cited by Reuters, Ryan Castilloux, founding director of strategic metals consultancy at Adamas Intelligence, says that autos, renewable energy, defense, and technology would all suffer. There are no hard figures available yet for the extent of economic damage, but the consensus seems to be that if China turns off the tap of critical materials it would directly affect large chunks of the U.S. economy.

It would essentially be like dialing the tech industry a few decades back. It's only natural to wonder why the United States has left itself exposed this way. Actually, the country was the biggest producer of rare earths from the 1960s to the 1980s at its Mountain Pass mine in California. The processing plant was shut down on environmental concerns in 1998 and the entire site was mothballed in 2002 to keep in toxic wastewater. In short, the country's position has been: rare earths mining is a costly, messy, and dangerous affair; why not let someone else do it? To make matters even worse, the U.S. mine still relies heavily on Chinese firms for processing—again due to environmental concerns.

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An Ace in Beijing's Hand?: Not everybody is on the same page, though, with some experts unconvinced that the chilling scenario described here would necessarily unfold that way. Tim Worstall, a former rare earths trader, told the Verge that a China embargo would only lead to temporary pain for the United States, which it would be able to solve before too long. Critical operations like military and defense likely have more than enough stockpiles to outlast such a ban. It turns out that not all rare earths are that rare, with USGS (United States Geological Survey) classifying 17 of those elements as "moderately abundant" with significant deposits in the United States, Canada, Brazil, India, and Australia. The major problem for the U.S. would not be lack of those resources per se, but how quickly it can ramp up production at its existing facility—and possibly scale up.

In 2010, China cut off exports of rare earths to Japan, yet the island nation was none the worse for wear. That's because prices skyrocketed, thus encouraging Chinese smugglers to devise schemes to deliver the goods off the books. Meanwhile, production in other regions rapidly ramped up while Japanese manufacturers worked out ways and means of using less of the materials.

Eugene Gholz, an associate professor the University of Notre Dame and a rare earth expert, also told the Verge that a similar spat between China and Japan offers valuable lessons. In 2010, China cut

off exports of rare earths to Japan, yet the island nation was none the worse for wear. That's because prices skyrocketed, thus encouraging Chinese smugglers to devise schemes to deliver the goods off the books. Meanwhile, production in other regions rapidly ramped up while Japanese manufacturers worked out ways and means of using less of the materials. That might have been nearly a decade ago, yet the U.S. would probably fare even better given the even larger scale of economic integration across the globe.

Source: https://oilprice.com, 26 May 2019.

OPINION – Tyler Cowen Bloomberg

Nuclear War is Still Very Possible and Very Scary

One of the most striking facts of today's world is that young people do not seem to worry very much about nuclear war. Climate change is by far the larger concern, while nuclear war is seen as a threat of the past. As Chapin Boyer, who is in his late 20s, wrote in the *Bulletin of the Atomic Scientists* a few years ago: "I cannot remember a time when the threat of nuclear weapons seemed real. ... My generation grew up believing that the problem of nuclear weapons had been solved." In contrast, I am inclined to think that the risk of nuclear war remains the world's No. 1 problem, even if that risk does not seem so pressing on any particular day.

So what about nuclear war? Looking forward, the reality is that the risks of such a war are quite small in any particular year. But let the clock run and enough years pass, and a nuclear exchange of some kind becomes pretty likely. I have found that people with a background in financial market trading are best equipped to understand the risks of nuclear war.

In the 1950s and '60s, fears of nuclear war were palpable. In 1951, the president of Harvard wrote a letter to his 21st-century successor. "There are many who anticipate World War III within the decade," James B. Conant wrote, "and not a few who consider the destruction of our cities including Cambridge quite possible." It turned out such views were too pessimistic, perhaps overly influenced by still-fresh memories of two earlier world wars. But if Conant's generation was extrapolating too much from recent experience, might we be making a similar mistake? Nuclear weapons have not been used against humans since 1945, and we are now assuming they will remain dormant for the rest of history.

Each generation has its own form of recency bias, as it is called in behavioral economics. Just after Sept. 11, for example, there was great concern about follow-up attacks. (Thankfully, nothing comparable followed.) Now we worry a lot - maybe too much - about insolvent banks, insufficiently high inflation, and the Chinese shock to U.S. manufacturing.

So what about nuclear war? Looking forward, the reality is that the risks of such a war are quite small in any particular year. But let the clock run and enough years pass, and a nuclear exchange of some kind becomes pretty likely. I have found that people with a background in financial market trading are best equipped to understand the risks of nuclear war. An analogy might be helpful: Say you write a deeply out-of-the-money put, without an offsetting hedge. This is in fact a very risky action, though almost all of the time you will get away with it. When you don't, however – when market prices move against you - you can lose all of your wealth quite suddenly. In other words: Sooner or later the unexpected will come to pass. The correct intuitions about this kind of risk do not always come easily to the inexperienced investor. In similar fashion, shortsighted voters do not appreciate the ongoing risk of nuclear war.

Which brings me to my reaction to Steven Pinker's renowned book *The Better Angels of Our Nature: Why Violence Has Declined*: He does not think enough like a financial economist. Yes, the arguments for optimism often appear stronger than the arguments for pessimism, and indeed they are. When it comes to nuclear weapons, however, the arguments for pessimism only have to be true once - and that is likely to happen sooner or later, no matter how positive the general trends.

So, combining that insight about risk with the phenomenon of recency bias, I return to my

original thought: We should be very worried indeed about nuclear weapons. They are all still there, and most of them probably still work. We can never be quite sure about the accuracy of the systems for early detection of incoming missiles, and whether there might be false signals of a launch, as there were in 1983.

There are also reasons particular to the present moment to be concerned about nuclear weapons. They are becoming easier and cheaper to build, and it is not implausible to think that nations such as Iran, Turkey and Saudi Arabia might get them in the next 20 years, to the detriment of regional stability. North Korea keeps adding to its stockpile of nuclear weapons and improving the quality of its delivery systems.

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Meanwhile, a generation of hypersonic delivery systems, being developed by China, Russia and the U.S., will shorten the response time available to political and military leaders to minutes. That raises the risk of a false signal turning into a decision to retaliate, or it may induce a nation to think that a successful first strike is possible. Remember, it's not enough for the principle of mutual assured destruction to be generally true; it has to be always true.

Source: https://www.macombdaily.com, 18 May 2019.

OPINION – Anne Harrington, Cheryl Rofer

There is No Check on Trump's Rage Going Nuclear

Donald Trump is taking the United States back to an earlier time—one most people thought had been left behind. His aggressive boorishness, entitlement, and belief that he can do whatever he wants are qualities from an age when men's control was assumed, and others stayed silent. And nowhere is his retrograde masculinity more dangerous than in his control of the nuclear button.

As president of the United States, Trump has absolute authority to launch nuclear weapons—without anyone else's consent. In the past, it was taken for granted that the president would follow an established protocol that included consultation with the military, his cabinet, and others before taking such a grave step, but Trump is not legally bound to these procedures. Presidential launch authority is a matter of directive and precedent rather than specific law. Trump's bravado, penchant for inflated rhetoric, and impulsive decision-making style—including catching his leadership off guard by informing them of policy directives via tweet—have stoked old fears about placing the authority to launch in the wrong hands. So has his constant violation of once cherished presidential norms, including refusing to make public his tax returns and failing to read his daily intelligence brief.

