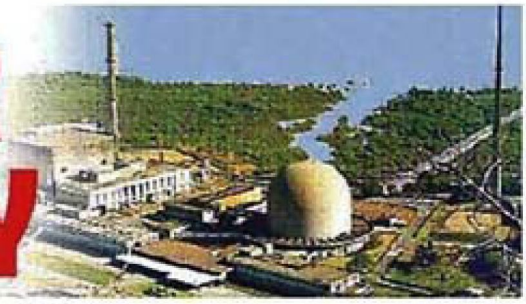
NUCLEAR SECURITY



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

Vol 14, No. 11, 01 APRIL 2020

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OPINION – Manpreet Sethi

Cyber-Nuclear Security Challenges: An Issue that Won't Go Away

As the world—pretty much the entire world—grapples with COVID-19, it is clear that the enormity of the pandemic will not leave any aspect of the economy untouched. Inter-state and societal interactions are also expected to feel the impact. Life may never be the same again. An event of almost similar magnitude in recent memory is the one that took place on 11 September 2001, when the twin towers in New York city came crashing down. That incident, too, changed many things, particularly how the world travelled; as elaborate and many inconvenient security restrictions became the norm.

With the current uncertainty generated by the new Coronavirus, it is a good time to spare another thought for the dangers of nuclear security that too can emerge quickly and leave a widely destructive trail. The subject of nuclear terrorism has silently faded out of public sight and political attention ever since the NSS process ended in 2016. Of course, institutions like the IAEA, Interpol, and some arms of the UN have continued to implement action plans that were drawn when the NSS process wound up. But, over the past four years, there has not been much public scrutiny of the implementation of measures related to the many dimensions of nuclear security. This is too important an issue to let out of sight, and any untoward incident that would qualify as an act of nuclear terrorism would yet again have an impact of the kind that 9/11 or COVID-19 have wrought on countries.

Over the past four years, there has not been much public scrutiny of the implementation of measures related to the many dimensions of nuclear security. This is too important an issue to let out of sight, and any untoward incident that would qualify as an act of nuclear terrorism would yet again have an impact of the kind that 9/11 or COVID-19 have wrought on countries.

The NSS process that lasted through 2010-2016 paid special attention to the securing of nuclear and radiological material through proper material accounting and regulatory processes. National responsibilities were clearly delineated and were to be performed in keeping with some identified international instruments and benchmarks.

During these four years, the number of subscriptions to these instruments increased, and countries took pride in showcasing efforts towards the fulfilment of their relevant obligations. Attention was also drawn to the physical security of nuclear sites, including obviating chances of airplane crashes into nuclear reactors, à la 9/11.

The NSS process, however, finished without adequately shining the spotlight on all dimensions of nuclear terrorism. While the chances of theft of nuclear material or physical intrusion into nuclear sites and unauthorised access to orphan radiological material were addressed and sought to be minimised, the possibility of cyberattacks to virtually interfere with nuclear operations did not get as much attention.

In contemporary nuclear threat perceptions, cyber threats to nuclear power plants and facilities as part of a country's critical infrastructure have significantly grown. With physical access becoming difficult, cyberattacks—which can be long distance, remote-controlled, and non-attributable—have naturally emerged as more attractive. These can be undertaken for purposes of espionage of technological information, data theft from networked systems, or to trigger some sort of malfunctioning of command and control systems, including accidents such as the loss of coolant (LOCA) kind at a nuclear power plant.

While no such incidence of a great magnitude has yet taken place in the 400-plus nuclear power plants operational across the world, cyber probes of various kinds have, nevertheless, occurred. As per one publication, "There have been over 20 known cyber incidents at nuclear facilities since 1990 all over the world...." A recent such incident came to light in the context of the cyberattack on the Indian nuclear power plant at Kudankulam in September-October 2019.

According to media reports that began to come out in October 2019, a US-based cyber security company had, on 4 September 2019, informed the NPCIL, the operator of all Indian nuclear plants, that an unauthorised actor had breached domain controllers at the KKNPP. The initial reaction from the plant officials was a complete denial of any malware infection in their systems since such a cyberattack was "not possible." A press release from the KKNP Training Superintendent and Information Officer stated, "KKNPP and other Indian nuclear power plants control systems are stand alone and not connected to outside cyber network and Internet." But, a day later, the NPCIL admitted that there had indeed been a security breach that had been informed to them by the Computer Emergency Response Team-India (CERT-In). The breach was eventually traced to an infected personal computer that was used for administrative purposes, but was also connected to the Internet. Fortunately, as was reported, the PC was isolated from the critical internal network.

Several cyber experts have pointed out vulnerabilities in this process that may be created by use of removable media, approved access points for maintenance activities, third-party updates, or even by charging personal phones via reactor control room, etc. For all its benefits, air gapping obviously does not guarantee adequate security and cannot be a reason for complacency.

Indeed, the Computer and Information Security Advisory Group of the Department of Atomic Energy (CISAG-DAE), which is responsible for the cyber security of nuclear power plants, has long argued that the practice of air gapping, or physically isolating critical computers or networks from unsecure networks such as the Internet, is an effective way of securing critical infrastructure. However, several cyber experts have pointed out vulnerabilities in this process that may be created by use of removable media, approved access points for maintenance activities, third-party updates, or even by charging personal phones via reactor control room, etc. For all its benefits, air gapping obviously does not guarantee adequate security and cannot be a reason for complacency.

Much speculation has taken place after the KKNPP incident about who might have been behind the attack. Several theories abound, and some are backed by analysis undertaken by cyber professionals. Most have concluded that the

motive of the attack was theft of information and not sabotage of plant operations. While plant control and instrumentation systems were not compromised in any way, the attack did highlight the challenge of definitive attribution in case of cyberattacks. This can be exploited by both state and non-state perpetrators of such attacks. Another benefit accrues from the ambiguity about the purpose of the attack. Even when ostensibly unsuccessful, an incidence of this nature nevertheless sends nuclear operators scrambling for patches for perceived vulnerabilities, and thus causes accretion of costs and dissipation of energies.

The only defence against them can be stringent articulation and implementation of cyber security SoPs by all those involved, and zero-tolerance for any violations by vigilant regulators. Outsiders (adversaries of all kinds) will constantly be on the lookout for vulnerabilities, and the onus will be on the insiders to keep all avenues blocked.

While enough cyber experts are engaged within and outside the nuclear establishment to secure them from cyber threats, it needs saying that the cyberspace allows new opportunities to resolute enemies to create problems at functioning nuclear plants by causing sabotage to effectuate different degrees of malfunctioning. These threats will only increase as greater digitalisation of power plants' control systems takes place, which is inevitable given the pervasive utilisation of such technologies. The only defence against them can be stringent articulation and implementation of cyber security SoPs by all those involved, and zero-tolerance for any violations by vigilant regulators. Outsiders (adversaries of all kinds) will constantly be on the lookout for vulnerabilities, and the onus will be on the insiders to keep all avenues blocked.

India must remain engaged with the international community on this issue and be part of national or IAEA-driven technical or training programmes. Regular cyber security courses for all plant personnel, depending on their involvement in digital networks, will be critical to imbue the establishment with a cyber security culture. This culture, in fact, must pervade a wider universe that should also include suppliers, vendors, contractors, and even transporters; any of whom could be used by resolute adversaries to sneak in cyberattacks. In case of nuclear power plants, virtual security is going to matter as much as their physical security.

Source: Dr Manpreet Sethi is a Senior Fellow at the Centre for Air Power Studies (CAPS), New Deli. http://ipcs.org/comm_select.php?articleNo=5664, 23 March 2020.

OPINION – ED Lyman

Nuclear Power Safety and the COVID-19 Pandemic

With the world facing overwhelming and immediate threats from the COVID-19 pandemic, the risks of nuclear power are probably far from the thoughts of most people. But there is no escaping the fact that nuclear plants, which provide about 20 percent of the US electricity supply, require highly-trained staff to operate them safely and to protect them from terrorist attacks.

With the world facing overwhelming and immediate threats from the COVID-19 pandemic, the risks of nuclear power are probably far from the thoughts of most people. But there is no escaping the fact that nuclear plants, which provide about 20 percent of the US electricity supply, require highly-trained staff to operate them safely and to protect them from terrorist attacks.

They also need periodic maintenance to ensure that critical safety systems remain in good working order. And, they must be closely supervised by the NRC to ensure that plant owners are effectively implementing nuclear safety and security requirements. However, the NRC does not generally oversee the health and safety of plant workers unless it is related to radiation exposure, so it is largely up to the plant owners themselves to implement protective

measures against COVID-19 to ensure they have a functioning workforce. Reports about potential coronavirus cases among the workforce at Plant Vogtle in Georgia and allegations of a lack of enforcement of social distancing protocols there raise concerns about the adequacy of the industry's response to the COVID-19 pandemic.

During crises such as the current pandemic, ensuring that nuclear power plants operate safely and reliably is even more critical. Tens of millions of Americans live within 50 miles of operating nuclear power plants. A reactor accident or terrorist attack could release a large amount of radioactive material into the environment, potentially exposing many people to high levels of radiation. As the world saw after the 1986 Chernobyl and 2011 Fukushima accidents, such an event at a US nuclear plant might force people from their homes for months or longer and contaminate food and water supplies—the last thing Americans need to deal with right now. Compounding the impacts of such a disaster with the social and economic disruptions caused by spread of the virus would further strain an already fragile health care system and economy. Thus, it is incumbent on the NRC to make sure that the pandemic does not compromise nuclear safety and security—and if it does, to take whatever actions, including ordering plant shutdowns, are necessary.

The NRC will likely face tremendous pressure from nuclear plant owners, some of whom are financially strapped, to keep their plants running and generating revenue. The NRC should have developed a policy long ago to address these questions, but like the rest of the U.S. government, it is now playing catch-up fast.

However, the NRC will likely face tremendous pressure from nuclear plant owners, some of whom are financially strapped, to keep their plants running and generating revenue. The NRC should have developed a policy long ago to address these questions, but like the rest of the U.S. government, it is now playing catch-up fast.

Short-Staffing Nuclear Plants: A key question the NRC may soon face is how it should react if a nuclear plant is unable to maintain the required numbers of licensed control room operators and security personnel per shift. For example, a single control room at a two-unit plant must be staffed with three operators and two senior operators. Also, there must be at least ten armed responders on each shift to protect the plant from radiological sabotage attacks—and the actual number most plants have committed to providing is likely higher. There are also regulations governing work hours and fatigue management that were put into place partly to address excessive overtime issues that arose after the 9/11 attacks. Licensees could apply for waivers from work hour restrictions if the number of available personnel were to decline, but those extensions would be limited due to the potential for fatigue. If a plant is unable to meet any of these requirements, it generally must shut down unless the NRC provides an exemption from the regulations or relief from license commitments.

NRC can allow reactors to operate while in violation of their legally binding license commitments by granting a "notice of enforcement discretion." The radiological risk to public health and safety will generally increase when the plant is operating outside of approved license limits. In evaluating whether to issue a notice of enforcement discretion, the NRC uses a standard that there should be "no significant increase" in radiological risk after reactor owners have implemented compensatory measures. This standard is nominally the same during a pandemic or other national emergency as at any other time. But difficult choices may be necessary if nuclear plant shutdowns were to jeopardize the availability of electricity during such an emergency, which is unlikely given that most regions of the country have supply well in excess of their reserve margins and COVID-19 is suppressing demand. In any event, such considerations are beyond the scope of NRC's authority to ensure radiological safety and security.

The Industry's Proposal: Increase Risk: These issues are not new. In 2006, the NRC held a workshop to consider the impacts of a pandemic flu outbreak on safety. A number of difficult policy

questions were discussed, including the potential need to sequester workers early in an outbreak and the effect of high rates of absenteeism. But little was done to resolve these questions.

In 2007 the Nuclear Energy Institute (NEI), the nuclear industry's main trade organization in Washington, submitted a draft "Pandemic Licensing Plan" to the NRC for review. The plan recognized "the potential for an influenza pandemic to reduce nuclear plant staffing below the levels necessary to maintain full compliance with all NRC regulatory requirements," described "the regulatory actions necessary to permit continued operation with reduced staffing levels for approximately four to six weeks" and recommended, "NRC enforcement discretion as the most efficient and effective licensing response to a pandemic." In justifying this approach, NEI argued that "regulatory relief to permit rescheduling of selected activities and deferral of most administrative and programmatic requirements would balance the risk from continued operation with the risk from regional blackouts and grid instability."

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At the time, the NRC did not buy NEI's argument for broad and pre-approved enforcement discretion that would increase radiological risk during a pandemic, responding that "the NRC staff finds that without bounding entry conditions and more specific technical bases for the proposed regulatory relief, NEI's approach still presents significant challenges that may prevent meaningful overall progress in pandemic preparation. For instance, the plan contains only limited justification concerning the public health and safety need for nuclear power plants to remain on-line during a pandemic; likewise, the plan does not adequately explain why increased safety and security risk may be offset by considerations of need for electric power. Moreover, the plan continues to raise other significant legal and policy issues that would need to be resolved."

The Situation Today: Too Little, Too Late: Although the NRC and NEI continued to discuss these issues more than a decade ago, there is no indication that their differences were ever resolved. Concern about an influenza pandemic was overshadowed by the Fukushima accident. Today, the NRC is in a different place. Three of the four sitting commissioners are Republicans who embody the spirit of the pro-industry, anti-regulation Trump administration. It would be shocking to see the NRC staff criticize an NEI proposal in 2020 the way it did back in 2008.

In an NRC public meeting on March 20 to discuss regulatory issues related to the coronavirus pandemic, an NEI representative referred to the 2007 NEI Pandemic Licensing Plan as the basis for the industry's regulatory contingency approach, and no one from the NRC raised the staff's previous concerns about the plan. The NRC staff said that the agency was planning to issue a memorandum to provide guidance on enforcement issues, but did not address the standards it would be using to approve enforcement discretion—and in particular, whether it now accepted NEI's argument that a net increase in radiological risk would be appropriate to reduce the unlikely risks to the electrical grid. The NRC assured me that its risk standards for granting enforcement discretion have not changed and that if they deemed any plant unsafe, they could and would issue an order to shut it down. More details should be available when it releases its Enforcement Guidance Memorandum later.

However, there may be extreme circumstances where the NRC may have to make difficult decisions that would involve the balancing of radiological risk and electricity supply risk. If so,

the NRC will need to consult not only with other government agencies responsible for grid security and infrastructure protection but also with the public. Such discussions should begin now. Hopefully, it is not yet too late to come up with a satisfactory answer.

