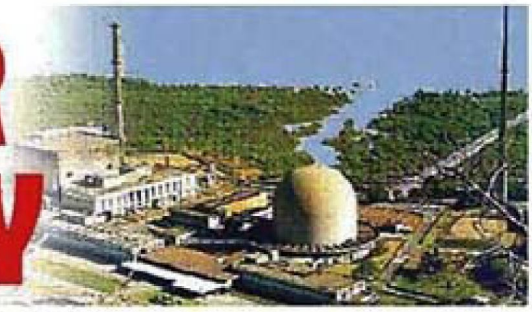
NUCLEAR SECURITY



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

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OPINION – Tom Chivers

Nuclear Power is Safe and Gets Cheaper the More We Embrace It

The government's new energy strategy white paper, introduced in the wake of Russia's invasion of Ukraine, is intended to reduce the UK's reliance on fossil fuels and help us reach net zero in the next 30 years. But there's been some controversy over the fact that it includes a major role for nuclear power: about 15 per cent of British electricity is currently generated by nuclear plants, and the paper aims to get that up to 25 per cent. This isn't a universally popular idea, especially (and perhaps ironically) among some environmental campaigners. The Green Party, in particular, opposes them: Caroline Lucas, the party's only MP, calls nuclear power "too costly, too slow, and too dangerous". The country as a whole is more in favour, with about two people in every three polled saying that nuclear should play a role in our energy mix, and one in three saying that it should play a major role. But is Lucas right? Is nuclear costly and slow, and – most importantly, surely – dangerous?

If you live near certain power plants, you will be exposed to above-average levels of radiation. Plumes of waste from the plant are released from vents around the plant and are breathed in by humans. The waste is radioactive, and can cause mutations and (according to the usual model of radiation risk, at least) raise the chance you will get cancer. Inevitably enough, I'm talking about coal plants. Coal contains trace amounts of uranium and thorium – about one to two parts per million of each, on average, in the US.

Cool Runnings: If you live near certain power plants, you will be exposed to above-average levels of radiation. Plumes of waste from the plant are released from vents around the plant and are breathed in by humans. The waste is radioactive, and can cause mutations and (according to the usual model of radiation risk, at least) raise the chance you will get cancer. Inevitably enough, I'm talking about coal plants. Coal contains trace amounts of uranium and thorium – about one to two parts per million of each, on average, in the US. Fly ash, the partially combusted carbon left over from the burning coal, carries those radioactive elements into the

atmosphere. "If you live near a coal-fired plant," says Geraldine Thomas, a professor of oncology at Imperial College London who specialises in radiation-induced cancers, "you're subject to three times more radiation than if you live near a nuclear plant."

The amount of spent fuel coming out of a reactor is tiny compared to the millions of tonnes of fly ash that came out of coal-fired stations, or the carbon dioxide that comes out of gas plants.

It should be said that the radiation even from a coal plant is trivial, anyway. Radiation exposure is measured in "Sieverts". The average person on the Earth's surface is exposed to about 0.27 millisieverts a year from cosmic rays, and a roughly similar amount from radioactivity in ground rocks. If you live in Cornwall, where the granite rocks contain tiny amounts of uranium, you'll receive far more: perhaps seven millisieverts.

People are also exposed to radiation – perhaps 6 millisieverts, at least in the U.S. – from other sources, like medical scans, and radon in building materials. By comparison, a 1978 study found that living near a coal plant exposes you to about 0.019 millisieverts, and a nuclear plant much less than that.

We live on a radioactive planet: the amount of extra radiation you'll get from proximity to a modern nuclear power plant in normal operation is undetectably low, even if you work at one. "Nowadays your average nuclear worker is probably getting less radiation than the average intercontinental pilot, with the cosmic rays," says Richard Wakeford, a professor of epidemiology specialising in ionising radiation at the University of Manchester. "The idea that there's any potential danger from a nuclear plant in normal operation is complete rubbish," says Thomas, robustly. But it's not just the normal running of a reactor that people worry about. There are also concerns over nuclear waste, and – of course – accidents.

Wasting Time: When nuclear power plants run, they make waste. The spent fuel is still radioactive, and the materials used to cool the reactor become radioactive from exposure. And that waste remains dangerous for a long time, especially the high-level waste like spent fuels. Understandably, that makes people nervous. But it's worth putting in context. Francis Livens, a professor of radiochemistry at the University of Manchester's Dalton Nuclear Institute, says: "The amount of spent fuel coming out of a reactor is tiny compared to the millions of tonnes of fly ash that came out of coal-fired stations, or the carbon dioxide that comes out of gas plants."

That said, as Livens points out, "The volume of waste is tiny, but it's really nasty. So you may only have a few hundred tonnes, but you really have to look after it carefully." Luckily, we know how to do that. "My personal opinion is that waste disposal is not a technical problem," says Livens. "All the technical problems are solved or solvable. If you look at Sizewell B, it's been running for nearly 30 years, and all the fuel is stored on site and will be until it stops operating. You have a reactor and a spent fuel store, and it's all on the same location." Since it's such a small amount of high-level waste, if you can find space to build the reactor, you can find space to store it, in heavily engineered concrete-and-iron casks. Later, after the reactor is shut down, spent fuel can be stored underground, or its concrete casks can be updated every few decades: either way, the space, risk and cost are trivial. But while it's not a *technical* problem, it is a *societal* problem, says Livens. "Everyone asks about the waste," he says. "It has a profile I'm not

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sure it deserves, but it does have it. The UK struggled for years with disposing of waste, because communities don't like having it disposed of in their patch, until they stopped treating it as a technical problem and started treating it as a societal problem."

Previously, the government would announce that waste would be stored somewhere, in a model known as "Decide, Announce, Defend". "The government decides it's going to put the waste in Francis Liven's garden," says Livens. "They tell me, I say 'You bastards,' and then there's a row." Often, the government would then back down, so the D-A-D model became cruelly known as "Decide, Announce, Defend, Abandon". Since 2007, though, there's been a change. "They went to voluntarism: they asked if some communities would be willing to put their hand up and take the waste in exchange for some benefits. You're doing a service for the nation and that should be recognised." The approach has been used for onshore wind – the community puts up with the wind turbine in exchange for cheaper energy – and, after some false starts, there's been progress with nuclear waste, too. The concerns over radioactive waste, though understandable, are overblown.

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Accidents will Happen? The big concern, of course, is nuclear accidents. The two famous ones are Chernobyl and Fukushima, although some people might remember the 1957 fire at Windscale, now Sellafield, in the Lake District, and the 1979 partial meltdown of the Three Mile Island reactor in Pennsylvania. Those all happened in relatively old reactors, and in the case of Fukushima was caused by an earthquake and tsunami of enormous proportions. Modern reactors have far better safety systems. But nonetheless, they happened, and released large amounts of radiation into the surrounding area. How dangerous was that?

This seemingly simple question is enormously controversial. The risks of exposure to large amounts of radiation are relatively well known: "The really gruesome effect like your skin peeling and gastric only happens at a really high dose," says Dr Heather Williams, a consultant medical physicist at the Christie Hospital in Manchester. "What we're looking at is increased cancer risk." The first efforts to measure that risk looked at survivors of the Hiroshima and Nagasaki bombs. And they found a relatively straightforward link: the higher the dose, the higher the risk of cancer. But that was only for people who had had a pretty high dose, a Sievert or more – hundreds of times what most of us are exposed to in a year.

It's much harder to see what the radiation risk is like at lower doses, because there are so many other things that cause cancer. "The further down you come in the dose, the more of a problem the background noise is," says Wakeford. There is some evidence at somewhat lower levels from workers in older nuclear plants, but at the sort of level relevant to nuclear safety, it's just too noisy. So, what researchers have traditionally done is assume that that simple dose-response link you find in the higher doses extends downwards: so if a Sievert of exposure gives you a 5 per cent increased risk, then a millisievert will give you a 0.005 per cent increased risk. This is known as the "Linear No Threshold" (LNT) model of radiation risk: that there is no level ("threshold") below which radiation is safe, it just increases from "not very dangerous" to "very dangerous" in a straight line. A lot of people think that's biologically implausible, because our bodies are pretty good at repairing small amounts of damage and are exposed to low-level radiation all the time.

The scientists I spoke to disagreed somewhat on the LNT model. Williams and Wakeford felt it was flawed but useful as a conservative baseline; Thomas thinks that it's silly, because at very low levels of radiation, it's impossible to ever prove or disprove. "You'd need to follow a billion people and monitor every single piece of radiation they're exposed to," she says, because the risks are so low. But they *do* agree that whether or not the LNT is right, the risk of radiation for everyone but the most acutely exposed are negligible.

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But they *do* agree that whether or not the LNT is right, the risk of radiation for everyone but the most acutely exposed are negligible. Thomas points to a study which found that even the cleanup engineers at Chernobyl ended up being at less risk of cancer than people who lived in the same house as a smoker.

And while the Tôhoku earthquake and resulting tsunami killed 15,000 people, radiation from Fukushima killed *possibly* one person, and even that Thomas is sceptical of: "The government paid up [for the lung-cancer death of one citizen]. But the WHO said it was not attributable to radiation, and he was only exposed to 19 millisieverts. It was almost certainly nothing to do with Fukushima." Meanwhile, the evacuation of 150,000 people from the area surrounding the plant certainly *did* cause several dozen deaths. The nuclear accidents were terrifying, and Chernobyl certainly did kill several dozen people through acute radiation exposure, and caused thousands of thyroid cancers and leukaemias in people who were exposed as children. I don't want to downplay the tragedy of it. There has been a huge overstatement of the scale of the disaster – the recent HBO miniseries, for instance, implies that the emergency workers who attended the initial disaster were so radioactive that they were dangerous to be around, which is nonsense, and claims that the meltdown nearly led to a nuclear explosion, which is physically impossible. Nonetheless, it was a major disaster, and people died who didn't need to. But even if we say that 60,000 people died because of Chernobyl, the most extreme claim and likely a large overestimate, and attribute them to nuclear energy, then it is many, many times safer than fossil fuels.

Nonetheless, it was a major disaster, and people died who didn't need to. But even if we say that 60,000 people died because of Chernobyl, the most extreme claim and likely a large overestimate, and attribute them to nuclear energy, then it is many, many times safer than fossil fuels.

Too Slow, Too Costly? Nuclear power really is very safe. But Lucas made two other criticisms, and they're fairer: that it is slow to build, and it is costly. The Hinkley Point C reactor was announced 12 years ago, and isn't expected to start running until 2026. It will likely have cost around £20 billion by then. It's hard to estimate exactly, but the cost of a watt of nuclear electricity is probably between five and 10 times that of solar or offshore wind. Why is nuclear so slow and so expensive? Livens says that a lot of it is simply that it's very big and difficult to build and requires lots of high-tech stuff, plus it's a long time before you can use it. "The cost is dominated by the capital cost of the reactor. You borrow a humongous amount of money to build it, it takes a decade during which you're earning no money, and then you switch it on and start earning money to pay it back." Just like a mortgage, he says, the interest represents a large part of the cost.

But there are ways of improving the situation. One, of course, is to start building them quicker so you can start earning faster. The second Hinkley reactor will be much like the first, and the plan is to use the same plans to build another reactor at Sizewell in Suffolk. In the past, we've moved from one kind of reactor to another, so the skills aren't transferable. Also, points out Tim Lord, an energy economist at the Institute for Government, we haven't actually built a new reactor since Sizewell B in 1995, so for Hinkley we've essentially had to build the entire workforce and supply chain from scratch. A similar idea but more extreme is the "small modular reactor" concept, nuclear plants which can be built to standardised plans, largely off-site, and then assembled like a prefab school classroom. Rolls Royce, which has decades of experience building reactors for nuclear submarines, hopes to get its first one up and running by 2030.

You can also reduce the cost of borrowing by letting the government do it, rather than the energy company. Governments can borrow at much lower interest than private companies, because banks trust them to still exist in 20 years' time. That would reduce the risk for energy companies and allow governments to negotiate a much lower price on the eventual energy. This system, the Regulated Asset Base model, has already been used on other infrastructure projects and will be in place for the next generation of nuclear plants.

Nuclear power will still likely take longer to build and be more expensive than solar and wind, especially since renewable prices *just keep dropping*, which is wonderful. But nuclear has advantages. For one thing, it's continuous: wind and solar only work when the wind is blowing or the sun is shining.

Is there a Place for Nuclear? That said, nuclear power will still likely take longer to build and be more expensive than solar and wind, especially since renewable prices *just keep dropping*, which is wonderful. But nuclear has advantages. For one thing, it's continuous: wind and solar only work when the wind is blowing or the sun is shining. There are ways around that, with interconnectivity and with batteries, but they're not in place yet. For another, it's got a small footprint. A Rolls Royce small modular reactor takes up about the size of two houses: it would need rather more space than that for all the infrastructure, but it's not a big installation. It will provide as much energy as about 150 big wind turbines, which would cover entire hillsides or a large swath of sea.

But nuclear has a role to play, alongside new solar and wind: the more green energy sources we have the better. If we can get past its PR problem, its unfair reputation for being dangerous, perhaps we can start getting better at building it quickly and cheaply. The best time to start would have been 30 years ago, but the second-best time is now.

And while wind and solar are very good at making electricity, electricity is only about half of our energy use. Nuclear can create the seriously high temperatures required for steel, glass, cement and other manufacturing processes, which would be very inefficient with electricity, and can also be used to create hydrogen for fuels. The energy strategy is incomplete, says Lord: it is strong on ambition but short on detail, such as how the costs of nuclear will be brought down, and how the new supply chains will be built. Many governments have promised to build nuclear fleets before and failed. But nuclear has a role to play, alongside new solar and wind: the more green energy sources we have the better. If we can get past its PR problem, its unfair reputation for being dangerous, perhaps we can start getting better at building it quickly and cheaply. The best time to start would have been 30 years ago, but the second-best time is now.

Source: https://inews.co.uk/news/science/nuclear-power-safe-cheaper-uk-embrace-it-1570802, 13 April 2022.

OPINION – Louis Jacobson

What are 'Tactical' Nuclear Weapons? And what do they Mean for Russia, Ukraine and the World?

Russia's invasion of Ukraine is going poorly enough that President Putin might decide to use what are known as tactical nuclear weapons, according to both Ukrainian and U.S. leaders. In an interview, President Zelenskyy told CNN's Jake Tapper that all countries should be prepared for the possibility that Putin could use nuclear weapons. CIA Director William Burns also warned of this possibility during a recent speech. Nuclear weapons haven't been detonated as tools of war since 1945. But with increasing concern about their risks, we researched what tactical nuclear weapons are, what Russia would seek to accomplish by using them, and how the West might respond.

What is a Tactical Nuclear Weapon? Nuclear experts say the term "tactical nuclear weapon" is typically used to describe a nuclear weapon

with comparatively low impact and fired from a relatively close distance. Sometimes these are referred to as "low yield" nuclear weapons. "Their intended purpose is for attacks on military formations in the field or bases and logistics hubs," said Brendan Green, a professor at the University of Cincinnati who studies military doctrine and international affairs. The targets could be as limited as a group of tanks or a large infantry unit, said Richard K. Betts, a professor of war and peace studies at Columbia University.

But just because these nuclear weapons are considered small doesn't mean their impacts would be minor. In the Russian nuclear arsenal, Green said, most nuclear weapons that would be considered "tactical" would be "as large or larger than the bombs that destroyed Hiroshima and Nagasaki" to end World War II. Because the U.S. bombs were dropped on sizable Japanese cities, they are estimated to have killed 100,000 residents and injured a similar number. "Even one of these weapons would severely mess up the target," Green said, although the impacts would depend on how high in the air the bomb was detonated, how built-up the target area was, and how much flammable material was nearby.

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Russia is thought to have about 2,000 tactical nuclear weapons, said Matthew Bunn, a nuclear policy analyst at Harvard University's Kennedy School of government. The U.S. has fewer — a couple hundred, depending on the precise definition. Most are B61 bombs that would be delivered by aircraft, Bunn said.

Why Might Russia Use One? In theory, there could be a military benefit from using a tactical nuclear weapon — namely, causing battlefield carnage more quickly and completely than conventional weapons could. But military experts agreed that an incremental advantage on the battlefield is not why Putin might use them. "There are no military targets in Ukraine that Russia could destroy with a nuclear weapon that it couldn't also destroy with conventional weapons," Bunn said. This means that the advantage of a nuclear weapon "would be its shock value."

