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समाचार पत्रों से चयनित अंश
Newspapers Clippings

डीआरडीओ समुदाय को डीआरडीओ प्रौद्योगिकियों, रक्षा प्रौद्योगिकियों, रक्षा नीतियों, अंतर्राष्ट्रीय संबंधों और विज्ञान एवं प्रौद्योगिकी की नूतन जानकारी से अवगत कराने हेतु दैनिक सेवा

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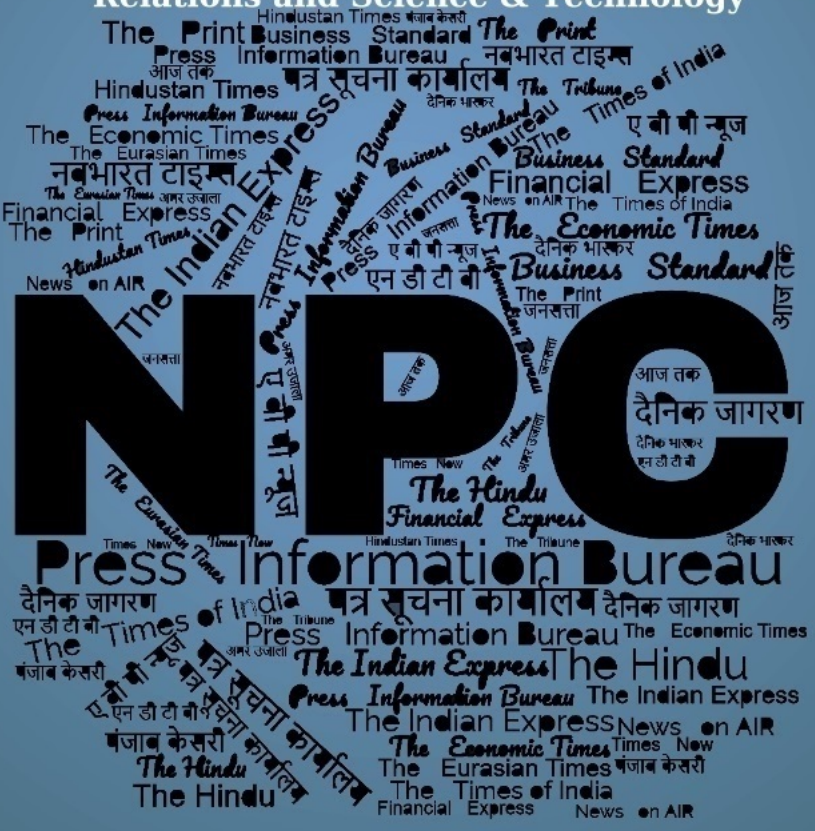

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THE TIMES OF INDIA

Wed, 12 Jun 2024

DRDO plans India's first underwater-launched UAV, awards contract to Pune startup Sagar Defence

To boost India's underwater military capabilities, Defence Research and Development Organisation (DRDO) has decided to develop a first-of-its-kind underwater-launched unmanned aerial vehicles (ULUAVs), with help from a Pune-based defence startup, that will be launched from a submarine.

DRDO's Technology Development Fund (TDF) has awarded the technology development contract for ULUAVs to Sagar Defence Engineering Pvt Ltd after selecting it out of the 17 firms through a competitive bidding process.

DRDO's Defence Research & Development Laboratory (DRDL) will assist Sagar Defence, which had earlier developed a maritime spotter drone for the Indian Navy, in ULUAV technology development. The agreement with Sagar Defence was signed in the presence of DRDL director Dr G A S Murthy and Indian Navy officials.

A ULUAV will have the capability to be deployed quickly, safely and autonomously from a moving submarine. It will have high endurance and long range, giving it a huge surprise element advantage. It will enable discreet surveillance missions, allowing submarines to monitor potential threats without revealing their presence. Mridul Babbar, director & vice-president of business development, Sagar Defence, told TOI, "This ULUAV technology is going to be highly advanced. Only a few countries in the world possess ULUAVs but they are not highly advanced.

Like the US ULUAV has a range of 7 km and its endurance is for 30 minutes. However, DRDO has entrusted us to develop a ULUAV that will have a longer endurance of more than one hour and will have a range of over 20 km. And we are the first to develop this technology in India. This ULUAV will be for maritime and underwater domain awareness and will be used for data gathering." This will be expandable and in future, weapons can also be installed on it, he added.

The project signifies Modi govt's proactive approach to fostering indigenous innovation and technological advancement. Sagar CEO Captain Nikunj Parashar said, "This contract not only underscores the trust and confidence that DRDO has in our capabilities but also serves as a testament to the strides we are making in defence innovation."

By harnessing the capabilities of unmanned aerial vehicles in underwater environments, the defence industry stands to gain a decisive edge in intelligence, surveillance and reconnaissance, enhancing situational awareness and operational effectiveness across the maritime domain.

https://timesofindia.indiatimes.com/india/drdo-plans-indias-first-underwater-launched-uav-awards-contract-to-pune-startup-sagar-defence/articleshow/110919999.cms

Defence News

Defence Strategic: National/International

Press Information Bureau
Government of India

Ministry of Defence

Fri, 07 Jun 2024

Vice Chief of the Army Staff Lt Gen Upendra Dwivedi appointed as next Chief of the Army Staff w.e.f. afternoon of June 30, 2024

The Government has appointed Lt Gen Upendra Dwivedi, PVSM, AVSM, presently serving as Vice Chief of the Army Staff, as the next Chief of the Army Staff with effect from the afternoon of June 30, 2024. The present Chief of the Army Staff Gen Manoj C Pande, PVSM, AVSM, VSM demits office on June 30, 2024.

Born on July 01, 1964, Lt Gen Upendra Dwivedi was commissioned into the Infantry (Jammu & Kashmir Rifles) of the Indian Army on December 15, 1984. During his long and distinguished service spanning nearly 40 years, he has served in a variety of Command, Staff, Instructional and Foreign appointments. The Command appointments of Lt Gen Dwivedi include Command of Regiment (18 Jammu & Kashmir Rifles), Brigade (26 Sector Assam Rifles), Inspector General, Assam Rifles (East) and 9 Corps.

In the rank of Lt Gen, the officer has tenanted important appointments including that of Director General Infantry and General Officer Commanding in Chief (Headquarter Northern Command) from 2022-2024, before getting appointed as the Vice Chief of the Army Staff.

An alumnus of the Sainik School Rewa, National Defence College and US Army War College, Lt Gen Upendra Dwivedi has also undergone courses at the DSSC Wellington and Army War College, Mhow. In addition, the officer was conferred 'Distinguished Fellow' in the coveted NDC equivalent

course at USAWC, Carlisle, USA. The officer has an M Phil in Defence & Management Studies and two Master's Degrees in Strategic Studies and Military Science.

He has been decorated with the Param Vishisht Seva Medal (PVSM), Ati Vishisht Seva Medal (AVSM) and three GOC-in-C Commendation Cards.

https://pib.gov.in/PressReleasePage.aspx?PRID=2024481

अमर उजाला

Wed, 12 Jun 2024

Next Army Chief: कौन हैं ले. जनरल उपेंद्र द्विवेदी? जो होंगे नए सेना प्रमुख, भारत–चीन सीमा का है लंबा अनुभव

डिप्टी आर्मी चीफ लेफ्टिनेंट जनरल उपेंद्र द्विवेदी नए सेना प्रमुख होंगे। वह जनरल मनोज पांडेय की जगह लेंगे। लेफ्टिनेंट जनरल द्विवेदी की नियुक्ति में सरकार ने वरिष्ठता के सिद्धांत का पालन किया है। रक्षा मंत्रालय ने इस बारे में जारी एक बयान में कहा, सरकार ने वर्तमान सेना उप प्रमुख लेफ्टिनेंट जनरल उपेंद्र द्विवेदी को अगला सेना प्रमुख बनाने का फैसला लिया है। उनकी नियुक्ति 30 जून से प्रभावी होगी।

लेफ्टिनेंट जनरल उपेंद्र द्विवेदी ने यहां से हुई है शिक्षा

लेफ्टिनेंट जनरल उपेंद्र द्विवेदी का जन्म 1 जुलाई 1964 को हुआ था। लेफ्टिनेंट द्विवेदी ने सैनिक स्कूल रीवा, नेशनल डिफेंस कॉलेज और यूएस आर्मी वॉर कॉलेज से हुई है। उन्होंने डीएसएससी वेलिंगटन और आर्मी वॉर कॉलेज (महू) से भी कोर्स किया है। इसके अलावा उन्हें यूएसएडब्ल्यूसी, कार्लिस्ले, अमेरिका में प्रतिष्ठित एनडीसी समकक्ष पाठ्यक्रम में 'विशिष्ट फेलो' से सम्मानित किया गया। उनके पास रक्षा और प्रबंधन अध्ययन में एम फिल और सामरिक अध्ययन और सैन्य विज्ञान में दो मास्टर डिग्री हैं।

PVSM, AVSM समेत कई सम्मान मिले

लेफ्टिनेंट जनरल उपेंद्र द्विवेदी को परम विशिष्ट सेवा पदक (पीवीएसएम), अति विशिष्ट सेवा पदक (एवीएसएम) और तीन जीओसी–इन–सी प्रशस्ति पत्र से सम्मानित किया गया है।