Source: ED Lyman is Acting Director, nuclear safety project; senior scientist, Global Security Program. https://allthingsnuclear.org/elyman/nuclear-power-safety-and-the-covid-19-pandemic, 26 March 2020.

OPINION – Rajeswari Pillai Rajagopalan

Confronting India's Nuclear Regulation Challenge

India should recognise that no country has a completely fool-proof mechanism and it should not get excessively defensive about its nuclear security policies and practices. India plans to increase the share of nuclear power in the overall energy mix by more than three times from the current share by 2021. While India has impressive plans to expand its nuclear sector, it also needs to pay more attention to issues such as regulation of the industry. Earlier in March, India's Minister of State for Personnel, Public Grievances, and Pensions and Prime Minister's Office, Dr Jitendra Singh, publicised this while responding to a question in the Lok Sabha of the Indian Parliament. Dr Singh said that the current installed nuclear power capacity is 6,780 MW, which makes up around 1.84 percent of the total installed capacity of 368,690 MW. He said that the existing capacity of 6,780 MW will be augmented to 22,480 MW by 2031 by undertaking "progressive completion of projects under construction and accorded sanction."

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He added that there will be a capacity addition of 5,300 MW in the next five years, including a 500 MW PFBR being constructed at the Madras Atomic Power Station in Kalpakkam, India and implemented by BHAVINI. In an earlier debate in the Lok Sabha in June 2019, Singh had said that the installed nuclear power capacity would reach 13,480 MW by 2024-25 with the completion of certain projects.

In a November 2019 debate in the Lok Sabha on India's nuclear energy target, the government stated that it has instituted several measures for increasing the share of nuclear power in its overall energy matrix, including the "administrative approval and financial sanction" of 10 indigenous 700 MW PHWRs, with a further two LWRs to be set up in cooperation with Russia. In addition, India had also set up the nuclear insurance pool (INIP) to deal with private sector concerns about India's nuclear liability bill. India's Atomic Energy Commission has approved 10 additional uranium mining projects, and further two related projects will come up in Jharkhand. The Modi government has been silent about a related issue: that of nuclear security-related legislation or institutional measures.

India has also streamlined much of its legislative and institutional practices based on the international guidelines and standards set by the IAEA. India's nuclear safety measures have been periodically updated to reflect the changing security concerns.

While these are important steps, the Modi government has been silent about a related issue: that of nuclear security-related legislation or institutional measures. Nuclear safety and security are particularly important for India given the political instability and security environment that prevails in the region. India rightly acknowledged this even before global attention on the issue following the 11 September terrorist attacks in the United States.

India has also streamlined much of its legislative and institutional practices based on the international guidelines and standards set by the IAEA. India's nuclear safety measures have been periodically updated to reflect the changing

security concerns. In February 2020, in a statement in the Indian Parliament, Singh reiterated that India "ensures safety of Nuclear Power Plants according to International Standards."

Nevertheless, India has come under international scrutiny when it comes to its nuclear security standards. This has been the case primarily because India has shied away from openly spelling out its nuclear security policies and practices. Excessive secrecy has actually damaged India's reputation on this score. Even more importantly, India should take the issue seriously because of its own plans to expand nuclear power generation capacity. This could at some stage also involve private sector participation and it would be better for the government to spell out the rules and regulatory mechanisms.

India has a good record to promote, and a number of developing countries look at India as a model to emulate. But India's apparent discomfort in acknowledging its own nuclear security successes and challenges and engaging with the larger global nuclear community can be stifling for New Delhi in beefing up global nuclear security approaches.

This is not just a concern expressed by the global nuclear community but also by India's CAG, which has been critical of the relationship between India's current nuclear regulator, the AERB, and the Indian DAE. There have been several studies that highlight the need for India to address this is in a more effective manner, so as to strengthen its own security practices but also to improve its international standing.

The government of India has acknowledged the need to address this issue as well. In September 2011, the Manmohan Singh government introduced the NSRA Bill in an effort to establish a more independent nuclear regulator. However, it was not taken up over the next three years and the bill lapsed. There was expectation that the Modi government would reintroduce the bill and kick-start a debate in the Parliament but there is no sign yet of this happening.

India needs to formalise these changes in a new nuclear legislation in the Parliament so as to strengthen its own credibility and operational practices. The NSRA Bill is important because it would be a significant improvement over the current AERB regulatory architecture. It would establish a Council of Nuclear Safety (CNS) under the leadership of the prime minister himself. While there are critics of this as well, it is still an important demonstration of the government's resolve to have a truly independent nuclear regulator. It is important in operational terms as well, in bringing about more stringent auditing practices. In terms of the optics, it would be good that the promoter and regulator of nuclear energy are separated.

This is not difficult for India to do because it has operationalised many of the essential components in ensuring this separation, be it in addressing physical protection, nuclear transportation, or insider threats. But India needs to formalise these changes in a new nuclear legislation in the Parliament so as to strengthen its own credibility and operational practices. India should also take its international reputation seriously in order to strengthen its case with global non-proliferation platforms such as the NSG.

Lastly, India should recognise that no country has a completely fool-proof mechanism and it should not get excessively defensive about its nuclear security policies and practices. More importantly, India has a good record to promote, and a number of developing countries look at India as a model to emulate. But India's apparent discomfort in acknowledging its own nuclear security successes and challenges and engaging with the larger global nuclear community can be stifling for New Delhi in beefing up global nuclear security approaches. India must start the NSRA debate in the Parliament as a first step to improve itself. But it also provides a new opportunity for enhancing India's status now that the NSS process has come to an end.

Source: https://www.orfonline.org/research/confronting-india-nuclear-regulation-challenge-63692/, 25 March 2020.

OPINION – Alexandra Witze

How a Small Nuclear War would Transform the Entire Planet

As geopolitical tensions rise in nuclear-armed states, scientists are modelling the global impact of nuclear war. It all starts in 2025, as tensions between India and Pakistan escalate over the contested region of Kashmir. When a terrorist attacks a site in India, that country sends tanks rolling across the border with Pakistan. As a show of force against the invading army, Pakistan decides to detonate several small nuclear bombs. The next day, India sets off its own atomic explosions and within days, the Nations begin bombing dozens of military targets and then hundreds of cities. Tens of millions of people die in the blasts.

That horrifying scenario is just the beginning. Smoke from the incinerated cities rises high into the atmosphere, wrapping the planet in a blanket of soot that blocks the Sun's rays. The planet plunges into a deep chill. For years, crops wither from California to China. Famine sets in around the globe.

This grim vision of a possible future comes from the latest studies about how nuclear war could alter world climate. They build on long-standing work about a 'nuclear winter' — severe global cooling that researchers predict would follow a major nuclear war, such as thousands of bombs flying between the United States and Russia. But much smaller nuclear conflicts, which are more likely to occur, could also have devastating effects around the world.

... Researchers report that an India–Pakistan nuclear war could lead to crops failing in dozens of countries — devastating food supplies for more than one billion people1. Other research reveals that a nuclear winter would dramatically alter the chemistry of the oceans, and probably decimate coral reefs and other marine ecosystems. These results spring from the most comprehensive effort yet to understand how a nuclear conflict would affect the entire Earth system, from the oceans to the atmosphere, to creatures on land and in the sea.

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Scientists want to understand these matters because the nuclear menace is growing. From North Korea to Iran, nations are building up their nuclear capabilities. And some, including the United States, are withdrawing from arms-control efforts. Knowing the possible environmental consequences of a nuclear conflict can help policymakers to assess the threat, says Seth Baum, executive director of the Global Catastrophic Risk Institute in New York City, who has studied the risks of triggering a nuclear winter. "Fleshing out the details of ways in which it can be bad is valuable for helping inform decisions," he says.

Cold-War Forecasts: Nuclear-winter studies arose during the cold war, as the United States and the Soviet Union stockpiled tens of thousands of nuclear warheads in preparation for all-out assaults. Alarmed by leaders' bellicose rhetoric, scientists in the 1980s began running simulations on how nuclear war might change the planet after the initial horrific deaths from the blasts. Researchers including the US planetary scientist and communicator Carl Sagan described how smoke from incinerated cities would block sunlight and plunge much of the planet into a deep freeze lasting for months, even in summer4. Later studies tempered the forecasts somewhat, finding slightly less-dramatic cooling5. Still, Soviet leader Mikail Gorbachev cited nuclear winter as one factor that prompted him to work towards drawing down the country's nuclear arsenals.

After the Soviet Union collapsed in 1991, the world's stockpiles of nuclear weapons continued to drop. But with many thousands of warheads still in existence, and with more nations becoming nuclear

powers, some researchers have argued that nuclear war — and a nuclear winter — remain a threat. They have shifted to studying the consequences of nuclear wars that would be smaller than an all-out US–Soviet annihilation.

That includes the possibility of an India–Pakistan war, says Brian Toon, an atmospheric physicist at the University of Colorado Boulder who has worked on nuclear-winter studies since he was a student of Sagan's. Both countries have around 150 nuclear warheads, and both are heavily invested in the disputed Kashmir border region, where a suicide bomber last year killed dozens of Indian troops. "It's a precarious situation," says Toon.

Both India and Pakistan tested nuclear weapons in 1998, highlighting growing geopolitical tensions. By the mid-2000s, Toon was exploring a scenario in which the countries set off 100 Hiroshima-size atomic bombs, killing around 21 million people. He also connected with Alan Robock, an atmospheric scientist at Rutgers University in New Brunswick, New Jersey, who studies how volcanic eruptions cool the climate in much the same way that a nuclear winter would. Using an advanced NASA climate model, the scientists calculated how soot rising from the incinerated cities would circle the planet. All around the dark, cold globe, agricultural crops would dwindle.

But after a burst of publications on the topic, Robock, Toon and their colleagues struggled to find funding to continue their research. Finally, in 2017, they landed a grant worth nearly US$3-million from the Open Philanthropy Project, a privately funded group in San Francisco that supports research into global catastrophic risks.

The goal was to analyse every step of nuclear winter — from the initial firestorm and the spread of its smoke, to agricultural and economic impacts. "We put all those pieces together for the first time," says Robock.

The group looked at several scenarios. Those range from a US–Russia war involving much of the world's nuclear arsenal, which would loft 150 million tonnes of soot into the atmosphere, down to the 100-warhead India–Pakistan conflict, which would generate 5 million tonnes of soot. The soot turns out to be a key factor in how bad a nuclear winter would get; three years after the bombs explode, global temperatures would have plummeted by more than 10 °C in the first scenario — more than the cooling during the last ice age — but by a little more than 1 °C in the second.

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Toon, Robock and their colleagues have used observations from major wildfires in British Columbia, Canada, in 2017 to estimate how high smoke from burning cities would rise into the atmosphere7. During the wildfires, sunlight heated the smoke and caused it to soar higher, and persist in the atmosphere longer, than scientists might otherwise expect. The same phenomenon might happen after a nuclear war, Robock says.

Raymond Jeanloz, a geophysicist and nuclear-weapons policy expert at the University of California, Berkeley, says that incorporating such estimates is a crucial step to understanding what would happen during a nuclear winter. "This is a great way of cross-checking the models," he says.

Comparisons with giant wildfires could also help in resolving a controversy about the scale of the potential impacts. A team at Los Alamos National Laboratory in New Mexico argues that Robock's group has overestimated how much soot burning cities would produce and how high the smoke would go. The Los Alamos group used its own

models to simulate the climate impact of India and Pakistan setting off 100 Hiroshima-sized bombs. The scientists found that much less smoke would get into the upper atmosphere than Toon and Robock reported. With less soot to darken the skies, the Los Alamos team calculated a much milder change to the climate — and no nuclear winter.

The difference between the groups boils down to how they simulate the amount of fuel a firestorm consumes and how that fuel is converted into smoke. "After a nuclear weapon goes off, things are extremely complex," says Jon Reisner, a physicist who leads the Los Alamos team. "We have the ability to model the source and we also understand the combustion process. I think we have a better feel about how much soot can potentially get produced." Reisner is now also studying the Canadian wildfires, to see how well his models reproduce how much smoke gets into the atmosphere from an incinerating forest.

Robock and his colleagues have fired back in tit-for-tat journal responses. Among other things, they say the Los Alamos team simulated burning of greener spaces rather than a densely populated city.

Dark Seas: While that debate rages, Robock's group has published results showing a wide variety of impacts from nuclear blasts. That includes looking at ocean impacts, the first time this has been done, says team member Nicole Lovenduski, an oceanographer at the University of Colorado Boulder. When Toon first approached her to work on the project, she says, "I thought, 'this sure seems like a bleak topic'." But she was intrigued by how the research might unfold. She usually studies how oceans change in a gradually warming world, not the rapid cooling in a nuclear winter.

Lovenduski and her colleagues used a leading climate model to test the US–Russia war scenario. "It's the hammer case, in which you hammer the entire Earth system," she says. In one to two years after the nuclear war, she found, global cooling would affect the oceans' ability to absorb carbon, causing their pH to skyrocket. That's the opposite to what is happening today, as the oceans soak up atmospheric carbon dioxide and waters become more acidic.

She also studied what would happen to aragonite, a mineral in seawater that marine organisms need to build shells around themselves. In two to five years after the nuclear conflict, the cold dark oceans would start to contain less aragonite, putting the organisms at risk, the team has reported.

In the simulations, some of the biggest changes in aragonite happened in regions that are home to coral reefs, such as the southwestern Pacific Ocean and the Caribbean Sea. That suggests that coral-reef ecosystems, which are already under stress from warming and acidifying waters, could be particularly hard-hit during a nuclear winter. "These are changes in the ocean system that nobody really considered before," says Lovenduski.

In the case of a US–Russia nuclear war, the dark skies would cause the trade winds to reverse direction and water to pool in the eastern Pacific Ocean. As during an El Niño, droughts and heavy rains could plague many parts of the world for as long as seven years.

And those aren't the only ocean effects. Within a few years of a nuclear war, a "Nuclear Niño" would roil the Pacific Ocean, says Joshua Coupe, a graduate student at Rutgers. This is a turbo-charged version of the phenomenon known as El Niño. In the case of a US–Russia nuclear war, the dark skies would cause the trade winds to reverse direction and water to pool in the eastern Pacific Ocean. As during an El Niño, droughts and heavy rains could plague many parts of the world for as long as seven years, Coupe reported last December at a meeting of the American Geophysical Union.

