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OPINION – Prakash Menon

The Nuclear Cloud Hanging over the Human Race

The smoke injected into the stratosphere due to a nuclear attack would block the sunlight and result in a 'Nuclear Winter' - freezing temperatures that pose an existential threat. One study estimates that in an India-Pakistan exchange, the immediate casualties could number 125 million lives.

With the recent administrative changes in Jammu and Kashmir, Indo-Pak hyphenation has come back to haunt India's aspirations to break out of that narrow mould and be perceived as an independent player on the global stage. The clubbing of India with Pakistan is an echo of India's political and strategic confinement to the sub-continent. Pakistan has always attempted to paint the Indo-Pak situation as a nuclear flashpoint essentially to invite international intervention in what India insists is a bilateral issue.

A recent report in the *Bulletin of Atomic Scientists* by Toon et al entitled "How an India-Pakistan Nuclear War Could Start and have Global Consequences" provides grist to the mill of the nuclear flashpoint theory. But it also raises an issue that has yet not found its place in the public imagination nor has sufficient cognisance been

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taken by the political and military leadership of nuclear weapon powers – the climatic consequences of nuclear explosions.

It is well known that nuclear powers have and continue to base their targeting requirements of nuclear weapons on calculations that are restricted mostly to the major but immediate effects of nuclear explosions – blast, heat and radiation. According to General Lee Butler, the

former United States, Strategic Forces Commander, during the cold war, the Standard Integrated Operation Plan (SIOP) had targeted Moscow with 400 nuclear weapons and Kiev with 40. Several scientific studies of the impact of nuclear explosions since the 1980s up to the

present which utilises advanced computer models, confirm the effect of smoke injected into the stratosphere that would block sunlight from reaching the earth's surface and is described as 'Nuclear Winter'. In essence global temperatures would plunge below freezing point thus posing threats to life support systems especially food production. In short, it threatened human existence itself.

Later studies that focused on regional nuclear wars especially in the Indo-Pak context, have indicated that the impact of a nuclear exchange would have an immediate significant and catastrophic impact in terms of death and destruction. The latest Toon study, estimates that in a situation where around 350 warheads are used by India and Pakistan, the immediate casualties would vary between 50 to 125 million lives depending on the yields of the weapons used which could vary between 15-100 Kilotons.

Such scales and speeds of destruction for both parties would indeed be of an existential nature. Therefore, both India and Pakistan despite the rhetoric during times of tension have so far displayed caution and refrained from getting into situations where nuclear weapons are alerted. The speedy de-escalation after Balakot is indicative of a cautionary approach. Of course, this is no guarantee that the next round would not witness a different outcome. For as long as nuclear weapons exist in the arsenals of both countries, the possibility of use remains, however low the probability.

It is now well known (but widely ignored by the strategic cognoscenti) that even a regional Indo-Pak nuclear war with hundreds of low yield nuclear explosions can also pose an existential threat at

the global level. The latest study states "In the India-Pakistan scenario, we calculated a total of 16.1 TG (1 TG is equivalent of one million tons of smoke) of black carbon injected into the upper atmosphere (11 from India and 5.1 from Pakistan) for weapons with yields of 15 kilotons; 27.3 TG (19.8 from India and 7.5 from Pakistan) for 50 kiloton weapons; and 36.6 TG (27.5 from India and 9.1 from Pakistan) for 100 kiloton weapons. The smoke would be heated by sunlight and lofted high into the stratosphere, where it could remain for years, since it does not rain in the stratosphere".

The Climate Model indicates that global average temperatures and precipitation would be significantly lowered and comparisons are drawn to the ice age that prevailed thousands of years ago. Agriculture around the world would be impacted and billions of people could face starvation. In earlier studies, even 5 TG of smoke produced (which is one third of what is expected in a lower scale Indo-Pak conflict), food production would change in China and the US for specific crops causing widespread shortages at the global level. Moreover, the ozone layer would be degraded as the rising smoke absorbs the sunlight and heats up the stratosphere that would permit ultra-violet rays of greater magnitude to reach the earth causing negative effects.

The political and strategic implications of the long-term impact on climate change challenges the foundations of the edifice on which nuclear weapon strategy has been constructed. It is obvious that any deliberate initiation of nuclear war has a high probability of posing an existential threat to humanity. Even with the achievement of the complete destruction of an adversary's arsenal through a first strike, the initiator cannot itself escape the existential threat posed by long term climate change. This indicates

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that the First Use doctrine in the name of strengthening deterrence stands fully exposed for its incredibility and the utter stupidity of the use of nuclear weapons.

There are of course arguments that predicate the possibility of a nuclear war between nuclear powers being limited to an exchange of few weapons that may not result in the scale of destruction envisaged to pose a threat to humanity. They may be right but surely they could be wrong for no one knows and can know what happens after the first nuclear weapon is fired which could also be accidental. Prudence therefore is on the side of avoiding such situations.

India and China are the only nuclear powers which adhere to a No First Use policy, based on the rationale that the only role of nuclear weapons is to deter their own kind. With overwhelming evidence now available regarding nuclear explosions and climate change, it is time that India and China jointly take the lead for a Global No First Use (GNFU) Treaty and retard the dangers that stem from expanding geopolitical tensions between nuclear powers.

Source: Prakash Menon is Director, Strategic Studies Programme, Takshashila Institution, Bangalore and former Military Adviser in the National Security Council Secretariat. <https://www.telegraphindia.com>, 16 November 2019.

OPINION – Aparna Pande

Pakistan's Moderates Threatening Nuclear War over Kashmir is a Sign it's Losing the Argument

Having failed to get international support in favour of its position on Kashmir post-Narendra Modi government's Article 370 move, Pakistan's establishment seems to have opted to raise the spectre, once again, of nuclear conflict. And this time even a moderate in the Pakistani establishment, Ashraf Jehangir Qazi, is threatening nuclear war in support of Kashmir's secessionists.

The strategy is similar to the one that led to the Kargil conflict in 1999. Pakistan hopes to use conflagration involving weapons of mass destruction as a means of getting an otherwise disinterested world to pay attention to an economically weak and politically divided Pakistan.

In an article, former ambassador to India, China, and the US, Ashraf Jehangir Qazi, implied that Pakistan should retaliate against India with nukes if India does not change its stance in relation to Kashmiris under Indian rule. Qazi asserts, "Pakistan's nuclear deterrent is meant to deter war not pursue war. But if the people of the Valley are threatened with genocide, as indeed they are, Pakistan's deterrent must cover them." Nuclear

threats when issued by former or serving high ranking government officials need to be taken seriously because they often reflect widely held beliefs within that country's establishment.

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That, Ashraf Jahangir Qazi, someone who has advocated good ties with India over the years appears today to be in favour of nuclear war is worrisome. There are others with more extreme views, such as Munir Akram who was recently reappointed as Pakistan's Ambassador to the UN, who have irresponsibly brandished the nuclear sword for years. But Qazi represented the more moderate version of Pakistani ultra-nationalism, until now.

But after over seven decades of referring to Kashmir as the 'jugular vein' and 'unfinished business of Partition,' after four wars with India (including 1971 that led to the breakup of Pakistan and the creation of Bangladesh) and after being unable to convince the international community of India's alleged hegemonic ambitions, it is understandable that the Pakistani establishment views itself at a loss.

Nuclear Statements: This is not the first time that Pakistani officials have spoken of nuclear war with reference to India. Earlier this year, Prime Minister

Imran Khan, during his speech before the UN General Assembly, appealed to the global community to act on Kashmir because “if the world does nothing to stop the Indian assault on Kashmir and its people, there will be consequences for the whole world as two nuclear-armed states get ever closer to a direct military confrontation.”

This is not to deny that in recent months there has not been loose talk about nuclear weapons from the Indian side as well. In mid-August, Indian Defence Minister Rajnath Singh opened the prospect of India revising its doctrine of NFU of nuclear weapons, given the threat of battlefield nukes being deployed by Pakistan. “The future of India’s NFU policy on nuclear weapons depended on circumstances,” he asserted. Further, the deputy chief minister of India’s most populous state, Uttar Pradesh, Keshav Prasad Maurya said in October 2019 that voting in favour of the BJP will mean “dropping of a nuclear bomb on Pakistan”.

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Nuclear Competition: Most nuclear weapon powers see their weapons of mass destruction as a means of maintaining status quo and as deterrents to bad behaviour on part of their enemies. In the subcontinent, India’s nuclear programme originated not out of a regional rivalry, but from the argument that non-proliferation should be global. Either no one should have weapons of mass destruction or everyone should have the right to own them.

Pakistan’s nuclear programme, on the other hand, is about contention with India. As a revisionist power, Pakistan developed its military nuclear programme primarily to advance its claim of parity with India and to settle what it considers the ‘unfinished business’ from the 1947 Partition.

India does not need the Pakistani threat to be a nation. It is a classic status quo state and is content within the borders it has. Indian nationalism is not defied around Pakistan. Pakistan needs hostility as a part of its

nationalism. As scholar and analyst Khaled Ahmed once said, Pakistanis have a hard time defining themselves as a nation except in opposition to India through the prism of their ideology. Unlike communist and fascist states where the ideology was derived from within the nation, in the case of Pakistan, the ideology defines the nation.

For most countries, nuclear weapons are an instrument of power and in earlier decades countries even like Soviet Union/Russia have been willing to discuss certain limitations. With Pakistan, however, the issue of nuclear weapons is intertwined with the identity of the state and the perceived existential threat from India. The Pakistani state views nuclear weapons as a defining characteristic of its identity: it is the only Muslim state with declared nuclear weapons.

