



OPINION – Manpreet Sethi

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Dissecting the Idea of ‘Limited’ Nuclear War

While nuclear weapons are designated as weapons of mass destruction, every now and then, the idea surfaces that the weapons can be custom-made and used in such a way as to restrict damage to limited levels. While there is no accepted definition of ‘limited nuclear war,’ it can be described as one in which a *limited number* of nuclear warheads with relatively *smaller yields* are employed to attack a *limited military targets* to impact a *limited geographical space* for *limited objectives*. Its purpose would be to signal deterrence by showing that levels of nuclear violence or the scope of nuclear use can be restricted by choosing military targets instead of cities, thereby making nuclear use more credible and even legally defensible. But can this be a workable proposition?

Origins of the Concept of Limited Nuclear War: The idea of limited nuclear war emerged to address the perceived limitations of deterrence premised on MAD. As the increase in nuclear warhead numbers in the US and USSR established a balance of terror, it led to the view that attacks on cities would make nuclear war an unlimited war. This was seen as degrading one’s deterrence by making nuclear strikes less credible against smaller or less than existential provocations.

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So, in an ostensible attempt to make the use of nuclear weapons more rationally feasible, analysts like Herman Kahn and Albert Wohlstetter in the 1960s and 1970s argued in favour of flexible nuclear use to conduct limited nuclear war. They contended that deterrence could be better signalled if a more effective use of nuclear weapons against military targets was made possible. Such thinking was both enabled by and also led to technological advances in the miniaturisation of nuclear warheads and the growing precision and accuracy of missiles that offered counterforce targeting options to conduct a ‘discriminate’

nuclear war. MAD was replaced by these ideas of nuclear utilisation target selection, or NUTS.

The idea of limited nuclear use was presented as taking the war back to the battlefield. US Secretary of Defence Brown, in the Annual Report of the Department of Defence to the Congress in 1981, said, "large-scale countervalue attacks may not be appropriate to deter the full range of potential Soviet threats...instead we could attack in a selective and measured way, a range of military, industrial, and political control targets, while retaining an assured destruction capacity in reserve." It was also argued that a policy of attacking military targets that minimises unintended civilian fatalities would offer incentives for an adversary to reciprocate under similar restraints by attacking military targets, thereby reducing the chances of mass homicide on both sides. The purpose would be to showcase the destruction potential of nuclear weapons to shock and scare the adversary into agreeing to the termination of hostilities on one's terms, but not unleash the complete fury of strategic use.

These ideas drove US strategy for many decades and even led to capabilities that offered flexible option to the US President. Simultaneously through, these was a pushback by the likes of Bernard Brodie, Robert Jervis, and many others during the same period, which contributed to much churning in nuclear discourse. The idea of nuclear war received a quiet burial once Presidents Reagan and Gorbachev pronounced the uselessness of nuclear war in 1987 and given the subsequent change in political relations with the end of the Cold War.

Return of the Prodigal: After remaining dormant for about 15 years thereafter, the idea of limited nuclear war to "handle regional conflicts with small nuclear armed powers" again sprung to life in the second half of the 2010s. Such an

eventuality was particularly envisaged in the context of "a rogue state" that might not be deterred by thousands of American nuclear warheads and choose to cross the nuclear threshold even in a small, limited conventional conflict.

To deter such eventualities, the US Nuclear Posture Review (NPR) 2018 announced, "Expanding flexible U.S. nuclear options now, to include low-

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yield options, is important for the preservation of credible deterrence against regional aggression." The NPR also found merit in threatening the limited use of nuclear weapons to deter possible disruptive activities by Russia and China. Russia's ambiguity on the use of low-yield nuclear weapons in response to aggression with non-nuclear weapons, widely referred to as

'escalate to de-escalate,' was cited as the reason for Washington's search for a "range of limited and graduated options, including a variety of delivery systems and explosive yields." The US accuses Russia and China of having "introduced limited war techniques... For Russia, 'jab and grab' land incursions; for China, the creeping militarization of maritime zones. Both techniques operate below the threshold of deterrence by punishment and seek to create territorial *faits accompli* that lower the costs of revisionism."

The latest US NPR of 2022 has retained the role of nuclear weapons to deter limited nuclear attacks with tailored deterrence. In order to make the threat of limited use look credible, a small number of existing SLBM warheads have been modified to provide a low-yield option so as to have a diverse set of capabilities "for responding to nuclear or non-nuclear strategic attack; and enhance deterrence by signalling to potential adversaries that their limited nuclear escalation offers no exploitable advantage..." All of this is being justified as being technologically feasible, causing

less of a humanitarian disaster, and hence being more legally defensible. But is that true? Can a limited nuclear war be credibly fought and won between two nuclear armed states?

Fighting a Limited Nuclear War: Nuclear war-fighting envisages operations in a logical and controlled manner with the idea of escalation dominance and cool control during a pre-conceived limited counterforce attack. But, wargame after wargame has shown the difficulties in containing nuclear wars that started with calibrated use to run along pre-determined pathways. There are two sets of challenges that can be identified in the case of a limited nuclear war.

Operational Military Challenges: The first of these arises from the uncertainty about the adversary's willingness to play the game of limited nuclear war. In his 1981 book, *The Evolution of Nuclear Strategy*, Lawrence Freedman stated, "It takes two to keep a war limited." It can never be taken for granted that the adversary will read the signal of limited nuclear use as intended and respond likewise. In fact, the adversary might completely misread the intention, as can be seen in this statement by a Soviet Major General, "the assertion made by supporters of 'limited' nuclear war that it could be kept within pre-planned limits and made 'controllable' is altogether false." The Soviets interpreted the American building of counterforce capabilities as a move towards a credible first strike.

Indeed, the adversary can never know or be sure that the intent is to keep the nuclear use limited and that the first volley will not be followed by more, especially since the first user would also

be signalling readiness for more attacks to deter the adversary's retaliation. If the adversary chooses a more elaborate response than had been envisioned by the first user, could this then remain a limited exchange?

In fact, the probability of being able to undertake limited nuclear attacks with no or only limited blowback amounts to wishful thinking. Analytical studies on how to conduct limited nuclear wars

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can only make educated guesses on matters of critical planning. For instance, such a planner may be able to reasonably determine the physical effects of nuclear explosions based on the yield of weapons, the height at which they would burst, the amount of warning time the adversary may have, the time of the

attack, etc. But, whether such calculations can completely factor in more complicated issues, such as the overall impact of the attack on the national psyche, or other immeasurable imponderables, such as "popular panic and administrative disorganisation," can never be

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ascertained. That a planned limited nuclear use will remain within expected parameters is virtually impossible to determine, and it would be foolish to base one's use of nuclear weapons on such an unknown.

A second practical difficulty in keeping the war limited can be seen in the context of the first user himself.

Since the basic premise of limited nuclear war is to hit the adversary's military targets in the hope that he would respond likewise, could result in "battles of great confusion". Even if the casualties in these cases might be low, there is every chance that the troops would be left isolated, leaderless,

with no or contaminated food and water supplies, even fighting equipment and spare parts, and with a low morale.

Political Challenges: The most serious danger that lurks in making the case that limited nuclear wars are fightable, containable, and even winnable is a heightened temptation to use nuclear weapons. It could lead to the belief that worthwhile military or political objectives are achievable through managed nuclear use. But, as stated earlier, there can be no guarantee that a nuclear exchange between two nuclear weapon states will remain limited. It may. But then it may not, and that might prove to be a risk that is too risky. In fact, a perception that the adversary is indicating greater nuclear swagger by getting away with 'limited' nuclear use could generate a greater sense of vulnerability and raise the incentives for pre-emption. This would make a nuclear exchange more likely, not less likely. Therefore, the deterrence effects of showcasing limited nuclear use need to be evaluated with care.

In fact, besides increasing the chances of deterrence breakdown, the pursuit of nuclear war-fighting capabilities (even if ostensibly for the purpose of deterrence) through the greater accuracy of nuclear-tipped missiles, elaborate intelligence, surveillance, and reconnaissance infrastructure, and damage limitation defences would also be a financially exhausting exercise.

A third consequential challenge comes from the harm that limited nuclear war would cause to the taboo against the use of nuclear weapons. The conduct of nuclear use in which the first user is able to show a successful ability to keep nuclear

war limited could set a precedent that others could be tempted to follow. It would 'conventionalise'

the use of nuclear weapons and make it appear normal to use small nuclear weapons in 'limited' ways. If this were to happen against non-nuclear weapon states, such as Russian nuclear use against Ukraine or Chinese nuclear use against Taiwan, it could spur proliferation. Non-nuclear weapon states (NNWS) would face a renewed sense of insecurity. In such a scenario, one can expect them to want to acquire nuclear capabilities of their own. Meanwhile, a 'successful' nuclear exchange between two nuclear-armed states could open another Pandora's box.

Another related danger would be the higher possibility of nuclear terrorism by non-state actors. The availability of nuclear weapons and related material and infrastructure in more states could not only raise risks of nuclear security but also raise the chances that terrorists, too, might

feel liberated from the taboo against the use of nuclear weapons. If states can find the limited use of nuclear weapons useful, so can non-state actors. Therefore, a limited nuclear exchange is likely to bring about a sense of complacency in nuclear use that could not be conducive for international security.