15 दिसंबर 1984 में ज्वाइन की थी सेना

लेफ्टिनेंट जनरल उपेंद्र द्विवेदी को सैन्य गतिविधियों में करीब 40 साल का अनुभव है। उन्हें 15 दिसंबर, 1984 को भारतीय सेना की इन्फैंट्री जम्मू और कश्मीर राइफल्स में कमीशन मिला था। अपनी लंबी और विशिष्ट सेवा के दौरान उन्होंने कई कमांड, स्टाफ और इंस्ट्रक्शनल में काम किया है। लेफ्टिनेंट उपेंद्र द्विवेदी की कमांड नियुक्तियों में रेजिमेंट 18 जम्मू और कश्मीर राइफल्स, ब्रिगेड 26 सेक्टर असम राइफल्स, आईजी, असम राइफल्स (पूर्व) और 9 कोर की कमान भी शामिल हैं।

रक्षा मंत्रालय ने जारी किया बयान

रक्षा मंत्रालय ने इस बारे में जारी एक बयान में कहा, 'सरकार ने वर्तमान सेना उप प्रमुख लेफ्टिनेंट जनरल उपेंद्र द्विवेदी को अगला सेना प्रमुख बनाने का फैसला लिया है। उनकी नियुक्ति 30 जून से प्रभावी होगी। लेफ्टिनेंट जनरल

द्विवेदी परम विशिष्ट सेवा मेडल और अतिविशिष्ट सेवा मेडल से सम्मानित हैं। द्विवेदी के बाद सबसे वरिष्ठ सैन्य अधिकारी लेफ्टि.जनरल अजय कुमार सिंह हैं जो दक्षिणी सैन्य कमान के कमांडर हैं।

जनरल मनोज पांडे का कार्यकाल एक महीने के लिए बढ़ाया गया

सेनाध्यक्ष जनरल मनोज पांडेय का कार्यकाल 31 मई को ही समाप्त हो गया था लेकिन दुर्लभ मामले में चुनावी प्रक्रिया के दौरान उनके कार्यकाल को एक महीने का विस्तार दिया गया था। रक्षा मंत्रालय का कहना था कि आर्मी रूल्स, 1954 के नियम 16 ए (4) के तहत ये सेवा विस्तार दिया गया। इससे पहले पहले इंदिरा गांधी की सरकार में 1970 के दशक में तत्कालीन सेना प्रमुख जनरल जीजी बेवूर के कार्यकाल को एक साल का विस्तार दिया था।

तीनों सेना प्रमुख अधिकतम 3 सालों तक पद पर रह सकते हैं

तीनों सेनाओं के प्रमुख 62 वर्ष की आयु तक या तीन सालों तक, जो भी पहले हो, सेवा कर सकते हैं। हालांकि लेफ्टिनेंट जनरल रैंक के अधिकारियों की सेवानिवृत्ति की आयु 60 साल है जब तक कि अधिकारी को 'फोर स्टार रैंक' नहीं मिलती है।

https://www.amarujala.com/india-news/govt-appoints-lt-gen-upendra-dwivedi-as-next-army-chief-2024-06-12

Press Information Bureau
Government of India

Ministry of Defence

Tue, 11 Jun 2024

Japan India Maritime Exercise – 24 (JIMEX – 24) Commenced At Yokosuka Japan

Indian Navy's indigenous Stealth Frigate INS Shivalik arrived at Yokosuka, Japan to participate in the bilateral Japan – India Maritime Exercise 2024 (JIMEX 24). This is the eighth edition of JIMEX, since its inception in 2012.

The ship was accorded a warm welcome by VAdm ITO Hiroshi, Commander JMSDF Yokosuka District & Ambassador Sibi George, Ambassador of India to Japan.

The exercise includes both harbour and sea phases. The harbour phase will comprise professional, sports and social interactions, after which the two navies will jointly hone their war fighting skills at sea and enhance their interoperability through complex multi-discipline operations in the surface, sub-surface and air domains. The IN is being represented by INS Shivalik and the JMSDF is being represented by the Guided Missile Destroyer JS Yugiri. Integral helicopters from both navies will also participate in the joint exercise.

Having grown in scope and complexity over the years, JIMEX 24 provides an opportunity to learn from each other's best practices and facilitates operational interactions between IN and JMSDF to foster mutual cooperation and reaffirm their shared commitment towards maritime security in the Indo – Pacific.

https://pib.gov.in/PressReleasePage.aspx?PRID=2024261

Press Information Bureau
Government of India

Ministry of Defence

Tue, 11 Jun 2024

Launch Of Lsam 13 (Yard 81) Fifth Barge Of 08 X Missile Cum Ammunition (MCA) Barge Project

The launch of 'Missile Cum Ammunition Barge, LSAM 13 (Yard 81)', the fifth Barge of 08 x Missile Cum Ammunition Barge project, built by MSME Shipyard, M/s SECON Engineering Projects Pvt Ltd (SEPPL), Visakhapatnam for Indian Navy, was undertaken on 10 Jun 24 at M/s Vinayaga Marine Petro Ltd, Mira Bhayandar, Maharashtra (launch site of M/s SECON Engineering Projects Pvt Ltd). The launching Ceremony was presided over by Cmde Manish Vig, General Manager (QA), ND(Mbi).

The contract for building 08 x Missile Cum Ammunition Barge was signed between MoD and M/s SECON Engineering Projects Pvt Ltd, Visakhapatnam on 19 Feb 21. The availability of these Barges would provide impetus to operational commitments of IN by facilitating Transportation, Embarkation and Disembarkation of articles/ ammunition to IN Ships both alongside jetties and at outer harbours.

These Barges are indigenously designed and built under relevant Naval Rules and Regulation of Indian Register of Shipping (IRS). The model testing of the Barge during design stage were undertaken at Naval Science and Technological Laboratory (NSTL), Visakhapatnam. These Barges are proud flag bearers of Make in India initiative of Government of India (GoI).

https://pib.gov.in/PressReleasePage.aspx?PRID=2024061

The Indian EXPRESS

Wed, 12 Jun 2024

Chinese armed forces have been upgrading. India must keep up

As part of the reforms in the People's Liberation Army (PLA) since 2015, China has focussed on preparing for combat keeping conditions of the "Information Age" in mind. It is doing so by integrating its services, arms and systems into a joint, network-centric fighting force.

The PLA Western Theater Command (WTC) has played a proactive role in securing China's southern and southwestern borders, preparing for conventional and non-conventional warfighting, and acclimatising its personnel to the rough terrains and harsh altitudes of Xinjiang and Tibet. India is one of the principal operational directions in which the WTC is mandated to act. India needs to

assess the WTC's operational structure, training mandates and warfighting priorities, especially the theatre's "multi-domain integrated joint operations" (MDIJO) efforts.

The WTC has focussed on three key factors. These include conducting combat training and preparedness exercises, getting acquainted with WTC's harsh terrain bordering India; and building air superiority and transportation capabilities.

The WTC invests significantly in combat training and simulation. Accounts of such exercises feature both its successes and failures. In August 2018, an anti-aircraft artillery unit of Xinjiang Military District (MD) conducted a live-fire exercise in the Tian Shan mountains to refine the troops' integrated combat capabilities. This was a test of the interplay between Command and Control (C2) and ground-based air defence units. The evaluation stage which assessed damage revealed that many anti-aircraft positions were in flames — indicating a failure on the surprise attack test. An assessment like this may give the Indian security apparatus clues as to the WTC's weaknesses and what it should focus on.

Given the tough terrains and complex environments, aerial dominance is central to the theatre's capabilities — and its biggest challenge. When pitted against India, an assessment of the ORBAT (order of battle) formulated by the Belfer Center indicates that as of 2020, the ground forces deployed on both sides are similar in numbers (over 2,05,000 troops), while Indian fighter jets outnumber Chinese — a 250 to 157 balance.

On ground-based air defence, four air defence brigades are attached each to the Xinjiang and Tibet Military Districts and the WTC 76th and 77th Group Armies. At the same time, the WTC air forces have their long-range surface-to-air missile installations. The WTC is enabling PLA ground and air forces to combine air defence systems. In light of this, India is investing in its own indigenous Very Short-Range Air Defence Systems (VSHORADS) and Man-Portable Air Defence Systems (MANPADS) to expand Army Air Defence (AAD) capabilities.

Over the years, anti-aircraft artillery units along with ground-to-air missile units, have become the backbone of the WTC's air defence capabilities. In May 2021, the Xinjiang MD engaged in six rounds of weapons acquisition. At the time, India and China were still recovering from the deadly Galwan Valley clashes of June 2020. The fifth and sixth rounds of acquisition focussed solely on aerial superiority, through the induction of the PHL-11 122 mm calibre self-propelled multiple rocket launcher system and the HQ-17A field air defence missile system.

The challenge of transportation is central to training in these terrains too. Given the "last-mile delivery requirements" of high-altitude zones specifically in the WTC, unmanned aerial vehicles (UAVs) are adopted for transporting food and essentials to active personnel. This is in addition to the induction of the Xi'an Y-20 "Kunpeng" heavy-transport aircraft, which can fly winter gear to border troops stationed along the LAC in seven hours.