If the war goes badly enough for Russia, Putin might pursue a nuclear detonation in desperation. For instance, he might do it if he is "so desperate to demonstrate power and show that he has somehow achieved a win," said Mai'a K. Davis Cross, a professor of political science and international affairs at Northeastern University. While a tactical nuclear weapon could be aimed at a populated area, it wouldn't have to be, if the purpose is to show defiance and resolve, experts said. Putin could detonate a weapon over the sea, in the atmosphere, or in a lightly populated area.

How Might the West Respond to a TNW? The West, led by the U.S., has several options, none of them appealing. It could ignore Russia's detonation; it could give in to whatever Russia is demanding; or it could escalate the conflict. While the pressure on the West to respond would be intense, a direct nuclear response would be the riskiest course. Although a nuclear tit-for-tat would not inevitably spiral into global annihilation, it would raise the risk of that happening, Green said, probably to unacceptable levels. "Whether or when escalation would stop is anyone's guess — a game of chicken on a grand scale," Betts said. The West may have some room to maneuver in its response, depending on the nature of a detonation. The destruction of a city would be harder to let pass, but an explosion in an unpopulated area and without significant direct casualties could allow the West to mount a response short of detonating its own nuclear weapons.

"If the Russian shot was really a 'demonstration,' like a high-altitude air burst that would be little more than a bright flash in the sky with no ground damage, possibly cooler and wiser heads would prevail," said John Pike, the director of globalsecurity.org. Whatever type of nuclear

detonation Putin might decide to undertake, the diplomatic consequences against Russia would be swift, experts agreed. "If Russia used nuclear weapons, the West would certainly double down on turning Russia into a pariah state for all eternity, and might well have increased success at that enterprise," Green said. Even a demonstration explosion "would be a big step for Russia, and would carry heavy long-term consequences." Ultimately, though, no one has a perfect answer for how to respond to a Russian escalation to nuclear conflict. "Hope is not a plan," Pike said.

Could Russia's use of a nuclear weapon open a pandora's box for the rest of the world? Any use of a nuclear weapon by Russia would break the 77-year "taboo" against using nuclear weapons. Even if the norm against using nuclear weapons isn't irreparably broken going forward, Russia's decision to detonate a nuclear weapon would weaken the norm. And if that happens, the world "will probably be different in important ways than the world we live in now," Green said. However, he added, "It is very hard to predict exactly how." Breaking the taboo could actually produce disparate, even opposing impacts, Betts said. "It would encourage stronger calls for nuclear disarmament or arms control, along with wider moves by countries to acquire their own nuclear forces, or use them, depending on the apparent success or failure of the Russian initiative," he said. Ultimately, there is little certainty about how the scenario would play out. "What's realistic?" Betts said. "Who knows? The world has no experience with this sort of action."

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Source: https://www.politifact.com/article/2022/apr/19/what-are-tactical-nuclear-weapons-and-what-would-t/, 19 April 2022.

OPINION – Peter Huessy

Where is Biden's Nuclear Strategy Headed?

The Biden administration has sent Congress the U.S.' sixth Nuclear Posture Review since the end of the "first" Cold War in 1991. While still classified, recent disclosures and the FY2023 budget submission give us a relatively clear idea of where U.S. nuclear deterrent policy and strategy are headed. Most important to the administration is the requirement to get the U.S. back into the lead with respect to nuclear arms control deals (which may or may not be compatible with deterrent requirements). There appear to be at least four aspects of this policy: First, bring back the 1987 INF Treaty; second, secure a new Iran nuclear agreement known originally as the JCPOA; third, extend and expand the New START Treaty of 2010; and fourth, unilaterally cut U.S. nuclear forces to 1,000 or fewer warheads.

There appear to be at least four aspects of this policy: First, bring back the 1987 INF Treaty; second, secure a new Iran nuclear agreement known originally as the JCPOA; third, extend and expand the New START Treaty of 2010; and fourth, unilaterally cut U.S. nuclear forces to 1,000 or fewer warheads.

The Russians have serially violated the INF treaty, and as such, it became untenable to continue adhering to a treaty with only one participant—Washington. Yet this fact is not readily apparent from the news coverage of the INF following the U.S. withdrawal. The nuclear agreement with Iran follows the same pattern. A number of analyses by the Institute for Science and International Security explain that Iran never fully adhered to the terms of the original 2015 JCPOA, especially in that Iran did not disclose its previous nuclear weapons technology activities to the IAEA. The IAEA has effectively ignored this point, despite that the IAEA is required to verify any previous Iranian nuclear work under the JCPOA.

It was only an Israeli raid on a warehouse filled with Iranian nuclear documents and their subsequent disclosure that revealed a significant Iranian effort to gather nuclear weapons technology. In the words of General Michael Hayden, a former U.S. national intelligence chief, Iran has become an "industrial strength nuclear state"—and the JCPOA did not prevent this, but rather facilitated it. So, while the U.S. did withdraw from the JCPOA, it did so not as a result of any animus toward arms control deals in principle, but particularly because this nuclear deal did little to prevent Iran from securing a nuclear-weapons capability.

As for the New START Treaty, the Trump administration adhered to the agreement, and it has now been extended for an additional five years by the Biden administration. It is unclear, therefore, what aspect of the New START Treaty needs to be enhanced.

As for the New START Treaty, the Trump administration adhered to the agreement, and it has now been extended for an additional five years by the Biden administration. It is unclear, therefore, what aspect of the New START Treaty needs to be enhanced. The U.S. has been and remains in strict adherence to its terms, although between three to five Russian strategic nuclear systems under development and in production may not be limited under the treaty, much as some 55 percent of Russia's deployed strategic and regional nuclear forces are not limited by New START. Thus, while Washington seeks to "lead" the world into an arms control future, it is unclear how it intends to do so. How can the U.S. resurrect the INF Treaty without Russian compliance? How would Congress approve a new or amended JCPOA (as required by law) that also removes a number of Iranian entities from the U.S. foreign terrorist list despite them posing the primary threats to America's Middle East partners?

The Russians and Chinese could accept the proposed unilateral concessions and provide the U.S. with nothing in return. But U.S. allies, especially in NATO and in the Western Pacific, could find these unilateral measures concerning if they were undertaken without care for how they affect U.S. extended nuclear deterrence.

If the U.S. is looking to secure a new nuclear arms deal with Russia—or even China—some questions and (Congressional) concerns must be answered beforehand. Indeed, any new strategic arms control deal would need to account for: all of Russia's nuclear weapons, including the multiple thousands of tactical, theater nuclear systems; and China's ongoing, "breathtaking" nuclear weapons buildup, variously projected to reach between 1,000-2,500 warheads by 2030-2040. It is in this light that any unilateral U.S. arms control measures, irrespective of what Russia and China are undertaking, should be evaluated. For example, in its proposed FY23 budget, the administration eliminates the Navy's proposed short-range, nuclear-armed cruise missile and the megaton-class B-83 gravity bomb carried by the B-2.

Looking down the road, the disarmament community continues to push for unilateral cuts by ending the new Sentinel land-based ICBM force and reducing U.S. strategic deterrent forces to 1,000 or fewer nuclear weapons, a 55 percent reduction. However, while the U.S. is seeking to "do arms control," the U.S. is also simultaneously putting forward an FY23 budget that, apart from the cuts mentioned above, actually keeps in place most of the nuclear deterrent modernization of the previous two administrations—which Congress has fully supported since 2010. In fact, Congress has modestly added funds to past nuclear deterrent force budgets.

Consequently, by adopting some of the disarmament communities' ideas and simultaneously proceeding with nuclear modernization, the administration may be giving contradictory signals to the U.S.' allies and enemies. The Russians and Chinese could accept

the proposed unilateral concessions and provide the U.S. with nothing in return. But U.S. allies, especially in NATO and in the Western Pacific, could find these unilateral measures concerning if they were undertaken without care for how they affect U.S. extended nuclear deterrence. The administration's consideration of adopting a "no first use" nuclear doctrine, for example, disturbed America's allies and, in response, the administration wisely rejected such a posture.

With its emphasis on reinvigorating "arms control," the administration could wisely move to corral both non-compliant Russian theater systems and the entirely of the growing Chinese arsenal, which, if successful, could significantly improve U.S. security. However, considering that the Chinese have rejected such negotiations unless the U.S. and Russia first cut their nuclear stockpiles to current Chinese levels, it appears that China's security leadership has no interest in nuclear arms control.

Source: https://nationalinterest.org/feature/where-biden%E2%80%99s-nuclear-strategy-headed-201868, 19 April 2022.

OPINION – Yen-Chiang Chang, Duan Xingyi

ICJ Advisory Opinion Key Step in Dealing with Japan's Nuclear Contamination Water Dumping

April 13 marks the one-year anniversary of Japan's decision to dump contaminated water from the Fukushima nuclear power plant into the sea. It is necessary for the international community to stop this, and one of the keys is to prove that Japan would be violating its international legal obligations. A better strategy would be to first request the International Court of Justice (ICJ) to issue an advisory opinion on the illegality of the planned dumping.

First, such a request will be effective if successfully made to the ICJ, judging from their previous advisory opinions. Second, a request for an advisory opinion could lower China's burden of proof and promote cooperation with stakeholders such as South Korea, North Korea, Russia, and the Pacific Island countries. Third, an advisory opinion is morally binding and can effectively support subsequent accountability activities. Although not legally binding, an advisory opinion given by the authoritative ICJ against Japan's plan to dump nuclear-contaminated water will put the country under greater moral and public pressure if it does not give up the dumping plan. In addition, the ICJ's advisory opinion will effectively support international litigation and arbitration, and important points can be used as a critical basis for court arguments. Fourth, such a request will reflect China's contribution to international legislation, and promote the improvement of the international law system.

Although not legally binding, an advisory opinion given by the authoritative ICJ against Japan's plan to dump nuclear-contaminated water will put the country under greater moral and public pressure if it does not give up the dumping plan. In addition, the ICJ's advisory opinion will effectively support international litigation and arbitration, and important points can be used as a critical basis for court arguments.

Of course, there are limitations to such a request. First, it's difficult to predict how the ICJ will view Japan's dumping plan as there have been few precedents on nuclear-related issues since the establishment of the ICJ and the International Tribunal for the Law of the Sea (ITLOS). In the precedents available, international judicial bodies have been cautious in dealing with nuclear-related issues.

Second, China cannot directly request an advisory opinion from the ICJ, but needs to jointly submit a motion for an advisory opinion in the U.N. organs and specialized agencies together with the interested countries. From past experience, the UN General Assembly is the most common and effective organ. So China's primary choice is to submit a motion through the UN General Assembly and make a resolution requesting an advisory opinion. The process requires adequate preparation and the support of a sufficient number

of member states. Finally, China still needs to prepare for holding Japan accountable through international judicial institutions. It needs to make preparations for two potential outcomes: One is that the ICJ won't issue an advisory opinion; the other is that Japan will not stop the implementation of its plan to dump contaminated water into the sea.

In summary, we propose exchanging views with Japan over its plan to discharge treated water into the sea. It's necessary to exchange views as soon as possible before Japan will officially start the plan in 2023. On one hand, we should exert pressure on Japan through talks. On the other, we should make preparations for other moves to hold Japan accountable. We could also figure out Japan's specific plans and intentions for dumping contaminated water through talks and acquire more pieces of evidence.

It's suggested we conduct close communications with other countries concerned including South Korea, Russia, North Korea and Pacific Island nations, preparing to initiate motions at the UN General Assembly and other UN specialized agencies. We should step up the collection of scientific evidence and strive for an advisory opinion from the ICJ. It's necessary for us to quicken the collection of fishery materials and the monitoring of nuclear-related data in coastal areas, so as to make a before-and-after comparison and calculate compensation. We should also use South Korea as a reference to promptly introduce or revise unclear-related regulations, and expand the scope and frequency of monitoring domestic radioactive materials, in order to provide a domestic legal basis for responding to Japan's dumping of nuclear-contaminated water.

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Source: https://www.globaltimes.cn/page/202204/1259122.shtml, 12 April 2022.

OPINION – Fermín Koop

Argentina Nuclear Chief: 'Nuclear Energy is Part of the Decarbonisation Solution'

In Argentina, President Fernández's government hopes to begin construction of a new nuclear power plant this year. The plant, located in the province of Buenos Aires, will generate 1,200 MW and cost US$8 billion, with the Industrial and Commercial Bank of China (ICBC) expected to finance the majority of the project. The China National Nuclear Corporation will provide the technology for the reactor. The project, originally presented in 2015, was relaunched following President Fernández's visit to Beijing in February, where he confirmed Argentina's membership of China's BRI. Although the two governments have already signed the contract for the plant project, many details are yet to be finalised. As the project moves towards its next steps, José Luis Antúnez, president of Nucleoeléctrica, the state-owned company that operates Argentina's nuclear facilities, spoke to Diálogo Chino about the plant's construction and the role of nuclear energy in Argentina's energy transition.

China will provide the enriched uranium necessary for us to manufacture the fuel for the plant in Argentina, which they will supervise. As the agreement was awarded directly and without a tender, it is necessary to demonstrate that the price and financing are reasonable. An environmental impact study must also be carried out.

Diálogo Chino: What is the Status of the Argentina–China Nuclear Project and what are the Next Steps? José Luis Antúnez: The contract has been signed and we are now working on the necessary steps to bring it into force. We have a maximum term of nine months to conclude, but we hope to achieve it in less time. We have to close the financial agreement – the credit details and the disbursement schedule. We hope to get the best possible conditions from China, especially now that Argentina has joined the Belt and Road Initiative.

Another important point to be agreed is the transfer of technology. China will provide the

enriched uranium necessary for us to manufacture the fuel for the plant in Argentina, which they will supervise. As the agreement was awarded directly and without a tender, it is necessary to demonstrate that the price and financing are reasonable. An environmental impact study must also be carried out.

What will the Nuclear Power Plant's Construction Look Like and how Long will it Take? Once the contract enters into force, we'll receive the first disbursement from China and start working to get the plant in service, which will take eight years. The work will be divided into 19 buildings in total, including one for the reactor, another for the turbine, and another for the control room, among others, on a 35-hectare site. We will award US$500 million in supply purchases to Argentinean industries and we will train future operators for the plant. We will hire 5,000 people at the peak of construction and more than 600 once it is in permanent operation. With this new plant, Atucha [the site of the already operational Atucha I and II stations] will become Argentina's nuclear hub.

The nuclear power plant will have a Hualong reactor, developed and already used in several plants in China. What are its characteristics and what does it mean for Argentina, which has a long nuclear history with other technologies? The Hualong reactor represents a new horizon for Argentina, as it could lead to further development of our local technological and scientific sector. We are going to acquire a new technology and take advantage of what we have already learned in other projects. In 2012, the Argentine government approved the technology but there was criticism that, at that time, it had not yet been tested. We were sure that China would be successful and fortunately we did not have to regret it. China already has four Hualong reactors in operation and six in the pipeline.

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The original 2015 agreement signed with China also contemplated the development of another nuclear power plant, but with Candu reactors – a Canadian technology with which Argentina has much more experience. Do you plan to reactivate it with funding from China? We want to get Hualong up and running before we talk about another project with China. Beyond that, the idea is to reactivate the Candu reactor. For now, Nucleoeléctrica, with its modest financial resources, is working on the engineering of the project. The purchases will be made from the Embalse nuclear power plant [in Córdoba Province], which operates with a Candu reactor. This does not mean that the reactor will be installed there, but that it will be designed there.

In addition to the new Hualong power plant, Argentina has been cooperating with China on several other nuclear energy projects. What are the next steps? China recently contracted us to carry out the life-extension engineering for the Candu power plant in Qinshan City. It's a way of gaining mutual trust. There are two more Candu projects in the pipeline in China, so there could be some very interesting things in the coming years.

The production of more than 60% of the world's energy emits carbon dioxide. The challenge is that, by 2050, energy must be produced with zero emissions. This is a huge task. Nuclear power is a clean technology and allows for large power plants. It is part of the decarbonisation solution.

What role does nuclear energy have for Argentina in its energy transition? The production of more than 60% of the world's energy emits carbon dioxide. The challenge is that, by 2050, energy must be produced with zero emissions. This is a huge task. Nuclear power is a clean technology and allows for large power plants. It is part of the decarbonisation solution. All nations are realising this. China was the first, with a programme to build 150 reactors in 30 years. Argentina will continue to increase not only its nuclear capacity, but also hydro, solar and wind.