Trump's bravado, penchant for inflated rhetoric, and impulsive decision-making style—including catching his leadership off guard by informing them of policy directives via tweet—have stoked old fears about placing the authority to launch in the wrong hands. So has his constant violation of once cherished presidential norms, including refusing to make public his tax returns and failing to read his daily intelligence brief.

Debates about launch authority have always been intimately bound up with whether we consider nukes' function to be primarily military or political. Nuclear weapons are so destructive that, since the bombs were dropped on Hiroshima and Nagasaki, even the explicit threat of their use has been sparing. They have been used as political deterrents and levers, instead of direct weapons of war. Reserving launch authority for the president was a key way to emphasize the political nature of the nuclear mission.

Historians trace the precedent of presidential launch authority to President Harry Truman's decision to check his generals' use of nuclear weapons. Historians trace the precedent of presidential launch authority to President Harry Truman's decision to check his generals' use of nuclear weapons. After destroying Hiroshima and Nagasaki, they planned to bomb a third Japanese city, but Truman forbade them to carry out the attack without his express consent and ultimately decided against it. According to Truman's commerce secretary, Henry Wallace, the president thought killing "another 100,000 people was too horrible." By assuming personal responsibility for the launch order, Truman started a tradition of differentiating this new technology from conventional weapons.

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Reserving launch authority for the president not only underscored the special status of nuclear weapons as a political asset, but it also took them out of the hands of the generals—men like Gen. Curtis LeMay. LeMay was a laconic man's man, known for his ruthlessness and impolitic statements. During World War II, he directed the firebombing of 63 Japanese cities, killing hundreds of thousands of people. It was LeMay who relayed the orders for the atomic bombing of Hiroshima and Nagasaki and later, as the head of Strategic Air Command (SAC), oversaw the war plans for an all-out nuclear attack against the Soviet Union. LeMay had no patience for subordinating operational effectiveness to moral concerns, or what he referred to as an American "phobia" against the use of nuclear weapons.

As Air Force chief of staff, LeMay clashed with McNamara over whether or not the existence of nuclear weapons should induce restraint when it came to confronting the Soviet Union. The conflict came to a head during the Cuban missile crisis. LeMay's advice to Kennedy during the crisis was to go all in. The goal was to emasculate the Soviets: "The Russian bear has always been eager to stick his paw in Latin American waters," he said.

LeMay resented the fact that SAC was subject to presidential launch authority. According to the historian Richard Rhodes, he had his own launch plans, ignoring national policy. While LeMay continued to believe that the United States could obliterate the Soviet Union while minimizing its own losses, in the civilian world ideas about the use of nuclear weapons were evolving. A new breed of defense intellectual was pushing the idea that the primary purpose of nuclear weapons was not to decimate U.S. adversaries but to prevent such weapons being used at all. Anchored in a game theoretic approach, these intellectuals assumed that the holders of nuclear weapons would be rational and that what each side believed about the other—credibility—was central to deterring nuclear use.

Robert McNamara, who served as President John F. Kennedy's defense secretary, was emblematic of this new approach and responsible for introducing this new breed of defense intellectual into the Pentagon. In contrast to LeMay's gruff demeanor, McNamara cut a refined figure with his wire-rimmed glasses, tailored suits, and perfectly coiffed, slicked-back hair. While no less callous than LeMay, McNamara carried himself in a manner consistent with his policies: He was a model of sophistication and restraint. A graduate of Harvard Business School, with an undergraduate degree in economics from the University of California, Berkeley, he was a member of the first wave of business leaders to develop and adopt quantitative methods for decision-making—methods that resonated with the new game theoretic approach to nuclear strategy.

Where LeMay's approach openly celebrated slaughter, McNamara's bloodlessness could lead to just as much destruction. The fact that teams of scientists provided mathematical justifications for the Cold War buildup in nuclear arms did not make the possibility of their use any less brutal.

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McNamara worked with Kennedy to deescalate the conflict, until the U.S. missiles in Turkey were eventually traded for Soviet ones in Cuba. At the end of the crisis, McNamara concluded: "In a sense, we'd won. We got the missiles out without war. My deputy and I brought the five Chiefs over and we sat down with Kennedy. And he said, 'Gentlemen, we won. I don't want you ever to say it, but you know we won, I know we won.'" LeMay countered: "Won? Hell, we lost. We should go in and wipe 'em out today."

The election of Trump has reversed the usual stereotypes of generals and civilians. In the Trump White House, generals like H.R. McMaster and James Mattis inspired confidence in their respect for social norms and display of restraint, while Trump represents the rejected LeMay model of masculinity—without the virtues of actual service and endurance that LeMay also exemplified.

When McNamara became defense secretary in 1961, U.S. nuclear strategy was a direct outgrowth of LeMay's strategic bombing campaigns. By 1965, McNamara had ushered in a shift in thinking about the role of nuclear weapons in U.S. national security away from LeMay's legacy of total war and toward a deterrence framework informed by rational calculation and restraint. In February of that year, with the support of President Lyndon Johnson, McNamara forced LeMay into retirement.

McNamara's approach prevailed—not only politically but culturally. The 1964 movie Dr. Strangelove rejected LeMay's approach to nuclear weapons. The cigar-chomping Gen. Jack D. Ripper is portrayed as insane, his paranoia leading him to release an airborne nuclear strike against the Soviet Union. Maj. T.J. "King" Kong rides the bomb down, brandishing his cowboy hat.

LeMay and McNamara not only represent two different approaches to nuclear strategy but two different ideals of masculinity. The election of Trump has reversed the usual stereotypes of generals and civilians. In the Trump White House, generals like H.R. McMaster and James Mattis inspired confidence in their respect for social norms and display of restraint, while Trump represents the rejected LeMay model of masculinity—without the virtues of actual service and endurance that LeMay also exemplified.

Trump's personal manner is like LeMay's—belligerent, inarticulate, refusing meaningful discussion, and deflecting criticism. And, like LeMay, his statements about nuclear weapons prioritize use over doctrine. When pressed on nuclear use by Chris Matthews of MSNBC in March 2016, Trump responded, "Let me explain. Let me explain. Somebody hits us within ISIS — you wouldn't fight back with a nuke? … Then why are we making them? Why do we make them?"

Trump's focus on the individual, the leader is not just narcissistic but also deeply patriarchal. For Trump's supporters, it is precisely the hope that Trump might "make America great again" by restoring their social world to its "natural" order, one in which the (white) man's home is once again his castle. His masculine bravado and willingness to eschew social norms in favor of social aggression and emotional combativeness are his attractive qualities, but it is precisely these characteristics that lead to senseless and irrational conflicts—conflicts that could quickly become global catastrophes in the nuclear era. …

This style of personal entitlement stands in sharp contrast to prior presidents, who (with rare exception) accommodate themselves to the role by placing the demands of the office before personal desires. It also stands in contrast to the masculine ideal that we have come to associate

with the office of the president, one that values rationality and sound judgment over brutishness and bravado.

The debate about civilian control of nuclear weapons, including presidential launch authority, was not only a struggle over whether nukes are primarily political tools or military weapons but also what type of person could be trusted with the ability to forever alter life on Earth. The move to take nuclear weapons out of the hands of the military was also a way of taking them away from trigger-happy generals like LeMay who were not only willing but eager to do the unthinkable. In the nuclear era, a more refined masculine ideal was ascendant. As epitomized by McNamara, this rational man took no pleasure in violence but rather, after careful study and consultation, accommodated himself to its necessity.Would Trump be willing to use nuclear weapons? That's unknowable—but he certainly doesn't need your, or anyone else's, consent to do it.