Evidence for the use of UAVs comes from a November 2020 drill conducted by the logistics departments of the PLA army and the Tibet MD, where a drone delivery unit was required to transfer hot food, water, medicine and other urgent aid to personnel located at a base in the mountains, assuming that the manned mobile ground transportation unit was "blocked by enemy fire." According to the report, the success of the drone delivery unit was determined by how decisive drone operators were in making a comprehensive judgement on terrain, wind speed,

temperature and other factors to ensure the unit's safe landing at the predetermined destination. The report promises that the PLA army logistics department is preparing to expand drone delivery to armament and ammunition supplies to active last-mile locations.

In an era where the Information Age is enabling revolution in military affairs (RMA), the PLA is adapting to new modes and methods of warfighting. Integrating these is key to the PLA's goal of becoming a "world-class force" by 2049. Over the next few years, it is only likely that the WTC will double down on such measures, creating a joint force capable of conducting successful combat operations. India, then, must continue to observe developments in the WTC and direct its efforts towards countering them.

With Rajnath Singh's re-appointment as India's defence minister, one of the priorities on his military modernisation agenda would be the creation of integrated theatre commands (ITCs) in the Indian armed forces. Even though there is no intended timeline for this yet, Singh has argued that in some countries, theaterisation has taken more than two decades to materialise. This is true in China's case if one considers the MR model a rung in the evolutionary ladder of theaterisation in the PLA. Now, as the point person for India's theaterisation, Chief of Defence Staff General Anil Chauhan has positioned the reform as India's response to jointness efforts in the PLA. Given that ITCs are intended to promote a joint culture and not a service-specific culture, Chauhan has expressed the belief that the reform will catapult India into a new era of combat preparedness. However, with the Chinese PLA many steps ahead of the Indian armed forces in this regard, a concrete delivery timeline and a larger, non-lapsable modernisation fund will be critical.

https://indianexpress.com/article/opinion/columns/chinese-armed-forces-have-been-upgrading-india-must-keep-up-9386658/

REPUBLICWORLD.COM

Tue, 11 Jun 2024

Kadet Defence Systems Pioneers India's foray into Jet-Powered Aerial Target Production

Kadet Defence Systems (KDS), a leading aerospace company in India, has achieved a significant milestone with the successful launch of JetPowered Aerial Targets, marking a historic leap in indigenous defence technology. These advanced aerial targets, designed and developed entirely in India, have been exported to foreign-friendly countries, solidifying India's position in the global defence market.

KDS' jet-powered aerial targets boast cutting-edge capabilities, including speeds exceeding 500 kilometres per hour, a flight range of 300 kilometres, and altitudes surpassing 6,000 meters. Equipped with low observable radar cross-section and swarming capabilities, these targets serve as vital tools for military training, weapon system development, and evaluation exercises. They facilitate the testing of various defence systems, including shoulder-fired missiles, guns, and

artillery systems, while also serving as high-speed decoys and CounterUnmanned Aerial System (CUAS) solutions.

India's Entry into Jet-Powered Aerial Target Manufacturing KDS' achievement marks a paradigm shift in India's defence technology landscape, transitioning from reliance on imports to domestic production of sophisticated aerial targets. This milestone underscores India's commitment to self-reliance in defence manufacturing and showcases the country's growing capabilities in advanced defence technology. By supplying these targets to both domestic and international markets, KDS contributes to India's vision of Atmanirbhar Bharat while establishing itself as a key player in the global defence sector.

The increasing demand for aerial targets within defence applications reflects their crucial role in enhancing military readiness and effectiveness. With realistic simulation features and advanced capabilities, aerial targets enable armed forces to conduct various tactical scenarios and mission objectives.

Avdhesh Khaitan, CEO of Kadet Defence Systems, expressed pride in the company's achievement and emphasized its dedication to innovation and excellence in defence technology. With this groundbreaking development, KDS not only strengthens national defence capabilities but also demonstrates the potential of Indian companies to compete on the global stage. Moreover, as India undertakes key weapon development programs, the availability of indigenous solutions for evaluation purposes enhances cost-effectiveness and data security in defence testing processes.

https://www.republicworld.com/defence/defence-technology/kadet-defence-systems-pioneers-india-s-foray-into-jet-powered-aerial-target-production/?amp=1

The EurAsian Times

Tue,11 Jun 2024

Pakistan Explores Nuclear Attack Submarine For 2nd-Strike Capability; Underwater Calculus For Indian Navy Set To Alter

In what could complicate the underwater battleground for the Indian Navy, the Pakistan Navy is exploring the option of having sea-based deterrence by equipping its under-construction Chinese submarines with nuclear-tipped missiles.

Pakistan's fiscal challenges had delayed the acquisition of the S-26 Hangor class submarines from China. Instead of receiving the first submarine at the end of 2023, the first of the Yuan-class submarines was launched in May 2024.

When eight of these submarines equipped with Air-Independent Propulsion join the Pakistan Navy, it will bolster the country's offensive sea denial strategy, which prioritizes using submarines and

missile-carrying maritime patrol aircraft in naval warfare. Expected to join the Pakistan Navy by the late 2020s and early 2030s, it will strengthen the AIP-equipped submarines in its Navy to 11.

Reports now indicate that the Hangor class submarine might not be a purely conventional attack submarine. Retired Pakistan Naval officers on the state-owned television network talked about Islamabad working towards an "assured" second-strike capability.

A report in Quwa quotes Vice Admiral Ahmed Saeed and Rear Admiral Saleem Akhtar, both retired Pakistan Navy officials, discussing the acquisition of Hangor-class submarines from China. Vice Admiral Saeed indicated the submarines will be a "hybrid" piece in Pakistan's broader deterrence posture.

"It will be a compromise between a purely conventional attack submarine and nuclear-powered boat, such as a nuclear-powered submarine (SSN) or a nuclear-powered ballistic missile submarine (SSBN)," the Quwa report said.

While retrofitting the Hangor class submarines with a nuclear reactor is implausible, the Pakistan Navy can deploy Tactical Nuclear Warheads (TNWs) on the subsurface vessels.

"It (the submarine) cannot be retrofitted to become a nuclear boat. Submarine reactors are extremely complex to build. Even China will not have a small enough to be fitted on Hangor (class submarine). If China intends to arm it with TNWs, that is a different matter," Air Commodore Anil Jai Singh (retired) told the EurAsian Times.

The former Indian Navy submariner indicates that building a nuclear-powered submarine is an expensive endeavor, and India has not embarked on it.

Pakistan has been working on TNWs to leverage it against India since its first nuclear weapons test in 1998. TNWs are smaller, more portable, and intended for use on the battlefield rather than as strategic deterrents. Pakistan intends to use TNWs against invading Indian forces to quickly defeat the forces without triggering a full-scale strategic nuclear war.

The Hangor-class SSP will likely use a variant of the Babur-3 SLCM, which Pakistan first tested in 2018. The Babur-3 has a stated range of 450 km.

Following the Babur-3 test, the Inter-Services Public Relations (ISPR) has underscored that Sea-Launched Cruise Missile is a key component of a "credible second-strike capability." Vice Admiral Saeed, during the discussion, contended that the Hangor class is not a dedicated nuclear platform.

Sea Leg Of Pakistan's Nuclear Deterrence

The Pakistan Navy is keen to acquire the ability to fire nuclear weapons from sea, but it does not require a large number of such platforms.

"The PN would only require one or two dedicated boats for the nuclear role. However, the Hangor class would manage strategic roles on a part-time basis; the conventional A2/AD mission would be its primary role," the Quwa report adds. Vice Admiral Saeed asserted that Islamabad should not stop at the Hangor-class submarine and should pursue a dedicated strategic platform.

A potential framework for a dedicated sea-based nuclear capability for Pakistan does not require a large number of units. Only two boats can be sufficient for the Pakistan Navy.

However, Commodore Singh does not seem to be bothered with just one boat in the Pakistan Navy. “One boat has very limited capability. India will know when it is in refit or undergoing maintenance or is otherwise in the harbor. PLAN (People Liberation Army-Navy) may lease one to Pak if it thinks Pak can develop/afford this capability in the future. At this point, it seems highly unlikely,” Singh opined.

Should The Indian Navy Be Concerned?

Pakistan can’t design and develop a nuclear-powered submarine, but Vice Admiral Saeed’s statements indicate that the Pakistan Navy might be studying the idea. Islamabad might be pursuing a nuclear submarine program as part of a long-term strategy.

Arming Pakistan with a nuclear-attack submarine might also benefit China, which would like the Indian Navy to be more competitive in the Indian Ocean Region (IOR). So far, China has been supplying submarines to Bangladesh, Pakistan, and Myanmar, making the underwaters in the IoR a very contested space.

Explaining how a Pakistan submarine armed with TNWs affects India, Captain Anurag Bisen (retired) said: “The Indian Navy will not be able to deploy its (aircraft) Carrier till the Pakistani nuclear submarine is accounted for.”

India has also been adopting a more flexible deterrence vis-à-vis its two aggressive nuclear-powered countries – China and Pakistan. On March 11, New Delhi successfully test-fired a long-range ballistic missile, Agni-V, with Multiple Independently Targetable Re-entry Vehicle (MIRV) technology. MIRV technology, which increases the survivability of its nuclear-tipped missiles, could also be useful for first strikes, experts have argued.