Despite this, there is still some rejection of nuclear energy in the country. What image do you think it

has in Argentina? I see the image improving, but we are somewhat out of step with other countries. We have environmental groups condemning the use of nuclear energy and we have legislation in provinces prohibiting its use. Nuclear energy has its flaws – it is an investment-intensive industry. We have to continue to improve our image, work well and demonstrate that, in the face of climate change, nuclear is part of the solution.

Source: https://dialogochino. net/en/climate-energy/53021-argentina-nuclear-chief-energy-decarbonisation-solution/. 21 April 2022.

NUCLEAR STRATEGY

CHINA

China Building Up Nukes at a Rapid-Fire Pace

In recent months, China has been building its nuclear arsenal at an unexpected pace, likely with the aim of deterring a US intervention in the event of an invasion of Taiwan and to maintain strategic deterrence through mutually assured destruction (MAD). According to a fact sheet released by the US-based Arms Control Association, China currently has a mere 350 nuclear warheads while the US has 5,500. However, the US believes that China plans to double its arsenal to 700 deliverable nuclear warheads by 2027 and 1,000 by 2030, exceeding the size and pace that the US DoD initially projected in 2020.

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China's hypersonic technology adds a particular qualitative edge to its nuclear arsenal. In July 2021, China tested its hypersonic glide vehicle – a fractional bombardment system (HGV-FOB) that flew for 40,000 kilometers with 100 minutes of flight time, the greatest distance and time a land-attack weapon any nation has ever achieved. This technology gives China global strike capabilities, and the ability to defeat any current and likely future missile defense system.

In June 2021, satellite imagery revealed that China may be constructing 250 long-range missile silos in at least three locations, fueling concerns that it is substantially increasing its land-based nuclear arsenal. These silos are believed to be capable of housing the DF-41 missile, which has a range of 12,000 to 15,000 kilometers and can carry up to 10 MIRVs. However, the actual number of nuclear missiles that could be stored in these silos could be much smaller, as China is known to have used decoy silos in the past.

Apart from building more silos, China is also exploring anew the idea of railway-delivered nukes for its land-based arsenal. These mobile launchers could exploit China's 37,000 kilometers of high-speed track to maximize mobility, survivability and concealment of the land-based element of its nuclear deterrent.

Apart from building more silos, China is also exploring anew the idea of railway-delivered nukes for its land-based arsenal. These mobile launchers could exploit China's 37,000 kilometers of high-speed track to maximize mobility, survivability and concealment of the land-based element of its nuclear deterrent. In terms of its sea-based nuclear arsenal, China operates four nuclear-powered Type 94 ballistic missile submarines. Each of these submarines can carry 12 JL-2 SLBMs, each of which is believed to carry a single nuclear warhead and possess a range of between 7,200 and 9,000 kilometers.

While these missiles can strike other nuclear states such as Russia and India when launched from waters near China, they do not have the range to threaten the US mainland. However, they can hit US territories such as Alaska, Guam and Hawaii. However, the Type 94 submarines are believed to be magnitudes noisier than their US and Russian counterparts, which makes them easily detectable. As such, China is working on the Type 96 successor design, which would be armed with the planned MIRV-armed JL-3 SLBM with a range of 9,000 kms. By 2030, the US DoD estimates that China could have a fleet of eight Type 94 and Type 96 submarines operating concurrently.

last year China revealed concept art for its H-20 bomber, a stealthy flying wing design reminiscent of the US B-2 Spirit bomber. The H-20 will be armed with nuclear and conventional missiles, have a maximum take-off weight of 200 tons, can carry 45 tons, fly at high subsonic speeds and can be equipped with at least four hypersonic stealth cruise missiles.

Historically, China has not emphasized the air-based leg of its nuclear arsenal. However, China has developed its own air-launched ballistic missile, which was last tested in 2018. It has also upgraded its long-serving Xian H-6 strategic bomber as a standoff missile launch platform, which itself is based on the Soviet Tupolev-16 bomber. Moreover, last year China revealed concept art for its H-20 bomber, a stealthy flying wing design reminiscent of the US B-2 Spirit bomber. The H-20 will be armed with nuclear and conventional missiles, have a maximum take-off weight of 200 tons, can carry 45 tons, fly at high subsonic speeds and can be equipped with at least four hypersonic stealth cruise missiles.

At the same time, China can use its nuclear power industry to support its nuclear weapons program. Last year, China planned to build 150 new nuclear reactors worth US$440 billion, which is more reactors than the rest of the world put together in the past 35 years. That said, it is highly likely that at least part of this infrastructure would be allocated to supporting China's nuclear weapons program, analysts say.

Source: https://asiatimes.com/2022/04/china-building-up-nukes-at-a-rapid-fire-pace/, 12 April 2022.

ISREAL

Israeli Ambassador Urges 'Deterrence' as Best Strategy to Prevent Nuclear Iran

The best strategy for preventing a nuclear-armed Iran is "serious deterrence," Israeli Ambassador to the U.S. Michael Herzog said in a virtual event with *The Washington Post* that also touched on the Israeli-Palestinian peace process and Israel's response to Russia's invasion of Ukraine.

"I do believe that if you reinstate deterrence, you will prevent war. I certainly believe that if you show assertiveness vis-a-vis Iran, as Israel has shown in the last few years in the region, you will deter Iran," Herzog said. When pressed by *Post* national security correspondent Souad Mekhennet what deterrence looks like, Herzog did not offer specifics. "We maintain our options open, we will build our capabilities to counter Iran, we will maintain our freedom of action. And we'll decide in due time what action to take," said Herzog. He added that the main thing he would hope to see in a nuclear agreement is "a deal without sunsets, or if at all, sunsets in a very far distance," referring to the so-called "sunset clauses" in the 2015 Joint Comprehensive Plan of Action, whereby certain terms of the agreement expire after a predetermined number of years.

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Senior Israeli leadership, including PM Naftali

Bennett and Defense Minister Benny Gantz, have openly expressed concerns about the ongoing negotiations in Vienna. Herzog reiterated the common refrain that Israel is "not part of the deal" and thus not bound by it. "The discussion between this deal and no deal is a difficult one because both options are unappealing," Herzog said in response to a question about what Israel views as the alternative to the agreement being negotiated in Vienna. "The most critical element is not whether you do a deal or you don't do a deal. It's whether you have deterrence vis-a-vis Iran." He said that Israel is "not going to sit idly by" as Iran becomes a "legitimized nuclear threshold state."

Sarmat missile had been test-launched for the first time from Plesetsk in northwest Russia and hit targets in the Kamchatka peninsula, nearly 6,000 km (3,700 miles) away. The test of the Sarmat, under development for years.

... Herzog blamed the difficulty in reaching a peace deal with Palestinians on Palestinian leadership — more specifically, on the lack of strong Palestinian leadership. Peace requires "leadership on both sides who can communicate and take decisions like we had had between Israel and Egypt, or between Israel and Jordan," Herzog said, referring to Israel's first peace deals with Arab countries, in 1978 and 1994, respectively. One potential boon for negotiations between Israel and the Palestinians could be the Abraham Accords, Herzog argued.

The new complex has the highest tactical and technical characteristics and is capable of overcoming all modern means of anti-missile defence. It has no analogues in the world and won't have for a long time to come," Putin said.

Source: https://jewishinsider.com/2022/04/israeli-ambassador-urges-deterrence-as-best-strategy-to-prevent-nuclear-iran/, 12 April 2022.

RUSSIA

Russia Tests Nuclear Capable Missile that Putin Calls World's Best

In a show of strength two months into its assault on Ukraine, Russia test-launched a new nuclear-capable intercontinental ballistic missile which President Putin said would make Moscow's enemies stop and think. Putin was shown on TV being told by the military that the long-awaited Sarmat missile had been test-launched for the first time from Plesetsk in northwest Russia and hit targets in the Kamchatka peninsula, nearly 6,000 km (3,700 miles) away. The test of the Sarmat, under development for years, did not surprise the West, but came at a moment of extreme geopolitical tension. Russia has yet to capture any major cities since it sent tens of thousands of troops into Ukraine on Feb. 24. Ukraine's defence ministry was not immediately available for comment. "The new complex has the highest tactical and technical characteristics and is capable of overcoming all modern means of anti-missile defence. It has no analogues in the world and won't have for a long time to come," Putin said. "This truly unique weapon will strengthen the combat potential of our armed forces, reliably ensure Russia's security from external threats and provide food for thought for those who, in the heat of frenzied aggressive rhetoric, try to threaten our country."

Announcing the invasion eight weeks ago, Putin made a pointed reference to Russia's nuclear forces and warned the West that any attempt to get in its way "will lead you to such consequences that you have never encountered in your history." Days later, he ordered Russia's nuclear forces to be put on high alert. "The prospect of nuclear conflict, once unthinkable, is now back within the realm of possibility," U.N. Secretary-General Antonio Guterres said last month. Russia's defence ministry said the Sarmat was fired from a silo launcher at 1512 Moscow time (1212 GMT). Russia's nuclear forces will start taking delivery of the new missile "in the autumn of this year" once testing is complete, Tass quoted Dmitry Rogozin, head of the Roscosmos space agency. ...

Source: https://www.reuters.com/world/europe/russia-tests-new-intercontinental-ballistic-missile-2022-04-20/, 20 April 2022.

'Danger is Serious': Russia Warns of Nuclear War over Ukraine

Russia's two-month-old invasion of Ukraine has left thousands dead or injured, reduced towns and cities to rubble, and forced more than 5 million people to flee abroad. Accusing NATO of engaging in a proxy war, Russia has said that there is a serious and real risk of nuclear war over Ukraine.

"The danger is serious, real. It can't be underestimated," said Russian foreign minister Sergei Lavrov asked on state television about the importance of avoiding World War Three. "NATO, in essence, is engaged in a war with Russia through a proxy and is arming that proxy. War means war," he said. Invoking the Cuban missile crisis of 1962, when the US and the Soviet Union came close to nuclear war, Moscow and Washington had understood the rules of conduct between the superpowers, he said: "Now there are few rules left."

Dmitry Medvedev, deputy chairman of Russia's Security Council, said that should Sweden and Finland join NATO then Russia would have to strengthen its land, naval and air forces in the Baltic Sea. Medvedev also explicitly raised the nuclear threat by saying that there could be no more talk of a "nuclear free" Baltic - where Russia has its Kaliningrad exclave sandwiched between Poland and Lithuania.

However, he also mentioned that Russia will continue negotiations with Ukrainian President Volodymyr Zelenskyy's representatives to try to reach a peace agreement. It would be "useful" to hold discussions with the US too, "but we don't observe any interest on their part regarding contacts on Ukraine or on other issues," said Lavrov. Both sides have said the talks are at a dead end. Lavrov has previously warned of the risks of a nuclear confrontation too, even as he has repeatedly declared that Russia's "principled" position is the "inadmissibility of nuclear war."

He isn't responsible for military decision-making in Russia and hasn't explained how he believes a nuclear conflict would begin. His recent remarks came after US defense secretary LLoyd Austin said in Kyiv that Washington wants to see Russian forces "weakened to the degree that it can't do the kinds of things that it has done in invading Ukraine." ...

Source: https://www. livemint.com/, 26 April 2022.

Russia Warns of Nuclear, Hypersonic Deployment if Sweden and Finland Join NATO

One of Russian President Putin's closest allies warned NATO that if Sweden and Finland joined the U.S.-led military alliance then Russia would deploy nuclear weapons and hypersonic missiles in a European exclave. Finland, which shares a 1,300-km (810-mile) border with Russia, and Sweden are considering joining the NATO alliance. Finland will decide in the next few weeks, PM Sanna Marin said.

Dmitry Medvedev, deputy chairman of Russia's Security Council, said that should Sweden and Finland join NATO then Russia would have to strengthen its land, naval and air forces in the Baltic Sea. Medvedev also explicitly raised the nuclear threat by saying that there could be no more talk of a "nuclear free" Baltic - where Russia has its Kaliningrad exclave sandwiched between Poland and Lithuania. "There can be no more talk of any nuclear–free status for the Baltic - the balance must be restored," said Medvedev, who was Russian president from 2008 to 2012. Medvedev said he hoped Finland and Sweden would see sense. If not, he said, they would have to live with nuclear weapons and hypersonic missiles close to home.

When asked how Washington views the potential addition of Sweden and Finland to NATO in light of Russia's warning, the U.S. State Department said there was no change in Washington's position and repeated that "NATO's open door is an open door." "Without speaking to any countries in particular, we would not be concerned that the expansion of a defensive alliance would do anything other than promote stability on the European continent," Department spokesperson Ned Price said in a briefing.

Russia has the world's biggest arsenal of nuclear warheads and along with China and the U.S. is

one of the global leaders in hypersonic missile technology. Lithuania said Russia's threats were nothing new and that Moscow had deployed nuclear weapons to Kaliningrad long before the war in Ukraine. NATO did not immediately respond to Russia's warning. Still, the possible accession of Finland and Sweden into NATO...would be one of the biggest strategic consequences of the war in Ukraine. Finland gained independence from Russia in 1917 and fought two wars against it during World War Two during which it lost some territory. Finland announced a military exercise in western Finland with the participation of Britain, the U.S., Latvia and Estonia. Sweden has not fought a war for 200 years. Foreign policy has focused on supporting democracy and nuclear disarmament.

Lithuania said Russia's threats were nothing new and that Moscow had deployed nuclear weapons to Kaliningrad long before the war in Ukraine. NATO did not immediately respond to Russia's warning. Still, the possible accession of Finland and Sweden into NATO...would be one of the biggest strategic consequences of the war in Ukraine.

Kaliningrad, formerly the port of Koenigsberg, capital of East Prussia, lies less than 1,400 km from London and Paris and 500 km from Berlin. Russia said in 2018 it had deployed Iskander missiles to Kaliningrad, which was captured by the Red Army in April 1945 and ceded to the Soviet Union at the Potsdam conference. The Iskander, known as SS-26 Stone by NATO, is a short-range tactical ballistic missile system that can carry nuclear warheads. Its official range is 500 km but some Western military sources suspect it may be much greater.

...While Putin is Russia's paramount leader, Medvedev's comments reflect Kremlin thinking and he is a senior member of the security council - one of Putin's main chambers for decision making on strategic issues. Lithuanian Defence Minister Arvydas Anusauskas said Russia had deployed nuclear weapons in Kaliningrad even before the war. ...

Source: https://www.reuters.com/world/europe/russia-warns-baltic-nuclear-deployment-if-nato-admits-sweden-finland-2022-04-14/, 15 April 2022.

USA

U.S. Conducted Subcritical Nuclear Tests in 1st under Biden Govt.

The U.S. conducted two rounds of subcritical nuclear tests last year, the first such tests under the administration of President Biden, according to the National Nuclear Security Administration. An NNSA spokesperson recently told *Kyodo News* the experiments were conducted on June 22 and Sept. 16, both in Nevada, adding data derived from the testing aims to ensure the reliability of nuclear stockpiles without returning to nuclear testing.

Subcritical nuclear experiments are deemed indispensable to a U.S. plan to modernize its nuclear warheads on intercontinental ballistic missiles and the development of a new type of cruise missile known as long-range standoff weapons.

Subcritical nuclear experiments are deemed indispensable to a U.S. plan to modernize its nuclear warheads on intercontinental ballistic missiles and the development of a new type of cruise missile known as long-range standoff weapons. The last time such tests, which do not involve a chain reaction leading to a nuclear explosion, were conducted twice in one year was in 2010 under the administration of President Obama.

The U.S. suspended underground nuclear tests in 1992 and began subcritical nuclear tests five years later. It argues that subcritical tests are not prohibited under the Comprehensive Nuclear Test Ban Treaty as they do not create a nuclear explosion. The NNSA, an arm of the U.S. Energy Department, has said that subcritical nuclear tests are required to sustain the safety and reliability of the U.S. nuclear stockpile. The tests came as nuclear disarmament talks remain stalled amid U.S. rivalries with other key nuclear-armed states,

China and Russia. Increasingly alarmed over the buildup of capabilities by nuclear powers, countries promoting disarmament are keen to make strides in June when the first meeting of parties to a U.N. treaty banning nuclear weapons is held in Vienna.

In recent years, the U.S. has begun developing W93, a new type of warhead intended for deployment by U.S. ballistic missile submarines by 2040. ...Three rounds of subcritical nuclear tests were conducted under the Trump government and four rounds under the Obama administration.