Beyond the oceans, the research team has found big impacts on land crops and food supplies. Jonas Jägermeyr, a food-security researcher at NASA's Goddard Institute for Space Studies in New York City, used six leading crop models to assess how

agriculture would respond to nuclear winter. Even the relatively small India–Pakistan war would have catastrophic effects on the rest of the world, he and his colleagues report in the Proceedings of the National Academy of Sciences1. Over the course of five years, maize (corn) production would drop by 13%, wheat production by 11% and soya-bean production by 17%.

The worst impact would come in the mid-latitudes, including breadbasket areas such as the US Midwest and Ukraine. Grain reserves would be gone in a year or two. Most countries would be unable to import food from other regions because they, too, would be experiencing crop failures, Jägermeyr says. It is the most detailed look ever at how the aftermath of a nuclear war would affect food supplies, he says. The researchers did not explicitly calculate how many people would starve, but say that the ensuing famine would be worse than any in documented history. Farmers might respond by planting maize, wheat and soya beans in parts of the globe likely to be less affected by a nuclear winter, says Deepak Ray, a food-security researcher at the University of Minnesota in St Paul. Such changes might help to buffer the food shock — but only partly. The bottom line remains that a war involving less than 1% of the world's nuclear arsenal could shatter the planet's food supplies. ...

Source: https://www.nature.com/articles/d41586-020-00794-y, 16 March 2020.

OPINION – Neal Singer

Initiatives to Protect US Energy Grid and Nuclear Weapons Systems

To deter attempts to disable U.S. electrical utilities and to defend U.S. nuclear weapon systems from evolving technological threats, Sandia National Laboratories has begun two multiyear initiatives to strengthen U.S. responses. One is focused on defending large U.S. electrical utility systems from potential attacks by hostile nations, as well as from damage inflicted by extreme natural disasters like hurricanes and solar flares. The Resilient Energy Systems campaign, a multi-year research portfolio with up to $40 million in total funding, is supported by Sandia's Laboratory Directed Research and Development program, which funds exploratory work in science and technology.

"The original electric grid was not designed with security in mind against cyber-hacks, or protection from electromagnetic disturbances, or natural disasters such as hurricanes or geomagnetic solar storms," portfolio manager Craig Lawton said. He also said that, "The primary objective of our mission portfolio is to mitigate vulnerabilities caused by antiquated technology in transformers and other components. Solutions require research, and we're looking for collective inputs of ideas from researchers in industry, utility companies, universities, other labs and of course Sandia."

To deter attempts to disable U.S. electrical utilities and to defend U.S. nuclear weapon systems from evolving technological threats, Sandia National Laboratories has begun two multiyear initiatives to strengthen U.S. responses.

Deterring Aggression by Updating Weapon Systems: The second research campaign is developing enabling technical capabilities to help the US maintain its strategic nuclear deterrent. The Assured Survivability and Agility with Pulsed Power research campaign is a multi-year portfolio with up to $40 million in total funding, again by Sandia's LDRD program. The mission portfolio is intended to explore technologies that use brief but powerful bursts of electrical energy to simulate nuclear explosions—without resorting to actual nuclear tests—to better understand their impact on electronics and materials.

"Our nuclear weapons systems have been relatively static, while the capabilities and technologies used by our potential adversaries are evolving at a rapid pace," said Sandia physicist Kyle Peterson, who developed and leads the mission. "We must be more agile in identifying potential threats to maintain an effective

deterrent against hostile military actions. "We're open to, and hope for, input from researchers in industry, universities and other national labs as well as Sandia to contribute ideas and work in this effort," said Peterson. Additional benefits from both mission portfolios are expected to include more efficient electrical generation, more accurate data for astrophysicists, and a closer approach to break-even and even high-yield fusion, which can generate electrical energy by fusing atoms—a goal of a branch of physics for 70 years.

Improving Resiliency of US Utilities: There's room for improvement in the protection of the U.S. energy system, said Lawton. He further said, "our electrical generating systems may be more vulnerable than we would like". "Many of these were built in simpler times, some around the early 20th century. Though remarkably durable, since then they have been overlaid with complex computer control systems to assist in responding to the complicated demands of today." These computer systems, he says, are vulnerable to cyber hacking that could alter or disable them, potentially disrupting power to large geographic areas.

"Electricity runs almost everything in modern society," Lawton said. "Without it, food goes bad, hospitals can't function, credit cards don't work. Dams letting out prescribed amounts of water and gas pipelines operate autonomously through codes." In addition to maliciously created computer problems, "damage from naturally occurring threats, like hurricanes, can cause problems that may stretch out for long periods of time if replacement parts aren't readily available," he said. While large utilities already have lightening surge arrestors to mitigate lightning strikes, and highly efficient lightning rods, "they don't operate fast enough to catch a nanosecond electromagnetic wave from a nuclear weapon exploded high in the atmosphere." The electromagnetic pulse could fry unprotected circuits, he said.

While utility companies are required to have contingency plans in place to provide power if one generator in a large system goes out, there's no prepared response if they lose many generators at once, he said. "These are some of the problems that we expect our upcoming work to mitigate," Lawton said. "We believe that ideas proposed to increase our electrical security will come from Sandia and other national labs, universities and the utility companies themselves."

***The Intense Realm of ASAP*:** Among the military problems that an adversary might present are more capable weapon systems as well as technology intended to confuse a U.S. missile and deflect it from reaching its target. The Assured Survivability and Agility with Pulsed Power, ASAP, campaign will invest in science and technology needed to ensure that "U.S. military objectives will be met in the event that deterrence fails," Peterson said.

Further study of brief strong pulses of electrical power are needed to help meet that goal. Pulsed-power accelerators store energy and release it in powerful bursts. Those can be converted into X-rays and neutrons to be used as a laboratory version of an actual bomb blast to assess how nuclear and conventional weapon systems would respond if subjected to those environments. Sandia uses pulsed power technology in a number of different facilities—Saturn, Hermes and Z—and is currently developing proposals to enhance some of these capabilities. One is directed-energy weapon systems, said Peterson. Pulses of pure energy could deter platoons of advancing soldiers by making them uncomfortably warm. Focused to a narrower beam, they could be used to shoot down incoming missiles near-instantaneously.

A dramatically improved successor to the Z facility has been proposed that would deliver 10 times the energy output of Z currently: a petawatt (quadrillion watts) electrical pulse. Said Peterson, "This would create unprecedented levels of X-rays and neutrons, as much as tens of thousands more neutrons than currently generated by Z today." Z is already the world's most powerful generator of X-rays. ...

However, to realize such a facility and other advances, the ASAP research campaign is needed to develop better understanding of basic support issues like high voltages and current delivery,

electrical breakdowns and how to prevent them, more efficient and reliable capacitors and switches, and new materials for delivering petawatts of electrical power.

Such basic engineering research will do a lot for science, said Peterson. According to him, it would enable better astrophysics experiments, create higher temperatures and pressures for material science, and higher fidelity environments for radiation effects testing on electronics and materials." Also, significant would be creating tools to manage the debris from repeated experiments from an improved Z that each would generate the energy equivalent of more than 20 sticks of dynamite exploding in nanoseconds in a tiny enclosed space. "If a Z successor were built without improvements in its underlying support structure, its first firing would be a lot easier to achieve than its second," said Peterson. He's looking for ideas from qualified researchers to help the mission succeed in its aim of improving national security.

The amount of money spent in one year by the US on nuclear weapons could instead provide 300,000 ICU beds, 35,000 ventilators and 75,000 doctors' salaries, according to the ICAN – a "coalition of non-government organizations promoting adherence to and implementation of the UN nuclear weapon ban treaty.

France spent around $4.9 million on nuclear weapons in 2019. This amount would translate to 100,000 ICU beds, 10,000 ventilators and the salaries of 20,000 French nurses and 10,000 French doctors. In the UK, nuclear spending costs nearly $8.7 billion in 2019. That could pay for 100,000 ICU beds, 30,00 ventilators, and the salaries of 50,000 British nurses and 40,000 British doctors.

Source: https://techxplore.com/news/2020-03-energy-grid-nuclear-weapons.html, 24 March 2020.

OPINION – Matthew Impelli

One Year of US Nuclear Weapons Spending Would Provide 300,000 ICU Beds, 35,000 Ventilators and Salaries of 75,000 Doctors

The amount of money spent in one year by the US on nuclear weapons could instead provide 300,000 ICU beds, 35,000 ventilators and 75,000 doctors' salaries, according to the ICAN – a "coalition of non-government organizations promoting adherence to and implementation of the UN nuclear weapon ban treaty."

In its recent report, the group stated that, according to armscontrol.org, the U.S. spent $35.1 billion on nuclear weapons in 2019. The costs are based on reported averages, but the study noted that the $35.1 billion in nuclear weapons spending would instead pay for "300,000 beds in intensive care units, 35,000 ventilators, and the salaries of 150,000 U.S. nurses and 75,000 U.S. doctors."

The report comes as the novel coronavirus has globally infected over 492,000 people, according to a tracker provided by Johns Hopkins University. As the number of confirmed COVID-19 cases increases, more resources are required. According to a recent report by healthaffairs.org, should the coronavirus continue to spread at its current rate, in a six-month period nearly 300,000 ICU beds would be needed in the US.

The shortage of ventilators in US hospitals has also been a major issue during the coronavirus pandemic. During a recent interview with Vox, Dr. Tom Freiden, former head of the Centres for Disease Control and Prevention (CDC), stated that "in the worst-case scenario, in which there is an exponential surge in COVID-19 cases, the need for ventilators could greatly outstrip the number available."

In addition to the shortage, the cost of the ventilators has also become a problem for hospitals. According to The Washington Post, they can cost between $25,000 to $50,000 and require very skilled people to run them. The report published by ICAN also touches on the nuclear spending costs of the United Kingdom and France. For instance, France spent around $4.9 million on nuclear weapons in 2019. This amount, based on reported averages, would translate to 100,000 ICU beds, 10,000 ventilators and the salaries of 20,000

French nurses and 10,000 French doctors. In the UK, nuclear spending costs nearly $8.7 billion in 2019. That could pay for 100,000 ICU beds, 30,00 ventilators, and the salaries of 50,000 British nurses and 40,000 British doctors. ...

Source:https://www.newsweek.com/one-year-us-nuclear-weapon-spending-would-provide-300000-icu-beds-35000-ventilators-salaries-1494521, 26 March 2020.

OPINION – Stuart Clift

Proposal for 'Low-Yield' Nuclear Weapons is a Farce

The advancement and deployment of a new nuclear weapon to our submarine fleet is beyond ignorance. And the fact that we are deploying "low yield" ballistic missiles to our arsenal reeks of total stupidity. This made-up Russian threat of "escalate to deescalate" is so far from reality. The reality and policy have been deterrent. You toss missiles at us we reply in force. Which would lead to total destruction of life as we know it. Trump's request for $29.9 billion to modernize delivery systems could be better used on education, health care and infrastructure.

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Sixty cents of every tax dollar go to feed the military industrial complex. We have 800 bases outside the United States that we know of, they have two. Who's the threat? The thinking that we can use "lower yield" weapons and not destroy ourselves in the process lacks any credibility. In an article published in Foreign Affairs in 1982, four American statesmen declared "no one has ever succeeded in advancing any persuasive reason to believe that any use of nuclear weapons, even on the smallest scale, could reliably be expected to remain limited." The Trump administration should contemplate these words as they embrace the new "low yield" weapons. The reality is it deters nothing. Maybe Trump will drop the bomb to show how tough he is and then the debate will be over and if we are not vaporized in the blast zone, we can mull our slow demise while pondering why we were so stupid.

Source: https://www.heraldnet.com/opinion/proposal-for-low-yield-nuclear-weapons-is-a-farce, 16 March 2020.

OPINION – Konstantin Bogdanov

Not-So-Nuclear War

On February 4, 2020, the U.S. Department of Défense officially announced the first combat patrol mission of a nuclear-powered submarine carrying low-yield nuclear-tipped ballistic missiles. Some details were reported several days before that: the platform was USS Tennessee, which had gone on combat patrol in the Atlantic in late 2019. The low-yield combat payload in question represent the all-new W76-2 thermonuclear warhead for the Trident II D5 SLBM. It is a derivative of the standard "light" W76-1 warhead, with the original secondary stage removed. As a result, the original yield of 100 kt has been reduced to between 5 and 7 kt.

According to official explanations, up to and including those contained in the new nuclear doctrine, the United States intends to use the weapon to give additional stability and flexibility to its regional (not strategic!) nuclear deterrence. The idea is that the number of such missiles will be limited, because they are intended for fairly specific purposes. The U.S. military had long

sought permission for low-yield nuclear weapons from the White House, arguing that the president was only limited to high-yield weapons as a last resort and that "interim" response options would come handy in certain scenarios. These were eventually termed "tailored" nuclear scenarios in the new doctrine.

These statements become more specific when looked at through the prism of expert chatter, stories run by specialized publications and private statements. Such as: What if the Russians attack an Eastern European country and, quite inevitably, receive a devastating response from NATO, but then they cunningly use their TNW to raise the stakes? How would the free world respond to that? Their requests are quite simple and clear. The only question here is, why use a strategic SLBM in a purely tactical mission?

***Something is Lacking*:** The US has two types of nuclear weapons in its arsenals that would perfectly fit the purpose in terms of their yield. There are AGM-86B (ALCM) long-range air-launched cruise missiles, the backbone of the strategic triad's air component. These are tipped with W80-1 warheads with dialable yield from 5 to 150 kt. There are also B61-family tactical nuclear gravity bombs that come in four different variants, some of them with 300 t and 1.5 kt yield in TNT equivalent.

Why Another Low-Yield Warhead? The problem is not in the warhead itself, but in the delivery method. Russia, and the USSR before it, have historically been inferior to NATO in terms of airpower. For this reason, Russia has always relied on air defence (and electronic warfare) and is perhaps still the best when it comes to building reliable multi-layered air defence. It is, therefore, extremely difficult to penetrate a single air-launched nuclear weapon through that detection and multiple engagements system. The ALCM has been around for a long time, it is a well-known missile. Its more advanced derivative, the AGM-129, was decommissioned because it proved to be inferior. The combat aircraft with B61 were similarly ill-suited for such a hostile environment. Starting a nuclear mission and stupidly losing the delivery vehicle to a Pantsyr or an S-400 would have been a much harder blow than refraining from participation in the escalating conflict.

Single nuclear strikes (as opposed to the massive use of nuclear force) on the theatre become a challenge. Theoretically, at some point, the United States will have nuclear systems that would be up to the task due to their stealth capabilities (LRSO cruise missiles, F-35 combat aircraft plus B61-12 guided bombs) or short flight time combined with the ability to break through air or missile defence (land, sea or air-launched hypersonic boost-glide systems). However, the problem articulated by the United States has to be addressed right now.