Ever since partition in 1947, Pakistan’s foreign and security policy has been framed around seeking parity with its larger neighbour India. The Pakistani military and intelligence establishment

that has dominated the state ever since independence, initially sought conventional military parity with India. When that became impossible by the 1960s, nuclear weapons were viewed as the panacea.

Nuclear Option: India has a declared No First Use policy as part of its nuclear doctrine. While India has not signed the global non-proliferation treaties – NPT and CTBT – it has signed a civil nuclear deal with the United States, agreed to IAEA’s supervision of its civilian nuclear reactors and signed the FMCT.

Pakistan, on the other hand, has refused to declare an NFU policy and has no declared nuclear doctrine. Senior Pakistani officials have often spoken about Pakistan’s nuclear red lines that include retaliation if “India attacked Pakistan and conquers a large part of its territory; India destroys a large section of Pakistan’s land and air forces; Imposition of a blockade to such an extent that it ‘strangles’ transportation of vital supplies and

adversely affects the 'war-waging stamina' of the country; India pushes Pakistan into political destabilisation or creates large-scale internal subversion."

However, as scholar and analyst Husain Haqqani states in his book *India v Pakistan: Why can't We Just be Friends?*: "Although Pakistanis feel great pride in their having achieved nuclear power status, nuclear weapons have neither made Pakistan more secure nor created the equivalence with India that Pakistan seeks." Now, facing massive losses, Pakistan knows the only way to ensure that the country remains relevant is by hovering its finger over the only button it has – that of nuclear war.

Source: <https://theprint.in/opinion/>, 05 December 2019.

OPINION – Rajaram Panda

Pope Francis in Japan Pleads for Abolition of Nuclear Weapons

The news that found surprisingly no mention in the Indian media was Pope Francis's visit to Japan in late November 2019 when he moved past the position of his predecessors and openly denounced nuclear weapons and questioned nuclear power, terming it as a "crime against the dignity of human beings". The Pope also travelled to the atomic-bombed cities of Hiroshima and Nagasaki and spoke to atomic bomb survivors as well as people who had experienced the 2011 earthquake, tsunami and nuclear meltdown that crippled the Fukushima Daiichi Plant in northern Japan.

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Pope drew thousands of people to his appearances in Nagasaki and Hiroshima, where he called for an end to the nuclear arms race. In denouncing any use of atomic weapons as "a crime not only against the dignity of human beings but against any possible future for our common home," he appeared to go further than his predecessors, who called for an end to stockpiling nuclear arms.

It may be recalled that the so-called triple-disaster in March 2011, the earthquake and tsunami killed 18,000 people and led to the nuclear meltdowns at Fukushima Daichi that ravaged the

northeastern Japan. After hearing from three survivors, Francis talked about the people "who lived in the affected areas" and who "now feel forgotten by others," and "must face ongoing problems: contaminated land and forests and the long-term effects of radiation." Francis further observed: "In addition to

scientific or medical concerns, there is also the immense challenge of restoring the fabric of society. Until social bonds in local communities are re-established, and people can once more enjoy safe and stable lives, the Fukushima accident will not be fully resolved". As a consequence of this, concern about the continuing use of nuclear power turned to demand for the complete abolition of nuclear power and shut down of nuclear power plant.

The last papal to visit Japan was by John Paul II 38 years ago. Francis went further than his

predecessors on the nuclear weapons issue. He wanted for the end of stockpiling of nuclear weapons. An article in *The New York Times* noted that that Francis "edged close" to denouncing the energy source altogether and warned of 'selfish decisions' on nuclear energy. Francis was concerned that Japan experienced the worst

nuclear disaster since Chernobyl but has yet to determine a viable alternative for its energy needs.

Japan has a tiny and shrinking Catholic population but the Pope drew thousands of people to his appearances in Nagasaki and Hiroshima, where

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Unfortunately, the arms race wastes precious resources which could be better used to benefit the integral development of peoples and to protect the natural environment. For the record, when the US dropped the first ever nuclear bomb in history on August 9, 1945 in the Japanese city of Hiroshima, it killed 140,000 people within minute and further 74,000 people perished when a second nuclear bomb was dropped in the city of Nagasaki three days later. Ever since, nuclear issue has emerged as a contentious issue that has engaged many nations in the world on how to check the misuse of this destructive weapon system.

In a world with serious inequalities, while the rich continue to prosper, there are millions of children and families live in inhumane conditions. Instead of the money being used to ameliorate the conditions of such deprived segment of the humanity, nations continue to squander the fortunes made through the manufacture, upgradation, maintenance and sale of ever more destructive weapons. This is truly unfortunate.

The New York Times report said that Nagasaki, a port city that first had contact with European explorers in the 1500s, is the center of Catholic life in Japan, although the observant population in the country has fallen to just over 450,000, a tiny minority in a nation of 126 million people. The vast majority of religious Japanese are either Buddhist or Shinto, with many practicing elements of both. Catholics have a history of being ostracized for their faith in Japan, and 26 Christians who were executed in the late 16th century under orders from the warlord Hideyoshi

Toyotomi are commemorated in a monument in Nagasaki.

Nagasaki is the cultural hub of Japan’s small Catholic population. When a US B-29 bomber dropped an atomic bomb in the vicinity of Urakami Cathedral of Nagasaki, then the largest cathedral in East Asia, it killed about 8,000 Catholics in the area. There Francis spoke to about 35,000 people in a baseball stadium next to the sculpture of the Virgin Mary that was found in the ruins of the Urakami church. The last pope to visit Japan, John Paul II in 1981, also visited Nagasaki and Hiroshima, where he warned of the dangers of nuclear power and said the suffering from the atomic bombings persisted. This time around, Francis also addressed the deterioration of international ties at a time when populist governments and leaders have taken to looking inward. The worrying aspect is that the world is witnessing an erosion of multilateralism, “which

is all the more serious in light of the growth of new forms of military technology”.

In Tokyo, the pope met with the newly enthroned emperor, Naruhito, and Japan’s prime minister, Shinzo Abe. Before an

audience of about 50,000 people, he said Mass at the Tokyo Dome, home of the Yomiuri Giants baseball team. He described the disconnectedness of a group of young people he had met at St. Mary’s Cathedral in Tokyo. Francis bemoaned that home, school and community, which are meant to be places where mutual support is extended to one another are “being eroded by excessive competition in the pursuit of profit and efficiency”. For the Pope, the trip to Japan, which followed a three-day visit to Thailand, was in some ways the fulfillment of a long-ago ambition. As a young Jesuit in Argentina, he had hoped to be sent on a mission to Japan, but a bout of life-threatening pneumonia thwarted the trip.

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Bishop's Conference of Japan in November 11, 2016 has called for the abolition of Nuclear power generation in Japan. Following the tsunami caused by the Great East Japan Earthquake of March 11, 2011 that resulted in a disaster at the Tokyo Electric Power Company's Fukushima Dai-Ichi nuclear power plant and eight months later, on November 8, 2011, the Catholic Bishops' Conference of Japan issued a message in Sendai, Miyagi Prefecture, addressed to all the people of Japan, entitled "Abolish Nuclear Power Plants Immediately: Facing the Tragedy of the Fukushima Dai-Ichi Nuclear Plant Disaster." Explaining its concern from a Catholic viewpoint the danger of nuclear power generation, it called for its complete abolition. Indeed Japan is subject to many severe earthquakes with the attendant danger of large-scale tsunamis, and therefore the conference concluded that the immediate cessation of all nuclear power generation in the country is imperative.

While it could look unusual for the bishops' conference of a single country to direct a statement to the entire world, what Japan experienced since the Fukushima disaster convinced the conference organizers to inform the world of the hazards of nuclear power generation and therefore appealed for its abolition.

Source: <https://www.eurasiareview.com/>, 09 December 2019.

OPINION – Daniel Oberhaus

The Next Nuclear Plants will be Small, Svelte, and Safer

For the last 20 years, the future of nuclear power has stood in a high bay laboratory tucked away on the Oregon State University campus in the western part of the state. Operated by NuScale

Power, an Oregon-based energy startup, this prototype reactor represents a new chapter in the conflict-ridden, politically bedeviled saga of nuclear power plants.

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NuScale's reactor won't need massive cooling towers or sprawling emergency zones. It can be built in a factory and shipped to any location, no matter how remote. Extensive simulations suggest it can handle almost any emergency without a meltdown. One reason is

that it barely uses any nuclear fuel, at least compared with existing reactors. It's also a fraction of the size of its predecessors.

This is good news for a planet in the grips of a climate crisis. Nuclear energy gets a bad rap in some environmentalist circles, but many energy experts and policymakers agree that splitting atoms is going to be an indispensable part of decarbonizing the world's electricity. In the US, nuclear power accounts for about two-thirds of all clean electricity, but the existing reactors are rapidly approaching the end of their regulatory lifetimes. Only two new reactors are under construction in the US, but they're billions of dollars over budget and years behind schedule.

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Enter the small modular reactor, designed to allow several reactors to be combined into one unit. Need a modest amount of energy? Install just a few modules. Want to fuel a sprawling city? Tack on several more. Coming up with a suitable power plant for a wide range of situations becomes that much easier. Because they are small, these reactors can be mass-produced and shipped to any location in a handful of pieces. Perhaps most importantly, small modular reactors can take advantage of several cooling and safety mechanisms unavailable to their big brothers, which all but guarantees they won't become the next Chernobyl.