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Last year's subcritical nuclear tests in June and September were part of three successive tests, with the first one conducted under the Trump administration in November 2020. The long-range standoff weapon, or LRSO, that Washington is developing is a cruise missile that can be launched from an aircraft outside an enemy's firing range. According to the NNSA, the development of the W80-4 warhead for use on the LRSO missile and the W87-1 warhead for ICBMs is expected to be completed in 2024 or later.

Military bunkers in the UK are being upgraded so they can be used to store US nuclear weapons again after 14 years of standing empty, according to US defence budget documents. In the Biden administration's 2023 defence budget request, the UK was added to the list of countries where infrastructure investment is under way at "special weapons" storage sites, alongside Belgium, Germany, Italy, the Netherlands and Turkey – all countries where the US stores an estimated 100 B61 nuclear bombs.

Source: https://mainichi.jp/english/articles/20220412/p2g/00m/0in/064000c, 12 April 2022.

USA–UK

UK Military Vaults Upgraded to Store New US Nuclear Weapons

Military bunkers in the UK are being upgraded so they can be used to store US nuclear weapons again after 14 years of standing empty, according to US defence budget documents. In the Biden administration's 2023 defence budget request, the UK was added to the list of countries where infrastructure investment is under way at "special weapons" storage sites, alongside Belgium, Germany, Italy, the Netherlands and Turkey – all countries where the US stores an estimated 100 B61 nuclear bombs.

Hans Kristensen, the director of the nuclear information project at the Federation of American Scientists (FAS), who first reported on the budget item, said he believed the British site being upgraded is the US airbase at RAF Lakenheath, 100 km north-east of London. The US withdrew its B61 munitions from Lakenheath in 2008, marking the end of more than half a century of maintaining a US nuclear stockpile in the UK. At the time of the withdrawal, the gravity bombs were widely seen as militarily obsolete and hopes were higher for further disarmament by the nuclear weapons powers.

That optimism has since been dashed, against the backdrop of Vladimir Putin's invasion of Ukraine, his regime's nuclear threats against NATO, and extensive nuclear weapon modernisation programmes pursued by both the US and Russia. As part of the US plan, the B61 has been given a new lease of life with a guidance system, the B61-12 variant, due to go into full production in May. The 2023 budget request says that NATO "is wrapping up a 13-year, $384m infrastructure investment program at storage sites in Belgium, Germany, Italy, the Netherlands, the UK, and Turkey to upgrade security measures, communication systems, and facilities". In the 1990s, RAF Lakenheath had 33 underground storage vaults, where 110 B61 bombs were stored, according to the FAS. Since their withdrawal the vaults have been mothballed. Kristensen said he believes the vaults are now being upgraded so

the new B61-12 bombs can be stored there, if needed.

The Biden administration has been careful not to make any moves that might be seen as escalatory in the nuclear arena in response to Putin's announcement he would put Russia's nuclear forces on higher alert a few days after his invasion of Ukraine. The US has cancelled scheduled tests of its intercontinental ballistic missiles, for example. For the same reason, Kristensen said he doubted the Biden administration is planning to increase the US nuclear stockpile in Europe. When the new B61-12 bombs are delivered, expected next year, they will replace older models already there. Instead, he thought the Lakenheath upgrade is intended to provided more flexibility to move the nuclear weapons around Europe. ...

Britain has become keen to take a more assertive role when it comes to its own nuclear deterrent, and last year announced it would increase its own stockpile of Trident nuclear warheads by 40% to 260, the first such increase since the end of the cold war. Whitehall sources say the UK has "a clearer appreciation" of its role as a nuclear weapons state in a renewed era of state competition with Russia and China. The UK MoD did not comment on the upgrade mentioned in the US budget. One British official said: "We won't provide anything on this as it relates to the storage of nuclear weapons." But the news comes just four months after the arrival in Lakenheath of the first of a new generation of nuclear-capable US combat aircraft, the F-35A Lightning II, the first such deployment in Europe.

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...The developments in Europe are part of a broader retreat from arms control. The Biden administration's nuclear posture review, which has been sent to Congress but not yet declassified, is reported not to contain the changes the president pledged during his campaign. In 2020, he said he would formally declare the sole purpose of nuclear weapons to be deterrence of a nuclear attack against the U.S. or its allies. But the review leaves open the option of using nuclear arms to respond to non-nuclear threats as well. ...

Source: https://www. theguardian.com/world/2022/apr/12/uk-military-vaults-upgraded-to-store-new-us-nuclear-weapons, 12 April 2022.

BALLISTIC MISSILE DEFENCE

USA

Lockheed Martin has secured a $74m contract to produce the THAAD weapon system for the US Missile Defense Agency (MDA). The system is expected to be deployed by 2025. Lockheed Martin Missiles and Fire Control, Upper Tier Integrated Air and Missile Defense vice-president Dan Nimblett said: "This award demonstrates the US government's continued confidence in the THAAD weapon system and in its unique endo- and exo-atmospheric defence capability. "With 16 of 16 successful flight test intercepts, and recent combat success clearly documenting the effectiveness of THAAD, adding an eighth battery will further enhance readiness against existing and evolving ballistic missile threats."

With 16 of 16 successful flight test intercepts, and recent combat success clearly documenting the effectiveness of THAAD, adding an eighth battery will further enhance readiness against existing and evolving ballistic missile threats.

The THAAD element is a transportable and rapidly deployable defensive weapon system that can be used to intercept short, medium, and intermediate-range ballistic missiles. The system leverages Hit-to-Kill technology to destroy the threat on direct impact, before it hits the on-ground assets. It can also target aerial threats outside the atmosphere. ... To date, the US Army received seven THAAD batteries, the last of which was activated in

December 2016. The latest contract will deliver the eighth THAAD battery to the US. Lockheed Martin recently reported its earnings in the first quarter of 2022. The company recorded sales of $15bn in the quarter, down 8% compared to same period last year. It expects to generate net sales of approximately $66bn this year.

Source: https://www.army-technology.com/news/lockheed-martin-thaad-system-mda/, 22 April 2022.

NUCLEAR ENERGY

CHINA

China's Nuclear Power Plant Marks its 20 Years

Qinshan nuclear power plant phase II, China's first large-scale commercial nuclear power plant, has been in operation for 20 years since its launch in 2002, said its operator China National Nuclear Corp. Located in East China's Zhejiang province, Qinshan Phase II has generated more than 304.5 billion kilowatt hours of electricity since it went into commercial operation. Currently, four units are under operation with a total installed capacity of 2.64 million kilowatts and an annual power generation capacity of 21 billion kilowatt hours, said CNNC. Through the operation and construction of Qinshan Phase II, China has accumulated massive experiences regarding nuclear scientific research, construction, equipment manufacturing, commissioning, operation and project management, it said.

Source: https://global.chinadaily.com.cn/a/202204 /15/WS62593897a310fd 2b29e 57483.html, 15 April 2022.

China Approves Construction of Six New Reactors

The construction of two new reactors at each of the Sanmen, Haiyang and Lufeng nuclear power plant sites in China has been approved by the country's State Council. The approvals are for Sanmen units 3 and 4, Haiyang 3 and 4 and units 5 and 6 of the Lufeng plant. At a 20 April executive meeting of the State Council - presided over by Premier Li Keqiang - it was noted that energy is needed to support economic and social development.

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"Based on China's national conditions, it is necessary to respond to new challenges in the external environment, seize key points, strengthen energy supply, and take precautions to promote the construction of energy projects with mature conditions and development needs, and promote the continuous optimisation of the energy structure," the state-run *Xinhua News Agency* reported. ... The State Council said nuclear power "should be developed in an orderly manner under the premise of strict supervision and absolute safety." "After years of preparation and comprehensive evaluation and review, the three new nuclear power unit projects at Sanmen in Zhejiang province, Haiyang in Shandong province and Lufeng in Guangdong province, which have been included in the national plan, were approved," *Xinhua* reported.

The Sanmen and Haiyang plants are already home to two AP1000 units each, and two CAP1000 units - the Chinese version of the AP1000 -have now been approved for Phase II (units 3 and 4) of each plant. The proposed construction of four CAP1000 reactors (units 1-4) at the new Lufeng site has already been approved by the National Development and Reform Commission (NDRC), but has yet to receive State Council approval. However, the State Council has now approved the construction of units 5 and 6 of the Lufeng plant, which China General Nuclear in a 21 April statement to the Shenzhen Stock Exchange confirmed would be Hualong One reactors.

Last month, the NDRC released its *Modern Energy System 14th Five-Year Plan*, which set the goal for the country's share of non-fossil energy consumption to increase to about 20% by 2025

and the proportion of non-fossil power generation to be around 39% by then. Under the plan, the government proposes "the steady construction of coastal nuclear power projects with an emphasis on safety". Installed nuclear generating capacity will reach 70 GWe by 2025, it said.

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Source: https://www.world-nuclear-news.org/Articles/China-approves-construction- of-six-new-reactors, 21 April 2022.

GENERAL

Should Middle East Climate Change be Tackled with Nuclear Energy?

A renewed interest in nuclear power is under way. With the climate crisis already pressuring countries to depend less on fossil fuels, Russia's invasion of Ukraine has now created another reason for governments to speed up their search for alternative energy sources. The IPCC recently issued its latest report warning the planet is left with a small window to prevent the worst effects of climate change, and nations need to decarbonise immediately. European countries such as France, the UK, Belgium and Finland are ramping up their nuclear ambitions to fight climate change and deal with the energy security issues resulting from the backlash towards the conflict in Ukraine. Even Germany, a country that has all but retired the use of its nuclear plants, contemplated extending the lifetime of its existing facilities before deciding to stick to the original plan of shutting them down.

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What's drawing these governments towards nuclear power is that unlike fossil fuels, it doesn't release carbon dioxide into the atmosphere and once the technology is up and running, it can pretty much guarantee a steady stream of energy for long periods of time. Questions around nuclear power's high cost and safety are factors that are preventing countries such as Germany from taking the same path as its peers.

The nuclear industry in the Gulf region is expanding, with the IAEA currently helping some countries develop their nuclear programmes. The kingdom of Saudi Arabia is one of them. As it stands, there are only two active nuclear power facilities in the region: the Bushehr nuclear power plant in Iran, and the Barakah nuclear power plant in the UAE. Bushehr has one operational reactor and another one under construction, and Barakah has two operational reactors with two more on the way.

Nuclear energy development in the Middle East is still in its early stages, but the number of plants is expected to increase given Saudi Arabia's plans to take forward its own capabilities. Data from the International Energy Agency (IEA) shows that countries around the Gulf have an energy mix that is 90 percent comprised of hydrocarbons that release huge amounts of carbon dioxide and methane into the atmosphere. In contrast, nuclear power is a zero-emission supply of energy that is made through fission, the process of splitting uranium atoms that generate heat to produce steam, which is then used by an electricity-making turbine.

Iran, the UAE, and Saudi Arabia rank high on the global greenhouse gas emissions list and their interest in nuclear power could be justified given their urgent need for decarbonisation, but the risks may indeed outweigh the benefits if

something were to go wrong with any of the facilities.

Source: https://www.aljazeera.com/news/2022/4/12/should-middle-east-climate-change-be-tackled-with-nuclear-energy, 12 April 2022.

INDIA

India's Activities in Nuclear Fusion

In January 2020 India's first Tokamak, the Aditya, completed 30 years of safe operation. Those thirty years saw India making steady if limited investments in nuclear fusion research. Apart from creating some tokamak 'assets' such as the Aditya and the Steady-State Superconducting Tokamak (SST-1), India's fusion-related activities have been heavily focused on domestic sub-systems development, given the country's history of being subject to abrupt technology denials. Domestic efforts in sub-systems development and basic research related to advanced tokamaks since the 1980s have positioned India to be a major partner in the ITER project, which is expected to yield the world's largest tokamak-based reactor.

India's DAE, which believes that fusion power is an important component of the country's long-term energy security, aims to fund a few demonstrators of its own with a view to commence building two 1000MWe grid-connected fusion reactors by 2050.

India's DAE, which believes that fusion power is an important component of the country's long-term energy security, aims to fund a few demonstrators of its own with a view to commence building two 1000MWe grid-connected fusion reactors by 2050. The key DAE-supported organisation leading fusion research in India is the Institute of Plasma Research (IPR). with its main campus in Gandhinagar.

India's indigenously developed tokamaks are all sited on the main IPR campus. (A unit imported from Japan is at the Variable Energy Cyclotron Center, Kolkata.) IPR's leading light was the late Predhiman K Kaw, who drove this fledgling organisation to leapfrog directly to contemporary tokamak technology, instead of pursuing what turned out to be less-promising approaches to confining a hot and dense plasma (which is at the core of fusion) in the conditions necessary for thermonuclear fusion to take place. Under Kaw's leadership, IPR, which had initially started off as a small effort under India's Department of Science & Technology, managed to become a full-blown institute. It commissioned India's first tokamak called the Aditya in 1989. Aditya's first 'shot' was conducted in the same year.

Aditya and SST-1: Aditya was set up as a tokamak with copper coils with a major radius of 0.75m and minor radius of 0.25m. It was designed to generate a circular plasma and operate with a toroidal field of 0.75-1 tesla (T), a maximum plasma current of 250kA and a pulse duration of up to 250 milliseconds. Its heating and current drive is provided by a combination of ion cyclotron resonance heating (ICRH), electron cyclotron resonance heating (ECRH) and lower hybrid current drive (LHCD). Besides becoming a mothership for developing the relevant human resources within the country, Aditya has also yielded rich scientific dividends for IPR. Some very important results on turbulent processes in tokamaks, which are of considerable interest to the global tokamak effort have been obtained through its use.

Aditya was the first to establish that transport plasma was not a steady ooze but was instead 'bursty'. Experiments conducted using Aditya have also yielded important ways and means to mitigate plasma instability issues such as magnetohydrodynamics-generated disruptions and runaways. As an aside, disruptions lead to the rapid loss of the plasma's stored thermal and magnetic energy, which in turn necessitates the introduction of mitigation systems that shield plasma-facing components (PFCs) from the heat flux and forces thus created. A disruption can also lead to generation of very high energy electrons or 'runaways', which in turn can cause the first wall (i.e. PFCs) of the tokamak to melt, followed by leaks in water cooling circuits.

To ensure that Aditya kept 'giving', it was decided to upgrade it to a divertor configuration with a view to carrying out experiments with shaped plasmas relevant to contemporary tokamak designs. The philosophy behind this move was that small and medium-sized tokamaks are a convenient tool for testing new concepts, technologies and materials, which cannot be conducted on larger machines without preliminary studies, given the risks involved. However, there are actually very few small and medium-sized tokamaks operational that have the advanced features required for providing experimental support relevant to large, advanced tokamaks. So, Aditya-U (literally Aditya-Upgrade) was born, whose assembly from the disassembled Aditya was completed by December 2016 with operations beginning in January 2017.

IPR's larger tokamak, SST-1, was equipped with a divertor configuration right from its inception – designed, as it was, to explore the interaction between the plasma and the first wall of the tokamak in steady-state discharges.

In comparison to its old form, Aditya-U has a circular X-section vacuum vessel and buckling cylinder, safety and poloidal ring limiter, toroidal belt limiter, besides three sets of divertor coils. The modification to divertor configuration was achieved by replacing the square cross-section vacuum vessel with the circular X-section type, creating space for the divertor coils. It has been designed to reach high temperatures (45keV or about half a billion degrees) and demonstrate good power exhaust efficiency. Aditya-U has already delivered a result that is significant for ITER. An electro-magnetic pellet injection system that fires Li2TiO3 pellets has been successfully demonstrated as a viable method for disruption control. Significant suppression of runaway electrons has also been demonstrated in Aditya-U, through the use of periodic gas puffs that suppress edge density and potential fluctuations in the plasma.

IPR's larger tokamak, SST-1, was equipped with a divertor configuration right from its inception – designed, as it was, to explore the interaction between the plasma and the first wall of the tokamak in steady-state discharges. SST-1 has a major radius of 1.1m and a minor radius of 0.2m, elongation of 1.7 and triangularity of 0.4–0.7, toroidal field of 3T and a plasma current of 220kA. Auxiliary heating and current drive is carried out using a LHCD mechanism while primary heating is done by ICRH and neutral beam injection (NBI). SST-1 of course has superconducting magnetic coils instead of the copper ones seen on Aditya-U, a steady-state current drive and heat and particle exhaust, all of which facilitate a long pulse operation. SST-1 was given a short-term upgrade, beginning in October 2019, which included installation of a pair of PF-3 current leads — required for moderately-shaped plasmas — a radio frequency (RF) spiral antenna assembly for alternate preionization and startup experiments and various diagnostics. Whether lower hybrid absorption can be realized by modifying loop voltage, as has reportedly been observed in other tokamaks such as Japan's TRIAM is currently being explored on the SST-1. As such, long-duration plasma discharges of around 650ms have been obtained in SST-1 using both single long-pulse LHCD and multiple short-pulse LHCD.