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This leads to a palliative solution that implies removing the secondary stage from the W76-1 and using the resulting mini-Trident as a guaranteed delivery vehicle. Strange as it may seem, high accuracy is not required here. Not only will the strike be directed against a "soft" target (tactical formations, emplaced positions, or above-ground structures), but it does not even have to hit that target since it is the very fact of the use of nuclear force that matters during the early stages of escalation and not the actual damage. It may seem clear, but how real is this image of "deterring" Russia? Is it even possible to have such a conflict as the one described in the American strategic papers?

On Reading and Comprehension Skills: Descriptions of a possible conflict along the lines

of "Russia suddenly invaded the Baltic states, pre-emptively used its TNW to confuse NATO and force the alliance into a retreat" do not even merit earnest critical consideration. It is quite sad that such ideas are widespread among western political scientists and security experts. However, even an expert with the greatest bias against Russia is likely to acknowledge that no matter what one thinks of Russian dignitaries, no matter what malicious intents one ascribes to them, believing these people to be infantile or irrational is a crucial research fallacy. Over the last couple of decades, the Russian elites have demonstrated a reserved, mistrustful and utterly rational (to the point of cynicism) approach to foreign and domestic policies, an approach that is utterly incompatible with the reckless idea of "let's occupy the Baltic states, detonate a bomb and threaten a total nuclear war, because we're bound to lose any other way."

But what is this idea based on? It is based on Russia's actual nuclear strategy, the general understanding of which is almost completely the opposite to its intended meaning. Russia has constructed a defence plan against a stronger enemy on the basis of the concept of the limited use of nuclear weapons in special cases.

The logic of "de-escalating" a military conflict by raising the stakes in the form of limited (including demonstrative) use of nuclear weapons has been repeatedly expounded both in general terms and in military details. Asymmetric scenarios are no exception. In such cases, a country responds to a massive attack of conventional forces with a first (limited) nuclear strike. Since, following the collapse of the Warsaw Pact and the lengthy socioeconomic crisis of the 1990s, Russia had significantly fewer conventional weapons than NATO, it was a rational strategic deterrence plan that implied balancing out conventional weapons with nuclear forces.

This was duly reflected in strategic planning documents. The foundation for such planning was laid back in 1993, when Russia officially disengaged itself from the 1982 Soviet obligation not to deliver the first nuclear strike, even though this use of nuclear weapons still applied to a global war only. Subsequently, Russia developed a full-fledged military doctrine in 2000 that allowed the use of nuclear weapons "in situations that were critical for the national security of the Russian Federation," including "in response to a large-scale aggression using conventional weapons."

In 2010, the new version of the military doctrine showed the direction of Russia's military development. The wording became more specific: now nuclear weapons could only be used in a conflict that "threatened the very existence of the state." The current 2014 doctrine retains this strict wording and additionally bolsters it by introducing the notion of "strategic non-nuclear deterrence" that had previously been absent.

In 2010, the new version of the military doctrine showed the direction of Russia's military development. The wording became more specific: now nuclear weapons could only be used in a conflict that "threatened the very existence of the state." The current 2014 doctrine retains this strict wording and additionally bolsters it by introducing the notion of "strategic non-nuclear deterrence" that had previously been absent.

Let us note that this latter step was taken at the peak of the military and political crisis between Russia and the West, in the second half of 2014. If Russia had indeed relied on the irrationally incommensurate nuclear deterrence of the West and, in accordance with the classical "madman theory," had wished to convince the West of this, there would have been no obstacles in the way of Russia enshrining such deterrence officially. Instead, Russia demonstratively enacted a "doctrinal détente."

***They Offered War and Nobody Came*:** Taken together, these developments reflected Russia's efforts to rebuild and modernize its armed forces setting a course for raising the threshold for the use of nuclear weapons and for gradually filling up all those potential rungs on the escalation ladder that previously had to be "secured" using nuclear means with non-nuclear precision-guided weapons.

A number of motives driving this evolution can be identified. First, it is a flexible and comprehensive approach to deterrence that was not entirely typical for the USSR in the last years of its existence. Second, there is a clear unwillingness to endow nuclear weapons with any significance greater than that inevitably required by the military strategic balance. Third, the logic of this development directly contradicts the very idea of "nuclear coercion" in regional conflicts with NATO. To coin a phrase, Russia has been gradually "clearing the mines" from a dangerous destabilizing situation that had emerged on the continent following the collapse of the Warsaw Pact and significant curtailing of the potential of Russia's armed forces. The temporary lowering of the threshold for using nuclear weapons reflected precisely the transitory nature of the current factors.

Thus, at the moment, we can presume that Russia cannot simply deliver a first nuclear strike when things start going wrong in a military conflict with a near-peer adversary. The circumstances have to be more severe than this, in which is clearly and presently suffering a large-scale military defeat that threatens a national disaster. Regardless of who started it.

Let us, however, go back to "mini-Tridents" and see what their place in this scenario is. Everything appears to be just the same, but there is one flaw that cannot be eliminated. Such weapons systems will hardly be an effective deterrent if Russia has been cornered so badly that it used nuclear weapons to de-escalate a catastrophically developing conflict with NATO (and it does not matter whether we are talking about the very fact of their existence, as the United States sometimes claims, or about the outcome of a retaliatory strike). The problem of an impending defeat has not been eliminated and, consequently, neither was the stimulus for the further use of nuclear weapons. In this case, the initiating state will simply move to the next rung of the escalation ladder, delivering a multiple strike on the battle ground or selecting a more valuable and sensitive target for a single strike (for instance, within the continental United States). Psychologically, this transition will be much easier (not to say more thoughtless) than the decision to deliver an initial strike.

The crucial thing is that this is precisely the scenario where the apparent military and technical advantages of the "mini-Trident" we mentioned above will lose their importance. Facing an imminent large-scale military defeat, Russia's integrated air and missile defence system will have been largely "dismantled" through the intensive and successful use of NATO's precision-guided weapons, and resistance to air and missile strikes will have taken on fragmented nature. In such circumstances, a "mini-Trident" is excessive as a delivery vehicle for a single strike. These tasks can be handled by usual means, such as cruise missiles or combat aircraft. Moreover, "mini-Tridents" will even be harmful in such a situation: an SLBM launched and detected by the early warning systems (which would be left intact in such a conflict), may be misconstrued by Russia given the acute stage of the crisis and thus prompt a launch-on-warning. NATO most certainly does not need this, since it would actually be winning such a war "on points."

The W76-2 Low-Yield Nuclear Warhead is officially aimed against the non-existent scenario of Russia using nuclear weapons in an act of provocation in the unrealistic event of a Russia—NATO conflict; is unable to deter Russia's first use of nuclear weapons in an actual crisis situation as prescribed by its nuclear doctrine; harbours an additional destabilizing potential.

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What is the Point of this Warhead Then? "I Don't Know Who Needed it or What They Needed it For."

Note that in our story, the outlandish strategy of "escalate to de-escalate" has become intertwined with the notion of escalation control, or the idea that a conflict (including a nuclear conflict) can be proactively managed by keeping it low-intensity. This is not surprising at all because the two concepts are the same thing. Consequently, we have to go much further back in time, to the turn of the 1950s–1960s in the United States, to find the roots of this phenomenon. The single, yet crucial remark here is that escalation control is a scholastic and convoluted theory, an exercise for minds with a propensity for abstract thinking. Meanwhile, "escalate to de-escalate" strategy, as it is described today, is, in terms of both political motivation and means of implementation, a highly oversimplified form of the concept.

The United States is a pioneer in terms of introducing plans for limited use of nuclear weapons in practice. If we recall the entire history of the its "counterforce"— the 1974 Schlesinger Doctrine, Carter's 1980 PD–59 plan and other contrivances of the heights of the Cold War, we will find it very hard to pretend that "mini-Tridents" appeared as an emergency response to Russia's particularly malicious nuclear doctrine of the last few years. Back in 1962, Robert McNamara said that the United States could look for a way to stop a war on favourable terms, using its own forces as a bargaining chip, threatening further attacks. He further noted that, in any case, the highly secured large reserves of fire power could convince the enemy to abstain from attacking U.S cities and could stop the war.

We should not view these things as tales of a long-gone bipolar past. A current 2019 American paper on planning nuclear operations states that, "Employment of nuclear weapons can radically alter or accelerate the course of a campaign. A nuclear weapon could be brought into the campaign as a result of perceived failure in a conventional campaign, potential loss of control or regime, or to escalate the conflict to sue for peace on more-favourable terms."

It is sometimes hard not to think that the current nuclear strategy of the United States is subject to a kind of "projective" logic, something that should be familiar to practicing psychologists and means projecting one's own aspirations and associations onto another person. In this ironic sense, mini-Tridents are very convenient as a nuclear weapon for "limited-scale" operations long since embraced by the U.S. military doctrine. Whether or not they are holding Russia back from an "escalate to de-escalate" strategy, or if Russia is somehow self-deterring, is beyond the point. What is important is the very fact that such a potential exists, as arms control experts put it, capabilities are always more important than intentions.

One feature of Trident II SLBM is its depressed trajectory, which makes it possible to use the missile where very short flight time and a relatively low apogee are needed. Thus, at a striking distance of 1900 km, the missile will reach the target in six to seven minutes, never going higher than 150 km, and it will cover a distance of 3000 km in nine to ten minutes with a maximum height of 185 km.

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strategic nuclear force of a potential enemy (the same accuracy with 15–20 times less yield) and planning officers could therefore erroneously perceive it as a relatively "stabilizing" kind of weapon. It is not such a weapon, due to a reduced nuclear use threshold and functional ambiguity of delivery vehicle.

Yet, the danger of low-yield nuclear warheads being deployed is not so much in the lowering of the nuclear threshold as such. First of all, it is about the continuation of a much more encompassing dual process, which erodes two categories: the clear differences between nuclear weapons and non-nuclear weapons on the one hand, and between strategic and tactical weapons on the other. Mini-Tridents bear the prints of both, especially if you recall how much effort was spent only 10–15 years ago to equip them with non-nuclear precision-guided warheads (nothing came of it, but lightening, or in this case, the shell, most certainly did strike the same place twice). The result of the changes taking place in the respective nuclear doctrines of the United States and Russia can hardly be considered positive.

In the case of Russia, the intentional management of nuclear uncertainty lays down destabilizing factors for possible military and political crises, complicating their course and simplifying the transition (including erroneous) from the non-nuclear section of the escalation ladder to the nuclear one.

The United States (if freed from the burden of having to explain its actions) directly raised the question of "usable" nuclear weapons, that is, a battlefield capability, and not an instrument of strategic deterrence. Thus, the image of conflicts of the future implies a limited use of nuclear weapons, including, possibly, against non-nuclear states—the United States has already tried to include such provisions in its 2018 nuclear doctrine. Subjectivity is also important here. Donald Trump is a man of exceptional sincerity and consistency. Look at his campaign promises and compare them with actions in the White House. But even during the election campaign, Trump noted that he does not understand the meaning of weapons that cannot be used.

Given all the severe restrictions we emphasized above, Russia continues to think of itself as of a besieged fortress that is about to fall. These leads, among other things, to the desire to make its nuclear doctrine as opaque as possible, implementing a strategy of "deterrence through uncertainty," the traditional refuge of the weakest side (take China, for example, which has been adhering to this approach for 50 years). Another national habit, namely making non-strategic strike systems dual-capable (which is both cheap and convenient, and, again, in certain scenarios increases the constraining uncertainty) creates further problems in this area. Both attitudes do the same job, albeit from different sides and in different ways. They both blur the "red lines" of the first use of nuclear weapons. In the case of the United States, this line descends lower to the area of "clashes," due to the development of delivery vehicles and the appearance of the illusion that such an employment can be controlled, is limited and implies supposedly low "collateral damage." It feels like a nuclear strike, but not really. In the case of Russia, the intentional management of nuclear uncertainty lays down destabilizing factors for possible military and political crises, complicating their course and simplifying the transition (including erroneous) from the non-nuclear section of the escalation ladder to the nuclear one.

This might sound like a paradox, but both superpowers are escalating the strategic nuclear risks by solving situational problems caused by the lack of political trust. One problem deals with the imaginary lack of low-intensity deterrence against Russia's aggressive behaviour, while the other continues to safeguard the risks of a no-less-imaginary NATO intrusion amid the continuing weakening of conventional forces. All the conditions for a self-fulfilling prophecy are met.

Source: https://moderndiplomacy.eu/2020/03/17/not-so-nuclear-war/, 17 March 2020.

NUCLEAR STRATEGY

USA

The Cold War's not Back, but Nuclear Gamesmanship Is

Perhaps more than at any time since the end of the Cold War, the Pentagon is getting serious about nuclear conflict. Over the past few years, the administrations of U.S. Presidents Barack Obama and Donald Trump have reportedly studied how to respond if Russia fires off a nuke during a war with NATO in the Baltic region. U.S. Secretary of Défense Mark Esper recently participated in a war game simulating a limited nuclear conflict with Moscow. The U.S. Navy just deployed a submarine-launched, low-yield nuclear warhead designed for such a scenario. Critics have responded by calling these preparations provocative and dangerous.

Perhaps more than at any time since the end of the Cold War, the Pentagon is getting serious about nuclear conflict. Over the past few years, the administrations of U.S. Presidents Barack Obama and Donald Trump have reportedly studied how to respond if Russia fires off a nuke during a war with NATO in the Baltic region. U.S. Secretary of Défense Mark Esper recently participated in a war game simulating a limited nuclear conflict with Moscow.

The controversy is reviving hard questions about nuclear strategy and deterrence that U.S. officials last faced during the twilight of the conflicts against the Soviet Union. Looking back at that era reminds us that mastering the realities of geopolitical rivalry often requires embracing the apparent absurdities of nuclear statecraft. Much of the current debate revolves around the Russian strategy known as "escalate to de-escalate." It refers to a scenario in which Russia would use conventional forces to quickly seize some piece of NATO-held territory, such as a slice of Estonia. Moscow would then introduce nuclear weapons into the intensifying conflict — perhaps by firing off a demonstration shot or even by targeting NATO forces in the field — in hopes of deterring the alliance from retaking the conquered territory. Experts debate whether escalate to de-escalate is really Russian doctrine, but it is clearly a possibility that NATO must contend with. This is why the Pentagon is rehearsing for limited nuclear war — to show that it can respond to Russian nuclear strikes in a proportional, and thus credible, manner that signals resolve without unleashing the apocalypse.