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Source: https://foreignpolicy. com/, 22 May 2019.

OPINION – Thomas Graham Jr., Richard W. Mies

National Security Stakes of US Nuclear Energy

The recent struggles of the U.S. nuclear energy industry may appear to be no more than the usual economic disruption caused by competition among technologies. But from our experience in diplomacy and the armed forces, we understand that a declining domestic civil nuclear industry has other ramifications. Critical U.S. national security interests are at risk.

We have dedicated our careers to controlling the destructive potential of nuclear weapons. But since the Atoms for Peace era, U.S. leadership in supplying peaceful nuclear energy technology, equipment, and fuel to the world has been important for world development and therefore critical for the United States to establish and enforce standards for nuclear safety, security and nonproliferation. But in recent decades, the U.S. share of international commercial nuclear energy markets has diminished, and so with it has the United States' ability to influence global standards in peaceful nuclear energy.

The critical moment for U.S. leadership in nuclear energy is when a country is developing nuclear energy for the first time. The supplier country and the developing country typically forge a relationship that endures for the 80- to 100-year life of the nuclear program. Unlike a coal or gas plant, nuclear reactors need specialized fuel and maintenance. Once established, the bilateral commercial relationship is not easily dislodged by a rival nation, providing the supplier profound and lasting influence on the partner's nuclear policies and practices.

The recent struggles of the U.S. nuclear energy industry may appear to be no more than the usual economic disruption caused by competition among technologies. But from our experience in diplomacy and the armed forces, we understand that a declining domestic civil nuclear industry has other ramifications. Critical U.S. national security interests are at risk.

Russia and China have identified nuclear energy as a strategic export, to be leveraged for geopolitical influence as well as for economic gain. According to a recent analysis, Russia is the supplier of more nuclear technology than the next four largest suppliers combined, and China is quickly emerging as a rival. If the United States fails to compete in commercial markets, it will cede leadership to these countries on nuclear safety, security and nonproliferation, as well as foreign

policy influence.

As the competition intensifies to deliver the next generation of nuclear power technologies, U.S. nuclear leadership is approaching a watershed opportunity. Simpler, scalable, and less expensive, small and advanced reactors are commercially attractive to an expanded range of markets — particularly in Africa, Asia and the Middle East.

The United States has the world's best training and development programs, unmatched regulatory experience, and multiple small and advanced reactor designs; we should be the easy choice for the next generation of nuclear technology. But early U.S. engagement in these important geopolitical regions is critical. Without it, Russia and China will lock up future nuclear markets through MOUs and other bilateral agreements.

Russia has brought six new plants online in the past five years and has six more plants currently under construction. In the same period, China has brought 28 new plants online and has 11 others under construction. These domestic projects provide Russia and China with a robust supply chain, an experienced workforce, and economies of scale that make them more competitive in bidding on international projects. Unless we continue to innovate and build new plants, we will cease to be relevant elsewhere.

And for addressing the national security risks of climate change, nuclear energy is not just an option but a necessity. Developing nations that are planning to meet power and water needs for large and growing populations must have reliable, demonstrated, zero-emission nuclear power in order to meet global climate goals as well. Advanced reactors are integral to these goals.

In the United States, nuclear energy is responsible for a fifth of the United States' total electricity and more than 55 percent of our emissions-free energy, but the pace of domestic construction of new natural gas plants far exceeds the few nuclear plants under development, and the existing fleet is retiring prematurely at an alarming rate.

Which brings us back to the domestic nuclear industry. U.S. global competitiveness and leadership are inextricably linked to a strong domestic nuclear program. Without a healthy domestic fleet of plants, the U.S. supply chain will weaken against international rivals.

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Even our own domestic energy security is supported by nuclear power. The nuclear plants operating today are the most robust elements of U.S. critical infrastructure, offering a level of protection against natural and adversarial threats that is unmatched by other plants. Because the nation's grid supplies power to 99 percent of U.S. military installations, large scale disruptions affect the nation's ability to defend itself.

We can regain U.S. leadership in nuclear energy. The key steps are to maintain the domestic reactor fleet, with its reservoir of know-how, and to assist American entrepreneurs in developing the next generation of the technology. But the first step is to recognize what is at stake.

Source: https://thehill.com, 25 May 2019.

OPINION – Quamrul Haider

Fusion: A Safer Nuclear Option

It is obvious that global efforts to combat climate change—that were agreed upon at the 21st Conference of Parties in Paris—have already gone off the rails. Subsequent conferences produced nothing but a long laundry list of unenforceable

rules to cope with the rapidly changing climate that is forcing millions of people to lead cramped lives with other climate refugees in the slums of sweltering, shrinking continents. Arguably, renewable energy is one of the most effective tools we have in the fight against climate change, and there is every reason to believe it will succeed, albeit partially only if we stop, or at least, cap fossil fuel emissions. Otherwise, we cannot simply bet on renewables to combat global warming.

Notwithstanding the remarkable growth due to technological advancements and huge cost improvements over the past decade, renewables, such as solar, wind, geothermal and tides, to name a few, are not available 24/7, year-round, everywhere. The sun does not shine at night or on cloudy or rainy days, and some days may be calm or less windy than others. Geothermal power plants cannot be built in places that do not have the right geological characteristics, while the energy carried by tidal surges can be utilised in coastal regions only, for a limited number of hours per day though.

In fission reactions, a heavy nucleus, such as uranium, breaks up into two lighter fragments and two or three neutrons. The process is accompanied by the release of a large amount of energy. Instead, scientists are actively engaged in developing safer nuclear power systems as one among several technologies that would not use the atmosphere as a waste basket. Specifically, they are focusing attention on nuclear fusion that would rekindle our trust in nuclear energy.

That brings nuclear power, which generates huge amounts of electricity with zero emission of greenhouse gases, into the climate change equation. Yet, it is seen by many, and with good reason, as the misbegotten stepchild of nuclear weapon programmes. What has given rise to our fears about nuclear power more than anything else are the accidents at Chernobyl in 1986 and Fukushima in 2011. The Fukushima disaster in particular has shattered the zero-risk myth of power reactors and heightened our concern about the invisibility of the added lethal component, nuclear radiation. These reactors entail substantial safety and security risks, waste disposal challenges and water requirements, too.

Nevertheless, scientists are reevaluating nuclear power as a possible solution to combat global warming. But they are not considering fission-based nuclear reactors that are used in power plants today. In fission reactions, a heavy nucleus, such as uranium, breaks up into two lighter fragments and two or three neutrons. The process is accompanied by the release of a large amount of energy. Instead, scientists are actively engaged in developing safer nuclear power systems as one among several technologies that would not use the atmosphere as a waste basket. Specifically, they are focusing attention on nuclear fusion that would rekindle our trust in nuclear energy. Nuclear fusion is a reaction in which two lighter nuclei, typically isotopes of hydrogen, combine together under conditions of extreme pressure and temperature to form a heavier nucleus, releasing energy in the process. Fusion has been powering the sun and stars since their formation. The energy released during fusion in the sun makes all life on earth possible.

The simplest way to replicate the primordial source of power on earth is via the fusion of deuterium and tritium. Deuterium is found aplenty in ocean water, enough to last for billions of years. Naturally occurring tritium is extremely rare, but it can be produced inside a reactor by neutron activation of lithium, found in brines, minerals and clays.