Though SST-1 was set up with a mix of indigenous and imported systems, IPR has worked intensively since then to ensure that future systems and upgrade packages for its existing assets are executed using domestically sourced components.

Though SST-1 was set up with a mix of indigenous and imported systems, IPR has worked intensively since then to ensure that future systems and upgrade packages for its existing assets are executed using domestically sourced components. For instance, while the original conductor for SST-1 had been imported from Japan during the late 1990s, it is now available from domestic sources. As such, IPR's sub-system development effort in partnership with Indian

industry has yielded domestically sourced large-volume ultra-high vacuum (UHV) systems, copper and superconducting magnets, cryogenic systems (both liquid helium and liquid nitrogen based), large cryostats for testing at low temperatures, plasma surface-cleaning methods, high current pulsed, shaped, regulated power supplies, control, monitoring and data acquisition systems, plasma diagnostics, very high power RF heating & current drive systems and neutral beam systems for heating and current drive.

A lot of this has also been catalysed through India's participation in ITER, which saw New Delhi emphasising domestic developmental work in the areas of magnet, divertor and cryopumping systems.

In a bid to consolidate all that has been achieved via homegrown tokamaks and participation in ITER, India's fusion community is now looking forward to construction of a large tokamak based fusion reactor called SST-2, due by around 2027.

ITER-India: India's contribution to ITER, dubbed 'ITER-India' is being run as a special project under IPR. It was in December 2005 that India became the full seventh member of ITER with a 10 per cent 'in-kind' contribution share out of a total of 150 distinct procurements. India's Larsen & Toubro supplied the ITER's cryostat, which is the world's largest vacuum application stainless steel vessel. It weighs 3850 tonnes, with a height of 30m and a diameter of 30m. The cryostat was installed in 2020. ITER-India is also responsible for supplying a number of other critical components and sub-systems, such as cryolines and a cryodistribution system for ITER's cryoplants; in-wall shielding, which requires around 9000 blocks from 70,000 precision cut plates; a cooling water and heat rejection system; ICRF source system; diagnostic neutral beam system to detect He ash during the D-T phase of the ITER plasma; plasma diagnostics; power supplies for DNB, ICRF and ECRF systems; two gyrotron sources of 1MW power output at 170GHz for 3600s pulse length; X-ray crystal spectroscopy; electron cyclotron emission as well as various optical fibers, detectors, visible spectrometers and opto-mechanical components.

Participation in ITER has led to significant blanket and divertor technology development initiatives in India. In particular, identification of special materials that provide long life and low induced radioactivity in the extreme environments associated with tokamak operations has been emphasised. In fact, a Cu-Cr-Zr alloy with total impurity levels not exceeding 0.1 per cent has been developed as a back plate material for mounting PFCs used in ITER. Alongside research into blanket materials there is also a thrust toward towards developing fusion fuel cycle and tritium systems. With India now confident of being able to scale up tokamak size, field strength, heating power and pulse length, the focus is inevitably shifting towards fusion reactor design, materials and remote handling. After all, the ultimate aim is to be able to build an optimised power generating reactor that is affordable, reliable and maintainable in a cost-effective manner.

India's Plans for SST-2 and then DEMO: In a bid to consolidate all that has been achieved via homegrown tokamaks and participation in ITER, India's fusion community is now looking forward to construction of a large tokamak based fusion reactor called SST-2, due by around 2027. SST-2 is likely to be a low fusion gain reactor that will have a fusion power output of 100-300MW and may use Indian lead lithium ceramic breeder and helium-cooled ceramic breeder (HCCB) blankets for tritium breeding, besides a He-cooled divertor.

The fusion-fission hybrid approach may also be explored via SST-2, especially given India's three-stage nuclear programme, which aims ultimately to breed a large fissile inventory of U-233 from the country's Th-232 deposits. The transmutation of long-lived nuclear waste from fission reactors and the possibility of using fusion neutrons as a driver in thorium-based sub-critical fission reactors will also be investigated.

Ultimately, SST-2 alongside what is gained from ITER operations will pave the way for realising and qualifying technologies related to a D-T fusion cycle for India's own DEMO programme. For instance, IPR is planning to perform an integral test by 'covering the out-board side of SST-2 with

a breeding blanket while the in-board side is covered with a shielding blanket' in a manner similar to what will take place in a DEMO reactor. India intends to attract foreign partners for setting up a DEMO reactor beginning sometime in 2037. Seen as a power source leveraging virtually inexhaustible fuel supply (due to the ready availability of deuterium in seawater and the prospect of breeding tritium), attractive safety characteristics and muted environmental impact, fusion may yet emerge as an element of India's move towards a net-zero carbon economy by 2070.

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Source: https://www.neimagazine.com/features/featureindias-activities-in-nuclear-fusion-9640516/, 21 April 2022.

JAPAN

'Nuclear Reactor on A Truck' – Japan's Mitsubishi Aims to Commercialize 'Reactor-On-A-Truck' by 2030s

Japan's experience with the Fukushima Daiichi Nuclear Power Plant catastrophe in 2011 has haunted the country's aspirations to rapidly scale up nuclear power for non-carbon emitting energy. However, Japan is now looking to be moving ahead to leverage a new technological approach to satisfy the country's future energy needs.

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Japan's Mitsubishi Heavy Industries intends to build and commercialize nuclear reactors small enough to be transported on trucks by the end of the decade, to capitalize on the demand for non-carbon emitting energy Nikkei Asia reported. The microreactors, which will be 3 meters tall and 4 meters wide, will weigh less than 40 tons. The reactor and power generation equipment will nestle inside a container truck, making it possible to transport it to remote or disaster-stricken locations. The microreactors' maximum output will be 500 kilowatts or one-twentieth of the capacity of normal nuclear reactors that generate more than one gigawatt. According to the report, each microreactor will require tens of millions of dollars, significantly less than the $6 billion or more than a 1.2-gigawatt nuclear facility would need.

The cost of producing one kilowatt-hour will be higher than that of a conventional reactor, but it will be comparable to the cost of providing power to isolated islands now. Remote places will be able to obtain a cost-effective, carbon-free source of energy owing to these microreactors. The business has also designed it compact enough to be buried underground to reduce the possibility of a mishap. The technology may be employed in space exploration.

Once the company secures clearance from Japan and other governments, Mitsubishi will commercialize the technology in the 2030s at the earliest. Due to their proximity to inhabited regions, microreactors will need to be made safer than traditional reactors. The company has also taken this into account, designing the technology such that all of the nuclear reactor's components, including the core, coolants, and other equipment, are housed in tightly sealed capsule containers. Furthermore, highly enriched uranium will be utilized as fuel, and the reactor will not need to be replaced over its 25-year

lifespan. The microreactor can be retrieved once the fuel has been used up. The reactors can be installed underground to lessen the danger of natural catastrophes and terrorism because they will only require little maintenance.

Mitsubishi Heavy will also lessen the chances of catastrophic coolant failure. The microreactors will use a solid-state graphite material that is very thermally conductive rather than liquid coolants. During normal operation, the graphite surrounds the core and distributes heat to the power generation system. Even when an accident occurs, natural ambient cooling removes excess heat from the core.

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Small Nuclear Reactors Around the World: These miniature nuclear reactors have been touted as game-changers on several levels. They're regarded as a process to avoid the cost overruns and construction delays that beset a nuclear power sector dominated by large reactors. The microreactor is designed to generate electrical power typically up to 10 MW(e). Though the technology has yet to be commercialized, multiple designs are progressing through licensing in North America and Europe, with demonstrations scheduled in the next few years. Oklo, for example, a US-based company, submitted a license application in March 2020 to design and operate a microreactor, with the first reactor expected to start up at Idaho National Laboratory by 2025.

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The US-based companies Westinghouse (0.2-5 MWe), NuScale (1-10 MWe), and UltraSafe Nuclear (5 MWe) are all building reactors with a power output of fewer than 10 MWe, while Sweden's LeadCold (3-10 MW3) and a UK consortium lead by Urenco (4 MWe) are also developing on comparable systems. Furthermore, the US Defense Department recently announced plans to Build a Miniature Nuclear Reactor. The Defense Department will develop a 1-5 Mega Watt nuclear microreactor at Idaho National Laboratory for a three-year (minimum) test period under the new initiative. It will be "the first electricity-generating Generation IV nuclear reactor built in the U.S.," the statement said. ...

However, these emerging technologies will undoubtedly influence the future of many countries' energy requirements. Microreactors will most likely study think to be shown first in remote parts of high-income nations such as the U.S. or Canada, but if the technology gets proven, energy-poor emerging economies will be the most potential markets for development.

Source: https://eurasiantimes.com/mitsubishi-aims-to-commercialize-reactor-on-a-truck-by-2030s/, 20 April 2022.

UAE

Barakah Nuclear Plant 'Powering UAE's Net-Zero Economy'

The Barakah Nuclear Energy Plant in UAE is a great investment that is paying dividends today and will continue to do so in the coming decades, remarked Mohamed Ibrahim Al Hammadi, the Managing Director and CEO of the Emirates Nuclear Energy Corporation (ENEC), while highlighting the plant's contributions to large-scale decarbonisation with an exciting vision for the continued clean energy transition in the UAE.

Al Hammadi was speaking on the Titans of Nuclear podcast that features interviews with experts throughout the nuclear energy field, covering advanced technology, economics, policy, industry and more. According to him, ENEC had

now passed the halfway mark for full commercial operations of the Barakah plant and is the catalyst for further innovation in the clean energy transition. "We have no doubts that the biggest infrastructure project in the UAE, the Barakah Plant, will continue to be a success in providing secure, safe clean electricity for the nation," he stated. "Both Units 1 and 2 are commercially operating. By developing four identical Units, we have given ourselves a learning curve across each Unit with the development of Units 3 and 4 allowing for 50% less manpower compared to Units 1 and 2" he added. ...

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Source: https://www.zawya.com/en/business/energy/barakah-nuclear-plant-powering-uaes-net-zero-economy-nxr5b8a9, 17 April 2022.

UK

Cerberus, Assystem to Design STEP Shielding

The project concerns the extreme environment within the central column of the STEP fusion reactor, where temperatures can range from over 100 million degrees Celsius within the plasma to less than -200 degrees within just a few metres. Cerberus Nuclear and Assystem are working closely with the STEP research team at UK Atomic Energy Agency (UKAEA) - which carries out fusion energy research on behalf of the government - to develop radiation shielding and cooling strategies within the in-board shield section of the central column. The overall aim is to protect the sensitive toroidal magnets within the central column that work to contain the high-temperature plasma. Cerberus' role involves optimisation of the shielding to maximise the operational lifetime of these crucial reactor components. Using its knowledge and expertise in neutronics transport, as well as interaction cross sections, the Warrington-based company will be simulating a wide variety of arrangements to support continued development.

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The aim for the first phase of work on STEP is to produce a concept design by 2024. The next phase will include detailed engineering design, while all relevant permissions and consents to build the prototype are sought. The final phase is construction, with operations targeted to begin around 2040. The aim is to have a fully evolved design and approval to build by 2032, enabling construction to begin. In December 2020, the UK government called on local communities across the country to put forward proposals to host STEP. Communities had until the end of March 2021 to submit their nominations and were required to demonstrate that their local area has the right mix of social, commercial and technical conditions to host the new plant - such as adequate land conditions, grid connection and water supply.

In October last year, UKAEA announced that five sites – one in Scotland and four in England - have been shortlisted to host STEP. These are: Ardeer in North Ayrshire; Goole in East Riding of Yorkshire; Moorside in Cumbria; Ratcliffe-on-Soar in Nottinghamshire; and the so-called 'Severn Edge' bid from South Gloucestershire and Gloucestershire. On conclusion of its assessment, UKAEA will make a recommendation to the Secretary of State for Business, Energy and Industrial Strategy with the successful site announced around the end of 2022.

Source: https://world-nuclear-news.org/Articles/Cerberus-Assystem-to-design-STEP-shielding, 12 April 2022.

Rolls Royce Plans First UK Modular Nuclear Reactor for 2029

British engineering firm Rolls Royce plans to turn on its first small modular nuclear reactor (SMR) by 2029. Speaking to *Reuters*, Rolls Royce small modular reactors chairperson Paul Stein said that the reactor's regulatory process "has been kicked off, and will likely be complete in the middle of 20243 . Stein also said his company had started negotiating with the UK Government and others with an aim to start generation by 2029.

The UK Government recently published its Energy Security Strategy, which emphasised an expansion in the country's nuclear generation. The whitepaper outlines plans for construction of 16GW of additional nuclear capacity, tripling the country's current nuclear generation. The government previously supported Rolls Royce's SMR development with $274m (£210m). It has now asked the UK's nuclear regulator to begin the approval process for Rolls Royce's SMR design.

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Stein said Rolls Royce would now start manufacturing of SMR parts expected not to change before licensing. The company previously said that it aims to complete "up to 10 [SMRs] by 2035". Before now, Rolls Royce's only experience in the power sector came from bespoke power system engineering via subsidiary MTU Solutions. The company's SMR design would generate 470MW with an initial cost of approximately $3bn. The company expects this to fall to $2.45bn over time, with an operating cost of $68/MWh. Some within the power industry consider SMRs to be unnecessarily expensive when compared to more proven renewables. At the same time, environmentalists have criticised SMRs for their waste output and comparatively long development cycle.

Source: https://www.power-technology.com/news/uk-first-smr-rolls-royce/, 19 April 2022.

USA

US Organisation Calls for Doubling of Nuclear

"Significant development of advanced nuclear technologies is needed for the U.S. to reach mid-century climate goals," NIA Executive Director Judi Greenwald said on the release of Fission Vision, the organisation's blueprint to achieve this goal. "*Fission Vision* answers the question: What is the role advanced nuclear energy could play at a scale and at a pace to help provide safe, reliable and affordable clean energy?" Fission Vision has three objectives, Greenwald said: catalysing a robust US innovation and commercialisation ecosystem; ensuring "social licence" to operate advanced nuclear energy; and re-imagining and integrating advanced nuclear energy with other clean energy sources. "If we can achieve these objectives - and we think we can - advanced reactors will play a major role in meeting our climate and energy goals by at least doubling US nuclear energy production by 2050," she added.

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Decarbonising the US economy means reducing carbon emissions from everything - not just the electric grid, but also transport, manufacturing, home heating, "and everything that heats, cools, lights, spins a motor, pumps a gallon of water or a gallon of sewage, ventilates a classroom or runs a hospital's heart-lung machine," the report notes. Low-carbon generating technologies like wind and solar have been deployed in increasing numbers in the past

decade and will reduce emissions from fossil fuels, but these technologies alone will not suffice for an entire energy system which is a "complex web of production and consumption" that needs a dispatchable source of generation when "abundant but variable renewable energy isn't available, and when safety, economic activity, and human health and comfort demand energy."

Doubling nuclear energy production will catalyse deployment of advanced nuclear energy technologies and play a major role in transitioning the USA to 100% clean energy by 2050, the report says, with "crosscutting technical and policy leadership" from the DOE an essential first step towards realising that.

Earthshot: Doubling nuclear energy production will catalyse deployment of advanced nuclear energy technologies and play a major role in transitioning the USA to 100% clean energy by 2050, the report says, with "crosscutting technical and policy leadership" from the DOE an essential first step towards realising that. "Creation of a new Advanced Nuclear Energy Earthshot at the Department of Energy, based on the DOE Earthshot initiative model pioneered for other technologies, could rapidly accelerate US development and deployment of advanced nuclear energy technologies," it adds.

The DOE's Energy Earthshots Initiative was launched in June 2021 to accelerate breakthroughs of more abundant, affordable, and reliable clean energy solutions within the decade, with the first - Hydrogen Shot - seeking to reduce the cost of clean hydrogen by 80% to USD1 per kg in one decade. Long Duration Storage Shot - which aims to achieve affordable grid storage for clean power - was launched in July, and Carbon Negative Shot - focusing on innovative technologies to remove CO2 from the atmosphere and store it at meaningful scales - in November. In total, 6 to 8 Energy Earthshots are planned.