Would the U.S. actually use nuclear weapons in a showdown with Russia? If so, could it keep a nuclear exchange limited? How much do perceptions of nuclear strength or weakness really matter? And why should the U.S. prepare to execute contingencies that carry an uncomfortably high possibility of disaster.

Yet this approach raises some sharp questions. Would the U.S. actually use nuclear weapons in a showdown with Russia? If so, could it keep a nuclear exchange limited? How much do perceptions of nuclear strength or weakness really matter? And why should the U.S. prepare to execute contingencies that carry an uncomfortably high possibility of disaster? Fortunately, we can get insight on these issues by looking back at the Cold War.

For decades, grappling with the intricacies of nuclear deterrence was a way of life for American planners, because the Pentagon rarely felt confident in NATO's ability to check a Soviet assault by relying solely on conventional weapons. So, the U.S. developed an evolving variety of nuclear strategies. Some rested on a near-instantaneous escalation to all-out nuclear war; others involved using calibrated nuclear strikes to signal American will and to shock Soviet leaders into de-escalation. These variations notwithstanding, four points stand out.

First, regardless of what they said in public, most policymakers were completely appalled by the thought of using nuclear weapons in a crisis. U.S. President Dwight D. Eisenhower, whose entire

defence strategy hinged on waging pre-emptive nuclear war, constantly reminded his advisers that such a war might mean the death of civilization. U.S. Secretary of Défense Robert McNamara secretly recommended to the two presidents he served — John F. Kennedy and Lyndon Johnson — that they never wage nuclear war, under any circumstances. President Ronald Reagan was often vilified as a warmonger, but he ritualistically repeated the mantra, "A nuclear war cannot be won and must never be fought." Even in war games, U.S. officials were incredibly reluctant to cross the nuclear threshold. In other words, two generations of leaders-built strategies around a threat in which they fundamentally did not believe.

Administration after administration developed plans for vaporizing the Soviet Union and its allies. In the late 1970s and 1980s, the Carter and Reagan administrations produced a cold-blooded strategy based on decapitating the Soviet leadership and waging a protracted nuclear war. They didn't do so because they thought it was feasible to fight such a conflict.

Second, a key reason U.S. official were so repelled by nuclear war was their intense scepticism that it could be kept limited. The Kennedy administration might talk about developing discrete nuclear options for responding to conventional attacks, but its leaders worried that the consequences of using even a single nuclear weapon would be unpredictable and uncontrollable. "The line between non-nuclear war and nuclear war is distinct and observable," McNamara said. "However, once the momentous decision has been made to cross that line, everything becomes much more confused." McNamara's successors, even those who laboured to introduce limited nuclear options into U.S. strategy, mostly came to the same conclusion.

So, was the entire Cold War arms race an exercise in futility? Not really, because a third point is that perceptions of the strategic balance still mattered enormously: They shaped risk-taking and decision-making. Eisenhower and Kennedy may have believed that a nuclear war would leave no winners, but the vast nuclear superiority America enjoyed in the late 1950s and early 1960s provided critical leverage in staring down Soviet challenges in Berlin and during the Cuban missile crisis.

As the nuclear balance shifted in the late 1960s and 1970s, it was Moscow that became more assertive, intervening in third-world hot spots and subtly intimidating Washington's exposed European allies. When the balance shifted back in the 1980s, Soviet officials understood that America's superiority gave it an edge in diplomatic crises, because Washington would enjoy a hard-to-quantify but undeniable military advantage if war came. Finally, all this meant that U.S. leaders believed they had little alternative but to go down the rabbit hole — to craft strategies and doctrines that they desperately hoped never to carry out. Administration after administration developed plans for vaporizing the Soviet Union and its allies. In the late 1970s and 1980s, the Carter and Reagan administrations produced a cold-blooded strategy based on decapitating the Soviet leadership and waging a protracted nuclear war.

They didn't do so because they thought it was feasible to fight such a conflict. Harold Brown, Jimmy Carter's secretary of defence, admitted that he had "no illusion that a large-scale nuclear war" could be a "sensible, deliberate instrument" of policy. They did so because a demonstrated ability to target what the enemy most valued, to close off all of its paths to victory in a nuclear war, was the only way to make certain that the nuclear threshold was never crossed.

The circumstances today are different, of course. It was one thing to threaten nuclear war over Western Europe, which was critical to the global balance of power. It would be another thing to do so over a piece of territory in the Baltics. America's best option, then, would be to further strengthen its conventional deterrence in Eastern Europe, so as to reduce the on-the-ground vulnerabilities that might make an escalate to de-escalate gambit

attractive to Russia. Yet the history of the Cold War also shows that preparing to fight a limited nuclear war over the Baltics may not be as insane as it seems. Perceptions of nuclear opportunity and danger matter enormously in great-power competition. Convincing the other side that America has the ability to execute even incredibly risky options may be the best way of ensuring that the U.S. never actually has to use them.

Putin's Russia has been modernizing its strategic nuclear bomber strike capability for two decades. Initially, this involved upgrading the Soviet legacy Tu-95 and Tu-160 bombers plus a few newly produced Tu-160s with more advanced nuclear missiles. Not surprisingly, strategic nuclear upgrades were given first priority.

Source: Hal Brands, https://www. bloomberg. com/opinion/articles/2020-03-11/the-cold-war-s-not-back-but-nuclear-gamesmanship-is, 11 March 2020.

RUSSIA

Russia's Plan to Modernize its Nuclear Bombers is Gaining Speed

Putin's Russia has been modernizing its strategic nuclear bomber strike capability for two decades. Initially, this involved upgrading the Soviet legacy Tu-95 and Tu-160 bombers plus a few newly produced Tu-160s with more advanced nuclear missiles. Not surprisingly, strategic nuclear upgrades were given first priority. Significantly, the Russians gave either nuclear only or dual capability (nuclear and conventional) with improved accuracy to all of its new long-range cruise missiles and, more recently, moved toward dual-capable hypersonic missiles.

These new missiles substantially increase the strike radius of Russian bombers. Moreover, Russia also retained the Soviet Cold War nuclear systems – the nuclear Kh-55/AS-15 long-range ALCM, the reportedly now dual-capable (originally nuclear only) short-range Kh-15 (AS-16) and gravity bombs.

These include the dual-capable Kh-555 cruise missile (an adaptation of the Cold War Kh-555), the new stealthy nuclear armed 5,000-km range Kh-102, and the new more accurate stealthy dual-capable 4,500-km range Kh-101, according to President Putin, the Russian Défense Ministry and Russian state media. The officially announced nuclear capability of the Kh-101 long-range cruise missile is virtually ignored in the West, but this development is very important because it gives the Russians the ability to potentially deliver precision or near precision low-yield nuclear strikes. In 2018, Russia announced that it conducted a salvo launch of 12 Kh-101 from a Tu-160 bomber. Today, Russia is reportedly developing the Kh-BD, reportedly a longer-range version of the Kh-101 and Kh-102 cruise missiles for its bombers.

These new missiles substantially increase the strike radius of Russian bombers. Moreover, Russia also retained the Soviet Cold War nuclear systems – the nuclear Kh-55/AS-15 long-range ALCM, the reportedly now dual-capable (originally nuclear only) short-range Kh-15 (AS-16) and gravity bombs. According to President Putin, "All of them [Tu-95 and Tu-160] must be able to carry both advanced cruise missiles and other powerful weapons."

In 2015, Russia announced a program to develop and deploy at least 50 much improved Tu-160M2 bombers (new engines with10% better performance or a 1,000-km range increase, new avionics, new electronic warfare equipment, new weapons, an active phased array radar, and a modestly reduced radar cross section). Fabrication of the Tu-160M2 bombers reportedly began in 2018[10]; it is now being tested. Deputy Défense Minister Yuri Borisov has said that the combat effectiveness of the Tu-160M2 will be two and a half times greater than that of its predecessor. Reportedly, two to three Tu-160M2s will be produced each year. Delivery to the troops reportedly will begin in 2021. It appears that hypersonic missiles will become almost the norm for Russian aircraft, the size of a long-range strike fighter or larger. In February 2020, Russian state

media reported that the Tu-160 was being modified to carry the hypersonic Kinzhal (Kh-47M2) dual-capable aeroballistics missiles. The implication of this development is that Russia's airborne hypersonic missile strike capability will be extended to intercontinental range, probably, eventually, with multiple missile types.

In February 2020, state-run Sputnik News reported, "All the existing [Tu-160] aircraft are set to be upgraded to the advanced 'M' and 'M2' versions, while a number of Tu-160M2 planes are expected to be produced from scratch."

Today, the subsonic Tu-95 Bear H bomber is essentially a strategic cruise missile carrier. The Tu-95 carries the same long-range dual-capable cruise missiles as the Tu-160. The two versions of the legacy Tu-95 could carry either six or 16 Kh-55 long-range nuclear cruise missiles. By hook or by crook, Russia managed to obtain 40 former Soviet Tu-95MS16 and 28 Tu-95MS6 bombers. These are being extensively modernized, a process that is still continuing. Russian Tu-95MS bombers are being fitted with improved engines. According to the Commander of Russia's Long-Range Aviation Lieutenant General Sergei Kobylash, "The complex will be equipped with such advanced systems as: inertial, astroinertial systems, satellite navigation systems, near-navigation radio-technical systems, air signal systems, onboard defence complex, electronic warfare complex." The Russian Défense Ministry has said that six modernized Tu-95MS will join the strategic bomber fleet in 2020. In February 2020, state-run Rossiyskaya Gazeta reported that the "latest MSM modification [of the Tu-95] is recognizable by the pylons under the wings for suspending eight Kh-101s. Six more Kh-55s are stored in a fuselage launcher. Thus, the Tu-95MChS reportedly can carry 14 cruise missiles, two more than the Tu-160." The underwing launchers can also carry the Kh-102. Its maximum load of Kh-555 is also reported to be 14 missiles.

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Russia is reportedly developing the KH-MT, a "ram-jet powered hypersonic design apparently intended for internal carriage [on the Tu-95MSM bomber]." This makes more sense than arming them with the Kinzhal hypersonic aeroballistic missile because the subsonic speed of the Tu-95 would reduce the range of the Kinzhal. The range of the Kinzhal depends upon the speed at which it is launched. This is not true for powered hypersonic missiles.

Since 2007, Russia has used both the Tu-160 and the Tu-95 for purposes of nuclear intimidation by routinely flying these aircraft into U.S., NATO and Japanese air defence identification zones. They have been used to launch cruise missile strikes against targets in Syria with the conventional version of Russia's long-range nuclear capable missiles (Kh-101 and Kh-555). This includes the ridiculous Tu-160 flights all the way around NATO to deliver missiles that could have been launched from Russian territory soon after bomber take-off. A senior Russian official once threatened to fly a Tu-160 over the territory of a NATO nation. In April 2015, the U.K. press reported that two Russian Tu-95 bombers flying over the English Channel were carrying at least one "nuclear warhead-carrying missile, designed to seek and destroy a Vanguard [strategic ballistic missile] submarine." According to Russia's state media, starting in a 2003 Indian Ocean exercise, Russia began to use its heavy bombers in a nuclear strike anti-ship role in conjunction with Russian Naval forces. The publicity given to the nuclear elements of these and other Russian exercises is intended to intimidate. If President Putin gets mad, his default mode is always nuclear threats.

Russia has also upgraded the legacy supersonic Tu-22M3 Backfire bomber with improved dual-capable long-range missiles (reportedly the Kh-555, the Kh-101) and the nuclear capable near hypersonic 1,000-km range Kh-32, the upgraded

Kh-32M and the planned upgrading of 30 Tu-22M3M bombers with new engines, new avionics and new weapons.[30] The Backfire reportedly has the capability to carry eight Kh-101.Testing of the improved Backfire has been announced. The legacy Soviet nuclear capable Kh-22 is reportedly still operational on the Backfire. The Backfire bomber will also reportedly carry up to four Kinzhal hypersonic missiles. The Backfire bomber is now not classified as a heavy bomber subject to limitations under the New START Treaty. Yet, the upgrades being reported in Russian state media would make it a heavy bomber under the New START Treaty. Failure to declare it as a heavy bomber would be a violation of the New START Treaty. This will be discussed below. In an unclassified 2017 report, the Défense Intelligence Agency stated that, "The LRA [Long Range Aviation] has an inventory of 16 Tu-160, 60 Tu-95MS, and more than 50 Tu-22M3 bombers."

Pak-DA will also carry gravity bombs, short-range and hypersonic missiles. Because it is sub-sonic, it is not a good candidate for the Kinzhal. It is more likely to carry a powered hypersonic missile. Russian state media have reported it will carry hypersonic missiles. The Russians claim that the Pak-DA will be cheaper than the Tu-160, but this is very unlikely since stealth aircraft have to be built with extreme attention to tolerances.

In 2009, Russia announced the development of the subsonic stealth cruise missile carrying Pak-DA bomber. It is rumoured to be powered by "a radically new type of engine." In 2019, Deputy Défense Minister Aleksey Krivoruchko said that the bomber would be operational in 2027. In January 2020, Izvestia reported that three protypes are under contract and that flight testing of the bomber will begin in 2023 and "mass production" of the bomber will begin in 2027. By "mass production," the Russians usually mean something like we would call low rate production. Reportedly, the Pak-DA can carry "30 tonnes of nuclear weaponry." The Pak-DA is likely to carry the same cruise missiles as the other Russian bombers, but the whole purpose of giving the aircraft stealth capability is to penetrate air defences and launch direct attacks or launch limited range missile attacks. There is no need for stealth if the aircraft will only carry 4,500-5,000-km or more range cruise missiles. Thus, it is reasonable to expect that Pak-DA will also carry gravity bombs, short-range and hypersonic missiles. Because it is sub-sonic, it is not a good candidate for the Kinzhal. It is more likely to carry a powered hypersonic missile. Russian state media have reported it will carry hypersonic missiles. The Russians claim that the Pak-DA will be cheaper than the Tu-160, but this is very unlikely since stealth aircraft have to be built with extreme attention to tolerances. In addition to its bomber role, TASS says it will also function as a "command centre or reconnaissance plane."

The scientists are developing a nuclear 'scalpel' capable of 'surgically removing' and destroying very localized targets. The low-yield warhead will be surrounded with a super hardened casing, which makes it possible to penetrate 30–40 meters into rock and destroy a buried target—for example, a troop command and control point or a nuclear munitions storage facility.