Evaluating India's Choices: India has a nuclear strategy based on deterrence by punishment. It does not believe that nuclear war-fighting can be contained with any certainty and, therefore, has refused to go down that path. It deters all kinds of purported uses of nuclear weapons, irrespective of how the adversary describes them, with its own ability to cause unacceptable damage through massive retaliation.

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Does this make for an unlawful or immoral strategy? As far as legalities are concerned, it may be recalled that the Advisory Opinion rendered by the International Court of Justice in 1996 in response to whether the use of nuclear weapons can be lawful was unable to take a clear stand on this and had left it to the nations to make the judgement on whether they needed to use these weapons for self-defence.

While the first use of the weapon might be carefully calibrated to cause minimal collateral damage, there can be no guarantee that the recipient of such an attack would follow along similar lines. Therefore, even a small use could eventually breach legal and moral constraints.

On the second issue of morality, while massive retaliation may conflict with the principles of distinction (of combatants and non-combatants), proportionality, or controllability of international humanitarian law, its articulation in India's doctrine is premised on creating the maximum chance of non-use of the weapon. This, in fact, is buttressed by two other doctrinal attributes: maintaining a narrow role for nuclear weapons solely to nuclear deterrence and accepting NFU.

India should seize this moment to reinforce faith in its own nuclear convictions and remind others that nuclear weapons are not ordinary or even a 'little more' than ordinary weapons. These are extraordinary weapons of mass destruction. Deterrence is their main purpose, and that comes best with the ability to cause unacceptable damage. Making that damage acceptable by meting it out in controlled quantities, whether as a first or second user, is a dangerous and foolish idea that is more likely to cause deterrence breakdown.

It is the fear of massive damage that is likely to be found more unacceptable by an adversary than the idea that 'small' nuclear wars can be tolerated. The latter, in fact, would likely enhance the chances of use. While the first use of the weapon might be carefully calibrated to cause minimal collateral damage, there can be no guarantee that the recipient of such an attack would follow along similar lines. Therefore, even a small use could eventually breach legal and moral constraints.

The world today is grappling with many nuclear risks. These range from stressed inter-state relations to unbridled nuclear modernisations and expansions, the deployment of dual-use delivery

systems and nuclear entanglement, and eroding faith in taboos. It would be disastrous if the idea of limited nuclear war as a feasible proposition were to be added to this list. The more nations move towards the idea of being able to contain a small nuclear war, the closer we will move towards routinising their use. Eventually, when a small nuclear use turns into a big one or a limited use into a little less limited one, would be anybody's guess.

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deterrence breakdown.

Source: <https://capsindia.org/dissecting-the-idea-of-limited-nuclear-war/>, 31 August 2023.

OPINION – David Appleyard

Re-Energising a Nuclear Supply Chain That's Fit for the Future

Decades of stagnation in the nuclear development pipeline have led to a weakened global supply chain. This must be addressed with far greater urgency if we are to meet our climate, security

and cost requirements. Climate change and energy security are two of the key drivers that are energising renewed interest in nuclear power. Governments, industrial interests, and even private investors are all looking at nuclear in ways that have not been in evidence for many, many years, if ever. And this focus isn't just on the more traditional gigawatt-scale endeavours but also a new generation of smaller advanced reactors that are opening up novel applications and opportunities for nuclear deployment.

However, this growing interest, while clearly positive, must also be tempered with the challenge of developing a supply chain that can meet market demands now and in the future. The commercial operation of Vogtle 3 is a welcome break in a development drought for the US that has lasted some 30 years. In Canada Darlington 4 was the last reactor to be connected to the grid, in 1993. Over the Atlantic in Europe things are hardly any better. In the UK, for example, Hinkley Point C will be the first new reactor to be built since Sizewell B began construction in 1987. Certainly, other nations and regions, notably Asia and the Middle East, have had more sustained successes of late. But it's clear that, for the West at least, much work needs to be done to build the necessary skills, manufacturing capacity and related services if a new generation of nuclear power is to emerge. Or at least emerge in any timely way across all the various facets of the nuclear lifecycle and both at the scale needed to meet our energy ambitions and at an economically sustainable cost for consumers.

In its newly released 5th edition of the World Nuclear Supply Chain, the World Nuclear Association (WNA) highlights these issues with a market view of the opportunities and challenges. Focusing on structures, systems, components and services, their analysis puts forward a series of recommendations that they believe can support

optimisation of the global supply chain to develop the required resilience, competitiveness and efficiency.

It's perhaps no surprise that among the trade body's recommendations is the suggestion that governments and the nuclear industry work together to prioritise supply chain sustainability and agility with measures that include long-term policy support for nuclear infrastructure and which can provide incentives for investment.

Climate change and energy security are two of the key drivers that are energising renewed interest in nuclear power. Governments, industrial interests, and even private investors are all looking at nuclear in ways that have not been in evidence for many, many years, if ever. And this focus isn't just on the more traditional gigawatt-scale endeavours but also a new generation of smaller advanced reactors that are opening up novel applications and opportunities for nuclear deployment.

They also predictably call for more streamlined processes when it comes to licensing NPPs. This is particularly important when considering the development of fleets of more standardised reactors that are to be installed across multiple jurisdictions, they say, noting that technical requirements should be harmonised through better collaboration that ensures licensing and supply chain oversight is streamlined.

More significantly, and in the short term more likely, they call for simplified procurement models that give suppliers better view of tenders that can help them participate. Standardised procurement frameworks and more cooperative contracting models are key here and the WNA also argues that recent NPP projects could be used as a baseline for developing a stronger supply chain by developing appropriate codes of conduct and establishing best practice. Collaboration between government and the private sector and between different parts of the supply chain are also necessary to ramp up sufficient capacity.

Research and innovation programmes that support newer technologies like robotics, AI, and advanced manufacturing will likely have a big impact on the development of a fit for purpose global supply chain too. There's really no doubt that rapid nuclear expansion is needed if we are to meet our global goals for a net-zero energy system, together with long-term energy security, and

affordability. That requires sustained and coordinated investment in the nuclear supply chain and recognising that is the most important step.

Source: <https://www.neimagazine.com/opinion/opinionre-energising-a-nuclear-supply-chain-thats-fit-for-the-future-11129270/>, 07 September 2023.

OPINION – Gavin Maguire

Nuclear Gets a Boost from Europe’s New Green Energy Targets

European lawmakers bowed to pressure from France to allow nuclear power to be used for ammonia and hydrogen production in order to pass new legally binding targets to expand renewable energy development in the European Union. France’s own hefty nuclear power sector – which generates over 60% of the country’s electricity – is clearly a key beneficiary of the allowances made by lawmakers as part of the deal which aggressively lifts EU renewable energy usage targets. But all of Europe’s nuclear power producers may get a lift from the new deal, which allows for certain non-emitting nuclear facilities to bypass rules relating to hydrogen production.

Thanks to the deal, France’s nuclear plants can produce and market hydrogen that may be used by industry as a replacement for fossil fuels, and contribute to the region’s goals of sharply reducing fossil fuel use while boosting supplies of clean fuels. Opponents to the deal with France wanted to restrict green hydrogen production to facilities fed by new renewable energy capacity, but were outnumbered by those in favour of the compromise which ensures that all of Europe’s main economies continue to push towards shared emissions reduction goals.

Nuclear Momentum: With certain nuclear plants

There’s really no doubt that rapid nuclear expansion is needed if we are to meet our global goals for a net-zero energy system, together with long-term energy security, and affordability. That requires sustained and coordinated investment in the nuclear supply chain and recognising that is the most important step.

But with existing plants that already generate non-emitting power now primed to also tap potentially lucrative growth markets in hydrogen and ammonia, nuclear power supporters may soon crowd out the opponents and boost the sector’s recognition as a key and clean part of Europe’s energy mix.

now considered eligible to produce the hydrogen and ammonia that are expected to be used as power sources and industrial inputs over the coming years, nuclear plants outside of France will likely take an interest in joining efforts to scale up clean hydrogen output.

In addition, the EU’s apparent acceptance that nuclear power is a key source of low-carbon energy will likely further shore up support for nuclear power. The sector has lost share to renewables and natural gas across Europe in recent decades, but has seen a resurgence in public and industry backing over the past year or so as Europe’s power costs surged in the wake of Russia’s invasion of Ukraine. Beyond France, several European countries rely on nuclear power to generate a substantial share of electricity, including Sweden, Spain, Switzerland, Finland, Belgium and Bulgaria. Non-nuclear nations are also exploring the feasibility of developing nuclear capacity, including Italy which this year passed a parliamentary motion to encourage the government to consider adding nuclear to the country’s energy generation mix. Even in Germany, which shut its last remaining nuclear reactors in early 2023, members of the coalition government recently called for the dismantling of plants to stop, in case they are needed in future energy crises.

The nuclear sector still has plenty of opponents, who point to decades-long construction times and multi-billion dollar price tags as key reasons why cheaper and quicker-to-build renewable sources may be a better fit for Europe’s energy needs. But with existing plants that already generate non-emitting power now primed to also tap potentially lucrative growth markets in hydrogen and ammonia, nuclear power supporters may soon crowd out the opponents and boost the sector’s recognition as a key and clean part of Europe’s energy mix.

Source: <https://www.reuters.com/markets/commodities/nuclear-gets-boost-europes-new-green-energy-targets-2023-09-13/>, 13 September 2023.