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The DOE's Earthshots model should be used to organise an integrated, cross-cutting approach to achieve dramatic reductions in nuclear project costs and timelines this decade, *Fission Vision* says: "An Advanced Nuclear Energy Earthshot would integrate DOE activities across multiple dimensions. It would integrate DOE Office of Nuclear Energy's more traditional R&D efforts with demonstrations in the new Office of Clean Energy Demonstration, innovative financing through the Loan Programs Office, and commercialisation and testing capabilities of the national laboratories. It would integrate innovation efforts from the front end through the back end of the fuel cycle. It would integrate advanced reactor innovation with supply chain innovation. It would also integrate DOE's efforts with the broader innovation and commercialisation ecosystem that includes a wide array of private companies. This will likely require DOE to develop new skills, new contracting and financing mechanisms and new partnerships, as well as better utilise existing ones. "Through an Advanced Nuclear Energy Earthshot, DOE would help create the conditions for success for *Fission Vision*."

Source: https://www.world-nuclear-news.org/Articles/US-organisation-calls-for-doubling-of-nuclear, 14 April 2022.

DOE Seeks Applications, Bids for $6 Billion Civil Nuclear Credit Program

The U.S. Department of Energy (DOE) announced plans to seek applications and sealed bid submissions under the $6 billion Civil Nuclear Credit Program (CNC) to support the continued operation of U.S. nuclear reactors — the nation's largest source of clean energy. The guidance published directs owners or operators of nuclear power reactors that are expected to shut down due to economic circumstances on how to apply for funding to avoid premature closure. This includes instructions on

formulating and submitting sealed bids for allocation of credits. This critical investment, made possible by President Biden's Bipartisan Infrastructure Law, will help avoid premature retirements of reactors across the country due to financial hardship, preserve thousands of good-paying clean energy jobs to sustain local economies and protect our supply of carbon-free electricity generation./

"U.S. nuclear power plants contribute more than half of our carbon-free electricity, and President Biden is committed to keeping these plants active to reach our clean energy goals," said U.S. Secretary of Energy Jennifer M. Granholm. "We're using every tool available to get this country powered by clean energy by 2035, and that includes prioritizing our existing nuclear fleet to allow for continued emissions-free electricity generation and economic stability for the communities leading this important work." /

The Biden-Harris Administration has identified the nation's current fleet of reactors as a vital resource to achieve net-zero emissions economy-wide by 2050 — a key deadline for reducing the harmful impacts of climate change. Shifting energy markets and other economic factors have resulted in the early closure of 12 commercial reactors across the U.S. since 2013. This has led to a rise in emissions in those regions, poorer air quality, the loss of thousands of high-paying jobs, essential employers and financial contributors to local communities.

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As urged by many public commenters during the Request for Information (RFI) period earlier this year, the first CNC award cycle will prioritize reactors that have already announced their intention to cease operations. Future CNC award cycles — including for the second to be launched in the first quarter in FY2023 — will not be limited to nuclear reactors that have publicly announced their intentions to retire./ For the first CNC award period, DOE is accepting certification applications and bid as a single submission to implement the program on a more rapid timeline.

Source: https://www.energy.gov/articles/doe-seeks-applications-bids-6-billion-civil-nuclear-credit-program?utm_campaign=&utm_content= 1 650459361&utm_date=2 0220420&utm _medium=ENERGY&utm_source=twitter, 19 April 2022.

NUCLEAR COOPERATION

SOUTH KOREA–POLAND

The KHNP delegation was led by CEO Jeong Jae-hoon with support from head of business development Yoosik Nam. Their offer provided for "the construction of six APR1400 reactors with a total capacity of 8.4 GW, the first of which could start operating in accordance with the schedule adopted in the Polish Nuclear Power Programme, i.e. in 2033," said the Polish Ministry for Climate and Energy.

Jeong carried a letter from the Korean Minister of Trade, Industry and Energy, Moon Seung-wook, which "conveyed the full support of the Korean government" for the offer. They were received by Polish Deputy Minister for Climate and Environment Adam Guibourgé-Czetwertyński and the country's Plenipotentiary for Strategic Energy Infrastructure, Piotr Naimski.

The Polish government noted that three nuclear vendors had expressed interest in the country's

programme: USA-based Westinghouse, France's EDF and KHNP of South Korea. As well as the Korean offer just received, it already has an offer from EDF based on the EPR2 reactor design and Westinghouse has until September this year to submit its offer, which will be based on the AP1000.

Poland's nuclear programme foresees six reactors of between 1 GWe and 1.5 GWe with the first starting up in 2033 and subsequent ones coming every two years. They would replace the coal-fired power stations that provide as much as 73% of electricity. The first large power plant will be in the north on Poland's Baltic coast and an environmental impact assessment for that was submitted to regulators at the end of March.

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The APR-1400 is an evolutionary pressurised water reactor with its origins in the CE System 80+ model. Principally designed by Korea Engineering Company, it produces 1400 MWe and has a 60-year design life. It supersedes the standardised 995 MWe OPR-1000 design, of which South Korea built 12. ...

Source: https://www.world-nuclear-news.org/Articles/Korea-offers-six-reactors-to-Poland, 25 April 2022.

NUCLEAR DISARMAMENT

GENERAL

War in Ukraine Set Back Clock on Nuclear Disarmament

Experts are raising alarm that Russia's invasion of Ukraine is hindering efforts for global nuclear disarmament and warning that the world is headed down the wrong path on curtailing arms buildup. In a new report on the state of nuclear security around the world, an expert said Russia's threat to use nuclear weapons this year has intensified calls for maintaining and strengthening nuclear deterrence, and given a new sense of urgency to those seeking swift abolition of nuclear weapons. "(The threat) made it much harder to achieve nuclear disarmament and nonproliferation," stated Hiroshima Report 2022.

The Hiroshima prefectural government and other organizations on April 14 released the annual report, in which foreign and domestic experts grade each country's efforts over the past year toward abolishing nuclear weapons. Since the Ukraine conflict began in February this year, it was not included in the main report, but a supplementary report delved into how the war is affecting the push for disarmament.

Hirofumi Tosaki, the director of the Center for Disarmament, Science and Technology of the Japan Institute of International Affairs and chief researcher of the Hiroshima Report, wrote a column in the separate report on Ukraine discussing the crisis. He warned that Russia's invasion of Ukraine and its threat to use nuclear weapons that was meant to intimidate the world could now spur states that do not possess nuclear arms into seriously considering acquiring nuclear weapons.

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He said politicians from Japan, South Korea and Poland are now calling for "nuclear sharing" agreements, in which they would ask the U.S. to deploy nuclear weapons in their countries and jointly operate them. The relationship between the U.S. and Russia, which both own more than 90 percent of the nuclear weapons around the world, has deteriorated significantly, he said. That has "made it difficult for them to make progress toward managing nuclear disarmament for the

time being," Tosaki said in his report. The main report stated that "nuclear-armed nations are relying more on nuclear deterrence." Britain received a much lower score in this latest report because it had announced that it would raise the maximum number of nuclear warheads it can stockpile. China also obtained lower points because it is believed to be developing a new delivery system where nuclear warheads can be mounted.

Japan hopes to stipulate in a joint bilateral statement that it will cooperate with the U.S. on the issue of nuclear disarmament. PM Fumio Kishida hails from Hiroshima and has made it his life's work to realize a nuclear arms-free world.

Source: https://www.asahi.com/ajw/articles/14599229, 15 April 2022.

Nuclear Disarmament, N. Korea, Ukraine on Agenda as Japan Prepares for Biden Visit

Nuclear disarmament and North Korea's abduction of Japanese nationals are likely to top the agenda as the Japanese government steps up its preparations for an anticipated visit by President Biden in late May. Japan hopes to stipulate in a joint bilateral statement that it will cooperate with the U.S. on the issue of nuclear disarmament. PM Fumio Kishida hails from Hiroshima and has made it his life's work to realize a nuclear arms-free world. Biden, too, has a strong interest in nuclear disarmament and some members of the Kishida administration have floated the idea of asking Biden to visit the atomic-bombed cities of Hiroshima and Nagasaki.

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There have been calls within the government to treat Biden as a state guest, in keeping with the welcome afforded to many previous U.S. leaders. As a state guest, Biden would receive the highest level of hospitality — the honor would also underline the strength of the Japan-U.S. alliance. State guests are invited to a welcome ceremony at the Imperial Palace and a banquet with the Emperor and Empress. However, a Quad summit — to be attended by the leaders of Japan, Australia, India and the U.S. — is planned for the day after the Japan-U.S. summit meeting, meaning the prime ministers of Australia and India will be in Japan at the same time as Biden. "It would invite criticism if the U.S. president were to receive preferential treatment," a senior Foreign Ministry official said. Attention will be focused on whether Japan, the U.S. and Australia can cooperate with India — which traditionally has had close ties with Moscow — over Russia's invasion of Ukraine. During the Japan-U.S. summit meeting, Tokyo and Washington will thus likely share their views on the best way to deal with India.

There has been no progress on the abduction issue in recent years, and abductees' families are aging: Shigeo Iizuka, who served as head of the Association of the Families of Victims Kidnapped by North Korea, died in December, age 83. Iizuka's younger sister Yaeko Taguchi was among those abducted by Pyongyang. Chief Cabinet Secretary Hirokazu Matsuno told reporters that the government is working toward realizing a meeting between Biden and the families. Tokyo is expected to reconfirm Washington's cooperation in resolving the abduction issue during the U.S. president's visit.

Source: https://www.stripes.com/theaters/asia_pacific/2022-04-16/preparations-underway-planned-biden-visit-japan-5708100.html, 16 April 2022.

EMERGING TECHNOLOGIES AND DETERRENCE

RUSSIA

Emerging Technology Horizons: Yet Another Hypersonics Wake-Up Call

Russian claims of using hypersonic missiles to strike targets in Ukraine should be a wake-up call. Though purists might argue that hypersonic weapons have been used before — any missile

exceeding Mach 5 in the atmosphere is technically hypersonic — this appears to be the first combat use of a hypersonic maneuvering missile, a weapon combining the attributes of speed, unpredictability and altitude for increased survivability.

How concerned should we really be, and will this finally solidify U.S. resolve to field its own systems? I can't help but think of a scene in Ridley Scott's 2005 movie Kingdom of Heaven. In that film a knight asks Saladin about the significance of his army capturing Jerusalem. Saladin replies quickly, "Nothing." Then adds dramatically, "Everything." So what does it mean that the Russians appear to have used hypersonic weapons in Ukraine? Nothing. And Everything.

The Russian military has made no secret of the fact that their hypersonic missiles can be used with both conventional and nuclear warheads. Russia has also bragged of their intent to deploy large numbers of different types of hypersonic weapons, with President Putin himself extolling his country's hypersonic capabilities and early adoption.

This first use should not be a surprise. The intelligence community has been warning us for many years of the threat posed by Russian and Chinese hypersonics programs. Based on this, an influential 2016 Air Force Studies Board report recommended a response to include both offensive and defensive programs, coordinated across the Defense Department. An outstanding report from the Center for Strategic and International Studies recently reached much the same conclusion. In fact, myriad studies have shown the value of hypersonics to the military in future combat, and even worse, the dire consequences of facing an adversary who is so armed. With the Russian use, those warnings carry even greater urgency.

Such a deployed capability would allow the Chinese to evade missile defenses and attack from an unexpected direction with little advanced notice; but the operational value to China is debatable, given that U.S. missile defenses are not currently designed to stop a massed attack from a peer adversary, either hypersonic or ballistic.

To be fair, it is not entirely clear why the Russians used their new weapons instead of more conventional missiles. A hypersonic attack was likely not a cost-effective option, nor did the Russian forces face the sort of air defenses that hypersonics are especially adept at penetrating. The targets that they hit do not appear to have been time-sensitive, eliminating yet another possible justification. So the answer to the question of what does it mean that the Russians used hypersonics is, well, "nothing."

Except, the Russian military has made no secret of the fact that their hypersonic missiles can be used with both conventional and nuclear warheads. Russia has also bragged of their intent to deploy large numbers of different types of hypersonic weapons, with President Putin himself extolling his country's hypersonic capabilities and early adoption. This first battlefield use was, if nothing else, a sobering message: "We have beaten you to deployment; you won't know if it's conventional or nuclear; and we have no reluctance to use it." In other words, it means "everything."

The Russians are not alone in using hypersonic weapons for strategic messaging. Reports emerged in late summer of a Chinese test of a fractional orbital bombardment vehicle, a maneuvering projectile that was launched into orbit and then brought back to Earth on a hypersonic glide path.

Such a deployed capability would allow the Chinese to evade missile defenses and attack from an unexpected direction with little advanced notice; but the operational value to China is debatable, given that U.S. missile defenses are not currently designed to stop a massed attack from a peer adversary, either hypersonic or ballistic. More significantly, this test looked very much like a first strike weapon, one that

demonstrates a desire to hit any point on the globe with minimal warning. In other words, this seems to be China messaging that they view themselves as a global power with a first-strike capability.

Nothing, and yet everything. Meanwhile back in the United States, we are still playing hypersonic catch-up, delayed by calls for ever more studies with often-flawed metrics. We are flight testing at a snail's pace — and mostly failing — while competitors develop, test and deploy operational systems at an alarming rate. Adding to our slow progress is a relentless chorus of hand-wringing naysayers. To wit, the Union of Concerned Scientists produced a report that is so incredibly confused and fundamentally flawed that its mistakes would be laughable had not the work been referenced so extensively. Similarly, a study on weapons costs that reached mistaken conclusions based on erroneous assumptions is still cited by some on both sides of the Potomac as a reason to limit hypersonic investments.

The 2022 defense budget and 2023 budget requests show leaders in the executive branch and Congress are taking hypersonics seriously and allocating significant resources. Programs are under way in the Army, Navy and Air Force as well as the Office of the Secretary of Defense, and the recently established Defense Department joint hypersonics transition office is flourishing, including a vibrant university consortium.

Even worse, we are hearing from those who should know better that key missions that would be assigned to hypersonic missiles can be done better by existing approaches. No, they can't. Or that hypersonics will be unaffordable — debatable, and clearly not when purchased in rubles or yuans. Or that our work in hypersonics is escalatory — despite adversaries developing and deploying regardless of what we do. Or that hypersonics still isn't sufficiently mature and thus not ready for deployment (see paragraph one above). Or that we can magically negotiate mutual hypersonic disarmament when even the best poker player must have some good cards to play.

The good news is that the 2022 defense budget and 2023 budget requests show leaders in the executive branch and Congress are taking hypersonics seriously and allocating significant resources. Programs are under way in the Army, Navy and Air Force as well as the Office of the Secretary of Defense, and the recently established Defense Department joint hypersonics transition office is flourishing, including a vibrant university consortium.

But we still face challenges in ground test and flight test infrastructure, and in creating an industrial supply chain to deliver hypersonics at the required scale. A coherent whole-of-department investment strategy is still elusive. All of which is to say, there is cause for cautious optimism, but we are not yet on a path to success. If the Russian use was a wake-up call — as was the Chinese test before it — one must wonder how many wake-up calls are required before we stop hitting the snooze button?

Lasers, longer-range maneuverable interceptor missiles, over-the-horizon attack systems and paradigm-changing hypersonic missiles will all fire from US Navy surface ships decades into the future. Laser-driven ballistic missile defense from surface ships is even emerging as a possibility.

Source: https://www. nationaldefensemagazine. org/articles/2022/4/20/yet-another-hypersonics-wake-up-call, 20 April 2022.

USA

New Technology may Enable Ships to Fire Hypersonic Missiles

Lasers, longer-range maneuverable interceptor missiles, over-the-horizon attack systems and paradigm-changing hypersonic missiles will all fire from US Navy surface ships decades into the future. Laser-driven ballistic missile defense from surface ships is even emerging as a possibility. These evolving attack systems, including

upgraded and proven, highly effective weapons such as Tomahawks, SM-3s, SM-6s and high-impact, drone and helicopter-killing lasers, will likely keep upgrading well into the future. However, there will likely be even larger, longer-range, and more lethal new weapons emerging in future years as well. The Navy and Missile Defense Agency are working on power-scaling of lasers and how they integrate with Aegis radar and fire control systems to perform ballistic missile defense missions. Could ship fired lasers travel all the way into space? Does not seem beyond the realm of the possible.