In December 2002, former Atomic Energy Minister and then-Director of the Sarov nuclear weapons laboratory, declared, "The scientists are developing a nuclear 'scalpel' capable of 'surgically removing' and destroying very localized targets. The low-yield warhead will be surrounded with a super hardened casing, which makes it possible to penetrate 30–40 meters into rock and destroy a buried target—for example, a troop command and control point or a nuclear munitions storage facility." This weapon would have great utility for Russia's nuclear escalation strategy, which is initially based upon low-yield nuclear strikes. Reliable air delivery of this weapon would require a stealth aircraft. The Pak-DA is the only known manned Russian aircraft today that could have a true stealth capability. Thus, such a

weapon is clearly a candidate for the Pak-DA.

Source:https://nationalinterest.org/blog/buzz/russias-plan-modernize-its-nuclear-bombers-gaining-speed-136902, 25 August 2020.

BALLISTIC MISSILE DEFENCE

SAUDI ARABIA–UAE

More than 1,000 Ballistic Missiles Targeted Saudi Arabia and UAE

26th day of March, 2020 marked the fifth anniversary of the launch of Operation Decisive Storm against the Houthis in Yemen. The operation was launched at dawn on 26 March, 2015, with the participation of at least ten countries, led by Saudi Arabia against the Houthi movement and the forces loyal to the ousted president, Ali Abdullah Saleh, and has not to date achieved its goals. Following the withdrawal of the UAE, the only remaining country of the alleged Arab coalition is Saudi Arabia, which is still fighting in Yemen in hope of defending its borders.

With the coming commemoration of Operation Decisive Storm, it emerges that the announcement of the Arab coalition, led by Saudi Arabia, regarding destroying 98 per cent of the air defences that the Houthis seized from the Yemeni army a few days after the launch of the offensive in March 2015, was nothing but empty propaganda.

For the sixth consecutive year, Yemen has witnessed a war between government forces and Houthi militants, who control several governorates, including the capital of Sanaa. With the coming commemoration of Operation Decisive Storm, it emerges that the announcement of the Arab coalition, led by Saudi Arabia, regarding destroying 98 per cent of the air defences that the Houthis seized from the Yemeni army a few days after the launch of the offensive in March 2015, was nothing but empty propaganda. The kingdom's statements were proven to be misleading after years of consecutive defeats.

Yahya Saria, Houthi military spokesperson, announced that over the past years the movement's forces have fired more than 410 ballistic missiles at Saudi Arabia and the UAE. He pointed out that the Houthis' missile force bombed vital military targets, installations and other facilities in the Saudi and Emirati depths, adding that over 630 ballistic missiles were fired at hostile military targets. Saria noted that the missile defence systems employed were: "Qaher systems, volcano, Badr, Quds 1, Mojanah, Nakkal, Qasim and Zulfiqar," explaining that the Houthi movement "has successfully conducted new experiments on missile systems that will be revealed soon."

International organisations accuse the Arab coalition, along with the rest of the parties to the armed conflict in Yemen, of being involved in numerous violations. According to the United Nations High Commissioner for Human Rights, the number of civilians killed and injured since the Arab coalition began its military operations in Yemen exceeds 17,000. In turn, the United Nations describes the humanitarian crisis in Yemen as "the worst in the world", affirming that more than 22 million Yemenis, more than two thirds of the population, require some form of humanitarian assistance and urgent protection, including 8.4 million people who do not know how to obtain their next meal, and nearly two million children suffering from severe malnutrition. The collapse of the Arab coalition in Yemen will lead to weakening Saudi Arabia's position and trapping it in a profound dilemma, as the withdrawing Emirati forces left behind local militias that could turn against Saudi Arabia in the event of affecting its influence or interests in the areas that it controls.

***Yemen: Over 257,000 Saudi-led Air Strikes in 5 Years*:** Since the beginning of the war, the UAE has continued recruiting militias to fight on its side, such as the security belt forces deployed in Aden and the governorates of Lahij, Abyan and Dhale, the Shabwani Elite forces in the Shabwah governorate, and the Hadrami Elite forces in Hadramout. This comes in addition to mobilising, on the west coast of the country, a group of former

Republican Guard forces loyal to the late President Saleh, who was killed by the Houthis after cutting ties with them in late 2017. Later, Saleh's nephew, Tariq Saleh, was chosen to lead the movement. The aforementioned forces will not be easy to control, which will contribute to worsening the humanitarian conditions of a poor country which is undergoing multiple crises, many of which were caused by the Arab coalition. This situation could lead to intensifying local and international indignation towards Saudi Arabia, which has been accused of deepening the grievances of the Yemeni people.

Between 2020 and 2026, 48 power reactors will be built globally. The peak will take place between 2020 and 2022, with 32 reactors due to begin operations. China will lead the way with 12 plans already underway, followed by India and Korea.

Source:https://www.middleeastmonitor.com/20200325-houthis-more-than-1000-ballistic-missiles-targeted-saudi-arabia-and-uae/, 25 March 2020.

NUCLEAR ENERGY

GENERAL

New Nuclear Projects: Where and When will they be Built?

The IAEA concluded its 12-day Integrated Nuclear Infrastructure Review (INIR) mission in Belarus on 4 March, aimed at reviewing the country's infrastructure development for its first nuclear power reactor. Belarus, alongside the UAE, is set to complete construction of its first nuclear power plant this year.

On a global scale, 15 countries – including China, India and Russia – will conclude the development of nuclear power projects, which are currently under construction, in the next few years. According to the World Nuclear Association, there are 440 nuclear power reactors in the world, amounting to a combined capacity of 400GWe, while more than 100 have been ordered. Estimates say that in 2018 these produced 2,563TWh of electricity, roughly 10% of the world's electricity. But how many nuclear power reactors will be built in the next years and where? Between 2020 and 2026, 48 power reactors will be built globally. The peak will take place between 2020 and 2022, with 32 reactors due to begin operations. China will lead the way with 12 plans already underway, followed by India and Korea. Power Technology looks at the two of the most important projects, Belarus' Ostrovets and the UAE's Barakah power plants.

Ostrovets: Belarus's first nuclear power plant, which will be situated 130km north-west of the capital Minsk, is set to be operational by this year. Funded by Russia, Ostrovets 1 will consist of a VVER-1200 pressurised reactor, producing 1200MWe of energy production.

A second reactor, Ostrovets 2, will have the same capacity and will be built by 2021. The country's decision to build a nuclear power plant was based on the need to loosen its strong and historically established dependency on Russia. In 2017, the country exported 3.5TWh of electricity and imported 6TWh, for a total of $2.5bn.

In order to cut down its dependency on Russia by 25%, Belarus introduced a 2011-2020 plan, which promoted Ostrovets 1's construction as well as hydropower stations and wind projects. ... The IAEA reviewed the nuclear programme according to its Milestone approach, a method used to help countries develop their first nuclear programmes. The programme's aim is to help states achieve "the commitments and obligations associated with developing a nuclear power programme."

Regarding the mission, Belarus deputy energy minister Mikhail Mikhadyuk said: "Hosting the INIR mission, Belarus demonstrated its transparency and genuine interest to receive an objective professional assessment of the readiness of its nuclear power infrastructure for the commissioning of the country's first nuclear power plant."

Energy and nuclear policy analyst Mycle Schneider told Power Technology that IAEA's INIR mission took place after neighbouring states voiced

concerns regarding the plant. He said: "Neighbouring countries have voiced concern over the lack of review of some serious safety concerns and Lithuania has transmitted an official note to the European Council, urging the Member States and the European Commission to deploy joint efforts 'convincing Belarus to implement the agreed (...) most important safety improvement measures before the commissioning of NPP'". "In the absence of short-term clarifications and serious audited back fitting, the Belarusian nuclear power plant remains a safety black hole at the border of the European Union."

It is known that Poland will not abandon coal completely. It is also known that renewable energy is not able to meet the needs of the Polish economy. So, the Polish Energy Strategy has provided for the construction of a civil, energy nuclear sector. "We achieve something that is very important for Europe.

Barakah Nuclear Energy Plant: Just like Ostrovets for Belarus, the Barakah Nuclear Energy Plant will be the UAE's first nuclear plant, as well as the first one in the Arab world. The project – owned by the UAE's Emirates Nuclear Energy Corporation (ENEC) and operated by Nawah Energy Company – will become operational in the next few months. The first unit (Unit 1) will generate around 1,400MW and, alongside three other units, will produce 5,600MW of electricity – up to 25% of the country's needs. ...

The government assumes that nuclear will contribute 20 per cent to the Polish energy mix. Government Plenipotentiary for Strategic Energy Infrastructure, Piotr Naimski says "in 20 years, we want to produce 6-9 gigawatts of nuclear power, which will mean that we will build six reactors in several places in Poland." It is still unknown where the first Polish nuclear power plant will be built.

Source: Ilaria Grasso Macola, https://www.power-technology.com/features/new-nuclear-projects-where-when/, 10 March 2020.

POLAND

Poland's Bid for Nuclear Power

Poland is still one of the few European countries that doesn't have a single nuclear reactor. Poles may only know of nuclear power plants from movies and television. But they remember their impact on people's lives through tragic memories such as the Chernobyl disaster. Now this will soon change.

"We constantly need new energy sources. We need new power plants that will provide electricity to the dynamically growing Polish economy, "says Zbigniew Gryglas from the Ministry of State Assets. It is known that Poland will not abandon coal completely. It is also known that renewable energy is not able to meet the needs of the Polish economy. So, the Polish Energy Strategy has provided for the construction of a civil, energy nuclear sector. "We achieve something that is very important for Europe. On the one hand, care for the natural environment, on the other: we maintain energy security," says energy expert, MEP Grzegorz Tobiszowski.

"A Fight for Climate and Clean Air": The President of Poland, Andrzej Duda says its "a fight for climate and clean air. We must make changes in our energy sector. We must have more gas-based energy. We will probably also build nuclear power plants." Poland won't do it alone because it has no experience and know-how. It will work together with the French or Americans. "I think that we can expect these decisions already this year," says Piotr Muller, a spokesman for the Polish government. "Negotiations are underway, it would be irresponsible on my part if I pointed out who is more preferred because these are talks about big money."

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unknown where the first Polish nuclear power plant will be built.

"Currently, there is talk about the location of the first nuclear power plant and it will be located on the Baltic Sea. Two locations west of Gdansk are currently under consideration," says Pawe³ Gajda from the Department of Nuclear Energy, AGH. The cost of building the new power facility is difficult to gauge because so many questions remain, but the Government's early estimates suggest spending around 25 to 30 billion euros.

"We can afford to build nuclear power plants in Poland! thank you very much!" says Naimski. There has been talk about nuclear power plants in Poland for over 30 years. The government insists that it doesn't throw words to the wind. In the face of climate challenges and external political pressure, it seems that this time Poland will move from words to deeds.

Source:https://www.euronews.com/2020/03/23/poland-s-bid-for-nuclear-power, 24 March 2020.

USA

DOD Awards Contracts for Development of a Mobile Microreactor

The Department of Defense has awarded three teams, BWX Technologies, Inc., Lynchburg, Virginia; Westinghouse Government Services, Washington, D.C.; and X-energy, LLC, Greenbelt, Maryland; contracts to each begin design work on a mobile nuclear reactor prototype under a Strategic Capabilities Office initiative called Project Pele.

Project Pele involves the development of a safe, mobile and advanced nuclear microreactor to support a variety of Department of Defense missions, such as generating power for remote operating bases. After a two-year design-maturation period, one of the three companies may be selected to build and demonstrate a prototype.

... In January 2019, SCO issued a request for information to industry for the development of Project Pele technology. Three companies were chosen from the ensuing competition to develop engineering designs. Critical to the Pele program is coordination with the Department of Energy, the Nuclear Regulatory Commission, and industry partners that allows the rapid development of workable prototype designs that support evaluation, safety analysis, and, ultimately, construction and testing.

In order to technically assess the feasibility of a mobile reactor, it is necessary to complete a high-fidelity engineering design to confirm its safety, resiliency, and reliability, and to reduce technical, regulatory and manufacturing risks. SCO, in partnership with the Department of Energy Office of Nuclear Energy, has reviewed modern design concepts and cutting-edge technology which it believes enable American industry to meet the challenges required.

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DOD uses approximately 30 terrawatt hours of electricity per year and more than 10 million gallons of fuel per day-levels that are expected to increase. A safe, small, mobile nuclear reactor would enable units to carry a nearly endless clean power supply, enabling expansion and sustainment of operations for extended periods of time anywhere on the planet.

Microreactors would significantly reduce the need for investments in costly power infrastructure. In civilian applications, they could be easily relocated to support disaster response work and provide temporary or long-term support to critical infrastructure like hospitals, as well as remote civilian locations where delivery of electricity and power is difficult.

The engineering design phase of Project Pele will continue for up to two years, after which the DOD will make an assessment on whether a microreactor capable of meeting necessary safety requirements is feasible. The Department of Defense has also published a Notice of Intent to conduct an Environmental Impact Statement associated with Project Pele in the Federal Register as required under the National Environmental Policy Act of 1969. ...

As part of the NEPA process, the public will have the opportunity to review and comment on proposed actions, alternatives and the environmental analysis. The public, as well as federal, state and local agencies, are invited to participate in the scoping process for the preparation of this EIS by attending a scoping meeting or submitting written comments. DOD will host a meeting as part of the public scoping process to identify and determine potential environmental impacts as well as to document key issues of concern to be analyzed in the EIS. All meeting details and submitted comments can be found in the NOI listed on the Federal Register website.

Source: https://www.defense.gov/Newsroom/Releases/Release/Article/2105863/dod-awards-contracts-for-development-of-a-mobile-microreactor/, 09 March 2020.

NUCLEAR COOPERATION

RUSSIA–BANGLADESH

Russia and Bangladesh Expand Nuclear Cooperation

A number of documents have been signed between Russian state nuclear corporation Rosatom and the government of Bangladesh that will enhance existing bilateral cooperation in the use of atomic energy for peaceful purposes. Russia is currently constructing a two-unit nuclear power plant at Rooppur, Bangladesh.

A package of documents was signed in Dhaka following a meeting between Rosatom Director General Alexey Likhachov and the Prime Minister of Bangladesh, Sheikh Hasina. Likhachov also held meetings with Bangladeshi Minister of Foreign Affairs Abulkalam Abdul Momen, and the Minister of Science and Technology, Yeafesh Osman. The parties signed a protocol to amend the intergovernmental agreement between the governments of Russia and Bangladesh on the construction of nuclear power plants in Bangladesh. The new protocol establishes the right of Bangladesh to engage Rosatom on a long-term basis to assist in the operation, maintenance and repair of units 1 and 2 of the Rooppur plant, as well as to supply the equipment, expendable materials, spare parts and to provide training for maintenance crews in the course of plant operations. This, Rosatom said, will enable it to carry out maintenance, operational support and repair of the Rooppur plant throughout its entire life cycle.