The appeal of fusion energy is enduring for several reasons. For equal mass, calculations indicate that fusing two nuclei in a controlled way would release nearly four million times more energy than burning fossil fuels and four times as much as nuclear fission reactions. Moreover, to run a 1,000 MW power plant with a fusion reactor, it is estimated that about 150kg of deuterium and three tonnes of lithium would be required per year, while the current fission reactors consume 25 to 30 tonnes of enriched uranium. A similar coal-fired power plant uses

about three million tonnes of fuel. Clearly, gram for gram, fusion reactor wins the energy race hands down.

Unlike fission, fusion will have a low burden of radioactive waste. Fusion's by-product is helium, which is an inert, non-toxic, non-radioactive gas used to inflate balloons. In addition, a fusion power plant would not require transporting hazardous radioactive materials. Furthermore, because there is no "critical mass" required for fusion, the possibility of a "runaway" reaction that could result in a core meltdown—the most serious calamity possible in a fission reactor—is not an issue with fusion reactors.

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Considerable amount of research on the development of reactors that would harness fusion energy is currently underway at several laboratories in the United States and around the world. However, the high cost of research and very expensive hardware limit most of the work to multinational consortia.

The 35-nation ITER project under construction at Cadarache in France is the world's largest fusion reactor. Launched in 2006, ITER has been beset with technical delays, labyrinthine decision-making and costs that have soared from an initial estimate of five billion euros to around 20 billion euros.

Despite the slow pace, construction of the project reached the halfway point last year. It is an important milestone for the multi-billion-euro facility, whose goal is to begin generating power on an experimental basis by 2025, although the technology to produce electricity commercially is likely many decades away. Once fusion reactors become a reality, they would be an absolute game-changer in the sense that there will be a paradigm-shifting development in the global energy mix, thereby laying the groundwork for a clean energy revolution. As a source of non-hazardous, carbon-free energy, producing no long-lived radioactive waste, fusion will eventually make fossil-fuel-fired power plants and uranium-based nuclear facilities obsolete. More importantly, if we want to keep the lights on and the wheels of industries running while hardly producing greenhouse gases, nuclear fusion would provide sustainable energy on a nearly unlimited scale. Finally, according to researchers at Columbia University in New York, in order to avoid disastrous effects of climate change, we have to reduce greenhouse gas emissions by at least six percent annually. They argue that "it's hard to see how we could conceivably accomplish this without nuclear."

Source: https://www. thedailystar. net, 26 May2019.

OPINION – Sydney J. Freedberg Jr.

Beyond INF: An Affordable Arsenal of Long-Range Missiles?

With the landmark INF Treaty likely to expire in August, the US will be free to develop new long-range, land-based missiles to counter China's — and by Pentagon standards, it could do so pretty cheaply, according to a new study from a highly regarded thinktank. Converting the Navy's Tomahawk cruise missile to launch from land would cost about $100 million, according to the Center for Strategic & Budgetary Assessments. After development, CSBA continued, each individual land-based Tomahawk missile would cost about $1.4 million for a variant that could only hit stationary targets like airbases or $2.5 million for one capable of tracking moving targets such as ships.

Weapons with longer ranges and more advanced stealth features to avoid being shot down would

cost significantly more, of course. But even the most expensive option CSBA studied in its latest report — a hypersonic boost-glide weapon capable of hitting moving targets 4,000 miles away — would cost only $1.3 billion to develop and then $23 million per missile.

It turns out that land-based missile batteries are a lot cheaper than missile-carrying bombers and warships — which, of course, is precisely why China has built such a massive arsenal of them. In fact, offensive surface-to-surface missiles are much much cheaper than the missile defense interceptors required to shoot them down, because it's a lot easier to build a weapon that can hit an airfield or even a warship moving 30 knots than it is to build one that can hit a missile moving hundreds of miles per hour.

CSBA estimates it would take two American THAAD interceptors, at $9.4 million apiece, to assure the shoot-down of a single Chinese DF-16, at $6 million a shot. (And that's just the cost of the interceptors — not the system that helps make them effective.) At ratios like those, guess who runs out of ammo first? But by building land-based offensive missiles of its own, CSBA has long argued, the US can turn the tables on China and Russia and pursue a "cost imposition" strategy of its own.

Now, land-based weapons are also much less mobile than bombers and warships, which is why the US, with its far-flung interests, has preferred air- and seapower. But with China and Russia investing heavily in anti-aircraft and anti-ship firepower to blunt America's edge (a strategy known as Anti-Access/Area Denial), ground-launched missiles are starting to look like an attractive back-up option. So the US Army is reentering the long-range missile business — what it calls strategic fires — for the first time since the INF Treaty banned such weapons in 1987. ...

Now, estimating the cost of future weapons is notoriously tricky. CSBA lead author Jacob Cohn, who kindly walked me through their analysis and corrected (hopefully all of) my mistakes, are the first to put some caveats on their figures. All their estimates for both range and cost are approximations, they emphasized, are not exact. The more novel the weapon, the less precise the estimate.

So we can be pretty confident of CSBA's figures for converting the sea-launched Tomahawk — in both in its longstanding land-attack variant and its new anti-ship mode — to fire from a truck-based launcher, which the US actually already did, back in the 1980s with the GLCM. CSBA is likewise on firm ground with the cost of converting the existing JASSM/LRASM family of missiles, which are significantly stealthier than Tomahawk and thus harder to shoot down, from air- and sea-launch to ground launch. That said, the actual range of the anti-ship LRASM is a matter of debate, and I used a figure from a different source than CSBA.

There's a lot of extrapolation needed for weapons which would use proven technologies but which the US isn't currently working on, notably the MRBMs and IRBMs, types the US hasn't built since the Pershing II of the 1980s. Nor is it just the cost of the weapons themselves. In many cases, where future weapons were too big to fit on the Army's existing HIMARS and MLRS launchers, CSBA went so far as to factor in the cost of converting available trucks into mobile missile platforms.

By contrast, the think tank had to extrapolate from historical data to model an extended-range version of the Precision Strike Missile (PRSM), since the Army is currently developing a baseline model with an INF-compliant range of 499 km. CSBA had to extrapolate even more for new technologies in the early stages of development, notably, the hypersonic options. Likewise, there's a lot of extrapolation needed for weapons which would use proven technologies but which the US isn't currently working on, notably the MRBMs and IRBMs, types the US hasn't built since the Pershing II of the 1980s.

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All that said, CSBA's estimates all derive from three well-founded principles:

1. Converting an existing missile to a new launch platform — in this study, Tomahawk and JASSM/LRASM — is cheaper than developing a new one.

2. Building a shorter-range missile is cheaper than building a longer-range one, which requires a large booster.

3. Building a missile that can hit static targets on land, like supply depots and airbases, is cheaper than building one that can hit moving targets, like tanks or ships, which requires a sophisticated seeker in the warhead.

On the upside, once you've developed a missile smart enough to hit moving targets, it can easily hit static ones as well. (Or you can produce a cheaper, dumbed-down version that can strike fixed targets, saving money at the price of flexibility). That means developing any of the anti-ship missiles in the chart would also give you the land-attack version for no additional development cost.

So, while simply adding up the estimated cost of developing every potential weapon that CSBA studied would give you a total of $12.1 billion, a lot of that is double-counting. If you add up only the anti-ship versions — which, again, would give you the land-attack capability as well — you get a total of just $6.5 billion, spread out over at least five years.

Besides, in practice, you wouldn't develop every weapon CSBA explored, since some are similar enough to each other to be redundant. In particular, CSBA's small Medium Range Ballistic Missile (basically a baby Pershing) and the large MRBM (a super Pershing) are two different approaches to almost the same mission. So while the usual program overruns might well push the costs of individual programs above CSBA's estimates, the total cost for an array of options should stay in the same range. For a Pentagon that's spending about $12 billion to develop the new B-21 stealth bomber, $7 to $12 billion seems a reasonable price to develop an array of new land-based missiles as a backup plan.