EJECT Launch Technology & Vertical Launch Systems: For this reason, industry and the Navy are correctly looking to supplement, build upon and enhance very effective Vertical Launch Systems on Navy surface ships. New weapons, propulsion technologies and energetics are rapidly emerging, generating a need for new innovative launcher technologies. In the near term, this means engineering ways to support a fast-arriving generation of ship-launched hypersonic weapons.

This is the fundamental premise and concept of operation informing Northrop Grumman's innovative EJECT launch technology, a system engineered to supplement VLS and support hypersonic missile as well as other emerging larger ship-fired missiles and weapons. "The bottom line is that the Navy's surface ship launcher technology is kind of at a crossroads here. The current system was designed nearly half a century ago, and while still an elegant solution, the technology is aging. And when you look at the future, large surface combatants for example, DDG(X), the Navy's next surface combatant is being designed now and will be at sea late into the century. The Navy needs a launcher that enables increased lethality and has the flexibility to address new threats," Roy Pascal, Senior Program Manager at Northrop Grumman, told Warrior in an interview.

Pascal explained Northrop Grumman's innovations to supplement VLS, which he called a very "elegant system." Building upon this, Pascal added that the technological emphasis is to build upon 'hot-launch' technology by leveraging mature eject technology. "Eject technology as you know is supported by either a compressed air system or a gas generator able to pressurize the volume beneath the missile, in its canister. This pressure then injects the missile out of the launcher [canister] at which time the missile ignites and flies away to perform a mission. In contrast to that, on surface ships, the Navy exclusively uses hot launch technology. Hot launch technology requires the missile's booster to be ignited within the launcher, such that the missile flies out under its own power," Pascal said.

Emerging threats continue to generate a need for larger and more energetic or explosive weapons, given that enemy weapons are longer-range, more precise and increasingly capable of attacking a wider envelope of threats. This is the circumstance Northrop Grumman is hoping to address and be in front of Enemy weapons, such as China's DF-21 and DF-26, may increase a need for surface ships to operate at greater distance from its target.

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to manage.

The missile releases this tremendous plume, which contains all kinds of damaging particulates, which then impacts the launcher, the ship's deck, and any electronics in the area, for example, radars; those sorts of things that can get fouled with these particles. These plumes can be 100 feet in length and are very damaging. As you strive to launch larger, more powerful missiles, that plume gets worse. So fundamentally EJECT technology addresses these shortcomings," said Pascal. The key result of this technology is that there becomes little to no constraints upon missile size or energy due to the launcher, because, as Pascal explained, the boosters are not ignited until well above the platform.

The intent with the technology is to not only present near term options for the Navy but also approach the development of EJECT with a modular, open architecture technical framework to enable evolving and consistent modernization over time.

"The plume impacts are greatly reduced, which is why Northrop Grumman believes that EJECT technology is the right technology for the future fleet. The plume impacts are greatly reduced and the plume lasts for a shorter duration of time impacting the platform. Though it is worth pointing out, we're not advocating replacement for the existing VLS system," Pascal explained. The intent with the technology is to not only present near term options for the Navy but also approach the development of EJECT with a modular, open architecture technical framework to enable evolving and consistent modernization over time. For instance, Northrop Grumman engineers are exploring the prospect of different canister or launcher shapes to, as Pascal explained, "optimize for whatever payload you are shooting." "Eject technology canisters are typically cylindrical. And while existing VLS canisters are rectangular, it doesn't have to be constrained. We've looked at trapezoidal shaped canisters, for example. The point being is that you can adapt and optimize for whatever payload you're shooting," Pascal said.

A modular approach relies upon and engineers a set of interfaces and technical standards such as common IP protocol to enable interoperability and continued maturation of the systems as new breakthroughs continue in coming years. Adaptability is the conceptual core of this approach. The operational concept behind EJECT is grounded in a firm belief that the Navy does need a different launcher to improve lethality and flexibility for Navy surface ships in the future. In a broader sense, Northrop Grumman's weapons innovations are intended to support the Navy's Distributed Maritime Operations strategy to support longer range, more lethal attack across disaggregated yet heavily networked forces.

Source: https://warriormaven.com/sea/new-technology-may-enable-ships-to-fire-hypersonic-missiles, 18 April 2022.

NUCLEAR NON-PROLIFERATION

IRAN

IAEA Continues to Monitor Nuke Activities of Iran without Camera Recordings

The Atomic Energy Organization of Iran (AEOI) said that the IAEA continues to monitor activities in Iran's nuclear sites, but it has no access to the recorded information in its cameras. "Monitoring continues, but until a (nuclear) agreement is reached, the information will remain with us and will probably be deleted," Behrooz Kamalvandi, spokesman for the AEOI.

The Atomic Energy Organization of Iran (AEOI) said that the IAEA continues to monitor activities in Iran's nuclear sites, but it has no access to the recorded information in its cameras. "Monitoring continues, but until a (nuclear) agreement is reached, the information will remain with us and will probably be deleted," Behrooz Kamalvandi, spokesman for the AEOI, was

quoted by Iran's Arabic language news network Al-Alam as saying.

Regarding the transfer of some nuclear facilities in Karaj, near the capital Tehran, to Natanz complex in central Iran, he said "unfortunately due to the terrorist operation against Karaj facilities, we had to intensify security measures and moved an important part of these machines." "Centrifuge machines have been moved to a safer location because of their importance, and they are now operating," he noted. On April 4, Iran informed the UN nuclear watchdog about its plan to transfer the producing machines of centrifuge parts from Karaj to Natanz.

The AEOI spokesman added that with the agreement reached with the IAEA, the issues regarding the past activities of Iran would be solved by June. "We do not have any technical issues at the moment, although there might be some small issues that are being solved," he said. ...

Source: https://www.business-standard.com/article/international/iaea-continues-to-monitor-nuke-activities-of-iran-without-camera-recordings-122041700024_1.html, 17 April 2022.

NUCLEAR SAFETY

SLOVENIA

Slovenia Committed to Nuclear Safety, Says IAEA

IRRS missions are designed to strengthen the effectiveness of the national nuclear and radiation safety regulatory infrastructure, based on IAEA safety standards and international good practices, while recognising the responsibility of each country to ensure nuclear and radiation safety. The IAEA team concluded an 11-day mission to assess the governmental, legal and regulatory framework for nuclear and radiation safety in Slovenia. The mission was requested by the government of Slovenia. It was hosted by the Slovenian Nuclear Safety Administration (SNSA), the country's nuclear regulatory authority, and the Slovenia Radiation Protection Authority (SRPA) which regulates radiation safety in medicine and veterinary practices. The team comprised 17 people and included experts from Brazil, Finland, France, Hungary, Ireland, Lithuania, Malta, Pakistan, Slovakia, Sweden and Switzerland, as well as three IAEA staff.

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The mission team held a series of interviews and discussions with the SNSA and SRPA, as well as with the Minister of Environment and Spatial Planning and the Minister of Health. The team also observed safety inspections at the Krško nuclear power plant, the Jožef Stefan Research Institute, the Institute of Oncology Ljubljana and the Vrbina waste management facility. The team identified good practices, including: SNSA's initiative to develop written instructions for licensees on how to participate in successful and effective remote inspections at an early stage of the pandemic; SNSA's web portal which provides on-line dose rate monitoring results and nuclide specific results from environmental samples to the public; and the establishment of a national protection strategy for nuclear and radiological emergencies, which was developed in line with IAEA emergency preparedness and response guidance.

IRRS mission team leader Cantemir Ciurea, president of Romania's nuclear safety regulator, said: "SNSA and SRPA are well experienced regulators in nuclear and radiation safety and have demonstrated their commitment to continuous improvement." Highlighting the country's emergency exercises using cyber security scenarios as one example of where the country is leading in nuclear safety, Ciurea added

that "such scenarios are at the interface between nuclear safety and security and being prepared for these emergencies demonstrates a mature framework for emergency response."

The team also identified several recommendations and suggestions on how the government and the regulators could further enhance the Slovenian regulatory system, including: providing sufficient funding and human resources for both SNSA and SRPA to fulfil their responsibilities; improving coordination between all relevant competent authorities responsible for nuclear and radiation safety and nuclear security; developing guidance for licensees on the use of authorisation request documents; improving training of inspectors to cover principles, concepts and technological aspects of safety inspections and on procedures for inspecting facilities and activities; and developing communication strategies and plans to ensure the stakeholders are informed about their work.

Military's forceful capture of Ukraine's nuclear facilities have fuelled anxieties around potential nuclear accidents and exposed the nuclear installations' vulnerability during intra-or-interstate conflicts. For the first time, the world is witnessing a situation where the IAEA is engaged in diplomatic negotiations with the occupying army to ensure the safety of Ukraine's nuclear installations.

The final IRRS mission report will be provided to the government in about three months. ... ...The IRRS mission to Slovenia will be followed by an IAEA Integrated Review Service for Radioactive Waste and Spent Fuel, Decommissioning and Remediation (Artemis) mission - scheduled for 22-30 May - which will assess radioactive waste and used fuel management, decommissioning and remediation programmes in the country. Slovenia has one nuclear power plant, Krško, which is co-owned by neighbouring Croatia and provides almost 40% of Slovenia's electricity. Slovenia also has one research reactor and a radioactive waste facility, and uses radiation in industry, research and education applications.

Source: https://world-nuclear-news.org/Articles/Slovenia-committed-to-nuclear-safety,-says-IAEA, 14 April 2022.

UKRAINE

After Ukraine, Nuclear Safety can no Longer be Left to Chance

The war in Ukraine and the Russian military's forceful capture of Ukraine's nuclear facilities have fuelled anxieties around potential nuclear accidents and exposed the nuclear installations' vulnerability during intra-or-interstate conflicts. For the first time, the world is witnessing a situation where the IAEA is engaged in diplomatic negotiations with the occupying army to ensure the safety of Ukraine's nuclear installations. Due to military occupation, the hostage-like situation at the Zaporizhzhia station has reportedly affected the plant's normal operations. Similarly, the conditions at Chernobyl, too, remain volatile even after Russian forces appear to have left the site for fear of radiation contamination. These events likely have severe downsides for public perceptions of atomic power and call for bridging the institutional gaps in global nuclear safety and security architecture.

Since the onset of the nuclear age, the nuclear industry has paid particular attention to the safe design and operation of nuclear power installations globally. Anchored in international treaties like the Convention on Nuclear Safety (CNS) and other allied instruments, the global nuclear safety regime traditionally focused on addressing technical and human faults in the nuclear industry that could compromise the safety of nuclear systems. The strong safety measures became essential after the early incidents, such as fires at the Windscale (1957) and the SL-1 reactor (1961) in the United Kingdom and the U.S., which fuelled public concerns about unforeseen events and radiation risks. In

response, the nuclear industry developed the "probabilistic" safety approach to mitigate uncertainties caused by extreme natural or technical failures. This approach also enabled the scientific community to assess the probabilities of accidents and communicate safety risks in comparative terms, thus making them appear more manageable.

However, the threat of armed conflict and targeting of nuclear facilities in the event of large-scale war needed additional legal and normative commitments. The Cold War's politics significantly impacted how states negotiated such obligations, especially the non-targeting of nuclear facilities. As early as 1956, international bodies like the International Committee of the Red Cross (ICRC) adopted draft rules to outlaw armed attacks on nuclear facilities. The ICRC's rule-based framework failed to attain universality amidst the counterforce warfare strategies that did not exclude nuclear plants as the potential targets in the events of the war. Soviet forces similarly considered attacking American nuclear installations in the event of conflict and refused adherence to nuclear security norms that started emerging in the early 1950s.

The threat of armed conflict and targeting of nuclear facilities in the event of large-scale war needed additional legal and normative commitments. The Cold War's politics significantly impacted how states negotiated such obligations, especially the non-targeting of nuclear facilities. As early as 1956, international bodies like the International Committee of the Red Cross (ICRC) adopted draft rules to outlaw armed attacks on nuclear facilities.

Subsequently, in 1977, Article 56 in Protocol I of the Geneva Conventions called out excluding installations like dams, dykes, and nuclear electrical generating stations from military attacks. Israel's airstrike that destroyed Iraq's Osirak research reactor in 1981 and missile strikes on Iran's nuclear facilities by Iraq during the Iran-Iraq War in the 1980s saw a blatant violation of these regulations. The IAEA's General Conference, too, adopted five resolutions urging member states to refrain from targeting nuclear installations during conflicts. Nevertheless, the legally binding international agreement to protect nuclear facilities in war zones remained out of reach throughout the Cold War.

The strategies of deterrence and mutual annihilation doctrines held great powers back from accepting legally-binding commitments on the non-targeting of nuclear facilities during the Cold War. Consequently, the Cold War bequeathed a highly-skewed nuclear safety regime that narrowly focused on developing technical approaches while leaving military threats to chance. The limitations of the technical methods like the probabilistic safety approach soon became evident during accidents like Chernobyl. The large-scale radioactive fallout at Chernobyl severely exposed the infirmities of the probabilistic logic and attracted widespread public scrutiny of the industry's claims about nuclear safety and security.

The IAEA's General Conference, too, adopted five resolutions urging member states to refrain from targeting nuclear installations during conflicts. Nevertheless, the legally binding international agreement to protect nuclear facilities in war zones remained out of reach throughout the Cold War.

In the post-Cold War phase, the Soviet Union's disintegration created an additional danger to the physical security of nuclear materials. The heightened threat of nuclear terrorism after the 9/11 terror attacks saw the international community designing nuclear security measures to prevent the illicit transfer of radioactive materials. In contrast, the prospect of intra-or-inter-state conflict impinging on reactor safety continues to escape international attention despite a significant increase in

regional conflicts threatening nuclear infrastructures.

The Convention on Nuclear Safety (CNS), adopted in 1994 in response to the Chernobyl disaster, also marked a lost opportunity to address the threats of armed conflicts. Post-Chernobyl, the nuclear safety efforts merited firm, legally binding commitments to enhance the compliance of nuclear-operating countries with global design, operation, and regulatory standards. As agreed under CNS in the final stages of negotiation, the voluntary nature of compliance nevertheless marked a severe loophole in nuclear safety and security architecture. In March 2011, the accident at Fukushima in Japan in March 2011 again revealed the inability of existing safety approaches to foresee all possible events, let alone control them and called for safety practitioners to work towards addressing both natural and manufactured dangers consistently.

Post-Chernobyl, the nuclear safety efforts merited firm, legally binding commitments to enhance the compliance of nuclear-operating countries with global design, operation, and regulatory standards. As agreed under CNS in the final stages of negotiation, the voluntary nature of compliance nevertheless marked a severe loophole in nuclear safety and security architecture.

Russia's armed attacks on Ukraine's Chernobyl and Zaporizhzhia plants assume significance in this broad techno-historical setting. The Russian tactic to use atomic infrastructure as a shield sets a bad precedent and erodes the sanctity of the Geneva Conventions. Furthermore, the IAEA's ongoing talks between the two warring parties raise concerns about the agency's role and future of radiation protection. The history of nuclear accidents shows that an event in one part of the world can have severe downsides for public acceptance worldwide.

The international community thus needs binding normative and legal commitments that decouple nuclear facilities from international politics, as nuclear accidents mean collateral damage that affects all parties equally. Bolstering nuclear safety commitments is also vital for nuclear plant operating countries to maintain public faith in nuclear power and its viability for fighting global climate change. Given its significant presence in the worldwide energy market, the Russian nuclear industry has strong incentives to observe the atomic safety norms. Therefore, it is only prudent that the Russian army ends its irresponsible occupation of Ukraine's nuclear facilities and observes its obligations under the Geneva conventions.

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Source: https://nationalinterest.org/feature/after-ukraine-nuclear-safety-can-no-longer-be-left-chance-201781, 16 April 2022.

Ukraine Claims Two Russian Missiles Flew Over Zaporizhzhia NPP; Fears Nuclear Threat

As the war between Kyiv and Moscow entered its day 62, the Ukrainian troops continue to show strong resistance against the Russian armed forces. In the latest development, the Energoatom National Nuclear Energy Generating Company has claimed that two Russian airborne missiles flew at low altitude over the Zaporizhzhia Nuclear Plant which is near the Zaporizhzhia metro station. Petro Kotin, the President of Energoatom, stated that the airborne missile flew at about 6:41 am and 6:46 am on April 26. The development comes as the Zaporizhzhia Nuclear Power Plant was captured by Russian armed forces on March 4.