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In addition, a package of appendixes to the contract for the supply of nuclear fuel for the Rooppur plant was signed between Rosatom subsidiary TVEL JSC and the Bangladesh Atomic Energy Commission (BAEC). The contract is valid until the end of the operational lifetime of both units at Rooppur. ...

Source:https://www.eurasiareview.com/22032020-russia-and-bangladesh-expand-nuclear-cooperation/, 22 March 2020.

NUCLEAR NON-PROLIFERATION

GENERAL

Postpone the NPT Review Conference to 2021 and Convene in Vienna

The writer has attended all nuclear NPT meetings since 1987 as a delegate, including as senior adviser to the chair of Main Committee I (nuclear disarmament) in 2015 and to the chair of the 2014

preparatory committee; as alternate head of the International Atomic Energy Agency delegation to the NPT; and as a non-proliferation expert with the Canadian delegation from 1987. Personal views are expressed here.

Finally, some moves are afoot in New York to postpone the NPT tenth quinquennial (five yearly) review conference presently scheduled to be held at the United Nations in New York from 27 April to 22 May.

President-Designee's Proposal: The distinguished President-designate of the review conference, H.E. Ambassador Gustavo Zlauvinen (until recently Deputy Foreign Minister of Argentina), following consultations with States parties and the NPT conference bureau, on 13 March, circulated a letter proposing postponement to an unspecified date because of the novel corona virus (COVID-19) pandemic.

The Review Conference was in the high risk category for COVID-19 and that utilization of risk factors such as downscaling or excluding overseas participants may not be a viable option. It also concluded that the criticality of the Review Conference being held was moderate. That is, complete cancelation would have dangerous ramifications, but suspension to a later date when the public health situation improves could mitigate many of these.

Ambassador Zlauvinen in his letter stated that, The risk assessment that was conducted by the Bureau for the NPT Review Conference, based on the risk matrix provided by the Secretariat, concluded that the Review Conference was in the high risk category for COVID-19 and that utilization of risk factors such as downscaling or excluding overseas participants may not be a viable option. It also concluded that the criticality of the Review Conference being held was moderate. That is, complete cancelation would have dangerous ramifications, but suspension to a later date when the public health situation improves could mitigate many of these.

The "Bureau" for the NPT review conference, along with the President, comprises the chairs of the preparatory committee sessions held respectively in 2017 (Vienna), 2018 (Geneva) and 2019 (New York) – who will at the review conference respectively chair the three main committees. Accordingly, based on past practice, Main Committee I (nuclear disarmament and security assurances) will be chaired by Ambassador Syed Mohamad Hasrin Aidid of Malaysia (representing the Group of Non-Aligned States); Main Committee II (nuclear verification and nuclear-weapon-free zones) by Ambassador Adam Bugajski of Poland (representing the Group of Eastern European States); and Main Committee III (peaceful uses of nuclear energy and strengthened review process) by Ambassador Marjolijn van Deelen of The Netherlands (representing the Western Group).

Representatives of the UN ODA and the IAEA assist the Bureau. In addition, the depositary States of the NPT – the Russian Federation, the United Kingdom and the United States – also weigh in with their views, often times inordinately. The chairs of the three main political groupings, noted above, also bring to bear the perspectives of their respective groups. All this to say, that usually it is optimistic to expect the Bureau to act in a manner that is other than conservative; what it needs is to be innovative and agile in dealing with unexpected situations.

The President-Designee's Letter Continued that, "The combination of a high COVID-19 risk with relatively moderate criticality and difficulty in utilizing risk reduction measures indicates that the Review Conference should not proceed as currently planned. I have been advised that, at this time, due to the number of meetings being postponed, and the uncertainty over how long the current circumstances will last, the Secretariat is unable to provide possible options for new dates and rooms. I take this opportunity to assure States Parties that I will undertake all efforts, in coordination with the Secretariat, to ensure that the Review Conference is held as soon as possible and that it is able to undertake its important mandate".

***Proposal by the Non-Aligned Movement*:** In contrast, a letter circulated by the chair of the NAM stated that, "Given the central importance of the NPT as an essential pillar of international security, the NPT Review Conference is not an event that can be scaled down to a limited period of time and/or participants". The NAM includes more than 110 of the 191 States parties of the NPT. The NAM communication goes on to note that,

"Given the severe gravity of the evolving situation with regard to the spread of the COVID-19 around the world and its impact on public health, and taking into consideration the NPT Review Conference has to be convened in an appropriate manner that fully allows for a thorough, balanced, and comprehensive review of the implementation of the Treaty, as well as ensuring that States Parties to the Treaty have undertaken all the necessary preparations, it is advisable that the States Parties to the Treaty, on an exceptional basis and without setting any precedence, adopt a decision as soon as possible on the postponement of the Review Conference scheduled from 27 April to 22 May 2020 to another date no later than the end of 2021, preferably during suitable window of dates in April and May 2021".

Given the central importance of the NPT as an essential pillar of international security, the NPT Review Conference is not an event that can be scaled down to a limited period of time and/or participants.

***Convene the NPT Review Conference in 2021*:** In recent weeks, I have proposed that in light of the COVID-19 pandemic the practical way forward would be to postpone the NPT review conference by one year – to April-May 2021. I have pointed out that the year after a scheduled review conference is a follow year with the preparatory committee for the next review conference starting in the second year following the conference. Hence, the nuclear arms control calendar for spring 2021 in unencumbered and the review conference easily can be postponed to that time window. Doing so would provide sufficient time for the COVID-19 pandemic to subside, for effective vaccine to be developed, and things to settle down such as airline flights and the global economy. There is no rush to try to squeeze in the review conference in the already crammed fall 2020 calendar and in any case, there is no certainty that the effects and after effects of the pandemic will have been resolved by then.

Ordinarily, pursuant to the NPT and the 1995 package of decisions to extend the Treaty indefinitely, review conferences are to be scheduled quinquennially (every five years). However, today's unprecedented situation is one where the WHO has declared the COVID-19 to be a global pandemic affecting more than 135 countries with more than 142,5000 people infected, 5,393 fatalities and many thousands more fighting for their lives in hospitals.

Hence, innovative thinking is called for to find a practical solution that provides both sufficient time to clear the pandemic and does not disturb the calendar of other scheduled events such as the third session of the Conference on Disarmament, the First Committee of the UN General Assembly, and the General Assembly itself – all of which are to take place between August to November/December this year. NPT Review Conferences are not UN conferences but are conferences of NPT States parties and paid for by them. The dates and venue are decided by the States parties themselves at one of the sessions of the preparatory committee based on consultations carried out by the Bureau and agreed by consensus or by no dissenting views being voiced.

Ambassador Zlauvinen has proposed, in his letter cited above, that the 2020 NPT Review Conference meet "conditions permitting, as scheduled, on 27 April for one meeting only and for New York-based delegates only". At this meeting the delegates would take the required procedural decisions for the conduct of the conference, including:

Election of the President of the Conference;

Election of Chairs and Vice-Chairs of the Main Committees, the Drafting Committee and the Credentials Committee;

Election of Vice-Presidents;

Confirmation of the nomination of the Secretary-General;

Programme of Work; and

Suspension of the Conference to a later date when the conditions are such that the meeting may be held and the necessary rooms and services are available. Hopefully this one-day meeting can place as called for on 27 April and the delegates should be able to agree on the six agenda items noted above without rancour or controversy. As regards, item 6 above, concerning the date and venue, in my view the NAM States need to pursue their proposal of a "suitable window of dates in April and May 2021" as that makes eminent sense for the reasons I have outlined in this article.

2021 NPT Review Conference in Vienna: With respect to the venue, the NAM States would be well advised to propose convening the review conference in Spring 2021 in the capital city of Austria – Vienna – which not only is the headquarters of the IAEA but also hosts the United Nations Offices in Vienna (UNOV), the UN ODA Vienna branch, and the Preparatory Commission for the CTBTO. Thus, Vienna has the capacity to host the review conference much as it is the venue for the first session of the preparatory committee for NPT review conferences.

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States parties from the other political groupings, as well as the five nuclear-weapon States (NWS), should not block or stand in the way of a clear majority of parties to postpone the conference to next year and all States parties must agree to meet in Vienna in the higher interest of strengthening the authority and integrity of the NPT – which all concur is the cornerstone of the global nuclear governance system of nuclear non-proliferation, nuclear disarmament and peaceful uses of nuclear energy.

In my opinion pieces, 'The 2020 NPT Review Conference: From the Sublime to the Ridiculous', published on 12 March, and in 'Relentless Spread of Coronavirus Obliges Postponing the 2020 NPT Review to 2021' of 2nd March, as well as in 'The NPT at 50: Perish or Survive?', I have laid out several convincing reasons why States parties are better off holding the NPT review conference in Vienna next year. These include, for example:

Bleak prospects at present for any progress on nuclear disarmament – a key element of the NPT – an issue on which some previous conferences have failed to agree on an outcome document. This impasse over nuclear disarmament already is creating tensions. If any proof is needed regarding near universal dissatisfaction one need only look at aggressive comments verbally attacking those in countries promoting fulfilling the nuclear disarmament obligations under the NPT. Thus, postponing the NPT conference to 2021 provides a respite of a year with the possibility of an improved political climate next year, not to mention subsidence of COVID-19.

Convening the review conference in Vienna will provide a welcome change in venue from the near toxic political climate at the United Nations in New York over issues such as Syria, the Middle East, visas and sanctions among others.

The location of Vienna in Central Europe will greatly reduce distances to be travelled by delegates from Asia, Africa and Oceania, as well as of course by European countries – these regions put together comprise the largest number of countries in the world. Only the North and South American delegates will have increased travel distances, but these obviously are a minority compared to those from other regions.

Costs of hotel accommodation and meals in New York are inordinately high as compared with Vienna, even after taking the Euro / US dollar exchange rate into account. Such savings would be beneficial both for official delegates as well as for civil society representatives.

In addition, now the rationale is questionable to hold NPT review conferences at any location in any nuclear-weapon State (NWS). It is arguable

that the NWS have not delivered on nuclear disarmament to the level expected, rather to the contrary nuclear weapons are being modernized in some NWS, the threshold of possible use of nuclear weapons has been lowered, and existing nuclear arms reduction treaties are under threat. Thus, it is logical to hold "nuclear non-proliferation" treaty review conferences in a militarily "neutral" non-nuclear-weapon country such as Austria that has consistently been a strong promoter of nuclear non-proliferation and nuclear disarmament and hosts important international nuclear organizations such as the IAEA and the CTBTO.

It is logical to hold "nuclear non-proliferation" treaty review conferences in a militarily "neutral" non-nuclear-weapon country such as Austria that has consistently been a strong promoter of nuclear non-proliferation and nuclear disarmament and hosts important international nuclear organizations such as the IAEA and the CTBTO.

If Not Now, Then When? Despite the promises under the NPT, more than 13,000 nuclear weapons still exist in the five nuclear-weapon States party to the Treaty – with nearly 3,000 on ready to launch status, as well as nearly two million kilogrammes of weapon-usable nuclear material. The danger of nuclear war whether by accident or design is at an all-time high, the Doomsday clock is teetering at 100 seconds to midnight – that is 100 seconds to possible nuclear Armageddon! In these circumstances, the NPT remains the sole multilateral nuclear arms control treaty and its integrity and authority must be preserved if we are to have any chance of avoiding a nuclear holocaust.

On 27 April, or whenever, as proposed by President-designate Ambassador Gustavo Zlauvinen, NPT States parties meet to decide on procedural matters concerning the NPT review conference, the only correct decisions regarding dates and venue are: late April-early May 2021 in Vienna. If NPT States parties do not live up to their responsibilities now, then when?

Source:https://www. indepthnews.net/index.php/opinion/3383-postpone-the-npt-review-conference-to-2021-and-convene-in-vienna, 16 March 2020.

IRAN

New Tensions between Iran and the IAEA Threaten the JCPOA

Earlier in March, the IAEA released two reports regarding Iran and the JCPOA, commonly known as the Iran nuclear deal. Unlike previous reports, which detailed Iran's compliance, the new documents were reminiscent of the pre-JCPOA era and could signal an increasingly negative trend in the country's relationship with the world's nuclear watchdog. Amid the outbreak of the deadly coronavirus, concerns are also being expressed by some experts that the disease could hamper the ability of the IAEA to monitor Iran's nuclear program. Opponents of the JCPOA are trying to use these developments to destroy what remains of the landmark 2015 agreement by achieving a "snapback" of UN sanctions lifted by the deal.

While Iran has the technological capacity to enrich at higher and more sensitive levels, it has not made the political decision to do so, perhaps to avoid antagonizing the remaining signatories of the nuclear deal. Iranian officials have stated that their steps are reversible and that Tehran is ready to go back to full compliance if "European signatories of the pact fulfilled their obligations.

According to the first report, Verification and Monitoring in the Islamic Republic of Iran, as of February, Iran's stockpile of LEU was 1020 kilograms, more than three times the amount allowed under the JCPOA. At the same time, Iran has kept its enrichment level at 4.5 percent—more than the 3.67 percent specified in the nuclear deal but well below 20 percent, which it enriched prior to the signing of the JCPOA, and from which it is relatively easy to reach the 80 percent needed to make nuclear weapons. While Iran has the technological capacity to enrich at higher and more sensitive levels, it has not made the political decision to do so, perhaps to avoid antagonizing the remaining signatories of the nuclear deal. Iranian officials have stated that

their steps are reversible and that Tehran is ready to go back to full compliance if "European signatories of the pact fulfilled their obligations." Iran wants to avoid snapping back of UN-imposed sanctions, which the remaining parties to the deal could do if Iran steps too far outside the limits of the 2015 accord.

The IAEA also issued a second negative report, NPT Safeguards Agreement with the Islamic Republic of Iran, strongly censuring Tehran for lack of cooperation with the agency. The IAEA has requested access to three undisclosed locations where Iran allegedly conducted undeclared nuclear activity. After initially ignoring three letters demanding access to these locations, Tehran responded by stating that the "Islamic Republic of Iran will not recognize any allegation on past activities and does not consider itself obliged to respond to such allegations." Iran's ambassador to the IAEA Kazem Gharib-Abadi added, "Intelligence services' fabricated information...creates no obligation for Iran to consider such request."