NuScale uses a light water reactor—by far the most common type of reactor in commercial nuclear power plants—but that’s about where the similarities end. NuScale’s reactor is 65 feet tall and 9 feet in diameter, and is housed in a containment vessel only slightly larger. About the size of two school buses stacked end to end, you could fit around 100 of them in the containment chamber of a large conventional reactor. Yet this small reactor can crank out 60 megawatts of energy, which is about one-tenth the smallest operational reactor in the US today.

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Going small has big benefits, says Jose Reyes, NuScale’s cofounder and chief technical officer. They’re safer, in part because they are small enough to sit in underground pools of water. If a reactor leaks, the heat can slowly diffuse into the pool. That also means the reactors could be built closer to the places where their power is needed, without the 10-mile safety buffer a conventional plant must have.

The NRC has been reviewing NuScale’s design since 2016; if the commission gives its blessing, the company can finally start building the first commercial reactor of its kind. The review process is brutal—NuScale submitted a 12,000 page technical application—and will likely stretch on for at least another year. But the company has already secured permission to build its first 12-reactor plant at the Idaho National Laboratory, which may start supplying power to communities in Western states as soon as 2026.

Earlier, a secretive nuclear startup called Oklo unveiled Aurora, its 1.5-megawatt microreactor, and announced it had received a permit from the Department of Energy to build its first one at the Idaho National Lab. Aurora looks more like an A-frame cabin you might find in the Alps than a nuclear reactor, but this, according to Oklo founder and CEO Jacob DeWitte, is exactly the point.

Small modular reactors may be the first tiny nuclear plants to make it on the US grid, but they won’t be the last. The Department of Energy is also interested in microreactors, a “plug and play” nuclear plant that usually generates less than 50 megawatts of power. Whereas small modular

reactors are better suited to industrial processes and other large power loads, microreactors are ideal for smaller needs like powering a remote military base or keeping the lights on in an isolated Alaskan community. But in the future they could also serve as an “always on” source of carbon-free energy in cities.

Microreactors have attracted interest from new and established nuclear energy companies alike. Earlier, a secretive nuclear startup called Oklo unveiled Aurora,

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Oklo faces significant hurdles on its road to regulatory approval, though. For one thing, Aurora is a liquid metal-cooled fast reactor, a design that has been used almost exclusively on submarines. “Frankly, the regulatory paradigm is built for large reactors,” DeWitte says.

While the Nuclear Regulatory Commission works to figure out how small reactors fit in the existing nuclear regulations, other energy policy makers are hyping the technology at every opportunity. Earlier this year, leaders from the US and Europe met for the first high-level international discussions about small modular reactors, and provincial governments in Canada recently met to promote small reactors. And

when Rick Perry stepped down as the US Secretary of Energy this month, he gave small modular reactors a special shout-out in his farewell video.

In the US, the push for small reactors has prompted

some changes to the regulatory environment to help companies get a first small reactor online at a federal facility by 2027. But small reactors will still need to prove they can be cost-competitive, says Steve Fetter, a professor of public policy at the University of Maryland. With the price of renewables like wind and solar rapidly falling and ample natural gas available, smaller, svelter reactors may never find their niche. Especially if a prime motivator is climate change, whose pace is exceeding that of regulatory approvals.

"I am skeptical of the ability to license advanced nuclear reactors and deploy them on a scale that would make a difference for climate change," adds Fetter. "But I think it's worth exploring because they're a centralized form of carbon-free electricity and we don't have a lot of those available." At least in the US, it might be the only way nuclear power gets another chance.

Source: <https://www.wired.com>, 13 December 2019.

OPINION – Rod Lyon

How North Korea could Start a War: Test a Nuclear Weapon in the Atmosphere

Any scenario in which Pyongyang attempts such a test—humorously labelled 'Juche Bird' by some—is fraught with danger. Indeed, even the preparations for such a test, including the loading of a nuclear warhead onto a long-range missile, might well trigger a US pre-emptive strike.

As North Korea's nuclear and ballistic missile programs have become more adventurous, a worrying possibility has begun to emerge. There's a chance that—at some point—the North Koreans might want to combine the two testing programs, by putting a live nuclear warhead on top of a ballistic missile. That means, assuming

There's a chance that—at some point—the North Koreans might want to combine the two testing programs, by putting a live nuclear warhead on top of a ballistic missile. That means, assuming all goes as it should, the missile would fly downrange to its appointed target zone, and the warhead would detonate in the atmosphere.

all goes as it should, the missile would fly downrange to its appointed target zone, and the warhead would detonate in the atmosphere. That sort of test—an end-to-end test of the full weapon system—would be a convincing demonstration that Pyongyang had crossed the critical bridges:

that it had a long-range ballistic missile with the throw-weight to carry a nuclear warhead, a warhead able to be placed atop the missile, and a re-entry vehicle that could survive the stresses of re-entry.

It would also be dangerous. A lot can go wrong during a ballistic missile test. When

things do go wrong, missile controllers usually order the missile to self-destruct. But most missile tests don't involve live nuclear warheads. Besides, in the early stages of a missile's development, testing is primarily about learning the limitations and vulnerabilities of the particular weapon system. Becoming familiar with a ballistic missile typically involves a number of launches—and God knows North Korea does few enough of those as it is. Remember the Hwasong-12, Pyongyang's intermediate-range ballistic missile? It's been tested three times. The Hwasong-14 ICBM? That was tested twice, both times on lofted trajectories. The latest missile, the Hwasong-15, has been test-fired only once—again, on a lofted trajectory.

Putting a live nuclear warhead on a missile that wouldn't clear Japan isn't an option. But putting one on an under-proven longer-range delivery vehicle doesn't sound like a smart move either. Still, Pyongyang might be tempted down that path in order to demonstrate the 'completion' of its programs.

Well, you might think, surely they have older, better-tested missiles somewhere in their arsenal. Sure they do, but those are generally short- and medium-range missiles—which aren't of much use if the point is to lob a warhead somewhere out into the distant reaches of

the Pacific Ocean. Putting a live nuclear warhead on a missile that wouldn't clear Japan isn't an option. But putting one on an under-proven longer-range delivery vehicle doesn't sound like a smart move either. Still, Pyongyang might be tempted down that path in order to demonstrate the 'completion' of its programs.

Such tests have been done before by other nuclear-weapon states. True, they're incredibly rare, and no such test has been conducted since the 1960s. In 1962, the US conducted a nuclear test involving an operational submarine-launched ballistic missile. The test, code-named 'Frigate Bird', was held on 6 May. It was 'the only US test of an operational ballistic missile with a live warhead'. It involved the launch of a Polaris A1 SLBM from the submarine USS Ethan Allen, a missile flight of about 1,000 nautical miles, and the atmospheric detonation of a 600-kiloton nuclear warhead in the vicinity of Christmas Island. (Let me hasten to assure Australian readers that the 'Christmas Island' in question was in the Line Islands in Kiribati, and not off the northwest coast of Australia.)

Although the details are sketchy, the Russians seem to have done something similar in Test 95, conducted on 13 September 1961. An SLBM launched from the Barents Sea flew to the test range on Novaya Zemlya. As a safety measure, the Russians seem to have deliberately replaced the missile's usual warhead with one of reduced yield, since the resulting nuclear detonation was about 6 kilotons. Some sources suggest there might have been other such tests as well, though it's important to count only those that actually involved ballistic missiles, rather than other weapon systems.

In October 1966, the Chinese conducted a nuclear test involving the ballistic-missile delivery of the warhead to their Lop Nur test site. This test was CHIC-4, held on 27 October. The missile was a CSS-1 medium-range missile, which flew about 900 kilometres before the warhead—a simple fission

design with a yield of approximately 12 kilotons—was detonated in the atmosphere. CHIC-3 had a yield of 250 kilotons, and CHIC-5 300 kilotons, so it's reasonable to conclude that the Chinese also

made an effort to dial back the CHIC-4 yield as a safety precaution. (As a point of interest, the CHIC-4 design—labelled 'early, [and] inefficient' by the CIA—is the one the Chinese later shared with the Pakistanis.)

Given that the US and Russia have both conducted end-to-end tests by using SLBMs, Kim Jong-un might be drawn to pursue a similar

option. An SLBM needn't involve overflight of Japan. And it would allow the test to be conducted remote from major urban areas. But that assumes, of course, that Kim has a working SLBM, not to mention a submarine capable of launching it—which he probably doesn't at this point in time. What Kim has is an under-tested ICBM capability, plus of course an under-tested intermediate-range ballistic missile capability. If he decides to try for an end-to-end nuclear test with one of those, we might be in trouble.

None of the previous tests by the US, Russia and China, remember, have involved an

intercontinental-range or even an intermediate-range missile. Any scenario in which Pyongyang attempts such a test—humorously labelled 'Juche Bird' by some—is fraught with danger. Indeed, even the preparations for such a test, including the loading of a

nuclear warhead onto a long-range missile, might well trigger a US pre-emptive strike. After all, how could a US president be confident that a nuclear-tipped ICBM was being launched only for testing purposes?

Source: <https://nationalinterest.org>, 13 December 2019.

The missile was a CSS-1 medium-range missile, which flew about 900 kilometres before the warhead—a simple fission design with a yield of approximately 12 kilotons—was detonated in the atmosphere. CHIC-3 had a yield of 250 kilotons, and CHIC-5 300 kilotons, so it's reasonable to conclude that the Chinese also made an effort to dial back the CHIC-4 yield as a safety precaution.