OPINION – Josh Meyer

North Korea Could Get Satellite and Nuclear Weapons Help from Putin. Why it Matters

The unusual summit this week between Vladimir Putin and North Korea's Kim Jong Un raised questions about what Russia might gain from a deal: weapons and ammunition to help in its war with Ukraine. But what North Korea receives in return could pose an even bigger threat to U.S. interests in the long run, analysts tell USA TODAY. They say Kim – dubbed Little Rocket Man by then-President Donald Trump – will likely get Russia's advanced satellite technology as part of the deal, enabling him to take his distinctly anti-Western global ambitions into space, the fast-evolving new domain of warfare.

But North Korea's access to Russian space and satellite technology is of particular concern to Washington when combined with Pyongyang's extensive ballistic missile arsenal, according to Anthony Ruggiero, counter-proliferation director on the White House National Security Council during the Trump administration. Most immediately, it would likely give one of the most geopolitically sanctioned and isolated world leaders the ability to successfully launch and operate spy satellites after decades of trying. Kim would then likely use them, at the very least, for military and intelligence-gathering purposes on the Korean peninsula, against U.S. allies like South Korea and Japan – and elsewhere around the world, Ruggiero and other North Korea watchers said.

During Kim's tour of Russia's most modern space launch center Wednesday, Putin promised to help Pyongyang build satellites, Reuters reported. It

also said the promised Russian aid comes as North Korea's scientists have vowed to try another launch of its new Chollima-1 booster in October in an effort to put its first spy satellite into orbit.

Satellite technology that can also be used for nuclear weapons. David Albright, a physicist, nuclear weapons expert and founder of the non-profit Institute for Science and International Security in Washington, said that Russia in its public statements is likely trying to be coy by saying it would provide assistance to North Korea with general satellite technology only. But Albright told USA TODAY that Pyongyang could easily use the satellites for military applications too, and use the technology in its nuclear weapons program.

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For instance, North Korea has an arsenal of nuclear warheads – topped intercontinental ballistic missiles, that could easily reach the United States. But they wouldn't work, in part because the frigid temperatures and intense radiation in space would fry

their circuitry, Albright said. The U.S., Russia and other advanced countries know how to protect their missiles from using the same technology they use to protect their satellites, enabling them to survive and hit their intended targets many thousands of miles away.

If Russia were to share that kind of satellite technology to North Korea, it could also use it to make its missiles a potential threat to the U.S. homeland, Albright said. "That's the assessment of my institute and while I don't think it's shared as much in the public domain, it's certainly shared among governments that we've talked to as well," Albright said. "This would allow them to get closer to targeting a city in the United States. So this is an important step and we've certainly been waiting and watching nervously North Korea's attempts to launch satellites." Over the past few months alone, Albright Ruggiero and other experts said, North Korea has tried and failed at at least two satellite launches. "So any help from Russia, I would view

negatively," Albright said.

Bigger U.S. concerns than just North Korean military satellites: Kim has said such satellites are crucial to enhancing the threat of his nuclear-capable missiles, according to an Associated Press report. It noted that North Korea has repeatedly failed to put its first military spy satellite into orbit.

But the sharing of such strategic weapons technology could also significantly enhance North Korea's ability to advance its broader ballistic missile and nuclear weapons programs with help from Russia, Ruggiero said. "This will open the proliferation pathway to further advance their programs," Ruggiero said. "North Korea's nuclear weapons program is pretty far advanced. But obviously, Russia has done a lot more in that sphere that will be of use to North Korea."

These types of technology exchanges are prohibited under United Nations-sponsored laws and sanctions, forcing North Korea to obtain technology for its nuclear and ballistic missile programs through a global network of front companies and third-party cutouts. Specifically, the UN Security Council passed a resolution in November 2016, 2016 requiring all member states — including Russia — to suspend scientific and technical cooperation with North Korea except for medical exchanges. Some areas of scientific or technical cooperation are also allowed, as long as the UN determines "the Committee has determined "on a case-by-case basis that a particular activity will not contribute to the DPRK's proliferation sensitive nuclear activities or ballistic missile-related programs." "This (potential agreement) is like, we're throwing that away, we're just going to cooperate on these things that are prohibited and we're not going to even pretend

we're not," Ruggiero said.

Victor Cha, a North Korea expert on the George W. Bush administration's National Security Council, said Putin wanted to "deliver a message both substantively and symbolically" by meeting Kim at the cosmodrome in the Russian Far East and giving him a tour of the facility's launch vehicle assembly building and

spaceport. By doing so, Putin is telling the world he is willing to help North Korea with satellite technology, and possibly technology for space-launched vehicles and ICBMs, Cha and his associate at the Center for Strategic and

International Studies, Ellen Kim, wrote in a commentary piece published Wednesday. These satellites would not only complicate U.S. efforts to shore up deterrence on the Korean peninsula with South Korea, but these would also help Kim obtain "key weapons

technologies to complete his drive for a survivable nuclear and ICBM capability to threaten the U.S. homeland."

Source: <https://www.usatoday.com/story/news/politics/2023/09/14/russia-north-korea-satellite-nuclear-weapons/70845185007/>, 14 September 2023.

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North Korea has launched its first operational "tactical nuclear attack submarine", a key part of leader Un's plan to develop a nuclear-armed navy to counter the US and its Asian allies. Submarine No 841 – named Hero Kim Kun Ok after a prominent North Korean historical figure – was launched with Kim overseeing the event.

NUCLEAR STRATEGY

NORTH KOREA

N Korea Heralds 'New Chapter' with 'Tactical Nuclear Attack' Submarine

Overseeing the event, Un calls for the rapid development of the country's navy and its 'nuclear weaponisation'. North Korea has launched its first operational "tactical nuclear attack submarine", a key part of leader Un's plan to develop a nuclear-

armed navy to counter the US and its Asian allies. Submarine No 841 – named Hero Kim Kun Ok after a prominent North Korean historical figure – was launched with Kim overseeing the event, according to the official Korean Central News Agency (KCNA).

The submarine was designed to launch tactical nuclear weapons from underwater, KCNA said, and “heralded the beginning of a new chapter” for North Korea’s navy. It did not specify the number of missiles the vessel could carry and fire, but after analysing the state media photos some experts suggested it would have the ability to carry 10 of North Korea’s Pukgoksong-3 weapons, and fire them from underwater.

Official photos suggested the launch was a festive occasion with colourful balloons, and confetti. Kim was shown being greeted by hundreds of people gathered on the dock with women dressed in traditional Korean hanbok and waving flowers and flags. Sailors clapped in unison as he walked past on a red carpet with senior officers following behind. The Hero Kim Kun Ok, which state media said would be deployed to the waters between the Korean peninsula and Japan, will perform its combat mission as “one of the core underwater offensive means of the naval force” of North Korea, Kim said, saying the country plans to turn its existing submarines into nuclear-armed attack submarines and accelerate its push to develop nuclear-powered submarines.

Source: <https://www.aljazeera.com/news/2023/9/8/north-korea-launches-new-tactical-nuclear-attack-submarine>, 08 September 2023.

PAKISTAN

Where and How Pakistan is Keeping its Nuclear Weapons

We all know that Pakistan’s economy is in shambles. Frequent protests are erupting over high fuel prices and exorbitant power bills. Petrol

is being sold at a record high of Rs 300/litre and there are power outages of many hours across many cities. After trying many times to seek financial help from China and Gulf nations, Pakistan had to ultimately agree to tough IMF conditions for a bailout.

However, amid all this economic catastrophe, Pakistan is still continuing with its obsession of increasing its nuclear arsenal. According to a research report by the Federation of American Scientists, “Pakistan continues to gradually expand its nuclear arsenal with more warheads, more delivery systems, and a growing fissile material production industry.” “Analysis of commercial satellite images of construction at Pakistani army garrisons and air force bases shows what appear to be newer

launchers and facilities that might be related to Pakistan’s nuclear forces,” the report says. The scientists have estimates that Pakistan now has a “nuclear weapons stockpile of approximately 170 warheads”.

Here are highlights from the report: *Pakistan currently is producing sufficient fissile material to build 14 to 27 new warheads per year.

Nuclear-capable Aircraft and Air-Delivered Weapons: The aircraft most likely to have a nuclear delivery role are Pakistan’s Mirage III and Mirage V fighter squadrons. The Pakistani Air Force’s (PAF) Mirage fighter- bombers are located at two bases. Masroor Air Base outside Karachi houses the 32nd Wing with three Mirage squadrons: 7th Squadron (“Bandits”), 8th Squadron (“Haiders”), and 22nd Squadron (“Ghazis”). A possible nuclear weapons storage site is located five kilometers northwest of the Masroor base.

Land-based Ballistic Missiles: Pakistan appears to have six currently operational nuclear-capable, solid-fuel, road-mobile ballistic missile systems: the short-range Abdali (Hatf-2), Ghaznavi (Hatf-3), Shaheen-I/A (Hatf-4), and Nasr (Hatf-9), and

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Land-based Missile Garrisons: As per the report, an analysis of commercial satellite imagery suggests that Pakistan maintains at least five missile bases that could serve a role in Pakistan's nuclear forces.