A snapback of sanctions under Chapter VII of the UN Charter would be the final blow to the agreement and would likely compel Iran to withdraw from the NPT, which obliges members not possessing nuclear weapons not to develop them. Such a scenario would endanger the entire non-proliferation regime and clearly be detrimental to US national interests.

He was apparently referring to the "Iran Nuclear Archive" stolen from a warehouse near Tehran by Israeli operatives in 2018. The documents provide a great deal of information about Iran's past nuclear activities, strategic intentions and a 2003 order to halt a structured weapons program but do not elaborate on any post-2003 decision-making. The release of the Israeli archive—publicized two weeks prior to US President Donald Trump's decision to unilaterally withdraw from the JCPOA in May 2018—seems to have influenced both the US decision to withdraw and a tougher stance toward Tehran on the part of the IAEA.

The negative reports are providing new ammunition to the Trump administration efforts to prevent the lifting of a UN-imposed arms embargo on Iran which is supposed to occur in October. In a statement to the IAEA's Board of Governors, US ambassador to the IAEA Jackie Wolcott denounced Iran's refusal to "address the Agency's questions regarding possible undeclared natural uranium at a location that has been heavily sanitized."

That the Trump administration seeks to completely kill the nuclear agreement is no secret. However, the remaining parties to the agreement—Britain, France, Germany, China, Russia and the European Union—retain a strategic interest in preserving the JCPOA. This explains why Germany, France and Britain—also known as the E3—extended the process of the dispute resolution after deciding to trigger a provision in the JCPOA, the Dispute Resolution Mechanism, in January under US pressure. A snapback of sanctions under Chapter VII of the UN Charter would be the final blow to the agreement and would likely compel Iran to withdraw from the NPT, which obliges members not possessing nuclear weapons not to develop them. Such a scenario would endanger the entire non-proliferation regime and clearly be detrimental to US national interests. As a Department of Energy spokesman recently noted, "It remains vital to the United States that the IAEA continue to perform its verification mission in Iran."

It's worth noting that new tensions with the IAEA are unfolding in the context of the coronavirus pandemic, which has killed more than 2,000 Iranians. Critics of the JCPOA, including Andrea Stricker and Jacob Nagel of the neoconservative Foundation for Défense of Democracies, have argued that Tehran appears to be "content with the pandemic's debilitating impact" on IAEA monitoring; however, the authors fail to provide any substantial evidence to support their claim.

In the same vein, George Moore of the James Martin Centre for Non-proliferation Studies (CNS) at the Middlebury Institute of International Studies has argued that suspending inspections, even temporarily, could leave a gap that Iran could exploit if it chose to develop nuclear weapons.

However, a careful analysis of Iran's behaviour suggests that Tehran is interested in maintaining the JCPOA, even though it has not received the economic benefits it was promised. Meanwhile, remote monitoring equipment on site in Iran continues to record the amount and level of low-enriched uranium Iran is producing.

In analysing Tehran's nuclear intentions, it is important to recognize why Iran began a quest for a nuclear deterrent. After initially suspending its nuclear activities following the 1979 revolution, Iran resumed work during the Iran-Iraq War, when it was systematically subjected to the use of chemical weapons by Iraq and feared Saddam Hussein was developing nuclear arms. However, Iran's geopolitical environment has fundamentally transformed since the US toppling of Saddam in 2003, and Tehran no longer faces an existential threat from either Iraq, or its neighbours. At a time when it is confronting a much more immediate crisis that has also taken the lives of senior officials, it seems unlikely that Tehran would choose this moment to try to break out and "dash" for a nuclear weapon, as Moore has suggested. Still, the recent trend in Iran's relationship with the IAEA is concerning. To alleviate tensions, Iran should fully cooperate with the IAEA's demands. The IAEA, in turn, should seek to satisfy its concerns without humiliating Tehran over activities that appear to have occurred long ago.

Source:https://atlanticcouncil.org/blogs/iransource/new-tensions-between-iran-and-the-iaea-threaten-the-jcpoa/, 26 March 2020.

NUCLEAR WASTE MANAGEMENT

USA

Nuclear Waste Disposal: Why the Case for Deep Boreholes is ... Full of Holes

In the budding days of the COVID-19 pandemic, President Trump idled his days away, launching random tweets about unrelated issues. One such issue was nuclear waste disposal: "Nevada, I hear you on Yucca Mountain...my Administration is committed to exploring innovative approaches – I'm confident we can get it done!"

After this particular proclamation, the nuclear expert community was left scratching its collective head. Does the president support Yucca Mountain as an eventual nuclear waste repository, or does he not? And, more puzzling, what "innovative approaches" for nuclear waste does he have in mind? Maybe he was thinking about the "waste eating" advanced reactors promoted by the US Energy Department and the private sector; maybe he was thinking about reprocessing spent nuclear fuel; or maybe he was thinking about deep boreholes for permanent waste storage.

In the budding days of the COVID-19 pandemic, President Trump idled his days away, launching random tweets about unrelated issues. One such issue was nuclear waste disposal: "Nevada, I hear you on Yucca Mountain...my Administration is committed to exploring innovative approaches – I'm confident we can get it done!.

The deep borehole concept is relatively simple and has been around since the 1950s. Rather than excavate one enormous mine like Yucca Mountain to store all US civilian nuclear waste, this solution would involve depositing nuclear waste in hundreds of narrow holes drilled into the earth's crust. The idea has plenty of boosters, among them a start-up called Deep Isolation, based in Berkeley, California. Founded by physicist Richard Muller and his daughter Elizabeth Muller, the company launched a Series A investment round earlier this year on the promise that it can bring the borehole concept to fruition. By leveraging the lateral drilling technology developed for tapping into shale gas deposits, the company that professes to be the "SpaceX" of nuclear waste claims to have hacked a solution for the permanent disposal of the United States' 82,000 metric ton inventory of commercially-generated spent nuclear fuel.

***Unfortunately, the Proposal is Full of Holes*:** The problem of Yucca Mountain. Ever since the 1950s, the United States has been searching for a place to bury its nuclear waste, which remains radioactive for tens of thousands of years. In 1987, against the will of Nevadans, the US Congress

designated Yucca Mountain to host the nation's spent fuel inventory through an amendment to the Nuclear Waste Policy Act. Ever since, the site has been treated as a political football. The facility was supposed to open in 1998, but far from completion, the project was dismantled in 2010. So far, the only thing that's been built there is a five-mile exploratory tunnel.

Meanwhile, those 82,000 metric tons of spent nuclear fuel remain in temporary storage. In practical terms, that means the spent fuel is sitting at about 80 different places spread out across 35 states, stored either in pools of water or in casks made of steel and concrete.

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The delays and shortcomings at Yucca Mountain have created opportunities for companies like Deep Isolation to profit from empty promises to deliver "alternative solutions. "The borehole business model. By pledging to streamline the process of disposing spent nuclear fuel, Deep Isolation has already amassed over $14 million in venture capital. To save nuclear plants from shipping their waste to a centralized repository 2,000 miles away, the company conceives to bury the waste more or less on-site at each power plant in nearly horizontal underground holes.

Unlike the Yucca Mountain repository, boreholes would be sited below the water table, at depths ranging from 600 meters to 2 kilometres, in sedimentary rock formations. The disposal zone would consist of or be overlain by shale rock formations, which contain ductile clay minerals that can heal any fractures that would otherwise facilitate the flow of water—a potential hazard—to and away from the waste.

Even though hundreds of boreholes will be required to house the nation's spent fuel inventory, this option is said to be inexpensive, relative to Yucca Mountain. Deep Isolation cites a lower-limit cost of $2 million to drill one hole but suggests that the approach will save money overall by eliminating things like further interim waste storage, transportation, and much of the necessary construction workforce. Confronted with an economies-of-scale argument that would favor a few, large-capacity facilities, the company markets its approach as "modular," so that the revenue generated from the completion of one easily-replicated, generic borehole can finance the development of subsequent boreholes.

A supposedly irrefutable safety case accompanies these seemingly excellent financials. Unlike the Yucca Mountain repository, boreholes would be sited below the water table, at depths ranging from 600 meters to 2 kilometres, in sedimentary rock formations. The disposal zone would consist of or be overlain by shale rock formations, which contain ductile clay minerals that can heal any fractures that would otherwise facilitate the flow of water—a potential hazard—to and away from the waste. Simple tests, such as analyses of natural chlorine isotopes, show that the water in these formations is millions of years old. This, Deep Isolation hopes, will convince stakeholders that the system is impenetrable, with negligible risk for contamination of nearby aquifers.

A watertight plan? Long before Deep Isolation announced its hack, the Energy Department had concluded in the 1980s that disposal of spent nuclear fuel in boreholes drilled to depths of roughly 10 kilometres was not an attractive alternative to mined repositories. In the years following, the US Nuclear Waste Technical Review Board, the US Nuclear Regulatory Commission, and waste management organizations of Sweden, the United Kingdom, and Canada reviewed concepts for shallower boreholes, with waste emplaced at depths ranging between 3 kilometres and 5 kilometres. Similar to the Energy Department study, these reviews concluded that borehole disposal would require decades of research, design, and development,

which—even if successful—did not promise safety margins superior to a well-sited, deep-mined repository. A more recent study that several colleagues and I authored found that Deep Isolation's even shallower boreholes, at depths of around 2 kilometers or less, would be plagued by the same problems and that suitable borehole disposal sites are, in fact, geographically scarce.

Many challenges to the viability of borehole disposal stem from the limit that modern drilling techniques impose on borehole diameters. Although the precise borehole geometry is dependent on location-specific geologic variables, deeper boreholes generally necessitate smaller diameters. Such a limitation has implications both in terms of the barrier system that surrounds the nuclear fuel and in terms of the ability to fully characterize the geology of the disposal site.

To accommodate canisters whose diagonal cross-section has a length of 30 centimetres, the diameter of Deep Isolation's curving boreholes must be larger than 40 centimetres. Since this exceeds the 22-centimeter standard for oil and gas extraction, the technical feasibility of Deep Isolation's drilling scheme remains unclear. But if it is feasible, then a 40-centimeter diameter borehole would restrict the thickness of the canister walls to about one centimetre. As compared to deep-mined repositories, which could accept canisters with walls thicker than 5 centimetres, thin-walled canisters will have adverse safety consequences for the workers who will load the waste into the boreholes. Therefore, potential worker exposures to and environmental releases of radioactivity during canister loading warrants careful consideration.

For instance, gamma radiation emitted by spent fuel can penetrate a canister wall and expose operators to radiation. The thick-walled canisters destined for deep-mined repositories will attenuate a significant portion of this penetrating radiation, but the thin-walled canisters inherent to borehole disposal will have negligible shielding capability. The sheer number of canisters will pose further challenges. Canister designs for mined repositories will have a capacity of at least four spent fuel assemblies, whereas borehole canisters will each contain only one assembly. Lowering hundreds of thousands of flimsy canisters into hundreds of narrow boreholes in a safe, timely fashion will be tricky, to say the least. If a canister is punctured or becomes stuck during this phase, then the risk to operators and the environment could be high.

Investing in the necessary research, design, and development needed for drilling, shielding, and canister emplacement for Deep Isolation's concept might be justified, if this approach would improve the financial and long-term safety case for spent fuel disposal relative to a deep-mined repository. But, the thin-walled canisters will also adversely affect long-term safety as well, insofar as they will be more likely to fail through corrosion compared to a thicker canister.

Borehole developers must compile a safety case that convinces regulators and the general public that the geologic environment around their disposal sites can function on its own to sequester radionuclides over the 1 million-year regulatory period. This means that in-depth sampling and analysis will need to be performed at every disposal site, undercutting the idea that boreholes represent a modular, easily replicable solution.

Whereas mined repository designs incorporate a series of engineered and natural barriers to delay or preclude the release of radionuclides into the groundwater system and into the biosphere, borehole disposal relies entirely on a geologic barrier. Hence, borehole developers must compile a safety case that convinces regulators and the general public that the geologic environment around their disposal sites can function on its own to sequester radionuclides over the 1 million-year regulatory period. This means that in-depth sampling and analysis will need to be performed at every disposal site, undercutting the idea that boreholes represent a modular, easily replicable solution.

Ironically, the concept that has been promised to liberate stakeholders of the upfront costs associated with these site investigations is destined to increase the complexity of these activities. Rather than one or a handful of disposal

sites, hundreds of disposal boreholes must be investigated thoroughly. Then, stakeholders must reach a high level of certainty that the bedrock, alone, can compensate for a lean engineered barrier system.

Grappling with uncertainty. Reducing long-term performance uncertainty is the sine qua non for garnering public support for spent fuel repository projects. Over the course of decades, mined repository programs can take a phased approach to resolving the uncertainties associated with the geologic variables that control the flow of groundwater to and away from the emplaced waste. These include an initial phase during which geologic samples are collected and analysed at several sites; an interim monitoring phase during which routine measurements are performed to capture the variability of those results; and a construction phase that allows workers, inside a rock cavern, to validate interpretations made in the earlier phases. By contrast, the deep borehole model, which relies on rapid siting, drilling, waste emplacement, and closure, affords little to no opportunity for site monitoring. It offers no way for scientists, regulators, or engaged citizens to enter the rock cavern and learn, through experience and careful examination, whether the repository will remain geologically stable for millennia.

A proven approach. Deep Isolation's rendition of borehole disposal includes a slew of Silicon Valley buzzwords apparently aimed at novice investors on crowdfunding websites. Even if several decades of labour does glean evidence of the technical feasibility of this alleged hack, then its long-term safety case would still be subject to inordinate uncertainty.

Nuclear waste experts have long emphasized disposal solutions that rely on mature technologies, for simple reasons. What will happen to surface-stored spent fuel if, while waiting for some shiny new object, a malevolent dictator assumes power? Or, what if a pandemic cripple the global economy?

In the end, then, a mined repository still may be the best answer. Technically viable and publicly accepted repository designs are successfully moving ahead in Sweden, Finland, Switzerland, France, Canada, and even China and Russia. Rather than committing, prematurely, to a single site (Yucca Mountain) or chasing after nonviable "alternative solutions," the United States would be wise to scale one or more of these internationally pioneered designs to accommodate the world's largest national spent fuel inventory. By coupling one of these technical solutions with the institutional reform proposed by expert committees, the United States might finally find somewhere to put its nuclear waste.

Source:https://thebulletin.org/2020/03/nuclear-waste-disposal-why-the-case-for-deep-boreholes-is-full-of-holes/, 26 March 2020.

Centre for Air Power Studies

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