The evolving nuclear deterrence in the Indian subcontinent also gives hope to Commodore Singh. “The threat of nuclear-tipped torpedo or missile will generate concern, but using TNWs is easier said than done. Pakistan keeps threatening to use its TNWs, but has it factored in the Indian response? Our nuclear doctrine clearly states our response in retaliation against a first strike. Can Pakistan take that chance?” Singh signs off.

https://www.eurasiantimes.com/pakistan-explores-nuclear-attack-submarine/

The EurAsian Times

Tue, 11 Jun 2024

China Aims At 1000 J-20 Fighters By 2035 When India Gets 5th-Gen AMCA; Can IAF Narrow The Gap With PLAAF

India has an ambitious lineup to achieve self-reliance in building indigenous fighter jets. Apart from the variants of Light Combat Aircraft, the Indian defense industry has been given the government’s nod to develop the fifth-generation Advanced Medium Combat Aircraft (AMCA) in 2024. However, the fact remains that by the time the AMCA starts flying, China will have fielded 1000 J-20 ‘Mighty Dragon’ 5th-generation jets.

After being the second country in the world to have an operational 5th-generation fighter jet in its fleet, China is already moving to develop 6th-generation fighter jet technologies.

J-20 is a twinjet all-weather stealth 5th-generation fighter aircraft designed by China's Chengdu Aerospace Corporation of the People's Liberation Army Air Force (PLAAF). It took to the skies for the first time on January 11, 2011, and was officially revealed in 2016.

The Mighty Dragons entered service in 2017, and PLAAF already has over 200 fighter jets in its fleet. The goal is to take the number to 400 by 2027 and 1,000 by 2035. China has deployed at least six J-20s less than 150 kilometers (km) from the de facto border with India in the Sikkim region.

The J-20 is a single-seater, multi-role stealth fighter designed to combine both air superiority and precision strike capabilities. Presently, the IAF has its fleet of 36 French-built Rafale combat jets to counter J-20s. Shigatse, where the PLAAF's J-20s have been reportedly deployed, is located less than 290 km from Hasimara air base in West Bengal, where the IAF has based its second squadron of 18 Rafale jets.

China is still struggling with the engines of its fighter jets. However, as the first country in Asia to field an operational stealth aircraft, it will have a lead of nearly one and a half decades to mature its 5th-generation fighter jet capabilities when the Indian AMCA is planned to enter service.

"India is still evolving technologies for its fifth-generation aircraft, the AMCA. India is also still a 'work-in-progress' in technologies related to aero-engines, AESA radars, EW systems, modern weapons, actionable Artificial Intelligence (AI), and other advanced avionics," Air Marshal Anil Chopra (retired), an Indian Air Force (IAF) has written.

Undoubtedly, there has been a clamor in the military experts in India for India to expedite its timeline. The Cabinet Committee on Security (CCS) sanctioned Rs. 15,000 crores ($1.9B) to design and develop AMCA only in March 2024. The Aeronautical Development Agency (ADA) under the Defense Research and Development Organisation (DRDO) will be the nodal agency for the development of the aircraft. The aircraft will be manufactured by state-owned Hindustan Aeronautics Limited (HAL).

The HAL is already working on augmenting its capability to manufacture more LCA Mk1A to meet the IAF order. After that, the work will be done on LCA MK 2. Then, it will be the turn of AMCA.

The ADA has been assertive that the 25-ton twin-engine AMCA will be at par or even superior to other 5th-generation stealth fighters globally when it materializes.

"At current technology levels, going alone will not be a practical option for India. India must hasten the LCA Mk2 and AMCA and get its MUM-T "Loyal Wingman" technology right. Many countries have collaborative routes. Should India join the GCAP or the French-led FCAS program? These are hard calls to make. Collaboration means sharing costs and risks," Air Marshal Chopra ruminates.

The Choice Between Self-Reliance & Capability

To add to the IAF's predicament, a large chunk of its fleet comprises third-generation fighter jets, even as its two major adversaries in Asia have been rapidly inducting and deploying newer fighter jets. India's bête-noir Pakistan could possibly acquire a fifth-generation fighter before AMCA.

Turkey announced in 2023 that it is starting negotiations with Pakistan to make it an official partner in combat aircraft development. The culmination of a series of bungling by the Indian defense establishment and top brass of the IAF over the years has resulted in the force staring at two lost decades of technological advancement.

Delayed acquisition and slow development of indigenous fighter jets have resulted in the IAF with dwindling units of aging fighter jets to defend the Indian airspace. As reported by the EurAsian Times, the IAF now has more surface-to-air missile units than fighter jets.

India's quest for the next generation of fighter jets began almost 15 years ago when it joined hands with Russia to develop the Fifth Generation Fighter Jet (FGFA).

The DRDO has often been criticized for setting up ambitious timelines only to miss them. The Project Director of AMCA, Dr. AK Ghosh, had stated during DefExpo-2022: "Once the project sanction is received, the prototype can be rolled out in three years and the first flight in one to one and half years after that." However, the IAF received the claim with a dollop of salt.

In November 2022, the Chief of the Air Staff (CAS), Air Chief Marshal VR Chaudhari, advised"prudence." He recommended foreign tie-ups as a fallback for developing "alternative systems and sensors" in case Indigenous development slips off the timeline.

Following the remarks from the IAF Chief, DRDO Chairman Samir Kamat announced a redone timeline on February 14, 2023. As per it, the first flight of the AMCA "may take seven years, and the induction can be done in ten years from now." The first flight timeline had already been pushed back from 2027 to 2030, and the induction was slated for 2035.

"Based on their track records and their proclivity for over-projection, there can be little doubt that DRDO and HAL (Hindustan Aeronautics Limited) leadership will be forced to push back timelines and seek performance concessions due to technology shortfalls during the AMCA project," IAF veteran Vijaindra K Thakur wrote in an article for the EurAsian Times.

An instance of these over-ambitious timelines is the Turkish KAAN fighter jet, whose development began at the same time as the AMCA project. The core group to develop the Indian stealth fighter was formed in 2009 with five defense scientists—Ashish Kumar Ghosh, Krishna Rajendra Neeli, MB Angadi, AK Vinayagam, and Fairoza Naushad. Turkey's Defense Industry Executive Committee (SSIK) decided to develop a next-generation air-superiority fighter in December 2010.

While the Indian project is still on the drawing board, the Turkish Aerospace Industry's aircraft has already undertaken its maiden flight.

Thakur adds: "While giving its go-ahead to the project, it is essential that the CCS be aware of the pitfalls and remain alert to the impact of project delays on the combat capability of the IAF. The nation can afford to wait for the AMCA but cannot afford to let its guard down."

The Modi Government 3.0 must maintain a balance between self-reliance or 'Atma-nirbharata' and the capability of the armed forces. The military's lethality and capability should be commensurate with the security challenges faced by the country.

https://www.eurasiantimes.com/china-aims-at-1000-j-20-fighters-by-2035/

THE ECONOMIC TIMES

Tue, 11 Jun 2024

Adani def & aero, EDGE Group sign agreement to set up global platform leveraging capabilities of both firms

Adani Defence & Aerospace and a leading group in the UAE have signed a cooperation agreement aiming to establish a "global platform" leveraging capabilities of both companies to bring together their respective product portfolios and cater to the requirements of global and local customers, according to an official statement. The agreement will also explore establishment of research and development facilities in India and the UAE, said the statement issued on Tuesday.

"Adani Defence & Aerospace, one of the leading defence and aerospace companies of India, has signed a milestone cooperation agreement with EDGE Group, one of the world's leading advanced technology and defence groups in the UAE," it said.

The agreement aims to establish a global platform leveraging the defence and aerospace capabilities of both companies to bring together their respective product portfolios and cater to the requirements of global and local customers, it added.

This includes evaluating cooperation across EDGE's and Adani's core product domains, including "missiles and weapons, covering airborne, surface, infantry, ammunition, and air defence products, platforms and systems, covering unmanned aerial systems (UAS), loitering munitions, counter drone systems, unmanned ground vehicles (UGV), as well as electronic warfare (EW) and cyber technologies", the statement said.

The agreement will also explore setting up of development, production and maintenance facilities of defence and aerospace solutions to not just serve the two captive markets, but also the Southeast Asian and wider global markets, the statement said.

"Our collaboration marks the beginning of a new era in enhancing defence capabilities, emphasizing our commitment to advance technological prowess and promoting bilateral defence cooperation between India and the UAE," Adani Defence & Aerospace CEO Ashish Rajvanshi was quoted as saying in the statement. It is a reflection of "our shared vision to fortify our nation's capabilities" by not just delivering cutting-edge solutions for the two countries but also setting new benchmarks in the global defence landscape, he said.

Edge Group Managing Director and Chief Executive Officer Hamad Al Marar said: "Our agreement with Adani Defence & Aerospace, represents a significant milestone, strengthening our ties within India's defence industry, and underscoring our mutual commitment to advancing UAE-India military ties."