- Akro garrison
- Gujranwala garrison
- Khuzdar garrison
- Pano Aqil garrison
- Sargodha garrison

The ever expanding nuclear arsenal of Pakistan is not just a matter of concern in India but for the entire world. In the words of US President Joe Biden, "Pakistan is "one of the most dangerous nations in the world due to the lack of cohesion in its nuclear security and command and control procedures".

Source: <https://timesofindia.indiatimes.com/world/pakistan/revealed-where-and-how-pakistan-is-keeping-its-nuclear-weapons/articleshow/103649163.cms?from=mdr>, 14 September 2023.

BALLISTIC MISSILE DEFENCE

USA

Report to Congress on Navy Aegis Ballistic Missile Defense

The Aegis ballistic missile defense (BMD) program, which is carried out by the Missile Defense Agency (MDA) and the Navy, gives Navy Aegis cruisers and destroyers a capability for conducting BMD operations. BMD-capable Aegis ships operate in European waters to defend Europe from potential ballistic missile attacks

from countries such as Iran, and in the Western Pacific and the Persian Gulf to provide regional defense against potential ballistic missile attacks from countries such as North Korea and Iran. The number of BMD-capable Aegis ships has been growing over time. MDA's FY2024 budget submission states that "by the...support."

The Aegis BMD program is funded mostly through MDA's budget. The Navy's budget provides

additional funding for BMD-related efforts. MDA's proposed FY2024 budget requests a total of \$1,747.2 million (i.e., about \$1.7 billion) in procurement and research and development funding for Aegis BMD efforts, including funding for two Aegis Ashore sites in Poland and Romania. MDA's budget also includes operations and maintenance (O&M) and military construction (MilCon) funding for the Aegis BMD program.

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Source: <https://news.usni.org/2023/08/30/report-to-congress-on-navy-aegis-ballistic-missile-defense-10>, 30 August 2023.

NUCLEAR ENERGY

CANADA

Bruce 6 Back on the Grid after Refurbishment

The unit has been reconnected to Ontario's grid following a successful Major Component Replacement (MCR) outage that was completed ahead of schedule and on budget. Beginning its MCR outage in January 2020, Bruce 6 is the first of six units to undergo the refurbishment process under Bruce Power's Life Extension Program, extending their operation to 2064 and beyond. According to Bruce Power, the programme is Ontario's largest clean-energy initiative and one of Canada's largest private sector infrastructure projects, funded by private-sector investors.

The company also thanked Ontario Power Generation (OPG) for sharing lessons learned and operating experience. OPG has completed the refurbishment of the first two of four units at its Darlington site in a ten-year programme that will enable the plant to continue operations until 2055. Bruce 3 - which began its MCR outage earlier this year - is reaping the benefits of lessons learned in Unit 6 to achieve time and cost savings, the company said. Innovations realised in Bruce 6's refurbishment will be carried forward to improve performance and quality in subsequent MCR outages, including tooling and inspection automation and robotics, and advanced modelling and training.

Hundreds of companies, and thousands of tradespeople, are involved in each MCR. The refurbishment includes replacing and upgrading key equipment - 480 fuel channels, 960 feeders and eight team generators - in addition to thousands of other modifications and tasks, before 5,760 new fuel bundles are loaded into the reactor core.

The CAP1000 reactor design - the Chinese version of the AP1000 - uses modular construction techniques, enabling large structural modules to be built at factories and then installed at the site. The first safety-related concrete was poured for the nuclear island of Sanmen 3 on 28 June last year, marking the official start of its construction. The first concrete for that of unit 4 was poured on 22 March this year. The largest and heaviest module - the cuboid-shaped CA20 - was installed at Sanmen 4 in April.

Source: <https://www.world-nuclear-news.org/Articles/Bruce-6-back-on-the-grid-after-refurbishment>, 08 September 2023.

CHINA

Landmark Module Installation at Sanmen 4

The CA01 'super module' has been installed at unit 4 of the Sanmen NPP in China's Zhejiang province, marking a construction landmark for the CAP1000 reactor. Weighing 1046.2 T and measuring more than 27 mts long, 29 mts wide and 24 mts high, the concrete and steel CA01 module sits inside the unit's containment module where it will house the plant's steam generators and other components. It is referred to as a super module because it is too large to be transported by road and rail, and was constructed on site.

The module was hoisted into place at Sanmen 4 on 6 September, the Shanghai Nuclear Engineering Research and Design Institute (SNERDI) announced. The construction of two new reactors at each of the Sanmen, Haiyang and Lufeng sites in China was approved by China's State Council in April 2021. The approvals were for Sanmen units 3 and 4, Haiyang 3 and 4 and units 5 and 6 of the Lufeng plant. The Sanmen and Haiyang plants are already home to two Westinghouse AP1000 units each, and two CAP1000 units were approved for Phase II (units 3 and 4) of each plant.

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cuboid-shaped CA20 - was installed at Sanmen 4 in April.

Source: <https://www.world-nuclear-news.org/Articles/Landmark-module-installation-at-Sanmen-4>, 08 September 2023.

CZECH REPUBLIC

Czech PM Suggests Four New Nuclear Units Needed

In a speech to open a conference discussing future strategy for the Czech Republic, PM Fiala said the country would need as many as four new nuclear power units. He said it had been a problem to not have "broad republic", with strategic investments in things such as nuclear energy featuring among the "pillars" that the country's future should be built upon. He then went on to highlight nuclear

as one of those projects which combined innovation and added value with the potential to give a big boost to the entire economy.

In March 2022, wholly-owned ĚEZ subsidiary Elektrárna Dukovany II launched a tender for the construction of a new NPP at the site. At the end of November 2022, ĚEZ announced that it had received initial bids from EDF, Westinghouse and Korea Hydro & Nuclear Power. Final bids are expected in the coming months. In March 2022, ĚEZ also said that it had earmarked an area of land at its Temelin site to be used in the future for the construction of the country's first SMRs and in February 2023 it identified the coal-fired power plants at Ditmarovice and Tuřimice as the preferred second and third SMR locations, with ĚEZ hoping to have the sites in operation by the second half of the 2030s.

Four VVER-440 units are currently in operation at the Dukovany site, which began operating between 1985 and 1987. Two VVER-1000 units are in operation at Temelín, which came into operation in 2000 and 2002. Past Czech energy policy has proposed two new units at each of the two existing sites. The Czech Republic gets about 34% of its electricity from its NPPs.

Source: <https://www.world-nuclear-news.org/Articles/Czech-PM-suggests-four-new-nuclear-units-needed>, 01 September 2023.

GERMANY

Germany Stepping Up Investment in Fusion

Germany will invest more than EUR1 B in fusion research over the next five years, Federal

Research Minister Bettina Stark-Watzinger announced. The minister announced that she would significantly increase research funding for fusion with an additional EUR370 M over the next five years. Together with funds already earmarked for research institutions, the Federal Ministry of Education and Research (BMBF) will provide more than one billion euros for fusion research by 2028.

The new funding programme strengthens the ongoing activities of the BMBF at the Institute for Plasma Physics (IPP), the Karlsruhe Institute of Technology (KIT) and the Research Center Jülich (FZJ). In December 2022, BMBF set up a commission of experts to take stock of the field of laser fusion, which has so far been little researched in Germany. In May this year, Stark-Watzinger accepted a memorandum from the commission. The memorandum describes the potential of Germany as an industrial and research location with a view to laser fusion and defines needs for further research on the way to a first fusion power plant.

Among other things, cooperation with the private sector is planned to develop infrastructure for laser-driven fusion. For this purpose, the BMBF will establish the Pulsed Light Technologies GmbH subsidiary through the Federal Agency for Disruptive Innovation SPRIND, through which up to EUR90 million will be invested over the next five years. In August 2011, the 13th amendment of the Nuclear Power Act came into effect, which underlined the political will to phase out fission nuclear power in Germany. As a result, eight units were closed down immediately: Biblis A and B, Brunsbüttel, Isar 1, Krümmel, Neckarwestheim 1, Phillipsburg 1 and Unterweser. The Brokdorf,

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Grohnde and Gundremmingen C plants were permanently shut down at the end of December 2021. The country's final three units - Emsland, Isar 2 and Neckarwestheim 2 - shut down in April this year.

Source: <https://www.world-nuclear-news.org/Articles/Germany-plans-massive-investment-in-fusion>, 07 September 2023.

KAZAKHSTAN

Kazakh People to Decide on Nuclear Plant Construction

Kazakhstan is to hold a referendum on the construction of a NPP in the country, President Kassym-Jomart Tokayev announced during a state-of-the-nation address. The date of the vote has yet to be determined. Kazakhstan's Ministry of Energy has proposed the potential reintroduction of nuclear power to reduce the country's reliance on fossil fuels, diversify its energy mix and reduce CO2 emissions. Kazakhstan NPP (KNPP), which has been designated as the owner/operator of the future plant, began preparing a feasibility study in 2018 to justify the need for nuclear power, the choice of the location for plant construction and to review the plant's projected power output.

Last month, the Ministry of Energy issued an update on progress towards the construction of Kazakhstan's first NPP, confirming the selection of Ulken in the Zhambyl district of Almaty region as the most suitable area for the plant for which four potential suppliers had been shortlisted. Under Kazakhstan's nuclear energy law, construction of a nuclear plant requires local agreement. The law requires public discussions, which aim to determine the attitude

of local people to the idea of building a NPP in their territory. Kazakhstan's Ecological Code requires public hearings to evaluate the project documentation on the construction of the NPP. The akimat, or local government, of the Almaty region has now begun these public discussions, the ministry said.