Source: https://breakingdefense.com, 28 May 2019.

NUCLEAR STRATEGY

PAKISTAN

Pakistan Tests Nuclear-Capable Ballistic Missile, Affirms Willingness for Dialogue with India

Pakistan says it has successfully conducted a "training launch" of a ballistic missile capable of carrying both nuclear and conventional warheads up to 1,500 kilometers. The move came amid Pakistan's heightened military tensions with neighboring rival India, and it is seen by observers as part of the efforts Islamabad is making to keep pace with New Delhi's massive investments in military hardware and advancements.

After the indigenously produced Shaheen-II medium range rocket was fired into the Arabian Sea on May 23, military spokesman Major-General Asif Ghafoor said that it is "a highly capable missile which fully meets Pakistan's strategic needs towards maintenance of desired deterrence stability in the region." Ghafoor noted the head of the military unit that oversees the country's nuclear program witnessed the training launch along with other senior officials, scientists and engineers. "President (Arif Alvi) and Prime Minister of Pakistan (Imran Khan) have also conveyed their congratulations on the achievement," he added.

The latest missile launch came a day after Pakistani Foreign Minister Shah Mehmood Qureshi spoke briefly with his Indian counterpart, Sushma Swaraj, on the sidelines of a meeting of the SCO member states in Kyrgyzstan. Following what he said was an informal interaction with Swaraj, Qureshi said he conveyed Pakistan's

readiness to engage in a dialogue with India to resolve all bilateral matters through negotiations.

Source: Ayaz Gul, https://www.indepthnews.net, 23 May 2019.

RUSSIA

Russia Launches New Nuclear-Powered Icebreaker in Bid to Open Up Arctic

Russia launched a nuclear-powered icebreaker, part of an ambitious programme to renew and expand its fleet of the vessels in order to improve its ability to tap the Arctic's commercial potential. The ship, dubbed the Ural and which was floated out from a dockyard in St Petersburg, is one of a trio that when completed will be the largest and most powerful icebreakers in the world. Russia is building new infrastructure and overhauling its ports as, amid warmer climate cycles, it readies for more traffic via what it calls the Northern Sea Route (NSR) which it envisages being navigable year-round.

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The Ural is due to be handed over to Russia's state-owned nuclear energy corporation Rosatom in 2022 after the two other icebreakers in the same series, Arktika (Arctic) and Sibir (Siberia), enter service. "The Ural together with its sisters are central to our strategic project of opening the NSR to all-year activity," Alexey Likhachev, Rosatom's chief executive, was quoted saying.

By 2035, Putin said Russia's Arctic fleet would operate at least 13 heavy-duty icebreakers, nine of which would be powered by nuclear reactors. The Arctic holds oil and gas reserves equivalent to 412 billion barrels of oil, about 22% of the world's undiscovered oil and gas, the US Geological Survey estimates. Moscow hopes the route which runs from Murmansk to the Bering Strait near Alaska could take off as it cuts sea transport times from Asia to Europe.

President Vladimir Putin said in April Russia was stepping up construction of icebreakers with the aim of significantly boosting freight traffic along its Arctic coast. The drive is part of a push to strengthen Moscow's hand in the High North as it vies for dominance with traditional rivals Canada, the US and Norway, as well as newcomer China. By 2035, Putin said Russia's Arctic fleet would operate at least 13 heavy-duty icebreakers, nine of which would be powered by nuclear reactors. The Arctic holds oil and gas reserves equivalent to 412 billion barrels of oil, about 22% of the world's undiscovered oil and gas, the US Geological Survey estimates. Moscow hopes the route which runs from Murmansk to the Bering Strait near Alaska could take off as it cuts sea transport times from Asia to Europe. Designed to be crewed by 75 people, the Ural will be able to slice through ice up to three metres thick.

Source: https://www.theguardian.com, 26 May 2019.

USA

Pentagon hits Pause on Redesign of Critical Homeland Missile Defense Component

The Pentagon has hit the pause button on a troubled effort to redesign the kill vehicle on the Ground-Based Midcourse Defense system's interceptors after reporting a two-year delay in its development earlier this year. The GMD system is designed to defend against possible ballistic missile attacks from North Korea and Iran.

Dr. Michael Griffin, the under secretary of defense for research and engineering, has decided to issue a stop-work order to Boeing on the development of the Redesigned Kill Vehicle — or RKV — which was first reported by *Inside Defense*. Boeing was directed to stop work on the RKV on May 24, a

company spokesman confirmed to *Defense News*.

The RKV is meant to replace the current Exoatmospheric Kill Vehicles on all current and future GMD interceptors — a total of 64 ultimately. The EKV, designed to destroy targets in high-speed collisions after separating from a booster rocket, has struggled in testing but has performed reliably in major test events in recent years including a complex salvo test earlier this year.

There are 44 GBIs in place at Fort Greely, Alaska, and Vandenberg Air Force Base, California, with plans to add 22 additional missile silos at Fort Greely to support 20 more GBIs. The RKV was due out for a critical design review in 2018 but that CDR was delayed by two years in the Missile Defense Agency's fiscal year 2020 budget request released in March. The agency requested $412.4 million in FY20 to develop the RKV. The plan was to conduct the first controlled flight test of the RKV in FY22 with an intercept flight test in FY23 and a second test in 2024. As a result of the delay of the RKV CDR, the plan was to finish up the installation of the 20 new GBIs at Greely in 2025.

... The Pentagon "recently encountered a technical issue in Missile Defense Agency's redesigned kill vehicle development program," Heather Babb, Defense Department spokeswoman, told Defense News in a May 28 statement. "The RKV team has been assessing and testing as needed, suspect components."

After receiving recent test results, Griffin, "has determined that the current plan is not viable and has initiated an analysis of alternative courses of action," Babb said. "To avoid unnecessary expenditures, USD(R&E) has directed the Missile Defense Agency to issue a stop work on the RKV activity within the current Boeing contract until a viable path forward is identified." The Pentagon did not say how long the analysis of alternatives might take to complete.

In the case of the current RKV program, Boeing was executing the MDA's design plans. "The government has indicated that they have initiated an analysis of alternative courses of action and we will support them in this effort as requested," the company said in its statement. "Boeing will continue to support requirements for our customers and national decision makers set forth for effective missile defense, as we have for more than two decades." The Missile Defense Agency Director Gen. Samuel Greaves said, during a Senate Armed Services Committee missile defense hearing earlier this spring, that the issue was not contractor-related but a technical one, but he would not provide details because they are classified.

At the April hearing, MDA appeared to still be focused on proceeding with the RKV program with only the schedule in question. Greaves said the agency was testing components and the timeline for the program might be adjusted over the next few months. He said he believed once the component testing wrapped up the timeline could be shortened, but added, "it could go the other way."

The Defense Department has already spent a fair amount of money on the RKV program — but the Pentagon also has a chance to look at the overall balance of funding to address the North Korea threat and investments to deal with very different missile threats from Russia and China.

It's unclear what alternative paths might be assessed during the strategic pause, but some options could be tweaking the design for the RKV to get it back on track or MDA could look at an alternate path that isn't just outfitting all present and future GBIs with the current EKV or jumping straight to the development of a Multi-Object Kill Vehicle (MOKV), but one that addresses taking out multiple targets — or volume kills — with one vehicle. The MOKV is to follow the RKV effort, but preliminary work on its development has been ongoing for several years.