"This agreement reflects our dedication to bringing our customers the most advanced and sophisticated products to the market, while taking advantage of the global export potential including critical UAE-grown technology," he added. "We are keen to set up the joint platform between Adani Defence and Edge to pioneer new technologies and set new standards in advanced military equipment and defence sector," Al Marar was quoted as saying in the statement. The

agreement with Adani Defence & Aerospace reinforces EDGE's commitment to India's defence industry, a market of strategic importance for the group, it said.

https://economictimes.indiatimes.com/news/defence/adani-def-aero-edge-group-sign-agreement-to-set-up-global-platform-leveraging-capabilities-of-both-firms/articleshow/110916186.cms

THE ECONOMIC TIMES

Tue, 11 Jun 2024

South Korea, US work on joint strategy over North nuclear threat

Senior South Korean and U.S. defence officials met in Seoul on Monday to work on new guidelines to coordinate their response to any nuclear threat from North Korea, officials said.

The guidelines laid out the principles and procedures for maintaining and enhancing a "credible and effective" nuclear deterrence policy and posture, according to a joint statement from the allies' third closed-doors talks on the issue. The Nuclear Consultative Group meeting came amid signs North Korea is racing to develop its nuclear arms and delivery systems.

Some South Korean politicians, including senior members of President Yoon Suk Yeol's party, have called for Seoul to develop its own nuclear weapons rather than just rely on the U.S. nuclear umbrella, a step Washington opposes.

Monday's meeting followed up on last year's summit, when the United States promised to give South Korea more insight into its nuclear planning for any conflict with the North. Vipin Narang, acting U.S. assistant secretary of defence for space policy who co-chaired the talks, said the guidelines set up an architecture for how the allies integrate conventional and nuclear capabilities which will be ultimately provided to each country's leadership in a crisis.

"The guidelines cover the principles and procedures for consultations, particularly in a DPRK nuclear crisis and inform alliance operational concepts and exercises," Narang told a news conference, using the acronym of North Korea's official name, the Democratic People's Republic of Korea. Cho Chang-rae, South Korea's deputy defence minister for policy, said highlevel officials from both countries will hold a simulated tabletop exercise before regular summertime drills, with a focus on the possibility of North Korea using a nuclear weapon.

The two Koreas are still technically at war after their 1950-53 conflict ended in an armistice, not a peace treaty. In late May, North Korea's attempt to launch a military reconnaissance satellite failed after a newly developed rocket engine exploded in flight. Seoul and Washington condemned the launch as a violation of U.N. Security Council sanctions banning Pyongyang's use of ballistic technology.

After their second meeting in December, both sides warned that any nuclear attack by North Korea against the United States or its allies will be met with a "swift, overwhelming and decisive

response" and result in the end of Kim Jong Un's regime. Their next meeting will be held in Washington near the end of the year, the joint statement said.

https://economictimes.indiatimes.com/news/defence/south-korea-us-work-on-joint-strategy-over-north-nuclear-threat/articleshow/110883582.cms

THE ECONOMIC TIMES

Tue, 11 Jun 2024

What are tactical nuclear weapons and why is Russia holding drills?

Russia and its ally Belarus are carrying out exercises to practise the deployment of tactical nuclear weapons.

What Are Tactical Nuclear Weapons And How Powerful Are They?

Tactical nuclear weapons are intended for battlefield use, as opposed to strategic weapons designed to be fired across vast distances to wipe out enemy cities. The underlying physics is the same, using nuclear fission and fusion reactions to release vast amounts of energy. The destructive power of tactical nuclear weapons, while typically smaller than strategic weapons, is still comparable with the atomic bombs used by the United States to destroy the Japanese cities of Hiroshima and Nagasaki at the end of World War Two.

How Many Do Russia And The U.S. Have?

The United States has about 200, half of which are at bases in Europe. Russia has about 1,558 non-strategic nuclear warheads, experts at the Federation of American Scientists estimated in March. These could be delivered by different means including being dropped as bombs or fitted to a variety of missiles that are capable of carrying either nuclear or conventional warheads.

What Do The Russian Exercises Look Like?

Russia said the first phase, conducted last month, involved Kinzhal and Iskander missiles. It took place in the southern region of Akhtubinsk, according to geolocation confirmed by Reuters. Video released by the defence ministry showed convoys of vehicles transporting Iskanders and presumably the nuclear warheads intended to be fitted to them. The warheads were blurred in the video. It also showed a Tu-22M Backfire bomber plane and a MiG-31K fighter, both capable of carrying the hypersonic Kinzhal. Video of the second phase on Tuesday showed an Iskander system being driven into a field and the missiles raised into position, as well as MiG-31 supersonic interceptors and Tupolev Tu-22M3 long-range supersonic bombers.

Why Is Russia Holding The Drills?

Russia says such exercises are normal practice but that they were made necessary by what it sees as hostile actions by the United States and its European allies. Moscow said last month it hoped the drills would cool "hotheads" in Western capitals, after French President Emmanuel Macron raised

the possibility of sending European troops to fight with Ukraine against Russia and British Foreign Secretary David Cameron said Kyiv was free to use Western-supplied weapons against targets on Russian territory. Western nuclear experts say Russia is sending a signal aimed at deterring NATO from wading more deeply into the Ukraine war.

What Would Be The Aim Of Using A Tactical Nuclear Weapon?

Experts say the point would not be to capture territory, because the use of such a weapon would create a poisoned radioactive wasteland. Rather, some believe Russia might use one in a scenario where its troops were in retreat and facing a major defeat. In a report for the International Institute for Strategic Studies in January, former Pentagon and NATO official William Alberque said Russia might consider using a non-strategic nuclear weapon (NSNW) to "sober up" the West and coerce it into resolving a conflict on Moscow's terms, calculating that the U.S. would be unwilling to cross the nuclear threshold in retaliation. President Vladimir Putin said last week that Russia would be able to achieve victory in Ukraine without resorting to nuclear weapons.

How Would We Know If A Tactical Nuclear Weapon Was Used?

Experts say preparations to launch one would probably be visible to Western military intelligence satellites, as it would involve the kinds of steps seen during the exercises, including moving warheads from a central storage facility. These would take place over a number of hours, with Russian command and control centres being placed on high alert. From the point of view of Russia's adversary, incoming missiles carrying tactical nuclear warheads would be indistinguishable from the types of missiles with conventional warheads that Russia has been firing at Ukraine for more than two years. But an actual nuclear strike would be clearly identifiable by the scale of destruction, the seismic shock and the massive release of radiation.

https://economictimes.indiatimes.com/news/defence/what-are-tactical-nuclear-weapons-and-why-is-russia-holding-drills/articleshow/110906579.cms

Science & Technology News

THE HINDU

Tue, 11 Jun 2024

IISc researchers develop sustainable method to remove heavy metal contaminants from groundwater

Indian Institute of Science (IISc) researchers have developed a novel remediation process for removing heavy metal contaminants such as arsenic from groundwater. According to IISc, the three-step method, which is patent-pending, also ensures that the removed heavy metals are disposed of in an environment-friendly and sustainable manner, instead of sending untreated heavy metal-rich sludge to landfills from where they can potentially re-enter groundwater.

However, after you remove the arsenic, you must do something about it so that it doesn't re-enter the environment, and that aspect is not given due consideration in the existing methods. Our process was designed to solve this problem," said Yagnaseni Roy, assistant professor at the Centre for Sustainable Technologies (CST), whose lab has developed the method.

IISc said that according to reports, 113 districts in 21 States in India have arsenic levels above 0.01 mg per litre while 223 districts in 23 States have fluoride levels above 1.5 mg per litre, which are beyond the permissible limits set by the Bureau of Indian Standards and the World Health Organization (WHO).

These contaminants can significantly affect human and animal health, necessitating their efficient removal and safe disposal. "On average, these organic species are approximately 50 times less toxic than the inorganic form present in groundwater," said Mr. Roy. IISc said the system is easy to assemble and operate. Manufacturing the adsorbent material involves a simple recipe.

In the lab, a small pilot-scale adsorption column system was able to generate safe drinking water (by WHO standards) for two people for three days. The researchers have been working with the INREM Foundation and Earthwatch, both NGOs, to deploy and test these systems in rural areas such as Bhagalpur in Bihar and Chickballapur in Karnataka.

https://www.thehindu.com/news/cities/bangalore/iisc-researchers-develop-sustainable-method-to-remove-heavy-metal-contaminants-from-groundwater/article68276797.ece

news9

Tue, 11 Jun 2024

Chandrayaan-3, Aditya-L1 missions done, ISRO prepares next astonishing feat with Pushpak RLV

India has been taking huge strides in space with its many achievements and has conquered all the challenges to become one of the leading space-faring nations in the world. There were the amazing Chandrayaan-3 mission when its spacecraft landed on the Moon, or the Aditya-L1 mission, when a satellite was placed in orbit to watch the Sun's activity 24/7 and many more.

And now, the Indian Space Research Organisation (ISRO) is all ready to send its Reusable Launch Vehicle (RLV), dubbed Pushpak, up into the skies again for more tests with the ultimate aim of sending a bigger vehicle out into space and bringing it back to Earth safely. This will be the third and final Pushpak RLV landing experiment.

While no specific date has been set by ISRO, Pushpak RLV test flight (3rd) is expected to happen in the first half of June, subject to weather conditions, S. Unnikrishnan Nair, Director, Vikram Sarabhai Space Centre (VSSC) told the Hindu in an interview. The Reusable Launch Vehicle test will take place at the Aeronautical Test Range at Chitradurga, Karnataka. Indicating that this will be a very tough test, Nair added that the degree of difficulty for this specific Pushpak RLV test will be increased manifold.