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until 1999, generating electricity and desalinating water. Kazakhstan currently operates research reactors as well as several other nuclear installations related to the front end of the nuclear fuel cycle, including uranium mining.

Source: <https://www.world-nuclear-news.org/Articles/Kazakh-people-to-decide-on-nuclear-plant-construct>, 01 September 2023.

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Four foreign potential suppliers of nuclear technology are being considered by Kazakhstan, the ministry said in January. These are EDF of France, China National Nuclear Corporation, Korea Hydro & Nuclear Power and Rosatom of Russia. A Russian-designed BN-350 sodium-cooled fast reactor operated near Aktau in Kazakhstan for 26 years

RUSSIA

Second VVER-TOI RPV Ready for Delivery to Kursk-II

New Generation 3+ VVER-TOI, a typical optimised water-water reactor pressure vessel (RPV) is being shipped from Atom mash (part of the mechanical engineering division of Rosatom) to the Kursk-II NPP site for installation in unit 2. The 340-tonne RPV will be transported by water and land. The VVER-TOI reactor Kursk-II unit 1 was shipped in 2020.

Kursk II is intended as a replacement station for the currently operating Kursk NPP, which comprises four ageing RBMK reactors (one of which is already closed). Units 1&2, currently under construction, will have VVER-TOI reactors – a development of the VVER-1200 reactor design. The VVER-TOI has increased power and improved technical and economic indicators, as well as increased resistance to extreme external influences.

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Source: <https://www.neimagazine.com/news/newssecond-vver-toi-rpv-ready-for-delivery-to-kursk-ii-11133589>, 08 September 2023.

UKRAINE

Westinghouse VVER-440 Fuel Loaded into Reactor

Westinghouse fuel has been loaded into a VVER-440 reactor for the first time, at Ukraine's Rivne NPP. The supply of fuel assemblies for the VVER-440 reactors, which have always used Russian-produced fuel, was the result of a contract signed in September 2020 as part of Ukraine's efforts to diversify its fuel supplies. The subsequent war, which began in February 2022, has led to Ukraine ending all future Russian nuclear fuel use.

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The event to mark the loading of the fuel was attended by people including Ukraine's Energy Minister, Halushchenko, Energoatom President Kotin, Sweden's ambassador to Ukraine, Oberg, Westinghouse CEO Fragman, Westinghouse Sweden MD Dag and the Rivne NPP DG Kovtoniuk.

Ukraine has said that it is switching to the US company's fuel, with plans to develop fuel domestically in future, using Westinghouse technology. Westinghouse's Fragman said the companies' specialists had worked together to produce ahead of schedule and said: "We...Russia."

Rivne 1 and 2 - which were commissioned in 1980 and 1981, respectively - are the only VVER-440 units in

Ukraine, with 16 others elsewhere in the EU. Ukraine has a total of 13 VVER-1000 units, including Rivne 3 and 4. Westinghouse has been supplying VVER-1000 fuel to Ukraine since 2005, when the first lead test assemblies were delivered to unit 3 of the South Ukraine NPP.

Since the beginning of the Russia-Ukraine war, there have been accelerated efforts for countries to diversify their fuel supply. Westinghouse's Swedish nuclear fuel manufacturing subsidiary, Westinghouse Electric Sweden AB, is leading the Accelerated Programme for Implementation of Secure VVER Fuel Supply. Launched in January this

year, the programme aims to meet the urgent need of European countries operating such reactors to find an alternative source of fuel.

Source: <https://www.world-nuclear-news.org/Articles/Westinghouse-VVER-440-fuel-loaded-into-reactor>, 11 September 2023.

USA

US Projects to Look at Nuclear Role in Carbon Capture

Two projects to explore the feasibility of using nuclear energy in systems to remove carbon

dioxide directly from the atmosphere - one led by GE Vernova and one led by Northwestern University - are included in a list of 19 projects selected to receive US DOE support. GE announced on 29 August that a pre-feasibility assessment to establish a direct air capture (DAC) regional hub near Houston, Texas, to remove up to 1 MT of CO₂ per year, led by Niskayuna, New York-based GE Vernova, has been selected as one of the awardees. Part of the proposed study will look at the feasibility of a novel DAC system design that integrates GE Hitachi's BWRX-300 SMR and renewable electricity to enable the gas to be captured from ambient air and stored underground or used as a value-added product such as a feedstock for sustainable aviation fuels. The DOE has allocated USD2.554 million to the project, alongside non-DOE funding of USD762,827, giving a total value of just over USD3.3 million.

A separate project, the Midwest Nuclear DAC Hub, will see Northwestern University of Evanston, Illinois testing the feasibility of deploying at-scale novel DAC solutions by developing a DAC hub powered by nuclear energy. The Midwest is the second largest regional emitter of carbon dioxide in the USA, and is home to both heavy-emitting industries and a rich ecosystem of innovation and research, DOE notes. Centring the study around nuclear power "ensures that a reliable low-carbon energy source (and the opportunity for heat integration) will be used for technology development", DOE said in its announcement of the award, for which it has allocated USD3 M, with non-DOE funding of USD927,910 for a total value of some USD3.9 M. GE Vernova is aiming to deploy a commercially

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scalable DAC solution by the end of the decade. In March, GE announced the successful demonstration of a scalable prototype DAC system at its Niskayuna research facility. The company is also a DAC technology provider for two other projects included in the DOE announcement,

which will be led by the University of Illinois, and executed in Colorado and Florida.

Source: <https://www.world-nuclear-news.org/Articles/US-projects-to-look-at-nuclear-role-in-carbon-capt, 31 August 2023>.

SMALL MODULAR REACTORS

UK

Tweaks to FLEX Design Sees Boost in Power Output

MoltexFLEX says a reevaluation of certain aspects of its FLEX molten salt reactor design has "yielded a more robust scientific and engineering foundation" for the reactor. A refinement of the reactor design has delivered a 50% boost in power output, while maintaining previous targets for overnight capital cost and cost per MWh. Warrington, UK-headquartered MoltexFLEX - a subsidiary of Moltex Energy Limited - is developing the FLEX reactor - the thermal neutron (moderated) version of Moltex Energy's stable salt reactor technology. The reactor is small and modular, allowing components to be factory-produced and readily transportable, reducing on-site work, increasing speed of construction, and minimising overall costs. It is passively safe, so does not require engineered, redundant, active safety systems. The FLEX reactor has no moving parts and is fuelled for 20 years at a time, meaning that there is very little operator input and very

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low ongoing costs. Each reactor was initially expected to deliver 40 MW of thermal energy at 700°C. According to MoltexFLEX, the cost of electricity generated by the FLEX reactor was likely to be GBP40 (USD50) per MWh. MoltexFLEX plans to have its first reactor operational by 2029.

Following a reevaluation of the design, MoltexFLEX says FLEX's power output has increased from 40 MWth/16 MWe as originally envisaged to 60 MWth/24 MWe, made possible by optimisation of the core design and the fuel pin material. The refuelling schedule has also been adjusted to account for the fact that the FLEX reactor will now use 5% low-enriched uranium (LEU) instead of 6% LEU. MoltexFLEX said this change "facilitates global deployment of the FLEX reactor by leveraging established security and non-proliferation measures and the existing fuel supply chain". The refinement of the design has also maintained the predicted overnight capital cost of an nth-of-a-kind reactor at approximately GBP2000/kW, and the levelised cost of electricity of a baseload electricity generating In May 2021, the Canadian Nuclear Safety Commission completed the first phase of the pre-licensing vendor design review for Moltex Energy's 300 MWe Stable Salt Reactor-Wasteburner (SSR-W 300) SMR. The SSR-W is a molten salt reactor that uses nuclear waste as fuel. The company aims to deploy its first such reactor at the Point Lepreau site in New Brunswick by the early 2030s.

Source: <https://www.world-nuclear-news.org/Articles/Tweaks-to-FLEX-design-sees-boost-in-power-output>, 11 September 2023.

USA

US Furthers Overseas Support for Coal-to-SMR Projects

Proposals from the Czech Republic, Poland and Slovakia have been selected to receive US support for coal-to-SMR feasibility studies under Project Phoenix. The USA is also to set up a 'one-stop shop' to support countries in Europe and Eurasia that are approaching SMR deployment decisions. Project Phoenix, announced by US Special Presidential Envoy for Climate Kerry at the COP27 climate conference last year, aims to support energy security and climate goals by creating pathways for coal-to-SMR power plant conversions while retaining local jobs through workforce retraining. The successful proposals receiving a share of USD8 M of US government support were selected through a competitive process open to 17 central and eastern European countries. Kerry announced the recipients of the awards in a side event to the Three Seas Initiative Summit in Bucharest on 6 September.

The successful grant application lodged by a partnership including Slovak utility Slovenské elektrárne proposed five Slovak sites for consideration SMR feasibility studies: the Jaslovské Bohunice and Mochovce NPP sites; the Nováky and Vojany thermal power plant sites; and the site of the US Steel steel plant in eastern Slovakia. The feasibility study will assess several aspects and select the most suitable sites for the possible future construction of SMRs, Slovenské elektrárne said.