And the Pentagon could use this as an opportunity to restructure contracts or recompete the entire GMD program, suggested Tom Karako, a missile defense analyst at the Center for Strategic and International Studies. The decision could "represent an inflection point" for homeland missile defense in its entirety, Karako told *Defense News*. It's clear, he said, capability over and above the current kill vehicle is needed — the Defense Department has already spent a fair amount of money on the RKV program — but the Pentagon also has a chance to look at the overall balance of funding to address the North Korea threat and

investments to deal with very different missile threats from Russia and China.

Source: Jen Judson, https://www.defensenews.com, 29 May 2019.

BALLISTIC MISSILE DEFENCE

INDIA

DRDO Successfully Test Fires Akash-1S Surface to Air Defence Missile

The DRDO on 27 May successfully test fired the Akash-1S surface to air defence missile system. This is the second successful test of the missile in last two days. This is a new version of the missile fitted with an indigenous seeker. Developed by the DRDO, the Akash missile system has the capability to neutralise aerial targets such as fighter jets, cruise missiles and air-to-surface missiles as well as ballistic missiles.

The Akash-1S is capable of striking down enemy fighter jets and drones very effectively and accurately. The Akash surface-to-air missile was designed to intercept enemy aircraft and missiles from a distance of 18 to 30 km. Earlier, DRDO successfully test fired an indigenously-developed 500 kg class guided bomb from a Sukhoi combat jet at Pokhran in Rajasthan. The defence ministry said the guided bomb achieved the desired range and hit the target with high precision. "The DRDO successfully flight tested a 500 kg class Inertial Guided Bomb today from Su-30 MKI Aircraft from the Pokhran test range in Rajasthan," it said.

Source: https://www.indiatoday.in, 27 May 2019.

RUSSIA

THAAD Missile Defense Systems are Coming to Russia's Doorstep

The U.S. Army has deployed to Romania one of its seven THAAD missile-interceptor batteries. The deployment coincides with a shut-down of the U.S. Aegis Ashore missile-defense site, also in Romania, for a scheduled upgrade. The THAAD battery on May 17, 2019 began setting up its equipment within sight of the Aegis Ashore missile-defense site. The U.S. Army and the U.S. Defense Department separately posted, then quickly deleted, at least one photo of the battery preparing for duty. Some websites have preserved the photo.

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The THAAD deployment is controversial. The system, in theory, possesses some of the same capabilities that Aegis Ashore does and could help to fill the gap left by the Aegis system's temporary suspension. But THAAD also has antagonized the Russian government, just like Aegis Ashore has done. Russia "can't understand what tasks the Aegis Ashore system will accomplish in the missile defense area," Russian deputy foreign minister Sergei Ryabkov in late April 2019 said.

The Pentagon and NATO repeatedly have tried to explain their reasoning for deploying THAAD. "At the request of NATO, the secretary of defense will deploy a U.S. Army THAAD system to Romania this summer in support of NATO ballistic-missile defense," U.S. European Command in early April 2019 announced. ... As of early 2019, the Army had acquired around 200 THAAD rockets for its seven batteries and roughly 40 launchers. The U.S. Missile Defense Agency on its website describes THAAD as a "land-based element capable of shooting down a ballistic missile both inside and just outside the atmosphere." The U.S. Army mans THAAD batteries on the island of Guam as well as in South Korea. The Army in March 2019 deployed a THAAD battery to Israel.

Aegis Ashore is a land-based version of the U.S. Navy's SM-3 missile-interceptor. The Missile Defense Agency by way of NATO operates Aegis Ashore sites in Poland and Romania. The sites help to defend Europe and the United States from limited missile strikes by a Middle East power such

as Iran.

But U.S. missile defenses for decades have been controversial in Russia. Moscow views American BMD systems as a threat to the global balance of power, as they, in theory, could render ineffective Russia's own nuclear-tipped rockets. In fact, most U.S. missile-defenses lack the speed, range and accuracy to intercept an intercontinental ballistic missile. Only the United States' Ground-Based Midcourse Defense systems in Alaska and California, both of which exist to intercept North Korean rockets, in controlled tests have proved to be capable of hitting some ICBM-class weapons.

Many Russians also believe, wrongly, that Aegis Ashore has a ground-to-ground capability and could function as a surprise first-strike weapon. Aegis Ashore "play[s] to a very specific Russian fear," said Jeffrey Lewis, a nuclear expert at the Middlebury Institute of International Studies at Monterey.

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Lewis said many Russians believe the United States has planned for years to secretly arm its missile-defense installations in Poland and Romania with nuclear weapons, transforming defensive weapons into what Lewis describes as a "covert" strike force whose true mission is to launch a surprise atomic attack on Moscow in order to "decapitate" the Russian government. "It's insane but I swear they 100-percent believe this," Lewis said of the Russians.

NATO stressed that neither Aegis Ashore nor THAAD poses a danger to Russia. "The THAAD unit will be under NATO operational control and the full political control of the North Atlantic Council," the alliance stated "It will only remain operational until the Aegis Ashore Romania site is back online. The update and deployment are expected to last several weeks. "In accordance with NATO's ballistic-missile defense system, the THAAD unit will be focused on potential threats from outside the Euro-Atlantic area. Aegis Ashore Romania is purely a defensive system."

Source: https://nationalinterest.org, 21 May 2019.

NUCLEAR ENERGY

GENERAL

Western Countries Urged to Maintain Nuclear Power Plants

Allowing ageing nuclear power plants to shut down will push up the price of electricity and increase greenhouse gas emissions, the International Energy Agency has warned, as it urges developed country governments to look at ways to keep them in operation. Many reactors in the US and the EU are approaching the end of their intended lifetimes, and if they are allowed to go out of service the proportion of those economies' electricity production coming from nuclear power will plunge over the next two decades. Utilities including Exelon, Southern California Edison and Entergy have been closing nuclear plants in the US. Germany has set a target of shutting all its nuclear plants by 2022.

The IEA is warning in a report published that if the decline in nuclear power in developed countries is not stopped, it will hamper the fight against climate change, and raise prices for consumers. Fatih Birol, the IEA's executive director, said the agency was not trying to tell governments that they should or should not keep their nuclear industries going, but wanted to give them a "heads up" about the consequences of their decisions for electricity prices and carbon-dioxide emissions. "Lifetime extensions for nuclear plants are not only a cost-effective solution, but also keep our climate targets alive," he said. "They are the most urgent policy challenge today."

Building new nuclear plants has in recent years proven difficult, with long delays and huge cost overruns hitting projects led by companies including EDF in Europe and Southern Company in the US. Even keeping existing plants in operation has been difficult, with some countries such as Germany adopting policies to phase them out, and competition from renewables and gas-fired generation in some markets.

In 1998 the share of the world's electricity provided by zero-carbon sources, including nuclear power and renewables, was 36 per cent. In 2018 it was still 36 per cent, despite the huge boom in renewables, because of the offsetting decline in nuclear power. The IEA argues that unless there is active policy intervention, those trends will continue.

In 1998 the share of the world's electricity provided by zero-carbon sources, including nuclear power and renewables, was 36 per cent. In 2018 it was still 36 per cent, despite the huge boom in renewables, because of the offsetting decline in nuclear power. The IEA argues that unless there is active policy intervention, those trends will continue. Reactors are on average 35 years old in the EU and 39 in the US. If no new plants are built and there are no lifetime extensions for existing plants, nuclear power will by 2040 drop in the US from about 20 per cent of electricity supply to 8 per cent, and in the EU from about 25 per cent to just 4 per cent, the IEA has calculated.