What is the ISRO Reusable launch vehicle mission?

The Pushpak RLV is an unmanned winged prototype flying machine that is taken to a designated height where it is released. It is then tested for its landing capabilities under all kinds of conditions. The latest Pushpak RLV mission, named LEX03, will see the vehicle being carried as high as 4.5 km and 500 metres laterally away from the runway on an IAF Chinook helicopter and then released. Pushpak's LEX-02 mission was taken to the same height but the distance to the side of the airport was lesser – just 150 metres.

And how will it get back? "It has to autonomously approach the runway, manoeuvre by making crossrange, downrange and altitude corrections to touch down on the runway," Nair told the Hindu. Among other tasks to be accomplished during the mission is to see how the rate of descent can be cut to reduce the impact load as well as as see how it handles the challenge under tailwind conditions.

Space-bound Orbital Re-entry Vehicle (ORV)

All these tests that the RLV is being subjected to is being done with the ultimate vision of sending a similar (much bigger) vehicle into space. This vehicle is being called Orbital Reentry Vehicle (ORV) What that next stage will entail is ISRO using an unmanned Orbital Reentry Vehicle (ORV) some 1.6 times the size of Pushpak. The intention by ISRO is to put it in a 400 km high orbit around the Earth where it will be flown aboard the Geosynchronous Satellite Launch Vehicle (GSLV) rocket specially modified for this vehicle. However, it is not expected to happen over the next two years.

According to Dr Nair, the vehicle that will be sent into space will have "thermal protection" and to make that as error-free an exercise as possible, it will have retractable landing gear.

https://www.news9live.com/science/bta-chandrayaan-3-aditya-l1-missions-done-isro-prepares-next-astonishing-feat-with-pushpak-rlv-2572111

news nine

Tue, 11 Jun 2024

The Future of Lunar Exploration

On 23 February, 2024, the Odysseus Moon lander began its descent towards the surface of the Moon from an altitude of 92 kilometres. The lander pitched over and approached the surface at a slant, using an automated landing sequence to avoid any craters or boulders.

There was a communications blackout during the terminal descent. It later emerged that one of the four feet of the lander caught something during the landing, causing it to topple. However, a Moon rock prevented the lander from toppling entirely, allowing it to continue communications.

Despite the off-nominal landing, it was a resounding success, and a historic mission. Odysseus was the first private spacecraft to reach the Moon, ushering in a new era of commercial operations. All previous missions to the Moon were research oriented, and state sponsored. A time capsule and an

art project were among the commercial payloads that Odysseus successfully delivered to the lunar surface.

The Moon is not so far any more

So far, the Moon was just the Earth's only natural satellite, a celestial body to study, to understand more about the history and evolution of the Solar System. Now, the Moon is being perceived as the eighth continent, an extension of the Earth, a new frontier with untapped commercial opportunities. Most, if not all of the proposed and planned missions to the lunar surface by countries all around the world are aimed at eventually setting up at least a semipermmanent human outpost on the Moon.

Beyond just establishing a research outpost, there is interest in commercialising the lunar surface. The incipient plans are wide ranging, and include space tourism, filmmaking, astronomy, manufacturing and mining. All of these activities will require to be supported by power distribution, transport and communications infrastructure. There are private companies vying to provide these services on the lunar surface. A major reason for this is the discovery of water in the highlands around the south pole of the Moon.

There are permanently shadowed craters here, where the light from the Sun always falls at an incline. It is possible that there are deposits of water ice at the surface, or close to the surface in the depths of these craters. Water itself can be used to grow food on the Moon. Oxygen can be extracted from water, which can be used in life support systems as well as rocket fuel.

The force of gravity is six times weaker on the lunar surface than the Earth. If humans can set up propulsion extraction facilities and fuel up launch vehicles, the Moon may become an ideal launch pad for deep space missions to the outer Solar System and beyond, significantly bringing down the cost of space travel. There are opportunities for manufacturing as well, taking advantage of the tenuous lunar atmosphere combined with the low lunar gravity.

Space Resource Technologies makes simulated Martian and Lunar regolith for testing developing technologies for future missions. When asked about the benefits of lunar exploration for humans on Earth, Anna Metke, CEO of Space Resource Technologies told us, "To enable a sustainable future for space exploration, resource utilisation and fuel humanity's expansion into space."

All the major spacefaring nations have planned and proposed missions to the Moon, which are all geared towards preparing the groundwork necessary to establish a semipermanent presence on the lunar surface, along the lines of research outposts in Antarctica or orbital platforms such as the International Space Station (ISS) or the Chinese Tiangong space station.

The race to the Moon is going on in earnest between China and the USA. China is leading an initiative called the International Lunar Research Station (ILRS) in close collaboration with Russia and a number of other partnering nations, including European ones. Europe is concentrating its efforts around the concept of a Moon Village, which is an initiative aimed at assembling a lunar community, as against a particular project or programme.

The European Space Agency (ESA) is working closely with NASA for realising the Artemis Basecamp. Here, we will have a closer look at each of these initiatives.

Water on the Moon

Whether or not there is water on the Moon is a subject that has been debated for centuries. The astronomers in the mid-seventeenth century who used telescopes to observe the Moon found dark patches, which were interpreted as seas. The Latin word for ‘seas’ is ‘maria’ in plural and ‘mare’ in singular, which is a terminology that has stuck, despite humans now knowing that there are no bodies of liquid water on the lunar surface.

Over the course of the nineteenth century and most of the twentieth century, the Moon was believed to be an inhospitable and dry space, as observations indicated that it lacked an atmosphere, which would cause any water on the surface to evaporate instantly. In 1961 theoretical physicist Kenneth Watson proposed the idea that water ice could exist in the permanently shadowed regions close to the lunar poles.

A map showing distribution of water ice near the lunar south pole, using data captured by the Lunar Reconnaissance Orbiter (LRO). (Image Credit: NASA). The samples returned during the Apollo missions between 1969 and 1972 did not reveal the presence of water. However, the Clementine spacecraft in 1994 discovered strong hydrogen concentrations in the permanently shadowed craters, indicating the presence of water ice on the Moon.

Hydrogen was also discovered within tiny beads of volcanic glass after Apollo samples were reexamined using modern, sophisticated techniques. In 2008 and 2009, ISRO’s Chandrayaan 1 mission, as well as NASA’s Cassini and Deep Impact probes discovered signs of water ice on the Moon.

A NASA instrument called the Moon Minerology Mapper on the Chandrayaan 1 orbiter comprehensively proved for the first time that water ice existed within the permanently shadowed craters on the Moon.

The water ice in the permanently shadowed regions has also been confirmed by observations conducted by NASA’s SOFIA airborne observatory, before it was retired in October 2022. The data gathered by SOFIA was used to create the first high-resolution map of water distribution on the lunar surface.

First detailed, wide area map of water on the lunar surface. The Chandrayaan 3 mission landed in the region, and Chandrayaan 4 may also go to the same place. (Image Credit: NASA/SOFIA). It is the availability of water that makes the south pole of the Moon such an attractive location to set up humanity’s first extraterrestrial outpost. The initial pathfinding missions, especially the ones with rovers will set out to identify the areas where water is available close to the surface, and map its abundance as well as distribution. The initial set of landers will also characterise the lunar regolith and the wispy lunar atmosphere, to better plan future missions, and the construction of Moon Bases.

NASA’s Artemis Basecamp

On 11 December 2017, the then President of the United States of America, Donald Trump called for Americans to “Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the Solar System and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the

United States will lead the return of humans to the Moon for long-term exploration and utilisation, followed by human missions to Mars and other destinations."

NASA intends to return American boots on the surface of the Moon, with the first landing currently scheduled for 2025. This will be the Artemis III mission that will use the SpaceX Starship to allow astronauts to access the lunar surface. However, there have been developmental delays with the hardware, and it is likely that NASA will have to revise its timelines.

Still, work is going on in earnest towards the mission, with NASA already identifying 13 candidate landing sites for the mission. Artemis III will be just the first of several crewed missions that will transport the hardware, resources and gear necessary to make staying on the Moon increasingly comfortable over time.

Initially, the base is expected to consist of a lunar cabin, a rover, and a mobile home with its own life support system, making it something of an extraterrestrial caravan, that will allow crew to take trips as much as 45 days in duration. There will also be a sustained robotic presence that allows robots to continue construction and assembly work without human supervision. From short surface stays, the eventual goal is to set up a basecamp that allows humans to visit for durations longer than two months at a time.

While initially, the landers such as Starship will themselves provide the astronauts with a temporary lunar headquarters. Eventually, NASA intends to set up a fixed habitat that can accommodate up to four astronauts at a time. NASA is evaluating rigid shells, expandable habitats and hybrid approaches. NASA is also on the verge of announcing the private company or companies that it has partnered with to develop a new Moon Buggy for Artemis missions, which can operate in both crewed and uncrewed configurations.

One of the biggest hurdles of operating on the Moon is the cost of transporting resources from the Earth to the Moon, which is an expensive endeavor. It currently costs $1.2 million to transport a kilogram of mass to the lunar surface. The idea is to use the resources available locally to the greatest extent possible.