Polish company Orlen Synthos Green Energy (OSGE) said it will use the funds it has been

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awarded under the Phoenix project to study a site at Ostrožeka. Ostrožeka is one of seven locations shortlisted earlier this year by OSGE for further geological surveys to host SMR plants based on GE Hitachi Nuclear Energy's BWRX-300, for which it holds the exclusive right in Poland.

Czech coal mining company Sokolovská uhelná, part of the SUAS Group, said it had been selected to receive a grant of USD1.5 million, which alongside an applicant's co-payment of USD0.5 M means its study will be worth up to USD2. M. Tomek, chairman of the supervisory Board of Sokolovská uhelná and SUAS Group, said the company is considering the site of the Tisová Power Plant and an industrial complex in Vøesová as possible locations for SMRs. The company said its application stated a preference for a pressurised water reactor of 400-500 MWe capacity. Project Phoenix and the NEXT One Stop Shop are subprogrammes of the US Department of State's Foundational Infrastructure for the Responsible Use of SMR Technology (FIRST) Program.

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Kyoto Fusioneering was spun out of Kyoto University as Japan's first fusion start-up in 2019 co-founded by Nagao, Konishi, Pearson and

Takeda. Its mission is to tackle reactor engineering and technology challenges, whilst cooperating with fusion developers around the world, to rapidly accelerate the growth of the fusion industry. The company's business model is to conduct R&D and

design of innovative fusion reactor technologies, and to provide these alongside engineering solutions to both private fusion enterprises and publicly funded fusion programmes at global research institutions.

Because most of the world's fusion power plant designs use tritium, there is a growing demand for tritium handling and tritium-compatible technology. The significance of managing the tritium fuel cycle for fusion commercialisation has been emphasised by recent reports from the National Academies of Sciences, Engineering, & Medicine (NASEM) and the Fusion Energy Sciences Advisory Committee (FESAC). With this in mind, CNL and KF will:

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Source: <https://www.world-nuclear-news.org/Articles/US-further-overseas-support-for-coal-to-SMR-proje>, 08 September 2023.

NUCLEAR COOPERATION

CANADA–JAPAN

CNL and Kyoto Fusioneering Partner to Accelerate Fusion Fuel Tech

Canadian Nuclear Laboratories (CNL) and Japan's Kyoto Fusioneering (KF) have entered a Strategic Alliance Agreement (SAA) to accelerate the development and commercialization of fusion fuel cycle technology. The SAA builds on a Memorandum of Understanding signed in March.

- Innovate tritium fuel cycle technologies and systems, advancing the readiness level of the complete tritium fuel cycle with a focus on safety, public protection, and system economics.

- Support fusion developers in design & development of pilot plants. This will include proving comprehensive design, consulting, engineering, testing and technology to meet the needs of public and private fusion energy development programmes globally.

- Support tritium handling and management, offering insights and solutions for efficient tritium

behaviour control and extraction in fusion pilot plant devices.

- UNITY-2, a fusion test loop proposed for construction at CNL is seen as complementary to KF's UNITY-1 (formerly UNITY- Unique Integrated Testing Facility), announced in July 2022 with the stated aim of demonstrating electricity generation using fusion relevant technologies in 2024. While UNITY-1 focuses on the thermal cycle system to harness heat from the fusion core, UNITY-2 focuses on demonstrating the complete fuel cycle.

- UNITY-2, designed to emulate fusion power plant conditions, will be a global first, integrating a full deuterium-tritium fuel cycle with the highest safety and tritium handling standards. It will demonstrate fuel exhaust and pumping, direct internal recycling, fuel clean-up and isotope separation, tritium management and storage, tritium extraction from liquid metal and molten salt coolants, air and water detritiation, and reactor fuelling. This facility will bolster materials, systems, and equipment development and verification.

Source: <https://www.neimagazine.com/news/newscnl-and-kyoto-fusioneering-partner-to-accelerate-fusion-fuel-tech-11133642>, 08 September 2023.

INDIA–USA

G20 Summit: Biden Holds Talks with PM Modi on Defence, Civil Nuclear Cooperation

US President Biden (on 8 Sep) went into talks with PM Modi on a wide range of bilateral issues as well as global developments shortly after his arrival in Delhi to attend the G20 Summit beginning September 9. ... Officials said the meeting between the two leaders will see meaningful progress on a number of issues, including the GE jet engine deal, the procurement of predator drones, on 5G and 6G spectrum, collaboration on critical and emerging technologies, and progress in the civil nuclear area.

Source: <https://www.thestatesman.com/india/biden-arrives-for-g20-summit-holds-talks-with->

[pm-on-defence-civil-nuclear-cooperation-1503219941.html](https://www.thestatesman.com/india/biden-arrives-for-g20-summit-holds-talks-with-), 08 September 2023.

JAPAN–UK

Japan, UK Enhance Cooperation on HTGRs

The UK's National Nuclear Laboratory (NNL) and the Japan Atomic Energy Agency (JAEA) have signed a memorandum of cooperation in the field of High Temperature Gas-cooled Reactors (HTGRs), as well as a memorandum for collaboration on the next stage of the UK HTGR Demonstration Reactor programme.

In December 2022, the UK government announced funding of GBP60 M for research into HTGRs, a type of Advanced Modular Reactor (AMR), aimed at helping to get a demonstration project up and running by the end of the decade. Following an initial call for evidence, the focus for the AMR R&D programme was placed on HTGR technology last year.

Phase A of the AMR R&D programme led to six successful bidders for pre-FEED (Front End Engineering Design) studies for reactor demonstration and fuel demonstration. Phase B is described as "an open, ...C". Phase B will conclude in February 2025. Phase C will see the licensing, construction and operation of an HTGR in the early 2030s.

On 18 July this year, the UK Department for Energy Security and Net Zero (DESNZ) announced that a team comprising NNL and JAEA was selected as one of the project entities to implement the Phase B reactor project. They received funding of GBP31 M. In parallel, DESNZ also announced that Phase B will also push the development of an advanced fuel required for AMRs, through the Coated Particle Fuel (CPF) – Step 1 Programme. NNL, working with JAEA, has been selected by DESNZ to deliver this fuels programme which will build expertise, knowledge and collaboration on coated particle fuel fabrication and scale-up activities.

In 2001, JAEA and NNL concluded a technical cooperation agreement and have been co-operating with the focus on the areas of nuclear fuel cycle and radioactive waste management as

well as advanced reactors. The agreement was renewed in April this year to further strengthen the cooperation for another five years. The latest memorandum will enable the continued cooperation between NNL and JAEA in the deployment of HTGRs and in the development of AMR fuel.

The governments of the UK and Japan expect HTGRs to contribute to the decarbonisation through the supplement of hydrogen and high-temperature steam to the processing, steelmaking and chemical industries, considered difficult to decarbonise, to achieve carbon neutrality by 2050. JAEA is collaborating with NNL to demonstrate Japanese HTGR technology outside of Japan and to promote its social implementation with the aim of returning the decarbonisation technology to Japan.

Source: <https://www.world-nuclear-news.org/Articles/Japan,-UK-enhance-cooperation-on-HTGRs,08September2023>.

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there had since been none, further raising tensions with Western powers. Iran and the IAEA announced an agreement in March on re-installing surveillance cameras introduced under a deal with major powers in 2015 but removed at Iran's behest last year. Only a fraction of the cameras and other monitoring devices the IAEA wanted to set up have

Only a fraction of the cameras and other monitoring devices the IAEA wanted to set up have been installed. Adding to the issues likely to cause tension with the West, Iran's stock of uranium enriched to up to 60% grew by an estimated 7.5 kg to 121.6 kg, the report said, even though 6.4 kg of it was diluted with uranium enriched to a lower level.

90% of weapons grade, continued to increase albeit at a slower pace, despite some of it having been diluted.

The reports, sent to IAEA member states ahead of a quarterly meeting of the IAEA's 35-nation Board of Governors next week, also said that after limited progress on re-installing IAEA surveillance cameras in the previous quarter,

been installed. Adding to the issues likely to cause tension with the West, Iran's stock of uranium enriched to up to 60% grew by an estimated 7.5 kg to 121.6 kg, the report said, even though 6.4 kg of it was diluted with uranium enriched to a lower level.

The IAEA continues to have regular access to Iran's

NUCLEAR PROLIFERATION

IRAN

Iran Expands Stock of Near-Weapons Grade Uranium, IAEA Reports No Progress

Iran's stock of uranium enriched to up to 60% purity, close to weapons grade, continues to grow and there has been no progress in talks with Tehran on sensitive issues such as explaining uranium traces at undeclared sites, two reports by the U.N. nuclear watchdog. According to one of the confidential quarterly reports to member states, the IAEA said Iran's stockpile of uranium enriched to up to 60% purity, close to the roughly

declared nuclear facilities and its core nuclear activities under long-standing agreements that predate the 2015 nuclear deal, but the 2015 deal added monitoring to areas such as the production of parts for centrifuges, machines that enrich uranium. Even where IAEA monitoring equipment has been re-installed, such as at a site in Isfahan, it does not have access to the footage that its cameras record since that was not included in the March agreement it negotiated with Iran.

Source: <https://www.reuters.com/world/middle-east/iaea-reports-no-progress-iran-uranium-stock-enriched-60-grows-2023-09-04/>, 04 September 2023.