To avoid that outcome, Mr Birol said, governments need to find economic instruments and market structures that will help nuclear plants compete against wind and solar power that still often benefit from subsidies and mandates, and against gas-fired plants that often receive capacity payments to reward them for being available when needed.

"Nuclear lifetime extensions are economical compared to other investment alternatives, but don't benefit from the comparable tax credits or clean energy targets of renewables," he said. "As a result, they might be financially unviable." Some US states including New York and Illinois have introduced financial structures to support their nuclear plants, but such mechanisms have proven highly controversial. A similar plan backed by Republicans in Ohio has been criticised by conservative groups as "cronyism" and "corporate welfare".

Source: Ed Crooks, https://www.ft.com, 28 May 2019.

INDIA

Kakrapar Atomic Power Plant Connected to Grid

The KAPS-1 unit/reactor attained criticality on May 19 (initiation of controlled self sustaining nuclear fission chain reaction) following the replacement of the entire coolant channel, feeder replacement and safety upgrades. The replacement of the coolant channel and feeder were necessitated after the reactor shut down automatically on March 11, 2016, following leakage of heavy water from its coolant channel. The leak was plugged 10 days later.

The first 220 MW nuclear power plant at Kakrapar Atomic Power Station (KAPS-1) in Surat in Gujarat was synchronised with the grid on 24 May, said the NPCIL. An official said the power generation levels will be gradually increased. The KAPS-1 unit/reactor attained criticality on May 19 (initiation of controlled self sustaining nuclear fission chain reaction) following the replacement of the entire coolant channel, feeder replacement and safety upgrades. The replacement of the coolant channel and feeder were necessitated after the reactor shut down automatically on March 11, 2016, following leakage of heavy water from its coolant channel. The leak was plugged 10 days later.

India's atomic power plant operator NPCIL has two 220 MW units PHWR at KAPS. Following the heavy water leak, unit 1 was under cold shut down.

Similarly, the renovation and modernisation of KAPS-2 was completed in 2018 and it is operating at full capacity, the official added.

Source: https://energy. economictimes. indiatimes. com, 24 May 2019.

NUCLEAR COOPERATION

CHINA–RUSSIA

Nuclear Deal between China, Russia Worth $1.7b

Chinese and Russian nuclear companies will sign a deal worth more than $1.7 billion for the No.3 and No.4 reactors at the Xudapu Nuclear Plant using Russian technology, accelerating Sino-Russian cooperation on nuclear energy. Construction of two reactors at the Xudapu Nuclear Plant in Huludao, Northeast China's Liaoning Province, is scheduled to start in October 2021 and August 2022, China National Nuclear Corp (CNNC) said in an announcement. It did not specify when the contract will be signed. Under the deal, Russia will have overall responsibility for design, while China will handle the design of specific details including the general layout, conventional island and balance of plant. Both reactors will use the Russian-designed VVER-1200 / V491 reactor device, with a thermal power of 3,212 megawatts. The power station is set to operate for 60 years.

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"The China-Russia comprehensive strategic partnership of coordination has pushed bilateral cooperation in various fields. The cooperation helps China gain experience while helping Russia improve its technology in building third-generation nuclear plants, which benefits both countries," Han Xiaoping, chief information officer at China5e.com, a website of an energy information and consulting service, told the Global Times.

Lin Boqiang, director of the China Center for Energy Economics Research at Xiamen University, told the *Global Times* that the application of the VVER-1200 technology will add to China's status as a testing ground for the world's third-generation nuclear technologies, and put the Russian technology in competition with China's third-generation Hualong One technology. Cooperation with Russia on nuclear energy will provide guidelines to China. ...

The Xudapu Nuclear Plant, together with the Tianwan Nuclear Plant in East China's Jiangsu Province, are part of a 20-billion-yuan ($2.9 billion) nuclear deal signed in June between CNNC and Rosatom State Corp Engineering Division, the Russian state nuclear company. The deal is the biggest bilateral cooperation project involving nuclear energy, according to CNNC. Under the deal, the two parties will jointly build four VVER-1200 nuclear reactors. As of November 1, 2017, the number of nuclear power units in operation in the Chinese mainland reached 37, ranking third globally, according to data from the Chinese National Energy Administration. China also has 19 nuclear power units under construction.

Source: http://www.globaltimes.cn/content/ 1149880.shtm, 14 May 2019.

NUCLEAR NON-PROLIFERATION

INDIA

Nuclear Test Ban Agency Asks India to Turn "Observer"

The Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) has invited India to become an "Observer" with access to International Monitoring System data, so it can take an informed decision on ratifying a much-debated nuclear disarmament treaty. ...Ten nuclear tests have been conducted ever since the CTBT opened for

signature in 1996. Although 184 countries have signed the treaty so far, it is yet to come into force because eight countries with nuclear capabilities - including India - are yet to sign and ratify it.

India has claimed in the past that the CTBT is discriminatory because it favours "five nuclear weapon states" when it comes to fulfilling obligations for eliminating nuclear weapons. Instead, it wanted the CTBT to have a clause on complete nuclear disarmament in a time-bound manner because there are technological differences between the 'have' and 'have not' countries. India was concerned about the likelihood of those already possessing nuclear weapons upgrading their arsenals through sub-critical and laboratory simulated testing.

Being an observer would give India access to data from the International Monitoring System's 337 facilities located in 89 countries that monitor the planet for signs of nuclear explosions. This system can detect even small nuclear explosions using seismology, hydro-acoustics, infrasound and radionuclide technologies. Nowhere can you get this quality of data necessary for earthquake monitoring. The IMS also helps warn of tsunamis and volcanic ash, and identifies plane crash sites.

Lassina Zerbo, the executive secretary of CTBTO, said, "I am not asking India to ratify the treaty. But it can become an Observer, allowing India to attend our meeting, see how CTBTO works, and take the time needed to make the decision." He was addressing a group of Indian journalists at the CTBTO headquarters located in Vienna on May 10. Mr Zerbo said that he understands India's apprehensions, and would try his best to win the country's trust by addressing them.

... "Being an observer would give India access to data from the International Monitoring System's 337 facilities located in 89 countries that monitor the planet for signs of nuclear explosions. This system can detect even small nuclear explosions using seismology, hydro-acoustics, infrasound and radionuclide technologies. Nowhere can you get this quality of data necessary for earthquake monitoring. The IMS also helps warn of tsunamis and volcanic ash, and identifies plane crash sites," said Mr Zerbo.

... Upon being asked why the organisation was not putting pressure on countries like the United States and China to ratify the treaty, the CTBTO executive secretary said that Beijing was taking small steps in this direction. "Five IMS stations have been certified in China over the last 15 years. The US continues to be the biggest funder for the CTBTO, and has not cut funds at any point," he added. For a start, Mr Zerbo has invited India to participate in the science and technology conference scheduled between June 24 and 28 in Vienna. ...

Source: https://www.ndtv.com, 15 May 2019.

Kazakh Mazhilis members approved during a May 15 plenary meeting the draft law on ratification of the Treaty on the Prohibition of Nuclear Weapons. "The treaty is the first international document in history that introduces a legal ban on nuclear weapons – the last of the types of weapons of mass destruction that has not previously been banned. A legal ban on nuclear weapons, that is, their de-legitimisation, is the first step towards its complete destruction.