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NUCLEAR STRATEGY

PAKISTAN

Pakistan Navy's Nuke Storage Facility at Arabian Sea Port of Ormara Sees Massive Expansion

While Pakistan's Army gets all the attention within and outside the country, its navy has its fair share of strategic assets too, and has been expanding with Chinese assistance in every field. One of the biggest expansions has taken place at the Arabian Sea port of Ormara in Gwadar district of Balochistan province, about 350 km west of Karachi, which is supposed to be a storage facility for the nuclear capable Hatf-VII/Babur missile. Satellite images suggest that the entire facility, once complete, will likely cater to a regiment of Babur coastal missile systems on tractor erector launchers (TELs).

The storage facility, mostly constructed overground, is located at the hammerhead-shaped peninsula in Ormara. Construction began in the first half of 2009, and has proceeded in different phases till date. The slow pace is probably to avoid detection, which would be visible in the case of a fast-paced programme. By 2018, the 25-acre area originally covered by the facility was expanded to 425 acres, boxed in by an external fence.

Latest satellite images now show that the external fence now occupies an area of almost 1,000 acres, covering almost the entire hammerhead of Ormara. The open area is possibly being prepared for launch positions, but it has not yet been fenced completely. There are two main storage bunkers, with an internal size of 10m x 25m. The bunkers, like most overground nuclear ammunition bunkers, have a sloped wall covering of compressed earth, at a 60-degree slant. The top is also covered with compressed earth. It also

has a small chimney-like opening for environmental conditioning. The bunkers were constructed in 2009 and had their main entrances automated as late as 2017. The gates seem to be almost a metre thick. The size of these two storage bunkers indicate that they could probably be holding about eight TELs of the Babur coastal missile system, with a range of approximately 750 km.

Recent construction activities show a newly-built highbay garage, which has regularly been upgraded with an air conditioning plant, and an additional porch-type protruding shed. Two more buildings can be observed,

which could be motor transport garages. There is an additional hard standing created for temporary parking of vehicles. There are four large buildings to the west of the original storage facility. Two of these are very similar to storage buildings observed elsewhere in Pakistan's nuclear storage facilities.

The size of the two buildings suggests that they could possibly store about a regiment-sized missile force. The other two buildings are probably for support vehicles and other facilities.

At four locations, some kind of underground work is in progress. It is, however, not possible to identify them with the images available, as they are covered with camouflage netting. There could also be a cut-and-cover type of construction being planned. The facility is surrounded by tall wire fences in at least five layers, interspersed with tall watch towers.

The two main bunkers have special guard posts around them, along with internal double fencing. As mentioned above, the entry at the bunkers is automated with at least a metre-thick gates. All the buildings are connected with the central command post and with each other through underground cabling and electricity connections.

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The road entry point has been beefed up with seven layers of obstacles, with watch towers at both ends. There are three vehicle entry barriers beyond the seven road barriers.

Source: <https://theprint.in>, 03 December 2019.

BALLISTIC MISSILE DEFENCE

INDIA

DRDO and SFC to Look into Why Nuclear-Capable Agni Night Test Failed

In a major setback, the first night trial of the 3,500 km range nuclear-capable ballistic missile, Agni-III, carried out by the SFC, the tri-service unit that oversees operations and security of nuclear weapons, failed after being tested at a defence base off the Odisha coast Saturday [30 November] evening.

Officials are now studying the reasons for the failure of the missile that has been inducted into the Indian military. "We will have to

analyse all information gathered to really say what happened," a top government official told *ThePrint* when asked why the test failed. This was the first night test of the missile, capable of carrying both conventional and nuclear warheads weighing up to 1.5 tonnes; a successful test would have validated the technical parameters set for the user and its readiness to handle the weapon during night hours.

As in all tests carried out by the user, the test missile was randomly picked from the lot it has been equipped with. While the SFC conducted the trial as part of its training, the DRDO provided logistic support. *The New Indian Express* reported that the missile "tumbled" into the sea after first phase separation. "The missile travelled around 115 km into its initial flight trajectory when things went awry. It deviated from the flight path forcing the mission team to terminate it midway" the daily said quoting sources. It added that the flight trajectory of the missile was set for nearly 2,800

km.

Source: <https://theprint.in/>, 01 December 2019.

SOUTH KOREA-CHINA

South Korea, China Agree to Step Up Exchanges to Re-set Ties after Missile Defence Row

South Korea and China agreed to beef up diplomatic and cultural exchanges to "completely normalise" ties that soured over the deployment of U.S. anti-missile systems in 2017, Seoul officials. Making his first visit to South Korea in over four years, China's State Councillor Wang Yi, who also serves as foreign minister, met South Korean Foreign Minister Kang Kyung-wha and was set to meet President Moon Jae-in.

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Relations between the two countries were strained by a dispute that erupted over the installation of the US THAAD system in South Korea, which led to a sharp slump in South Korea's tourism, cosmetics and entertainment industries.

Kang and Wang agreed to hold the first gathering of a planned joint vice-ministerial panel on people-to-people exchanges "in the near future" and create a new meeting on maritime affairs, South Korea's foreign ministry said in a statement. "Both sides concurred that relations should be put back on a normal orbit and completely normalised," a ministry official told reporters after the meeting.

Kang and Wang also discussed Moon's expected trip to China for a trilateral summit with Japan, a possible visit to Seoul by Chinese President Xi Jinping, as well as stalled denuclearisation talks between North Korea and the United States, the ministry said.

Calling the two countries "close neighbours, friends, and partners", China's Wang said at the start of the meeting that they should work together to keep regional peace and stability. The biggest threat the world faces is "unilateralism

that destroys the global order and hegemonic acts that challenge rules of international relations," Wang said, in a purported swipe at the United States, whose rivalry with China is intensifying.

Addressing North Korean issues, Wang said North Korea's reasonable concerns about its security should be respected and resolved, China's foreign ministry said in a statement. Kang told Wang she hoped for in-depth discussions to promote economic, cultural and people-to-people exchanges, as well as "ways to work together to establish denuclearisation and peace on the Korean peninsula".

South Korea sees China as instrumental in reviving the stalemated nuclear talks between the United States and North Korea, a longtime ally of Beijing. Kang and Wang agreed to cooperate to facilitate the talks based on shared views that North Korea's nuclear programmes cannot be accepted, peace should be maintained and there must not be war again, another South Korean foreign ministry official told reporters.

... Wang last visited Seoul for a trilateral meeting, also attended by Japan, in 2015. A year later a row blew up over the planned sitting in South Korea of the U.S. THAAD system, designed to intercept ballistic missiles. Beijing said it upset the regional security balance as the system's powerful radar could penetrate into Chinese territory. South Korea and the United States went ahead regardless, installing the anti-missile system in 2017, saying it was warranted because of North Korea's provocations.

North Korea has test fired dozens of missiles since, most recently on the U.S Thanksgiving

holiday. Seoul is also seeking to open additional military hotlines with Beijing to promote communications as Chinese military aircraft frequently violate South Korea's air defence zone, creating another source of contention. China's *Global Times* newspaper said relations with Seoul had begun to thaw, despite remaining problems of the THAAD deployment. ...

Source: <https://in.reuters.com/article/s>, 04 December 2019.

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NUCLEAR ENERGY

AUSTRALIA

Australian Inquiry Recommends Lifting the Ban on Modern Nuclear Power Plants

An inquiry has recommended lifting the ban in Australia on the use of the most modern nuclear power plants and new designs under development in a report issued. The report, written by the Australian House of Representatives Standing Committee on the Environment and Energy, sets out a clear path to explore the potential for nuclear energy in Australia.

The report, 'Not without your approval: a way forward for nuclear technology in Australia', sets out three recommendations by which to evaluate the nuclear energy options available and remove the current moratorium on the use of the latest Gen III+ designs, which are now under

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... The report recommends a detailed examination of the range of nuclear technologies available and the economics of nuclear energy. ...

Source: <https://www.powermag.com>, 13 December 2019.

EU

Nuclear Forms Part of Climate Change Solution, Says European Parliament

The European Parliament adopted a resolution on COP25 - the 25th Session of the Conference of the Parties to the UNFCCC - to begin in Madrid. The resolution states that all technologies - including nuclear - are needed to combat climate change, for which it has called an emergency.

The resolution on COP25 calls for the European Green Deal, announced by European Commission President-elect Ursula von der Leyen, to include a target of 55% emissions reductions by 2030 in order to be able to reach its target on climate neutrality by 2050. It was adopted by 430 votes in favour, 190 against and 34 abstentions.

The resolution says the European Parliament "believes that nuclear energy can play a role in meeting climate objectives because it does not emit greenhouse gases, and can also ensure a significant share of electricity production in Europe; considers nevertheless that, because of the waste it produces, this energy requires a medium and long-term strategy that takes into account technological advances (laser, fusion, etc) aimed at improving the sustainability of the entire sector."

A draft of the resolution presented by the European Parliament's Environment Committee (ENVI) had called for a phase-out of nuclear energy in the EU, claiming it is "neither safe, nor environmentally or economically sustainable". ENVI adopted the draft resolution on 6 November

with 62 votes to 11. However, following a debate on the resolution on 25 November, that position did not make it through to the final text. Amendment 38, which instead states the European Parliament's support of nuclear, was approved by 322 votes, with 298 votes against it and 45 abstentions.