Grossi Calls for Iran’s Serious Cooperation with IAEA

Speaking at a press conference before the IAEA’s Board of Governors in Vienna, Grossi called on Iran to seriously cooperate with the Agency in accordance with the Joint Statement signed in Tehran on 4 March. Grossi said that there is no link between Iran and the IAEA cooperation and the recent indirect talks between Iran and the US and the prisoner swap between them, saying that he only cares about the nuclear issue with Iran. He pointed to the recent IAEA report on Iran’s nuclear program, claiming that there has not been “much progress” in relations between Tehran and the IAEA on the outstanding issues.

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The IAEA chief said that Iran and the IAEA joint statement was supposed to be “a gradual process of confidence-building”, adding that the joint statement was supposed to increase Agency’s presence in Iran electronically (CCTV cameras) and otherwise. He added that the issue of the recorded data by the cameras in Iran was supposed to be tackled. The nuclear chief further said that Iran and the IAEA have to reach an agreement on access to the recorded data and information of the cameras in Iran, while also noting that the two sides are nowhere near that agreement for the time being. ...

Source: <https://en.mehrnews.com/news/205936/Grossi-calls-for-Iran-s-serious-cooperation-with-IAEA>, 11 September 2023.

Iran Unveils Home-Grown Reactor Simulator

Iran’s nuclear professionals are now able to train using a fully Iranian-designed and built reactor simulator. The Generic Nuclear Reactor Training simulator - or GNRTS - has been designed and

built by the Atomic Energy Organisation of Iran (AEOI). It represents a two-loop PWR with a thermal power of 100 MW and a net electrical output of 30 MWe, with a core of 21 rectangular 17x17 fuel assemblies and a fuel enrichment of 4.9%. The real-time simulator can recreate various scenarios to train technical personnel and nuclear engineering students in the basic concepts of operational characteristics of a PWR plant in normal operating conditions as well as in abnormal and emergency conditions. An opening ceremony for the simulator, which is at the AEOI’s

Nuclear Science and Technology Research Institute (NSTRI), was held in July. During the ceremony, AEOI head Eslami said the NSTRI had been assigned a mission to train the human resources that will be needed over the coming years if it is to achieve its 20 GWe nuclear capacity goal.

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Iran’s Bushehr unit 1 - a Russian-designed VVER-1000 PWR, which uses infrastructure that was already in place from a previous, uncompleted German-designed plant - began commercial operation

in 2013. A second VVER-1000 is under construction at Bushehr, with further units planned or proposed at Bushehr and other sites. The Bushehr reactor operates under IAEA safeguards.

Source: <https://www.world-nuclear-news.org/Articles/Iran-unveils-home-grown-reactor-simulator>, 06 September 2023.

URANIUM PRODUCTION

FRANCE-NIGER

Orano Gives Updates on Uranium Enrichment Plans and Niger Situation

Orano has revealed plans to extend enrichment capacity at its Georges Besse II (GB-II) uranium

enrichment plant, and has begun the regulatory process to produce HALEU there. Separately, the company has confirmed it is “reorganising” work at its Niger operations to mitigate logistical impacts following the recent coup. Lurin, senior executive vice president of Orano’s Chemistry-Enrichment Business Unit, set out the French fuel cycle company’s enrichment plans in a video interview released to coincide with World Nuclear Symposium 2023.

The decision to extend capacity follows requests from some US and European customers who are seeking alternatives to Russian sources of supply, Orano “should be able” to provide the various forms of enriched uranium to supply the different SMR and advanced reactor technologies that are being developed, Lurin said. The company can produce the high-assay low-enriched uranium - also known as HALEU - that these reactors will need either by enrichment at its existing facilities, or by deconversion of uranium hexafluoride.

Orano’s other projects in Niger - the remediation project at the COMINAK mine, which closed in 2021, and studies and activities at the Imouraren project - are continuing, the company said. Niger produced 2,020 tU in 2022 - all from SOMAïR - according to figures from World Nuclear Association. This makes the mine, at Arlit, the world’s seventh largest in terms of uranium production in 2022.

Source: <https://www.world-nuclear-news.org/Articles/Orano-gives-updates-on-uranium-enrichment-plans-an>, 11 September 2023.

USA

Centrus to Start HALEU Production in October

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US-based Centrus Energy Corp says it expects to begin first-of-a-kind production of HALEU in October, approximately two months ahead of schedule. HALEU fuel contains uranium enriched to 5-20% uranium-235 (higher than the 3-5% typically used in light water reactors). It is

required by most of the advanced reactor designs being developed under the US DOE’s Advanced Reactor Demonstration Program.

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Currently there is no commercial supply chain to support HALEU production prompting DOE to launch a programme to stimulate the development of a domestic supply. Under a competitively-awarded, cost-share contract signed DOE in 2022, Centrus was required to begin production of HALEU by the end of this year. At the American Centrifuge Plant

in Piketon, Ohio, Centrus has constructed the first US HALEU production facility licensed by the NRC. In June Centrus completed its operational readiness reviews and received regulatory approval to possess uranium at Piketon and to introduce uranium into the cascade of centrifuges there.

The capacity of the 16-centrifuge cascade that is expected to begin enrichment operations in October will be modest – about 900 kgs of HALEU a year – but with sufficient funding and offtake commitments, Centrus could significantly expand production, the company said. A full-scale HALEU cascade, consisting of 120 centrifuge machines, with a combined capacity to produce approximately 6 MTU/year, could be brought

online within about 42 months of securing the necessary funding.

Source: <https://www.neimagazine.com/news/newscentrus-to-start-haleu-production-in-october-11133660>, 08 September 2023.

NUCLEAR SAFETY

JAPAN

IAEA Sees No Rise in Tritium Level Near Fukushima Daiichi

The IAEA said that its independent sampling and analysis of seawater near the damaged Fukushima Daiichi NPP has found that the tritium levels have remained below Japan's operational limit. At the Fukushima Daiichi site, contaminated water - in part used to cool melted nuclear fuel - is treated by the Advanced Liquid Processing System (ALPS), which removes most of the radioactive contamination, with the exception of tritium. This treated water is currently stored in more than 1000 tanks on site. The total tank storage capacity amounts to about 1.37 MCUM and all the tanks are expected to reach full capacity in late 2023 or early 2024. Japan announced in April 2021 it planned to discharge treated water stored at the site into the sea over a period of about 30 years. TEPCO began discharging this water on 24 August.

IAEA staff at the agency's office at the site have since sampled seawater from several locations within 3 kms of the site, at sea and from the coast. The IAEA has been collecting marine samples in the waters off Fukushima over the past decade, following a request by the Japanese government to assist it in ensuring that

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Source: <https://www.world-nuclear-news.org/Articles/IAEA-sees-no-rise-in-tritium-level-near-Fukushima>, 11 September 2023.

INDIA

Kudankulam Nuclear Power Project Admin Says SGs for Unit 5&6 Stable and Safe on Barge

The administration said due to the waves, the barge was pushed towards the shore and remained afloat due to rocks on the sea bed. KKNPP administration said two steam generators, loaded on a barge aground

near the plant, were stable and safe. In a statement, they said the retrieval operation would be completed in two to three days. The administration said due to the waves, the barge was pushed towards the shore and remained afloat due to rocks on the sea bed. "Equipment for KKNPP Units 3 to 6 under Russian Federation scope is being transported by break bulk ships and unloaded at Tuticorin port. Further transport of over-dimensional equipment from Tuticorin port to the KKNPP project sites is carried out through barge.

Four steam generators (SGs) manufactured exclusively for KKNPP Unit 5 & 6 weighing 310T each were received on August 12, 2023 at Tuticorin port. Transportation of two SGs through the barge was already carried out on August 26 &

27, 2023 and safely rolled out to the KKNPP unloading Jetty. On August 8, 2023, during the transportation of the remaining two SGs, the barge disconnected from the tugboat near the mouth of the navigation channel of the unloading jetty," read the statement.

IAEA DG Grossi says that the arrival of its experts at Zaporizhzhia NPP a year ago was "crucial" and their presence continues to be of "paramount importance". In a message marking the anniversary of his visit to the plant to establish the IAEA Support and Assistance Mission to Zaporizhzhya.

Source: <https://www.newindianexpress.com/states/tamil-nadu/2023/sep/13/kudankulam-nuclear-power-project-admin-sayssgs-for-unit-5-6-stable-and-safe-on-barge-2614229.html>, 13 September 2023.

UKRAINE

Grossi Stresses Importance of IAEA Presence at Zaporizhzhia

IAEA DG Grossi says that the arrival of its experts at Zaporizhzhia NPP a year ago was "crucial" and their presence continues to be of "paramount importance". In a message marking the anniversary of his visit to the plant to establish the IAEA Support and Assistance Mission to Zaporizhzhya (ISAMZ), Grossi said."

The teams of IAEA staff stationed at the plant have rotated every few weeks, with the 10th such change of staff happening shortly before the anniversary. The plant, Ukraine and Europe's largest one, has been under Russian military control since early March 2022 and the IAEA officials have to cross the military frontline to get to and from the site. In the update, the agency said that unit 4 had been in cold shutdown since 12 August after a water leak was identified in one of the four steam generators, while unit 6 is in hot shutdown for steam production with the other four all in cold shutdown. The State Nuclear Regulatory Inspectorate of Ukraine issued regulatory orders earlier this year for all six to be in cold shutdown.