KAZAKHSTAN

Kazakh Mazhilis Members Ratify Treaty Banning Nuclear Weapons

Kazakh Mazhilis (lower house of Parliament) members approved during a May 15 plenary meeting the draft law on ratification of the Treaty on the Prohibition of Nuclear Weapons. "The treaty is the first international document in history that introduces a legal ban on nuclear weapons – the last of the types of weapons of mass destruction that has not previously been banned. A legal ban on nuclear weapons, that is, their de-legitimisation, is the first step towards its complete destruction," said Deputy Minister of Foreign Affairs Yerzhan Ashikbayev.

... To date, 23 countries have ratified the document out of the 50 required for its entry into force. The provisions of the treaty correspond to Kazakhstan's long-held non-proliferation stance. Kazakhstan renounced in the early 1990s what was then the world's fourth-largest nuclear arsenal inherited from the collapsed Soviet Union and has since become a global leader in the effort to seek a nuclear weapons-free world. "We expect that the ratification and entry into force of the treaty will last about four years, in general, the experts are quite optimistic.... We believe that the treaty will enter into force and become a new reality that all states will have to reckon with," said Ashikbayev.

Source: https://astanatimes.com, 27 May 2019.

NUCLEAR SAFETY

ESTONIA–FINLAND

Estonian, Finnish Environment Authorities Sign Nuclear Safety Memorandum

Estonia's Environmental Board signed a memorandum of understanding with Finland's Radiation and Nuclear Safety Authority, aimed at building further on the two agencies' cooperation, especially in the exchange of information and emergency response concerning nuclear and radiation-related events. A press release by the Environmental Board also stated that said cooperation will also cover radiation monitoring, an exchange of knowledge, decision-making processes concerning nuclear installations, training exercises, and legislation. The agreement was signed by the Environmental Board's director-general, Riho Kuppart, and the director-general of the Finnish Radiation and Nuclear Safety Authority, Petteri Tiippana.

According to Kuppart, the memorandum is building on "substantive and intensive" cooperation between the two authorities. "For the first time, we have now signed a specific agreement on which to base our work in the future," he added. Tiippana commented that this kind of international cooperation is particularly important where potential emergencies are concerned, when quick action is required. "With a working regime in place, we can be sure that the decisions adopted in the other country are based on identical threat estimates," he said.

Source: https://news.err.ee, 25 May 2019.

NUCLEAR WASTE MANAGEMENT

GENERAL

Nuclear Waste Management to Become Crucial as Emerging Economies Increase their Existing Nuclear Capacity, Says TMR

High-level waste (HLW) created due to the use of nuclear reactors has been identified as a major issue globally. Unlike industrial waste, the hazards associated with nuclear waste, such as its radioactivity, do weaken with time. The used nuclear fuel left after it has spent over 3 years in reactors, generating heat to produce electricity, is the most significant HLW produced during nuclear generation. A majority of nuclear waste management strategies are therefore targeted at disposing of high-level waste. Transparency Market Research (TMR) finds that HLW accounted for the dominant share of 35.9% in the global nuclear waste management market in 2015.

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Nuclear waste usually refers to materials or residues left after the burning of nuclear fuel in reactors. These residues mainly comprise radioactive materials that can cause acute radiation sickness. The rapidly growing population and the subsequently rising electricity demand, increasing dependence on fossil fuel, and increasing awareness regarding alternative energy sources are the key drivers of the global nuclear waste management market.

However, nuclear waste management requires high initial cost and has high payback period, which are inhibiting its growth trajectory to an extent. Nevertheless, the implementation of stringent government regulations aimed at curbing harmful emissions will boost opportunities for the market in the near future. TMR forecasts the global nuclear waste management market to reach US$5,627.5 mn by 2024, rising at a CAGR of 16.7% between 2016 and 2024. The market stood at US$1,382 mn in 2016. Increasing Installation of Pressurized Water Reactors Fuels Demand for Nuclear Waste Management

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Globally, the demand for waste management services is expected to be the highest from pressurized water reactors. Boiling water reactors are likely to exhibit the second highest demand for nuclear waste management in the global market. In 2015, the pressurized water reactors segment led the global nuclear waste management market holding a dominant share of 69.3%.

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Likewise, the demand for nuclear waste management in boiling water reactors is also expected to rise in the forthcoming years. These reactors operate in lower fuel temperature and require lower pressure compared to pressurized water reactors. The boiling water reactors segment is thus poised to exhibit a greater CAGR than pressurized water reactors.

Source: https://amarketresearchgazette.com, 21 March 2019.

MARSHALL ISLANDS

Fears Grow that 'Nuclear Coffin' is Leaking Waste into the Pacific

The tropical blue skies over the southern Pacific Ocean were enveloped by towering mushroom clouds lingering over the Marshall Islands in 1954 as the United States continued its testing of nuclear weapons. The United States conducted 67 nuclear weapon tests from 1946 to 1958 on the pristine Marshall Islands. The most powerful test was the "Bravo" hydrogen bomb in 1954, which was about 1,000 times more powerful than the bomb dropped on Hiroshima, Japan.

The extensive nuclear bomb testing blanketed the islands in radioactive ash, covering it in the fine, white, powder-like substance. Children, unaware of what the radioactive ash was, played in the "snow" and ate it according to the Atomic Heritage Foundation.

Today, there are growing concerns that the temporary containment of the nuclear waste resulting from those tests is leaking into the Pacific Ocean and could be cracked wide open from the next storm that rolls by. Specifically, the site is believed to be leaking one of the most toxic substances in the world, the radioactive isotope plutonium-239, a byproduct of nuclear bombs that decays with a half-life of 24,100 years.

In 1977 the United States worked to clean up the radioactive waste left strewn across the Marshall Islands. In total, an estimated 73,000 cubic meters of radioactive soil was collected across the

Marshall Islands. The US used a crater from an especially large nuclear bomb test on Runit Island to stash away the radioactive soil. The 328-foot crater from a May 1958 test was designated the dumping ground.

As this was considered a temporary solution, the crater bottom was not lined with impervious material, which would have prevented radioactive waste from entering the below aquifers and Pacific Ocean. After the material was piled into the crater, an 18-inch thick concrete dome was positioned on top of it as a temporary containment. Plans for permanent radioactive waste storage were never finalized and thus the temporary solution has sat as-is for nearly 40 years.

Shortly afterward, in 1983 the Marshall Islands agreed on their severity from the United States and with it, the islands released the United States of any responsibility for past nuclear testing.

Rising sea level, soil shifting, and storms have all caused new concern over the integrity of the "nuclear coffin" and its ability to contain radioactive waste. The dome is reportedly cracking and the local government fears the next big storm may split the concrete dome apart. In addition, groundwater models suggest that seawater is almost certainly accessing the crater. However, it is unclear how much nuclear waste is seeping from the unlined crater bottom into the Pacific Ocean and groundwater aquifers. Despite recent awareness around the issue, the Marshallese government does not have the money or expertise to properly clean up and isolate the nuclear waste. Thus, the Marshallese are left helpless as their tropical islands continue to leak deadly radioactive waste across its coral reefs.

Source: Trevor Nace, https://www.forbes.com, 27 May 2019.

Centre for Air Power Studies

The Centre for Air Power Studies (CAPS) is an independent, non-profit think tank that undertakes and promotes policy-related research, study and discussion on defence and military issues, trends and developments in air power and space for civil and military purposes, as also related issues of national security. The Centre is headed by Air Marshal K.K Nohwar, PVSM VM (Retd).

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