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Yves Desbazeille, director general of European nuclear trade body Foratom, said: "We are delighted to see the European Parliament recognise the role which low-carbon nuclear has to play in meeting climate change objectives and in ensuring security of supply." Foratom notes there are 126 nuclear power reactors in operation

in the European Union, providing 26% of its total electricity generation. However, nuclear power accounts for 50% of the region's low-carbon electricity output. The use of nuclear energy in the EU avoids the emission of 700 million tonnes of CO2 each year.

The European Parliament also adopted a resolution declaring a climate and environmental emergency in Europe and globally. The resolution was adopted with 429 votes for, 225 against and 19 abstentions. A number of countries, local administrations and scientists have already declared a climate emergency. The resolution calls for urgent "concrete

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action ... in order to fight and contain this threat before it is too late". The parliament wants the European Commission to ensure that all relevant legislative and budgetary proposals are fully aligned with the target of limiting global warming to under 1.5°C. ...

Source: <https://www.world-nuclear-news.org/>, 29 November 2019.

GENERAL

The Tide is Turning

As the global nuclear industry gathered in London in September for the 2019 World Nuclear Symposium climate change, innovation and the outlook for uranium were all on the agenda, NEI reports. The role of nuclear energy in combating climate change was inevitably a core topic of conversation at the World Nuclear Symposium. Agneta Rising, director general of the World Nuclear Association, opened the Symposium by setting out the importance of energy as “the essential agent for promoting human development”, and that “securing access to modern and affordable energy is essential for lifting people out of poverty, and for promoting energy independence and economic growth”.

She pointed out the need to remind policymakers around the world that nuclear reactors “are the low-carbon backbone of electricity systems, operating in the background, day in and day out, often out of sight and out of mind”, dubbing them “the silent giants” – a nod to the WNA’s latest white paper, ‘The Silent Giant: the need for nuclear in a clean energy system’ launched at the World Energy Congress shortly after the Symposium.

This notion was backed by Magnus Hall, the CEO of Vattenfall, who was unequivocal on the role of nuclear in climate change mitigation. He said “we must include nuclear. If we take nuclear away there is no solution”. However, he also stressed the issues around cost and said, “we currently have a situation where the cost of constructing a new reactor ends up being two or three times as much as the initial calculation. That cannot go on”.

Sama Bilbao y Leon, from the OECD’s Nuclear Energy Agency (NEA), picked up on some of these themes, and concluded that “if we are serious about achieving decarbonisation goals, we need to optimise all low-carbon technologies and we need a level playing field”. This ties in with the

WNA’s Harmony Programme, which calls for a level playing field in electricity markets to reflect the societal values generated by nuclear energy.

As part of its Harmony Programme WNA has set a target to build an additional 1000GWe of reactors across the world by 2050 at the latest, bringing the global share of electricity production of nuclear to at least 25%.

Improving Innovation: Beyond climate change, the perennial topic of innovation was once more a key topic of discussion during the symposium. A number of different sessions were either dedicated to this important issue, or featured it heavily, with topics ranging from updates on specific projects (e.g. NuScale’s light-water SMR) to policies and approaches generally required

to stimulate innovation. In the final panel session of the Symposium, everything from Rosatom’s floating nuclear power plant Akademik Lomonosov to a range of different innovative reactor designs were discussed.

Bernard Salha, chief technical officer at EDF and one of the speakers, stated that the nuclear industry, “needs to become much more innovative than it is. The global energy mix is changing”, a sentiment supported by Chris Levesque, the president and CEO of Terrapower, who concluded that “nuclear has all this technology which hasn’t been employed yet. We need to demonstrate it now.”

At the Symposium, the World Nuclear Association’s director general Agneta Rising and the director-general of the OCED Nuclear Energy Agency William Magwood IV signed a Memorandum of Understanding establishing a new partnership between the two organisations, aimed at sharing best practices and co-operating in supporting the wider understanding of nuclear energy and its development. After the signing, Magwood said: “Industry is often the major implementer of national energy policies and has the most relevant and comprehensive

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information about many vital aspects of those policies. This MoU will help the NEA gain important insights from industry”.

Positive Outlook for Uranium, but Potential Storm Clouds Ahead: The new edition of the World Nuclear Association’s biennial report on nuclear fuel was launched at the Symposium, attracting significant interest from across the world of uranium mining, nuclear energy and beyond.

At the launch, James Nevling, senior manager of Exelon Generation’s Nuclear Fuels department, put the principal reasons for this renewed optimism down to extended operating lifetimes, particularly in the USA, where the prospect of 80 years of operation is looking more likely, in addition to longer operating lifetimes assumed in France and some other European countries. He also highlighted the projections for fast neutron reactors in Russia, China and India; increased confidence in plans for newcomer countries; and the stronger the programme in India, which appears to be “more realistic and less theoretical than it did some years ago,” according to Nevling.

There is vastly more uranium in the ground than is needed to satisfy even the most optimistic of scenarios for nuclear growth. Uranium resources are therefore “unlikely to be a limiting factor for the expansion of nuclear programmes,” the 2019 edition of the Fuel Report states. Nevertheless, given the recent production cuts in uranium mining — most notably when Cameco last year suspended production at its McArthur River mine in Canada and Kazatomprom’s reduction in planned production — there is greater concern over whether supply will be able to pick up once demand increases. Speaking at the launch, Riaz

Rizvi, Kazatomprom chief strategy and marketing officer, said that the recent spending cutbacks in the mining sector would have “a fundamental impact on our ability as an industry to ramp back up.” He added: “I’m not worried about whether there will or won’t be uranium in the long run, but I think there could be some turbulent years in the not too distant future.”

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The 2019 Fuel Report – Key Findings:

For the first time in eight years, projections for nuclear generating capacity growth in all three scenarios (Lower, Reference and Upper) of The Nuclear Fuel Report: Global Scenarios for

Demand and Supply Availability 2019-2040 show an increase over the forecast period. Although the Lower Scenario’s figure of 402GWe of nuclear capacity is only a few gigawatts above the mid-2019 level of 398GWe, this scenario has seen the most significant increase in long-term capacity projections compared with the previous (2017) edition of the report. For the Reference and Upper Scenarios, global nuclear capacities are expected to rise to 569GWe and 776GWe, respectively, by 2040.

The report expects uranium production volumes to remain fairly stable until the late 2020s, and then decrease by 30% in the last five years of the forecasting period (2035-2040) as production comes to an end at many mines.

Global Scenarios for Demand and Supply Availability 2019-2040 show an increase over the forecast period. Although the Lower Scenario’s figure of 402GWe of nuclear capacity is only a few gigawatts above the mid-2019 level of 398GWe, this scenario has seen the most significant increase in long-term capacity projections.

Currently, production from mines is significantly below reactor requirements. More than 67,200t of uranium (tU) was needed to fuel the 369GWe of global nuclear capacity in 2018, whereas just under 53,500t was produced in that year – a drop in production of over 8700t since 2016. The shortfall between primary production and reactor requirements is covered by secondary supply,

particularly commercial fuel inventories. Over the coming years, the Fuel Report expects secondary supply to gradually diminish to around 5000-7000t/ year from the beginning of the 2030s.

By 2040 uranium requirements are projected to be 70,500t, 100,000t and 137,600t in the Lower, Reference and Upper Scenarios, respectively. The industry would in that case have to at least double its infrastructure of current, idled, under development, planned and prospective projects by 2040. However, the Fuel Report states that: "The issue remains that, due to current oversupply and associated low market prices, very few participants are able or willing to begin investing to convert these resources into reserves and ultimately into mines to keep the market in balance. Some state-owned strategic developments are proceeding, but there continues to be a lack of long-term fixed-price contracts, which are needed to underpin new projects controlled by market-based companies."

Source: <https://www.neimagazine.com/>, 03 December 2019.

USA

NRC Moves Review of NuScale's Smaller Nuclear Reactor to Final Phases

NuScale Power has clearly entered the second half of its quest to get federal approval for its small modular nuclear reactor (SMR) expected to be in service sometime in the next decade. Portland, Ore.-based NuScale announced that the U.S. NRC has completed the fourth phase of review for the SMR's design certification application. The review now goes in phases 5 and 6, which could be complete by late

2020 and then entered into rulemaking, according to the NRC website.

The company says that its technology—meant to lower the cost and footprint of nuclear power projects—is the only SMR to undergo design certification review by the NRC. NuScale has worked with the Department of Energy and several companies.

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"The completion of Phase 4 of the NRC's design review certification process is an unprecedented step forward for our company and for the advanced nuclear industry overall," said NuScale Chairman and

CEO John Hopkins in a statement. "We appreciate the tremendous effort the U.S. NRC has dedicated to its thorough and rigorous review of our groundbreaking technology thus far. "We are thrilled to be entering into the final stages of the NRC's review process and are looking forward to delivering America's first small modular nuclear reactor."

NuScale's SMR design focuses on several key distinctions from past reactor design: it is 65 feet tall by nine feet in diameter and cooled by a water-filled pool built below grade and using the principles of buoyancy-driven natural circulation instead of pumps. The reactor would only use 1/20th of the fuel compared to a large reactor, theoretically limiting damage in the case of an event. NuScale also uses its proprietary digital instrumentation and controls.

The NRC review began in 2018. NuScale's SMR design focuses on several key distinctions from past reactor design: it is 65 feet tall by nine feet in diameter and cooled by a water-filled pool built below grade and using the principles of buoyancy-driven natural circulation instead of pumps. The reactor would only use 1/20th of the fuel compared to a large reactor, theoretically limiting

damage in the case of an event. NuScale also uses its proprietary digital instrumentation and controls.