Apart from the weight of the payloads being a constraint, another is the size or bulk of the payloads as well. There is only so much that even the largest and most powerful rockets can accommodate, and future lunar missions may have to necessarily rely on multiple launches. One of the proposed construction approaches is to use additive manufacturing techniques or 3D printing to create bricks from the easily available lunar regolith.

Tests conducted on the Earth have indicated that such bricks can withstand the extreme conditions on the Moon. 3D printing using 'ink' derived from lunar regolith can also potentially be used to manufacture tools and spare parts, reducing the reliance on resupply missions from the Earth, and bringing down the cost of lunar operations. Researchers have also demonstrated the technological capability for extracting oxygen from the lunar regolith, using a carbothermal reactor.

The process of heating and extracting the oxygen from the lunar regolith takes place within the carbothermal reactor. Similar reactors are used on the Earth for the manufacturing of steel and solar panels, to produce carbon monoxide or carbon dioxide. The development of this technology addresses a critical gap in NASA's capabilities, and demonstrates that it is possible to extract oxygen from the lunar regolith.

Challenges of communicating with the Moon

Most of the planned and proposed missions are headed to the south pole of the Moon. Radio is the conventional approach to communicate with spacecraft, and from the lunar nearside as well as the south pole, it is possible for a spacecraft to directly communicate with the ground stations on Earth. However, far side missions will require a relay satellite that can act as a link between the hardware on the surface. On 20 March, 2021, China launched the Quiqiao 2 or Magpie Bridge 2 relay satellite to support its future lunar missions.

One of the problems with radio communications is bandwidth, that is the amount of data that can be transmitted in a particular interval of time. An attractive option that can relay about 200 megabits of data per second, and allow for the transmission of 4K video in realtime, is through the use of optical communications, or space lasers. NASA has already tested such a laser out on Earth, and will be evaluating the system during the Artemis II flight.

Commercial Lunar Payload Services

NASA's Commercial Lunar Payload Services (CLPS) programme intends to establish a regular cadence of private missions to the Moon with academic and commercial payloads, to support the Artemis programme. The landers are from a variety of private American aerospace companies that manage and operate the flights as well. Odysseus by Intuitive Machines was the first of these landers to deliver the payloads to the lunar surface.

On 8 January, 2024, another private American spaceflight company, Astrobotic had launched its Pregarine lander on board a Vulcan rocket by United Launch Alliance. The spacecraft started leaking fuel, making a landing impossible. It reached lunar distance, and then returned to the Earth. Astrobotic made the responsible decision of deliberately destroying the spacecraft with an atmospheric reentry. Intuitive Machines got the valuable hands-on experience of operating a spacecraft. The missions have to be carefully managed through a 24×7 operation, to anticipate and react to dynamic situations, such as a loss of fuel, and provide the services necessary to all of the individual private payloads on board. These may include operations, scheduling and data transfer.

Both Intuitive Machines and Astrobotic will be making another Moon landing attempt before the end of 2024. Astrobotic's Griffin lander will deploy a resource prospecting rover, while the second Nova-C lander from Intuitive Machines hopes to drill into the surface and hopefully discover lunar ice.

Firefly Aerospace, yet another private American aerospace company had finished assembly of its Blue Ghost lander in 2023. This is likely to be the next Moon lander, in the third quarter of 2024. Firefly Aerospace has already started work on assembling its subsequent lander. It is not just the private companies in America that are aiming to commercialise the surface of the Moon.

Skyroot Aerospace, that launched India's first privately built rocket in November 2022, the Japanese Robotic Spacecraft company Hakuto, and the Australian turnkey satellite missions provider HEX20 have signed a Memorandum of Understanding to develop the market for lunar orbiters from the Indo-Pacific region. iSpace aimed to be the first private company to execute a controlled Moon landing, but the Hakuto spacecraft crashed into the Moon on 26 April, 2023. The company is determined to try again this year, with a lander that will include a rover on board as well.

Chinese Chang’e lunar exploration programme

The China National Space Administration (CNSA) has been conducting a highly successful lunar exploration programme since 1997. The programme is named after the Chinese Moon goddess Chang’e, and includes orbiters, landers and rovers dispatched to the lunar surface. After launching an impactor and an orbiter, China became the third country to execute a soft, controlled landing on the lunar surface after USA and Russia, with the Chang’e 3 mission, that reached the Moon on 14 December, 2013. The lander carried a rover on board. On 2 January, 2019, The Chang’e 4 lander became the first spacecraft to land on the dark side of the Moon, and continues to operate on the lunar surface.

The Chang’e 5 mission landed on 1 December, 2020 equipped with a drill that collected a rock core sample from a depth of a metre. An ascender then ferried the sample back to the Earth, which was subsequently distributed to scientists from a number of countries including Russia, France, Sweden, Australia and USA. These were the first lunar samples to be returned to the Earth since the Apollo programme.

The samples from the Chang’e mission expanded our understanding of the formation, evolution and geology of the Moon. The lander made the first in-situ detection of water on the lunar surface, discovered signs of recent volcanic activity, found asteroid impact events that could be matched with strikes on Earth, discovered signs of impact-induced magnetite formation on the lunar surface, and generally expanded the scientific understanding of lunar geology.

The Quiqiao 2 relay satellite that has just entered lunar orbit will provide comms to Chang’e 6, that CNSA assembled at the Wenchang Space Launch Centre, and which landed on the lunar surface on 2 June. The sample return mission has a profile similar to the Chang’e 5 mission, and consists of an orbiter, a lander, an ascender and a reentry module.

China is collaborating closely with the international scientific comunity for the Chang’e programme, with the Chang’e 6 lander carrying payloads from the European Space Agency (ESA) and the French Space Agency (CNSA). There is also an Italian laser on board for calibrating the instruments and the ICUBEQ picosatellite from the Institute of Space Technology in Islamabad, that advances Pakistan’s lunar ambitions. Work on both the Chang’e-7 mission, and the Chang’e-8 mission is already in progress.

Chang’e 7 is headed to a portion of illuminated ground on the edge of the Shackleton Crater, which marks the lunar south pole. China has invited international payloads for the Chang’e-8 mission, which will demonstrate 3D printing on the lunar surface using locally sourced Moon dust as ‘ink’. Together the trio of Chang’e landers will form a research station, paving the way for the International Lunar Research Station (ILRS), an ambitious initiative led by China.

International Lunar Research Station

The ILRS is a long-term plan to set up a semipermanent outpost on the Moon, which can support visits by crewed missions, and also operate autonomously. Russia is a close collaborator with China on the ILRS, and China is collaborating with a number of countries and research institutions around the world for the programme. Over the course of 2023, China onboarded Egypt, Belarus, Thailand and South Africa to the ILRS initiative. CNSA has signed over 170 agreements with more than 50 countries for future cooperation in the space domain.

The ILRS rivals the Artemis Basecamp. The Artemis III mission is still officially slotted for 2025. China intends to land a crewed mission on the lunar surface before 2030. A pair of carrier rockets will be required to launch the mission, one for the lander and one for the crew module. According to the planned mission profile, the lander and the crew module will hop to lunar orbit after launch, and dock with each other.

The taikonauts or Chinese spacefarers transfer to the lander, and touch down on the lunar surface to conduct experiments and collect samples, and return to the lander. The lander then ascends to lunar orbit, docks with the crew module again, with the taikonauts transferring back, and returning to the Earth. After a competition, the names of the crew module and the lander were picked in February 2024. The crew module has been dubbed Mengzhou or Dream Boat, while the lander has been named Lanyue or Embracing the Moon. The spacecraft has been configured to be assembled in orbit after being launched separately, and can be used in Earth orbit as well as future deep space missions.

China is developing the Long March 10 carrier rocket just for the brand new lunar hardware. The rocket has three and a half stages, measures five metres in diameter and can transport 27 tonnes to lunar orbit. China is also developing a spacesuit that can be used for Moon walks by the taikonauts. The China Manned Space Agency (CMSA) is also developing a lunar rover called the Wengshu Chariot, that can be stowed away, and can operate in crewed or uncrewed configurations.

The Russian Luna Programme

On 11 August, 2023, a Russian Soyuz 2 rocket launched the Luna 25 mission, which was the first Post-Soviet mission to attempt a lunar landing. The mission was headed to the highlands around the south pole of the Moon, to investigate the amount of water available. Luna 25 did not shed enough velocity when approaching the Moon because of a glitch, and crashed into the lunar surface on 18 August, 2023.

Luna 25 was just the first of a series of lunar missions planned by Roscosmos. Luna 26 is a relay satellite, much like Queqiao 2, and also has the capabilities of mapping the surface at a 2.3 metre resolution. The stereo imaging capabilities will be valuable around the lunar polar regions because the harsh shadows make it difficult to differentiate between a mount and a depression. Roscosmos is aiming to launch the Luna 26 mission in 2027, and the Luna 27 mission by 2030, followed by the Luna 28 mission.

Both the landers are equipped with drills to penetrate deep into the lunar surface. Roscosmos expects to find water and volatile compounds with the missions. These Luna landers will work closely with the Chinese Chang’e landers, paving the way for the ILRS.