There was also an update on the situation with cooling water, which has been a concern since the damage of the dam and the reservoir used to feed the plant's cooling water supply. The IAEA says that the level of the ZNPP cooling pond continues to drop by about 1 cm per day but the discharge channel of the nearby thermal power plant remains intact.

The IAEA said there had been a "considerable reduction" in maintenance staff which was "currently...plant". It added that those running the plant had told them that new staff had been recruited and, while they were training and getting experience of

the site, "maintenance...tasks".

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Source: <https://www.world-nuclear-news.org/Articles/Grossi-stresses-importance-of-IAEA-presence-at-Zap>, 04 September 2023.

NUCLEAR WASTE MANAGEMENT

GERMANY-SWEDEN

Studsvik, GNS Collaborate on Waste Technology

Swedish nuclear technical services provider Studsvik and German radioactive waste specialist GNS Gesellschaft für Nuklear-Service mbH have formed a strategic and exclusive cooperation to implement Studsvik's inDRUM technology for the German market. inDRUM is a patented technology for the treatment of problematic wastes, such as legacy wastes in aging drums. Studsvik's inDRUM technology is a solution for transuranic (TRU) waste streams that have characteristics that do not meet waste disposal criteria. The technology can be used on low, intermediate and high-level radioactive wastes.

DRUM is a batch thermo-chemical system that treats containerised radioactive wastes by means of in-container thermal treatment to remove the free liquids, destroy organics, and deactivate corrosives and reactive materials from the containers. Treatment is achieved without removing or handling/sorting wastes from the container. In most applications, wastes are treated in the container in which the wastes were originally packaged. The thermally decomposed waste form is an inert, inorganic dry char (ash-like substance), significantly volume reduced (as much as 90%).

The inDRUM process consists of two main treatment systems: an electrically-heated container treatment vessel (CTV), where thermal treatment of drums is performed, followed by an off-gas treatment system that oxidises any volatile organic compounds, carbon monoxide, and traces of hydrogen volatilised from the CTV and removes and/or neutralises any acid gases, mercury or iodine present in the off-gas stream.

Source: <https://www.world-nuclear-news.org/Articles/Studsvik,-GNS-collaborate-on-waste-technology>, 04 September 2023.

SWITZERLAND

Defuelling Completed at Mühleberg

All the nuclear fuel at the shut down Mühleberg NPP has now been transported to the Zwiilag interim storage facility in Würenlingen, Swiss utility BKW announced. The removal of the fuel marks the completion of the first of three stages of decommissioning of the plant. The plant - comprising a single 373 MWe boiling water reactor - began operations in 1972 and was shut down on 20 December 2019. Dismantling operations began on 6 January 2020. However, it has only been considered permanently out of service since 15 September 2020 when its operating licence was replaced by a decommissioning order. Mühleberg is the first NPP in Switzerland to be decommissioned.

Mühleberg is being dismantled in three decommissioning phases. The first phase lasts until all the plant's fuel assemblies have been removed. The second phase ends with the lifting or clearing of controlled zones, while the third phase includes work to demonstrate that the system is no longer a source of radiological hazard. There were 418 fuel elements in the plant when it ceased operation. These were cooled in Mühleberg's fuel storage pool until they were ready for transportation. In April 2022, the first used fuel elements were sent to the interim storage facility in Würenlingen, with multiple transport campaigns following. A total of 66 shipments were required to move all of the fuel.

Spot, a robotic quadruped, has completed a trial at the Dounreay site in Scotland, UK, where it successfully navigated an evaporator cell in the Fuel Cycle Area that has been shut off for 25 years. Described as a "mobile agile robot", Spot - developed by Boston Dynamics - negotiated pitch-black conditions and several flights of stairs to complete this latest challenge.

Source: <https://www.world-nuclear-news.org/Articles/Defuelling-completed-at-Muhleberg>, 01 September 2023.

UK

Robot Navigates Dounreay Evaporator Cell

Spot, a robotic quadruped, has completed a trial at the Dounreay site in Scotland, UK, where it successfully navigated an evaporator cell in the Fuel Cycle Area that has been shut off for 25 years. Described as a "mobile agile robot", Spot - developed by Boston Dynamics - negotiated pitch-black conditions and several flights of stairs to complete this latest challenge.

At Dounreay its mission was two-fold; to map out the four-storey cell, collecting important radiological data for the team to use when planning the decommissioning of the facility; and to gain useful experience on how the robot and survey equipment should be used. The site joiners constructed a wooden mock-up of the evaporator cell entrance and temporary containment in a clean area to test the abilities of the robot and train the operators who would support Spot, before the work moved into the evaporator cell.

Swathed in its protective suit, once inside the evaporator cell the robot collected data to give

the team a complete three-dimensional map of the area. It also collected radiological data to create a full dosimetry map showing areas of higher radioactivity, which will enable the team to develop a radiological fingerprint. In June, Dounreay Site Restoration Limited and the Nuclear Decommissioning Authority announced they had partnered with Createc to launch an innovative twelve-month programme of work, taking on seven different remote robotic sensing projects, across five different Dounreay teams. The projects - which span security, planning, environmental and safety use cases - all involve the deployment of Spot.

Over the course of twelve months, Dounreay will systematically validate the suitability of several different types of sensors, combined with Spot, to support the digitalisation of existing on-site processes.

The use cases will demonstrate the multi-tasking value of the quadruped for nuclear sites, and its ability to carry out practical work for multiple teams. Dounreay was the UK's centre for experimental fast breeder research and development from 1954 until 1994.

Source: <https://www.world-nuclear-news.org/Articles/Robot-navigates-Dounreay-evaporator-cell> 05 September 2023.

What to Do with the UK's Civil Plutonium?

The UK's 140-tonne stockpile of civil plutonium could be used as fuel for thermal reactors or combined with the country's 100,000-T supply of depleted, natural and low-enriched uranium to fuel new fast reactors - or disposed of as waste in a future geological disposal facility - says a new report from The University of Manchester's Dalton Nuclear Institute exploring the options.

The report, *Managing the UK plutonium stockpile: No easy choices*, says that over the past six

decades the UK has built up the largest stockpile of civil plutonium in the world, which is currently stored at Sellafield as plutonium dioxide powder. It says that the Nuclear Decommissioning Authority (NDA) is carrying out an improvement programme over the coming decades of the facilities, packaging and storage. Among its 10 recommendations, the report says there needs to be a national dialogue

allowing stakeholders on all sides to share their views in an evidence-based debate; the current programme of repackaging and storing the plutonium inventory in optimal conditions must be carried out by NDA and Sellafield Ltd to the currently programmed end point of 100-year design life storage; the hazard represented would be greatly decreased by conversion from dispersible powder into a solid form and government should ensure that a comprehensive assessment is carried out on the attributes and costs of the range of options and, because the different options have different pathways to putting plutonium beyond reach, government needs to develop a full understanding of the whole plutonium lifecycle for each pathway before committing to irrevocable decisions.

Source: <https://www.world-nuclear-news.org/Articles/What-to-do-with-the-UK-s-civil-plutonium-stockpile>, 05 September 2023.

USA

Court Annuls Licence for Texas Used Fuel Store

The licence issued for the construction and operation of a consolidated interim storage facility (CISF) for used nuclear fuel in Texas has been cancelled by a US appeals court. The court ruled that the US NRC does not have the authority to license a private storage facility away from nuclear reactors.

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Interim Storage Partners (ISP) was established in 2018 as a joint venture of Waste Control Specialists and Orano CIS, a subsidiary of Orano USA, to license a CISO to be built at WCS's existing waste disposal site in Andrews County, Texas. The proposed licence would authorise a CISO to store up to 5000 T of used commercial nuclear fuel as well as so-called Greater-Than-Class C waste for a period of 40 years. ISP plans a phased expansion of the facility over 20 years to eventually store up to 40,000 T of used fuel, subject to future approvals.

In July 2021, the NRC issued its final environmental impact statement (FEIS) on ISP's application, recommending a licence be granted for the facility. The licence was issued in September 2021. Fasken Land and Minerals, a for-

profit group working in oil and gas extraction, and Permian Basin Land and Royalty Owners, an association focused on protecting the interests of the Permian Basin, along with the State of Texas and others, petitioned for review of the licence. Texas lawmakers passed a law in 2022 prohibiting the storage of high-level radioactive waste in the state, except at currently or formerly operating nuclear power reactors. In a 25 August decision, a three-judge panel of the US Court of Appeals for the 5th Circuit ruled the NRC does not have authority from Congress to license such a facility under either the Atomic Energy Act or the Nuclear Waste Policy Act.

Source: <https://www.world-nuclear-news.org/Articles/Court-annuls-licence-for-Texas-used-fuel-store>, 30 August 2023.



Centre for Air Power Studies

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

Centre for Air Power Studies

P-284

Arjan Path, Subroto Park,
New Delhi - 110010

ZTel.: +91 - 11 - 25699131/32

Fax: +91 - 11 - 25682533

Email: capsnetdroff@gmail.com

Website: www.capsindia.org

Edited by: Director General, CAPS

Editorial Team: Dr Sitakanta Mishra, Rishika Singh, Dr. Ngangom Dhruba Tara Singh, Jay Desai, Anubhav Shankar Goswami,

Composed by: CAPS

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