Utah Associated Municipal Power Systems is planning to use NuScale's technologies in building a 12-module SMR plant in Idaho. The UAMPS facility is expected to be operational by the mid-

2020s, close to the same time that Georgia Power hopes to finally complete its \$25 billion Vogtle units 3 and 4 nuclear reactor expansion.

Several larger partners, such as Doosan Heavy Industries and Sargent and Lundy, have signed preliminary deals with NuScale to offer technical expertise and manufacture various components of the reactor. DHI and S&L also provided cash investments in the company. Still, Phases 5 and 6 of the NRC review remain. Phase 5 entails a review by the NRC's Advisory Committee on Reactor Safeguards (ACRS). The ACRS is an independent advisor to the NRC that reviews and reports on safety studies and reactor facility license and license renewal applications.

... U.S. nuclear generation accounts for about 19 percent of the nation's electricity mix. It represents 55 percent of the current carbon-free electricity currently generated in the U.S., according to the Nuclear Energy Institute.

Source: Rod Walton, <https://www.power-eng.com>, 13 December 2019.

NUCLEAR COOPERATION

RUSSIA-CHINA

Top Russian Nuclear University Eyes Future Cooperation with China

A top Russian institute on nuclear research has welcomed its first two Chinese students in recent years. The school also cooperates with Chinese universities and sees more chances for cooperation in the future. The National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) is Russia's top nuclear education institute and research center, and is acknowledged to be a leading one in the world.

Originally built to maintain atomic talent for Soviet Union in 1942, the university is becoming more

international. The school now has more than 1,400 foreign students from different countries in Asia, Europe and Africa. It cooperates with universities and institutes all over the world, as well as those in China.

Glorious History: A line of security gates and iron fences separate the outside world from the campus of MEPhI, suggesting a unique campus worthy of protection. People, including some in Russian military uniforms, come in or out with

the beep of a card. To enter the university, visitors need to obtain a permit showing their identification, and visa if they are from another country.

Inside the campus, sculptures of six Nobel Prize winners who used to study or work here are lined up in front of the main building, on top of which the national flag of Russia waves in light snow.

MEPhI still keeps many elements of the Soviet time - the buildings, the decorations inside the buildings, as well as its rich heritage in nuclear and physics studies. MEPhI owns a 2.5MW pool-type reactor, the IRT-2000, which was launched in 1967 and is under oversight of the Russian nuclear regulatory body and the International Atomic Energy Agency. It serves an important role in educating students by providing a first-hand experience of a nuclear reactor, according to the website of MEPhI. The school has advanced facilities such as the Laboratory of Nano-bioengineering, the Laboratory for Experimental Nuclear Reactor Physics and the Laser Center.

Possible Cooperation: Han Muyao had his first snow in Moscow in late October, quite early compared to his hometown of Shanghai. Han is a post-graduate student in MEPhI, studying information security. He arrived in early September, and has been learning Russian since. Now he has reached basic proficiency.

A top Russian institute on nuclear research has welcomed its first two Chinese students in recent years. The school also cooperates with Chinese universities and sees more chances for cooperation in the future. The National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) is Russia's top nuclear education institute and research center, and is acknowledged to be a leading one in the world.

... The Chinese students told the *Global Times* that the dormitory fee here is only 600 rubles (\$9.3) a year and the tuition fee is some 100,000 rubles, much cheaper than studying in a university in the US or the UK. "We live very well here," Han said. "Chinese students did not know MEPHI, which is a really recognized university in Russia and in the world. I hope more students from China could enter MEPHI, even those studying nuclear science and physics," Han told the *Global Times*.

The situation is because of the independence of China's educational system noting that China might be using Russian technologies, while preparing specialists on power plants by itself. In China, fostering a nuclear power plant operator, for example, would cost millions of yuan and more than 10 years. Students at the university level who learn about nuclear science can sign with nuclear companies or power plants. Many of them go to France or the US for training.

The situation is because of the independence of China's educational system, an employee in charge of MEPHI's International Department told the *Global Times*, noting that China might be using Russian technologies, while preparing specialists on power plants by itself. In China, fostering a nuclear power plant operator, for example, would cost millions of yuan and more than 10 years. Students at the university level who learn about nuclear science can sign with nuclear companies or power plants. Many of them go to France or the US for training, the *Global Times* learned from previous interviews.

Unlike China, which is somewhat underrepresented on campus, MEPHI does have a fair share of international students. Its cooperation with Vietnam and Turkey makes the two countries top origins of its foreign students. The school has over 200 Vietnamese students. "They work hard and are our top students," said the employee from the International Department.

Georgy Tikhomirov, deputy director of the Institute of Nuclear Physics and Engineering of MEPHI told the *Global Times* that currently, the university's

cooperation with China is only in "very narrow fields." But he believes more cooperation is possible in the future. A statement MEPHI sent to the *Global Times* shows the school has education cooperation with seven Chinese universities, including the top ones such as Tsinghua University and Beijing Institute of Technology.

Joint Hands: China and former Soviet Union's cooperation on peacefully using nuclear technology started in 1950s. Soviet sent specialists to China,

bringing materials and technologies, according to an article by the "Two Bombs and One Satellite" study association under the Association of Chinese Historians. The article was quoted by China's Ministry of National Defense on its website.

In recent years, China and Russia have been seeking cooperation on nuclear energy and research, and have worked together on various achievements. China National Nuclear Corporation and Russia's Rosatom State Atomic Energy Corp signed to work together on two new nuclear units in Xujiabao nuclear power plant in Northeast China's Liaoning Province in June.

With the help of Soviet specialists, China built reactors and a cyclotron for research use. Through teaching and experiments, the Soviet Union helped foster at least 6,000 Chinese specialists on nuclear physics by November 1959, the article said. "The experts from the Soviet Union believed that

Chinese scientists have gained everything they need to know, within the range the experts were allowed to say and knew," read the article. In 1960, the 233 Soviet specialists went back to their country due to a chilling of the China-Soviet relationship. Tikhomirov, the MEPHI director, said that in 1960s and 1990s, there were Chinese students at MEPHI, but there were also intermissions.

In recent years, China and Russia have been seeking cooperation on nuclear energy and research, and have worked together on various

achievements. China National Nuclear Corporation and Russia's Rosatom State Atomic Energy Corp signed to work together on two new nuclear units in Xujiabao nuclear power plant in Northeast China's Liaoning Province in June.

In June 2018, the two companies have signed to cooperate on the number 7 and 8 units of the Tianwan nuclear power plant in East China's Jiangsu Province. The Rosatom said construction of the two Tianwan units is ready to begin, Sputnik reported on October 23. Sputnik also reported in October that Russia will supply certain components for the construction project of China's fast-neutron nuclear reactor CFR600.

Source: <http://www.globaltimes.cn/content/1170767.shtml>, 29 November 2019.

RUSSIA-IRAN

Russia Suspends Fordow Project in Iran

TVEL has announced the suspension of its work to upgrade the Fordow Fuel Enrichment Plant because Iran fed uranium hexafluoride (UF6) into two gas centrifuge cascades located in the same room as the cascades meant to be reengineered for stable medical isotope production.

Iran's action followed its withdrawal from some of the obligations under the JCPOA, and TVEL's announcement came on the eve of the next round of talks between Iran and the JCPOA signatories at the IAEA's headquarters in Vienna.

TVEL, the nuclear fuel manufacturer subsidiary of Russian state nuclear corporation Rosatom, said it was "technologically impossible" to implement the Fordow project at this time. Uranium enrichment and stable medical isotope production cannot be sustained in the same room because air and equipment are exposed to UF6 "leftovers", making the produced stable medical isotopes unsuitable for medical purposes, TVEL said.

"To resume this work, it will be necessary to stop

and dismantle the cascades in which uranium enrichment takes place and to thoroughly clean the premises and equipment. Until these conditions are met, work on the project from the Russian side has been suspended," it said.

Since 2017, TVEL has been engaged in modifying two gas centrifuge cascades at the Fordow facility, intended for producing stable isotopes (xenon and tellurium) for medical purposes. The works were carried out in compliance with the JCPOA dated 14 July 2015. The IAEA and the JCPOA Joint Commission were regularly updated on project progress, TVEL said.

TVEL's suspension follows a US announcement last month [November] that the waiver allowing foreign companies to work at Fordow will end on 15 December. Russian Deputy Foreign Minister Sergei Ryabkov said that this pressure had "created a difficult environment" for Russia and other participants in the JCPOA.

Russian news agency RIA Novosti quoted Ryabkov as saying that Russia is suspending its participation in the project to "analyse the possibilities and potential negative consequences of the American measures" but was not stopping it altogether.

Source: <https://www.world-nuclear-news.org/>, 06 December 2019.

TVEL has announced the suspension of its work to upgrade the Fordow Fuel Enrichment Plant because Iran fed uranium hexafluoride (UF6) into two gas centrifuge cascades located in the same room as the cascades meant to be reengineered for stable medical isotope production.

NUCLEAR SAFETY

INDIA

Rosatom Installs Advanced Safety Feature at Kudankulam Nuclear Power Plant

Russia's Rosatom, the technical consultant and main equipment supplier for India's largest nuclear power plant at Kudankulam near Kanyakumari, has installed an advanced safety feature 'core melt catcher' or 'core melt localisation device (CMLD)', at the bottom of the upcoming Unit-3 power plant's protective shell to increase the safety of

the reactor.