China and Russia intend to start assembling the ILRS by 2030, with a focus on using local resources for constructing the habitats required. NASA has the same approach as well. It costs over a million USD to send a single kilogram to the lunar surface, which is why space agencies intend to use locally available resources on the Moon to the greatest extent possible.

Russia is exploring concepts for crewed missions, including building a lunar igloo within a mound, using the surrounding regolith or lunar soil. 3D printing technologies can be used to assemble bricks, the habitats themselves, tools and spaceparts. There will also be a requirement for communications facilities, to communicate with ground stations on Earth as well as the

autonomous hardware on the Moon. Russia is also considering autonomous vehicles that can extract the regolith, which can then be processed into ink for 3D printing, rocket fuel, with water and oxygen extracted for life support systems of the astronauts, as well as the inflatable greenhouses. Both NASA and Russia are evaluating innovative robots with wheels that scoop up the lunar dust. By moving the front and back wheels in different directions, these robots can stay in the same place, while digging into the regolith and collecting the material.

India's Moon Base

On 23 August, 2023, India became the fourth country to execute a soft, controlled landing at a time and place of its choosing on the lunar surface. The Chandrayaan 3 mission demonstrated India's capabilities of delivering hardware to the lunar surface, operating the spacecraft, and conducting scientific experiments. The mission met all of its objectives, and ISRO went a step ahead, with the lander hopping on the lunar surface, and the orbiter, which was carrying a radiation based heater, returning to Earth orbit despite having minimal fuel.

With these stretch goals, ISRO was demonstrating the capabilities required for follow-on Chandrayaan missions. The short hop on the surface demonstrated that ISRO hardware could take off after landing on an extraterrestrial surface, a capability required for a future sample return mission. The orbiter returning to Earth demonstrated a sample return spacecraft can make the same journey. The propulsion units had a pair of small, experimental radioisotope heater units (RHUs). More powerful, scaled up versions of these devices can be used in the future for longer missions on the lunar surface. Chandrayaan 3 could operate for only a single lunar day because it could not survive the extreme cold of the lunar nights, where temperatures can drop to as much as -270°C.

India is planning a series of follow-up Chandrayaan missions. The Chandrayaan 4 and thee Lunar Polar Exploration (LUPEX) mission, a collaboration with JAXA are both in the study phase. ISRO is planning the Chandrayaan 4 mission as a sample return mission, building on the capabilities demonstrated by Chandrayaan 3. The mission may also demonstrate 3D printing in the low gravity lunar environment.

The LUPEX mission is also headed to the south pole of the Moon. ISRO and JAXA plan to operate the Indian lander and the Japanese rover on the surface for between three and six months. The goal of the mission is to prospect for water in the permanently shadowed craters around the lunar south pole. It is possible that the same lander platform is used for both the Chandrayaan 3 and LUPEX missions. Both the missions are expected to be launched by 2028. ISRO plans to launch a series of Chandrayaan missions after Chandrayaan 4, building up the capabilities for landing an Indian astronaut on the Moon, in tandem with the Gaganyaan programme, an ambitious initiative to lift humans into Earth orbit primarily using domestic hardware. While reviewing the progress on the Gaganyaan programme, Prime Minister Narendra Modi directed ISRO to land the first Indian on the Moon by 2040.

ISRO went a step ahead, and came up with a roadmap that ended up with the construction of a Moon Base by 2047, in time for the 100th anniversary of Indian independence. At the 2023 National Symposium of the Indian Society of Geomatics (ISG) and the Indian Society of Remote Sensing (ISRS) at the Symbiosis institute of Geoinformatics in Pune, Maharashtra, ISRO Chairman S Somanath said, "For future Chandrayaan missions we need to have docking capability, we must be able to bring in samples from there, we must also do long duration Moon missions.

The last mission was just two weeks, we couldn't do more because of various limitations. This must be overcome, and we must do long duration missions. We must also create habitable capability there, and also building stations on the Moon over a long period of time. Next track is called the exploration track, where we create capacity to orbit the Earth, human access to space through Gaganyaan, building space stations, cislunar possibilities, and human landing on the Moon. The very important track is the launcher capability. Unless we have this capacity, none of these visions are possible.

The limited capacity of launching today, we see that it cannot grow beyond a point. We must develop newer rockets with high capacity so that we can achieve all these dreams, over a period of time." During the 11th convocation programme of the Pandit Deendayal Energy University (PDEU) in Gandhinagar, Gujarat, Somanath said, "We would also like to have a launch of a human spaceflight to Moon. Many people ask me this question, 'Why do you send a person to Moon, when Americans did it so many years back. Why you want to do it again?' I think many of you may be knowing that, today, the space economy is being talked about, which is Moon-based economy. I think these narratives you would have read very much, and in US they are working on how to create a Moon based economy, and exploration of space, based on facilities that are created on Moon. The Artemis Programme, which is piloted by US, is based on a Moon economy."

ISRO is headed to the Moon for geopolitical as well as economic reasons, and intends to collaborate closely with other national space agencies as well as private domestic spaceflight companies to commercialise lunar operations in a sustainable manner.

Somanath said, "We cannot be left behind. Like we did for the Antarctica mission. Today, we know we have a station there, and we are part of this exploration to understand Antarctica. And that same decision is what is being taken today, to be part of the Moon economy. And, we cannot be left behind. It has a scientific objective, it also has geopolitical and economic objective. I think this must be well understood by all of you. The energy that is created out of the Chandrayaan 3 landing really enables us to dream big today."

We asked Chaitanya Giri, Associate Professor of Environmental Sciences at FLAME University, about some of the benefits of lunar exploration people on Earth. Giri responded, "Over the past sixty years, almost all regions of the Moon have been mapped and studied spectroscopically. Americans have landed on the Moon, and Chinese, Europeans, Russians,

and Indians are vying to go next. There are two types of benefits: one tactical benefit to whichever country pursues exploration and one strategic benefit to those who do so with a long-term plan in hand. Countries that treat lunar exploration as a 'flight of fancy' and are too enamoured to leave the pursuit midway are bound to lose.

Strategically minded countries that will build technologies to not only go to the Moon but to assist human settlements, robotic operations, transportation and communications on the lunar surface are bound to get direct benefits through a number of space technologies that will spin off across various economic sectors. Indeed, these spin-offs won't come as easily as a magic wand shown in movies, but through rigorous investments, efforts and protection of intellectual property.

Of course, these spinoffs will eventually find their apt international market, but then the one who owns the intellectual property and the one that controls the manufacturing of these technologies

will dominate geoeconomically and geopolitically. So, humans, a.k.a. citizens of the countries that govern the spin-offs, will benefit more than those citizens who seek it from them." We then followed up with a question on the specific benefits of a Moon Base.

Giri told us, "A base on the Moon, whenever it transpires, is not and will not be a global collective asset. As per the current commercialisation trends, it is bound to be built and operated by those who have invested in it. Having said that, the advantages depend on who invests in it, their strengths and weaknesses, whether the base will be running any commercially sustainable operations, whether there is a return on investment, and whether the base is made with strategic goals in sight. The bases on the Moon will provide an advantage only to those who invest in them; the rest of the noninvestors will be bystanders. The advantage will depend on whether the moon base results in the extraction or harnessing of a new extraterrestrial resource or energy source, whether it leads to avant-garde spin-off technologies, whether the lunar base is a stop-over to Mars and other inner and outer solar system destinations, and whether it adds to the national economy. The advantages will be imminent once technical, monetary and human capital are invested sagaciously."

There are already commercial campaigns being planned for making movies on the lunar surface, and mining for resources. The lack of an atmosphere and the low gravity environment can be suitable for manufacturing processes not possible on the Earth, for example producing a sunshield that can mitigate global warming. Observatories on the lunar far side can observe celestial targets without the disturbance of the Earth atmosphere.

There will be a demand for ground transportation on the Moon, as well as power distribution networks, plans for all of which are being drawn up. Om Patnaik, 14 years of age, who studies in Grade 10 at Shiv Nadar School in Noida secretly wishes that the moon landing happens in the next 2 years so that there are no board exams.

We asked Patnaik what a future Indian Moon Base could look like. Patnaik told us that the spacefarers would use "Inflatable tents or sleep pods that they will carry along with them in their spaceship. Decathlon can market these as Moon Pods and sell them in one size fits all. Inflatables because they will be light and easy to carry in bulk. Build a super sonic shield around them that will act as a protective layer against space radiation." When asked what the spacefarers would wear, Patnaik replied, "For those who can afford it, a Darth Vader type suit with self pumping oxygen. A little less expensive option is the Mandalorian suit with a breathable helmet that residents will wear all the time, except when they eat and drink, with in-built gravity shoes to make walking easier on the surface. An even cheaper option can be Stormtrooper suits with no gravity boots, because I do not like them at all."

ISRO is in fact developing inflatable habitat modules for use on the Antariksha Bharatiya Space Station. These modules can be chained together, and can be transported on rockets. While such inflatable structures may be suitable for certain facilities, such as greenhouses on the lunar surface, they will not offer sufficient radiation shielding. Both ESA and Russia have proposed using lunar mounds for radiation shielding, with some scientists even suggesting building outposts with ancient subsurface lava tubes.

https://www.news9live.com/science/the-future-of-lunar-exploration-2572792