...The nuclear power company stated that the missiles flew over Zaporizhzhia Nuclear Plant, where 7 nuclear installations were located, UKUniform reported citing the company's statement. Explosions were reported due to Russian missiles in Zaporizhzhia. Energoatom stated that the nuclear threat is becoming worse in Ukraine and stressed that Russia has been threatening the whole world with "nuclear and radiation catastrophe." According to the statement released by Energoatom on Telegram, Zaporizhzhia nuclear power station in Ukraine, which is the largest power plant in Europe has been captured by the Russian military on March 4.

The Nuclear Power Company has stated that Russian forces have caused damage to equipment and ammunition in Zaporizhzhia nuclear power plant which has resulted in the station getting turned into a military base. The Russian forces were "terrorizing" the employees at the Zaporizhzhia nuclear power plant and the people at the satellite site. It is pertinent to note here that the war between Russia and Ukraine has entered its day 62.

Deep boreholes offer scalable, modular, and economical disposal for spent nuclear fuel and high-level waste. It is particularly useful for countries with smaller waste inventories who do not want to bear the high cost of the safety case for a mined store. Deep Isolation conducted a study last year of stakeholder views across 18 countries in the Americas, Europe and the Asia-Pacific to determine perceptions about deep borehole repositories for nuclear waste disposal.

Ukrainian Forces Preparing for Defence in Zaporizhzhia: The UK Defence Ministry in its latest defence update on 26 April, stated that Ukrainian armed forces have started doing preparations for defence in Zaporizhzhia as they prepare for a "potential Russian attack from the south." Furthermore, the Defence Ministry stressed that Russian armed forces were trying to encircle the massively fortified positions of Ukrainian troops. The Russian armed forces have been making efforts to move towards Sloviansk and Kramatorsk from the north and east of Ukraine. According to the UK Defence Ministry, Kreminna city has "reportedly fallen" and heavy fighting has been reported in the South of Izium.

Source: Apoorva Kaul, https://www.republicworld.com/world-news/russia-ukraine-crisis/ukraine-claims-two-russian-missiles-flew-over-zaporizhzhia-npp-fears-nuclear-threat-articleshow.html, 26 April 2022.

NUCLEAR WASTE MANAGEMENT

GENERAL

Is it Time to Consider Deep Boreholes for Nuclear Waste Disposal?

Deep boreholes offer scalable, modular, and economical disposal for spent nuclear fuel and high-level waste. It is particularly useful for countries with smaller waste inventories who do not want to bear the high cost of the safety case for a mined store. Deep Isolation conducted a study last year of stakeholder views across 18 countries in the Americas, Europe and the Asia-Pacific to determine perceptions about deep borehole repositories for nuclear waste disposal. Those surveyed agree that the next step for learning more about this solution is an end-to-end technology demonstration. The research, was presented in full at Waste Management Symposia in March, is based on interviews and surveys with members of the regulatory, policy and waste management organisations. The majority of those surveyed said they believe boreholes potentially have a significant role to play. They cited benefits of choice and flexibility, a smaller physical footprint and cost and time savings compared to central mined repositories.

Proposed changes to the EU's green investment taxonomy require that nuclear waste and decommissioning funds must be in place and that there must be operational facilities for disposing of low and intermediate-level waste, with a plan in place for a high-level waste disposal facility to be operational by 2050. Potentially being able to deploy a borehole repository in less time than a mined repository could make this option more

attractive. Deep boreholes also could potentially be co-located with a mined repository if needed.

The Research Process: The target research group was senior-level stakeholders with specific responsibilities for geological disposal of higher activity radioactive waste disposition. They were selected from: national government policymakers; waste management organisations; nuclear and environmental regulators; international agencies that influence national policies; university researchers; and national laboratories and other research institutions focused on radioactive waste disposal. In the research, 37 people completed an online survey, of whom 10 also did in-depth interviews. Two additional subjects completed in-person interviews only.

Deep Isolation's borehole designs have potential for providing additional siting flexibility because they leverage directional drilling and geo-steering techniques to place disposal canisters in vertical, inclined, or horizontal orientations in stable rock formations.

The study was conducted by Deep Isolation and one external researcher, Professor Neil Chapman of the University of Sheffield. Chapman is an expert in the geological disposal of radioactive wastes, with four decades of experience in environmental, strategic and waste management in the international nuclear industry. ...

Benefits of Deep Boreholes for Radioactive Waste Disposal: Survey participants were asked about the key potential opportunities and benefits that they believe deep boreholes can offer; and the policy, regulatory, technical, operational and societal challenges that remain to be addressed. When it comes to benefits, 74 per cent of respondents tended to agree or strongly agree that deep boreholes have a potential role to play in ensuring the safe geological disposal of the higher activity radioactive waste.

The benefits highlighted by those surveyed included: increased choice and siting flexibility, including the reduced physical footprint compared to traditional mined repositories; the potential for cost reductions across national waste disposal programmes; potentially attractive features from the perspective of community consent; and potential for economies of scale when it comes to regulatory processes. Deep Isolation's borehole designs have potential for providing additional siting flexibility because they leverage directional drilling and geo-steering techniques to place disposal canisters in vertical, inclined, or horizontal orientations in stable rock formations.

The great majority of those interviewed said boreholes would likely be suitable or highly suitable for small waste inventories of spent fuel, for example fuel from research reactors, and for vitrified high-level waste that could be disposed of at or near a nuclear power plant. There are already examples from two recent Deep Isolation studies, one commissioned by the Norwegian Nuclear Decommissioning Authority (NND) on behalf of a number of countries belonging to the European Repository Development Organisation and another for ARAO, Slovenia's nuclear decommissioning authority.

Deep borehole disposal is "a viable and cost-effective option for disposal of ERDO's high-heat generating waste" – and that it can dispose of 100 per cent of the high-level waste and long-lived intermediate level waste that is being temporarily stored by five European countries: Croatia, Denmark, the Netherlands, Norway, and Slovenia. It estimates that a deep borehole repository would cost one-third to one-half of the cost of a traditional mined repository.

The NND study, published in December, found that deep borehole disposal is "a viable and cost-effective option for disposal of ERDO's high-heat generating waste" – and that it can dispose of 100 per cent of the high-level waste and long-lived intermediate level waste that is being temporarily stored by five European countries: Croatia, Denmark, the Netherlands, Norway, and Slovenia. It estimates that a deep borehole repository would cost one-third to one-

half of the cost of a traditional mined repository. The ARAO study found that deep borehole disposal offers a safe, cost-effective solution for spent fuel from Slovenia's TRIGA II research reactor and that the most cost-effective approach would be to build one deep borehole repository for fuel from both the TRIGA II reactor and the Krško nuclear power plant. But borehole disposal is not only an option for countries with small spent fuel and radioactive waste inventories. More than half of the respondents believe that it is likely to be suitable, at least to some extent, for managing both small and large inventories.

The benefit of increased safety at greater depth would be better received, as it would not be so susceptible to tectonic events. Most (80 per cent) stakeholders said they want to see greater international collaboration on borehole disposal, with the top priority a full-scale (non-radioactive) demonstration.

Challenges of Deep Boreholes: Survey participants were asked to evaluate 26 potential challenges that might need to be overcome. A number of them were identified as being significant, including: demonstrating and documenting in more detail the operational process and safety case; a lack of evidence about societal attitudes regarding boreholes as a disposal design; and the extent to which there is policy or regulatory clarity at an international level about the requirements needed to demonstrate a deep borehole safety case.

Eighty per cent of those surveyed agreed or strongly agreed that the technology needs to be more thoroughly demonstrated end-to-end before it can be implemented as a licensed disposal method; 76 per cent agreed that the operational and post-closure safety case for this method is less well-developed. Almost half of the respondents said they did not know whether deep borehole disposal might bring benefits in terms of increased community acceptance. Some thought boreholes might be seen more favourably, but could not be more definite because societal attitudes to different forms of geological disposal have not yet been well-researched. "The question here is about trust in science, trust in geologists," said one respondent. Another said it may be easier for a community member to understand the simpler structure of a borehole than a complex mining operation that requires workers and equipment underground. One said that the benefit of increased safety at greater depth would be better received, as it would not be so susceptible to tectonic events. Most (80 per cent) stakeholders said they want to see greater international collaboration on borehole disposal, with the top priority a full-scale (non-radioactive) demonstration.

Demonstrating Technical Readiness of Deep Borehole Technology: Aspects of the deep borehole technology have still to reach the maturity needed for industrial-scale deployment. Deep Isolation recently completed its first preliminary technology readiness level assessment. Overall, it concludes that spent nuclear fuel handling above ground is the most mature technical industry process and that demonstrating borehole stability and canister emplacement is the highest priority in terms of technology development planning. It is not known whether processes such as pre-closure monitoring, canister retrieval and borehole sealing will require additional development and demonstration, because that depends on regulatory and risk-informed engineering requirements that are still being developed.

Deep Isolation agrees with study participants that an end-to-end demonstration should be a top priority. In 2019 the company completed a successful retrievability demonstration, where a nuclear waste disposal canister (with no waste inside) was emplaced and retrieved from a pre-existing drillhole in Cameron, Texas. The company is committed to building on this by working with the international community to launch the planning process for a long-term collaborative permanent borehole demonstration. Working with industry partners and government research institutions, it hopes to assemble an independent, science-driven, non-profit task force of experts and citizens to oversee the effort — the first

public-private partnership devoted to researching how deep boreholes can be used to dispose of spent nuclear fuel and other types of high-level radioactive waste.

The goal of the project is to advance the technical readiness levels of deep borehole disposal in a progressive, cost-effective and strategic manner, accelerating the preparation for global deployment of this as a licensed disposal technology. The facility, which will not conduct any work with radioactive materials, could serve as a centre of excellence where participants map out, demonstrate and stress-test every step of the end-to-end process for handling spent fuel in Deep Isolation canisters that are transported for disposal into a deep borehole. This project would be guided by four key principles:

Vatesi granted INPP permits to start industrial operation of a radioactive waste management facility and a radioactive waste storage facility. Germany's Nukem Technologies GmbH was contracted by INPP for the design, construction and commissioning of the Solid Waste Retrieval Facility (B2) and the Solid Radioactive Waste Management and Storage Facility (B34).

1. Transparent and inclusive governance.
2. Community engagement.
3. Scientific excellence.
4. A long-term, phased and prioritised approach.

As one study participant concluded: "The next, very big challenge would be to have a site or to have a test demonstration facility to show that everything that is planned or is expected from the deep hole disposal option is viable, could be implemented, that the safety can be proven also by tests, not only with calculations."

Source: https://www.neimagazine.com/features/featureis-it-time-to-consider-deep-boreholes-for-nuclear-waste-disposal-9612136/, 11 April 2022

LITHUANIA

Lithuanian Regulator Issues Waste Management Permits

On 28 March, Vatesi granted INPP permits to start industrial operation of a radioactive waste management facility and a radioactive waste storage facility. Germany's Nukem Technologies GmbH was contracted by INPP for the design, construction and commissioning of the Solid Waste Retrieval Facility (B2) and the Solid Radioactive Waste Management and Storage Facility (B34). The project was executed on a turn-key basis. The state-of-the-art facilities - built by Nukem at a cost of about EUR200 million (USD216 million) - are for the retrieval, transport, characterisation, sorting, conditioning and storage of the short and long-lived radioactive solid waste that accumulated during the operation of Ignalina plant and waste being generated from its decommissioning. The facility has two separate storage compartments: one for the storage of 2500 cubic metres of short-lived waste and the other for 2000 cubic metres of long-lived waste. Radioactive waste can be stored in this storage facility for up to 50 years.

Vatesi also issued a permit for the transportation of waste to the very-low-level radioactive waste repository built in the Visaginas municipality and for tests to be conducted of the repository systems using radioactive waste for the first time. The permit enables INPP to verify under real conditions that all equipment and repository systems comply with the technical design and nuclear safety requirements, that proper instructions and procedures are in place and staff are trained to operate the repository safely.

Since the end of 2017, the new Solid Radioactive Waste Management and Storage Facility has been operated in hot trials, using radioactive materials retrieved from the temporary storage facilities of the INPP units, treated, packed and stored in the new storage facilities. Based on the successful completion of this hot testing programme, Vatesi has approved

the industrial operation of the facility. The facility is a key element of the decommissioning of INPP and financed through the Ignalina International Decommissioning Support Fund (IIDSF). Established in 2001 and managed by the European Bank of Reconstruction and Development (EBRD), the fund has provided more than EUR830 million to date for the implementation of key decommissioning projects and the development of Lithuania's energy sector. The IIDSF is funded by the European Community as well as by Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxemburg, the Netherlands, Poland, Spain, Sweden, the UK, Norway and Switzerland.

Very-low-level Waste Repository: On 1 April, Vatesi also issued a permit for the transportation of waste to the very-low-level radioactive waste repository built in the Visaginas municipality and for tests to be conducted of the repository systems using radioactive waste for the first time. The permit enables INPP to verify under real conditions that all equipment and repository systems comply with the technical design and nuclear safety requirements, that proper instructions and procedures are in place and staff are trained to operate the repository safely. For this purpose, INPP plans to use the waste accumulated in the radioactive waste buffer storage facility at the Ignalina plant site. It will be transported to the site of the repository and disposed of in the repository. Such actions are necessary before the industrial operation of the repository and will be carried out in accordance with the Vatesi approved repository commissioning programme.

Since the departure of the Russian forces, safety checks have been carried out on the site and facilities and International Atomic Energy Agency Director General Rafael Mariano Grossi plans to head a mission to the site before the end of the month "to conduct nuclear safety, security and radiological assessments, deliver vital equipment and repair the agency's remote safeguards monitoring systems".

The very-low-level radioactive waste repository - also being funded by the IIDSF - can hold up to 60,000 cubic metres of waste. INPP plans to place waste in the repository until 2038, when the repository will be closed. After closure, repository surveillance (radiological and environmental monitoring, physical security) will be carried out for another 30 years. The passive supervision of the repository will continue for a further 70 years. After this period, the landfill site will be able to be used without any restrictions. ...

Source: https://www.world-nuclear-news.org/Articles/Lithuanian-regulator-issues-waste-management-permi, 19 April 2022.

UKRAINE

Ukraine's Centralised Used Fuel Storage Facility 'Ready'

The CSFSF is a dry storage site for used nuclear fuel assemblies from seven VVER-1000 and two VVER-440 reactors at the Rivne, Khmennitsky and South Ukraine nuclear power plants. It is designed to have a total storage capacity of 16,530 used fuel assemblies, including 12,010 VVER-1000 assemblies and 4520 VVER-440 assemblies.

In the interview Kotin said: "In principle, nothing prevents us from completing the work started before the war and starting to accept spent fuel there. On 9 March, we were supposed to get a licence from the regulator, but it was postponed. However, I think we will get it soon." He said that the main hurdle now was the current ban on the transportation of nuclear materials through Ukraine. That ban is in place because of the on-going military conflict. The Chernobyl site and surrounding area was occupied by Russian forces on 24 February and stayed under their control until they left at the end of March. During those weeks there was also a five-day period when Chernobyl lost access to external power and had to rely on emergency generators.

Since the departure of the Russian forces, safety checks have been carried out on the site and

facilities and International Atomic Energy Agency Director General Rafael Mariano Grossi plans to head a mission to the site before the end of the month "to conduct nuclear safety, security and radiological assessments, deliver vital equipment and repair the agency's remote safeguards monitoring systems".

In his wide-ranging interview with *Energo Business,* Kotin said that power was restored to the CSFSF on 16 April and checks of the site and equipment had showed everything working normally. He said that if a permit was issued, transportation of fuel to the storage site would begin. The CSFSF is a dry storage site for used nuclear fuel assemblies from seven VVER-1000 and two VVER-440 reactors at the Rivne, Khmennitsky and South Ukraine nuclear power plants. It is designed to have a total storage capacity of 16,530 used fuel assemblies, including 12,010 VVER-1000 assemblies and 4520 VVER-440 assemblies. Contracts were signed for its construction with USA-based Holtec International in 2005, though construction only began in 2017.

It entered cold testing - where the systems and facilities are tested without using actual used fuel - in January and had expected to receive its first shipments in April. The facility is located near the Chernobyl site, about 14 km from the Belarus border and is designed to last at least 100 years.

Source: https://www.world-nuclear-news.org/Articles/Ukraine-s-centralised-spent-fuel-storage-facility, 21 April 2022.

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
Tel.: +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, Dr. Poonam Mann, Dr. Silky Kaur, Abhishek Saxena, Anubhav S. Goswami,Prachi Lokhande, Dhrub Tara Singh**

Composed by: CAPS