Uniquely designed by Russian nuclear experts and an important safety system for modern nuclear reactors, the core catcher is designed to localise and cool the molten core material in case of an accident and confine it within the protective shell of the reactor to prevent radioactive emissions into the external environment. Core catcher, a next generation safety device, has improved seismic resistance, hydro-dynamic and shock strength, as well as flood protection and simplified installation and assembly technology. Weighing 147.5 tonnes, it was lifted to the height of 27 meters and installed in the design position by using a tracked crane placed between two nuclear islands, said a Rosatom official.

The new system gains significance as recently the Indian government had confirmed detecting a malware attack in September at the administrative software systems of the state-run NPCIL KKNPP. The Kudankulam power plant, based on light water nuclear technology, is being constructed as part of a Russia-India agreement in 1988. ... Currently Unit-3 and Unit-4 are under construction and the equipment supplier Rosatom has shipped in all the critical equipment of these units. "This is a special system for beyond-design-basis accidents management," said Vladimir Angelov, Director for Projects in India at ASE, the engineering division of Rosatom State Atomic Energy Corporation.

The core catcher, one of the elements of the passive safety systems, was first installed at China's Tianwan Nuclear Power Plant of Russian design. The main feature of the Kudankulam NPP project is its unique combination of active and

passive safety systems that provides maximum resistance against external and internal influences. ...

Source: <https://www.businesstoday.in/>, 06 December 2019.

SWITZERLAND

At 50, Europe's Oldest Nuclear Plant may Cause Serious Environmental Issues Soon

Beznau 1 is one of the oldest reactors in operation today, following only reactors 1 and 2 at Tarapur in western India. The plant poses "a major risk in terms of nuclear safety", nuclear expert Kasser said Beznau (Switzerland): Europe's oldest functioning nuclear reactor, at Switzerland's Beznau plant, will turn 50 – a lifespan deemed dangerously long by environmentalists who are demanding that it be shut down immediately.

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Commercial operation began at the plant in the northern canton of Aargau, near the German border, on December 9, 1969 — back when The Beatles were still together and a man had just walked on the Moon.

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Fifty years later, a message in German is printed in white letters on a bright blue wall of the building housing Reactor 1: "Anniversary 1969-2019. 355,000 hours of service". Beznau 1 is one of the oldest reactors in operation

today, following only reactors 1 and 2 at Tarapur in western India, which went online in October 1969, according to the IAEA. ...

The Swiss Nuclear Safety Inspectorate (ENSI) meanwhile told AFP that "Beznau 1 has proven that it fulfils all regulatory requirements thanks to significant equipment updates." But critics warn that the renovations do not compensate for the

reactor's advanced age. "I fully acknowledge that large sums have been invested in this plant, but you can't transform a Volkswagen Beetle into a Tesla just by investing in security upgrades," Florian Kasser, a nuclear expert with Greenpeace Switzerland, told AFP.

He noted that the last time the plant was shut for repairs — between 2015 and 2017 — analyses were carried out after flaws were discovered in the steel of the reactor's pressurised water tanks.

In a finding later confirmed by ENSI, experts concluded that the flaws were not linked to the operation of the reactor, and posed no safety risk. But Greenpeace maintains that

the tests did not take into account the effects of radioactivity on the wear and tear of the tank. Beznau poses "a major risk in terms of nuclear safety", Kasser said. The Green Party, which saw huge gains in recent parliamentary elections, agrees with that position and has demanded the plant's immediate closure.

The Beznau plant had become a touchstone of the heated debate about nuclear safety in Switzerland that intensified following the 2011 Fukushima nuclear disaster in Japan. In the aftermath of Fukushima, Switzerland announced plans to phase out nuclear energy and close its four plants, but no clear timeline has been set.

In a popular vote three years ago, the Swiss rejected a call to speed up the phaseout of the plants by decommissioning all reactors over the age of 45. "The operational lifespan of the plants has not been defined," the Swiss department of energy told AFP. As a result, it said, they could run for as long as ENSI deemed them safe, and as long as the operator found it financially viable to continue investing in the

required safety upgrades. ...

Source: <https://www.livemint.com/>, 05 December 2019.

NUCLEAR PROLIFERATION

NORTH KOREA

North Korea Says it has an Unpleasant "Christmas Gift" for Trump

The pariah nation's foreign ministry warned the US that its patience with nuclear talks is running out, concluding that "it is entirely up to the U.S. what Christmas gift it will select to get." In summer 2017, North Korea referred to a

test of an ICBM as a "gift package" for the US Independence Day celebration on July 4. Experts expect that this round of gifts could include more missile tests, a nuclear detonation, or even a conventional attack on South Korea. Such a provocation would be another sign of US president Donald Trump's failure to craft a solution to the decades-long problem of North Korean intransigence.

The US, along with South Korea, Japan, and China, have been pushing North Korea to suspend its nuclear weapons development in exchange for the lessening of sanctions that have crippled North Korea's economy. But under the leadership of Kim Jong Un, arms analysts say that North Korea has developed the capacity to launch nuclear weapons at US military bases in the Pacific and likely the US homeland.

So far, North Korea has used that leverage to win summit meetings with US president Donald Trump and the cancellation of joint US-South Korean military exercises. Now, Kim is expressing clear impatience with the lack of material relief. Part of

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the problem is that Trump does not understand the state of the talks. "My relationship with Kim Jong Un is really good, but that doesn't mean he won't abide by the agreement we signed," Trump told reporters at NATO summit. "You have to understand. You have to go and look at the first agreement that we signed. It said he will denuclearize."

A look at the statement, however, reveals nothing binding. North Korea did commit to denuclearization, but without any timetable or conditions. From the North Korean point of view, a nuclear-free Korean peninsula is a goal that will take many years and many concessions to reach. Experts on North Korea have repeatedly pointed out that Kim's government had not agreed to end its weapons program, and this summer it resumed testing short-range missiles in violation of United Nations sanctions.

In the view of experts like former CIA analyst Jung H. Pak, Kim is conducting a coordinated pressure campaign that plays on Trump's self-regard and impetuosity. Pak fears that Trump may follow his recent pattern of abandoning regional allies and will give major concessions to Kim's "nuclear extortion" in order to preserve the appearance of diplomatic success. That concern was underscored by Trump's response to questions about North Korea, which was to pivot to the pressure he is putting on South Korea—"they agreed to pay approximately \$500 million a year or more for protection." There's no mistaking Trump and Kim's similar worldview when it comes to coercive diplomacy, but so far Kim has proven the more talented deal-maker. That might not bode well for a peaceful 2020.

Source: <https://qz.com/>, 04 December 2019.

NUCLEAR NON-PROLIFERATION

IRAN

The remaining signatories to the faltering 2015 Iran nuclear deal will meet in Vienna with the

survival of the landmark agreement at stake after Tehran vowed to continue to breach the deal's limits on its nuclear programme. Envoys from Britain, France, Germany, China, Russia and Iran will take part in the meeting, which is the first time the six parties will have gathered in this format since July.

Since May, Iran has taken a series of measures, including stepping up uranium enrichment, in breach of the 2015 deal, with another such move likely in early January. Iran insists that under the agreement it has the right to take these measures in retaliation for the US's withdrawal from the deal in 2018 and reimposition of crippling sanctions.

Since last month [November], European members have in turn begun raising the possibility of triggering the so-called "dispute

resolution mechanism" foreseen in the accord, which could lead to the resumption of UN sanctions on Iran. On the eve of what was already likely to be a strained meeting, Britain, France and Germany accused Iran of developing nuclear-capable ballistic missiles, in a letter to the UN.

Iranian Foreign Minister Javad Zarif dismissed the allegation as "desperate falsehood". However, despite the mounting tension observers say Britain, France and Germany are unlikely to trigger the dispute resolution mechanism when their diplomats attend the joint commission meeting chaired by senior EU official Helga-Maria Schmid.

Analysts say if UN sanctions are re-imposed and the deal falls apart, Iran could also withdraw from the NPT. "It's not clear whether that's worth the benefit," Ali Vaez from the International Crisis Group told AFP. But he warned the risk of the deal collapsing was increasing as Iran was "running out of measures that are easy to reverse and non-controversial". "Both sides are locked into an escalatory cycle that is just very hard to imagine that they would step away from," he said.

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Francois Nicoullaud, former French ambassador to Iran, also says tensions were expected to continue to rise. "Maybe it won't be this time, but (the deal falling apart) will certainly be in the background of the discussions," Nicoullaud told AFP.

Iranian parliament speaker Ali Larijani warned that if European partners triggered the dispute resolution mechanism, Tehran may "seriously reconsider" its commitments to the UN nuclear watchdog, the IAEA, which monitors the deal's implementation. European efforts to shield Iran from the effects of US sanctions by creating a mechanism to carry on legitimate trade with the Islamic republic have borne little fruit, much to Tehran's frustration.

The EU is growing increasingly concerned by Tehran rowing back from its commitments. The dispute resolution mechanism in the deal has numerous stages, but it can eventually culminate in the UN Security Council voting on whether Iran should still have relief from sanctions lifted under the deal.

In such a scenario, says Vaez, "we will have a major non-proliferation crisis on our hands in the sense that the Russians and the Chinese have already declared they would not recognise the return of (sanctions)". Vaez said in the end the path to a diplomatic solution would depend on Washington's next moves and whether it would at least be willing to relax its attempts to prevent sales of Iranian oil, a vital source of income for the country. "The remaining parties to the deal have proved incapable of providing Iran with any kind of breathing space," Vaez said. Iranian President Hassan Rouhani said that Tehran is willing to return to the negotiating table if the United States first drops sanctions.

Source: <https://www.business-standard.com/html, 06 December 2019>.

NUCLEAR DISARMAMENT

UK

Labour will Remove Nuclear Weapons from Scotland

Richard Leonard would like to see Britain's Trident weapons system withdrawn from its base on the River Clyde. The Scottish Labour leader, who is a member of the Campaign for Nuclear Disarmament (CND), claims a Labour prime minister

would seek to boost international talks on getting rid of nuclear weapons.

Mr Leonard told the *Morning Star*: "I've made no secret of the fact that I am someone who is a member of the CND, so I do want to see nuclear disarmament. I just don't think there is justification for a programme of weapons of mass destruction across the globe." "I'm not happy to spend billions on Trident. Jeremy Corbyn has made

clear that an incoming Labour government that he led would be working on the international stage to give new impetus to disarmament talks, including nuclear disarmament talks. Which would eventually end with the removal of Trident from the Clyde." Mr Leonard was

speaking after the party placed a commitment to renewing the Trident nuclear programme in its Britain-wide manifesto.

In Scotland, a 2015 Labour conference resolution calling for nuclear weapons to be scrapped was reflected in previous manifestos. However, no such policy was included in the Scottish manifesto when it launched last month [November]. The SNP has previously said that the scrapping of Trident would be a key condition for the party supporting a Labour government.

Mr Leonard has now said that steps will be taken towards removing nuclear weapons from the Clyde, but this would not be done in order to

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pander to the demands of other parties. "I think the election of Jeremy Corbyn as prime minister of this country would see the arrival of a whole new initiative in international disarmament talks," he said. "There is a concern that intermediate nuclear weapon arsenals may be increasing, not decreasing. "So it's against that background that Jeremy Corbyn as prime minister of this country would be seeking to lead a change in direction internationally."

Source : <https://morningstaronline.co.uk/>, 02 December 2019.

USA-RUSSIA

Putin Offers US an Immediate Extension to Key Nuclear Pact

Russian President Vladimir Putin offered to immediately extend the only remaining nuclear arms reduction pact with the United States, but a senior US official said Washington wants a broader deal involving China. Speaking at a meeting with military officials, Putin said that Russia has repeatedly offered the US to extend the New START treaty that expires in 2021 but that it hasn't heard back. "Russia is ready to extend the New START treaty immediately, before the year's end and without any preconditions," he said.

The pact, which was signed in 2010 by US President Barack Obama and then Russian President Dmitry Medvedev, limits each country to no more than 1,550 deployed nuclear warheads and 700 deployed missiles and bombers. The treaty, which can be extended by another five years, envisages a comprehensive verification mechanism to check compliance, including on-site inspections of each side's nuclear bases. Its expiration would remove any limits on Russian and US nuclear arsenals for the first time in decades.

Arms control advocates have argued that the failure to extend the pact would be highly

destabilizing at a time when Russia-U.S. relations have sunk to the lowest levels since the Cold War.

Washington wants a broader deal involving China. Putin said that Russia has repeatedly offered the US to extend the New START treaty that expires in 2021 but that it hasn't heard back.

Putin and other Russian officials have repeatedly voiced concern about Washington's reluctance to discuss the treaty's extension. "Our proposals have been on the table, but we have got no response from our partners," Putin

said.

In Washington, a senior Pentagon official suggested the Trump administration is not interested in an immediate extension and sees no rush anyway as New Start doesn't expire until Feb. 2021.

John Rood, the undersecretary of defense for policy, told a Senate committee that the administration's main priority is getting Russia and China to agree to begin negotiations on a broader arms treaty to supplant New START. "If the United States were to agree to extend the treaty now, I think it would make it less likely that we would have the ability to persuade Russia and China to enter negotiations on a broader agreement," Rood said.

In an apparent bid to encourage the US to extend the treaty, the Russian military last month [November] showed its latest hypersonic weapon to US inspectors. The Defense Ministry underlined that it demonstrated the Avangard hypersonic glide vehicle as part of transparency measures under the New START. Putin unveiled the Avangard in 2018 along with other prospective weapons, noting that its ability to make sharp maneuvers on its way to a target will render missile defense useless.

The failure to extend the pact would be highly destabilizing at a time when Russia-U.S. relations have sunk to the lowest levels since the Cold War. Putin and other Russian officials have repeatedly voiced concern about Washington's reluctance to discuss the treaty's extension.

New START is the only remaining U.S.-Russian nuclear arms control treaty after both Moscow and Washington withdrew from the 1987 INF Treaty earlier this year. The U.S. said it pulled out because of Russian violations, a claim the Kremlin

has denied. Putin reaffirmed Russia's pledge not to deploy missiles banned by the INF treaty until the U.S. and its allies do so. "Russia isn't interested in unleashing a new arms race," he said.

Source : <https://www.militarytimes.com/>, 06 December 2019.

NUCLEAR WASTE MANAGEMENT

AUSTRALIA

Residents Vote against Nuclear Waste Dump Near Hawker in South Australia

Residents in South Australia's Flinders Ranges have voted narrowly against having a nuclear waste dump in their region. About 52% of the people who took part in the ballot voted against the federal government's facility being established on land near Hawker. The result came after a similar poll of residents on SA's Eyre Peninsula voted almost 62% in favour of the dump being built on one of two sites near Kimba.

The federal government is yet to respond to the poll, but environmental groups said it should rule out the Flinders Ranges as a potential dump site. 'The most divisive thing': two small towns brace for a vote on nuclear waste. Australian Conservation Foundation campaigner Dave Sweeney said the result came amid clear opposition from regional pastoralists and the area's native title holders. "There is no broad community support for a national radioactive waste facility in the Flinders Ranges," Sweeney said.

The Friends of the Earth said it was time for the federal government to abandon the dump plan altogether. "The government has previously stated that 65% would be a figure that would indicate the broad community support they need to select a site," spokeswoman Mara Bonacci said. "These ballot results show that the minister does not have that support."

Two sites near Kimba and one near Hawker have

been shortlisted as possible locations for the dump, which would be designed to take Australia's low- to intermediate-level waste. Most of the material comes from nuclear medicine. The community ballots are not binding on the government, which has promised to provide financial incentives to the community around the selected site.

Source: https://www.theguardian.com, 12 December 2019.

GENERAL

Radioactive Waste Management Market Revenue, Opportunity, Segment and Key Trends 2023

In 2014, the total power generated by these facilities is around 2,364 billion kWh. Nuclear waste management costs around 5% of the total cost of the electricity generated. Nuclear power plants provide around 15% of world's electricity with more than 430 nuclear power plants operating worldwide to generate electricity and numerous research reactors. There are around 75 new nuclear plants under construction in 15 countries. There are more than 10 countries across the globe that relies on nuclear energy to supply at least one forth of their total electricity.

There are two sources of nuclear wastes: waste produced from the nuclear power plant as a by-product or from other miscellaneous applications such as research and medicine and contains radioactive material. Nuclear waste is hazardous to most forms of life and is regulated by the government agencies. Most of the fuel used in nuclear power plants consists of small uranium pellets which are stacked inside an alloy fuel and is stored in airtight steel or concrete and steel containers or in steel-lined concrete pools filled with water.

Nuclear waste is radioactive and hot when it is taken out of the reactor and should be disposed properly

Nuclear power plants provide around 15% of world's electricity with more than 430 nuclear power plants operating worldwide to generate electricity and numerous research reactors. There are around 75 new nuclear plants under construction in 15 countries. There are more than 10 countries across the globe that relies on nuclear energy to supply at least one forth of their total electricity.

to protect human beings as well as environment. Nuclear waste can remain radioactive for a very long time and it is difficult to find a disposal facility for radioactive waste. A disposable facility should be able to contain waste for a long time and is chosen on the bases of type of waste being disposed. Radioactive waste disposal technologies have been evolving and strict environmental protection and population prevention standards are maintained.

There is approximately 270,000 tons of used fuel. Approximately 90% of used fuel is in storage ponds and the rest in dry storage. Nuclear fuel waste is arising 12,000 tons per year and about 3,000 tons of the waste is reprocessed. In 2010, majority of the nuclear waste was generated from the U.S.; which is about 280,000 tones followed by France which is around 159000 tons and Germany which produced around 45,000 tones.

Due to the complicated regulatory structure for managing nuclear waste, disposing the waste is a complex issue. Despite of the number of time a nuclear fuel is used, it is disposed in a permanent geologic repository. For an integrated used nuclear fuel management program, underground disposal in a specially designed facility is an essential element.

On the basis of types of nuclear waste, the global radioactive waste management market can be segmented into exempt waste (EW), long and intermediate level waste (LILW) and High level waste (HLW). Items that have been in contact with

radioactive materials such as tools, gloves, purification filters and personal protective clothing are categorized as low level radioactive waste.

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... Most of the nuclear plants in the world are more than 30 years old. Dismantling a nuclear facility is also a problem for the industry. Some of the key companies in the global radioactive waste management market include Swedish Nuclear Fuel and Waste Management Company, Ecology Services, Inc., Veolia Environmental Services and Kurion Inc among others.

Source : <http://techilabs.com>, 14 December 2019.



Centre for Air Power Studies

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

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