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International Symposium on Ballistics held in Hyderabad

The globally renowned International Symposium Ballistics -2019 is organized for the first time in India

Hyderabad: The Aeronautical Society of India has organized the 31st International Symposium on Ballistics – 2019 in association with the International Ballistics Society here on Monday. The globally renowned International Symposium Ballistics -2019 is organized for the first time in India in which nearly 500 delegates from 30 different countries are participating.

Dr G. Sathesh Reddy, Chairman DRDO & Chairman AeSI during his inaugural address said that “symposium will fuel the growth of research and development in niche technologies associated with ballistics in India”.

The symposium, he said, would provide immense exposure and opportunity to address some of the probing thoughts and issues in the areas of Launch Dynamics and Interior Ballistics, Exterior Ballistics, Terminal Ballistics, Explosion Mechanics, Vulnerability and Survivability and many other ongoing related areas of research. He also said that there is an urgent need to innovate and develop disruptive technologies as it would provide the basis for next generation effective, precise, accurate and safe systems.

Dr Sidney Chocron, President, International Ballistics Society in his presidential address said that the symposium is the apex level meeting in the field. “We regularly receive 300 to 400 participants and publish 200 papers where the abstracts are peer reviewed by a well qualified committee. Our last symposium in Long Beach, California, USA had representatives from 27 countries”, he said.

Later Dr VK Saraswat, Member NITI Aayog and Chief Guest said in his address that Ballistics being a very specialized technological field, requires indepth understanding and state-of-the-art facilities for development and testing together with stringent safety requirements and greater level of understanding both theoretically and practically. The importance of sharing the knowledge gained through experience and experimentation in the area of ballistics is the need of the hour.

The keynote address was delivered by Dr Ernest Baker, Technical Specialist Officer, Warhead Technology Munitions Safety Information Analysis Centre, NATO HQ. The event was graced by MSR Prasad DG (MSS), Dr Manjit Singh Director TBRL, BHVS Narayana Murthy, Dir RCI, KPS Murthy, Dir, HEMRL, Dr MRM Babu, Dir ASL, Dr VV Rao, Dir ARDE, DK Joshi Dir PXE, U Raja Babu, PGAD, & Senior Programme Directors, Project Directors, Industry partners and eminent academicians among others.



<https://telanganatoday.com/international-symposium-on-ballistics-held-in-hyderabad>

Tue, 05 Nov 2019

HSL completes refit of Torpedo Launch Vessel on a war footing

Hindustan Shipyard Ltd achieved another milestone in ship repair capability by completing the maiden refit of INS Astradharini, a torpedo launch and recovery vessel of Indian Navy, two weeks ahead of contractual refit completion date, the company declared on Monday. Rear Admiral L.V. Sarat Babu, Chairman and Managing Director of HSL, informed that it was for the first time that HSL docked a twin hull catamaran design vessel.

The bid for the refit was won by HSL on competitive basis and refit commenced from August 16, 2019. HSL has undertaken all jobs on a war-footing along with Patel Engineering works as prime contractor, and the refit was completed ahead of schedule with the active support of Naval Dockyard, Visakhapatnam.

He added that it was for the first time that majority of the works had been undertaken by MSMEs. He said that for consolidation of expertise developed both in HSL and in associated industries, continuity of orders would be essential.

He said HSL would also be bidding for medium refit life certification for the fourth naval EKM submarine, post-resolution of some long-pending technology transfer issues.

<http://www.defencenews.in/article/HSL-completes-refit-of-Torpedo-Launch-Vessel-on-a-war-footing-757794>

Tue, 05 Nov 2019

Admiral Sunil Lanba on the three essentials for our secure future

Delivering the 23rd Colonel Pyara Lal Memorial Lecture for 2019 organised by the United Service Institution of India, former Chief of Naval Staff Admiral Sunil Lanba shared what he felt were the three essential ingredients for developing military capabilities and nourishing partnerships as an enabler in protecting our national interest in current times.

Speaking on the topic “Building Military Capability, Developing New Partnerships and Protecting National Interests in an Uncertain World Order”, he hoped that these three vital elements would go a long way to better prepare us for future defence challenges.

Firstly, he pointed out that ‘optimisation of resources’ should be high on our collective agenda, given the diverse nature of socio-economic challenges that our country faces.

“Resource availability to meet national security needs would continue to be a challenge. Also given the fact that capacity building and cost sustenance are an expensive proposition, we need to look at innovative ways and measures to enhance sharing of our resources,” he said.

“In order to ensure every rupee committed to building the military should give the nation manifold returns of that, the services would have to institutionally address the issue of optimisation.”

In this regard, he acknowledged that much progress had been made in recent times in the establishment of the joint logistics node and joint training institutions, which were raised with the primary aim of optimising resources. But a lot more still needed to be done by the three armed forces to accord it with the required impetus. He also felt that the appointment of the Chief of Defence Staff (CDS) was a welcome step and the decision would also enable the services to drive the process forward.

The second aspect, he felt, was the need to focus our efforts on achieving self-reliance in defence production.

“We need to develop self-reliance, particularly in the field of core technologies involving weapons, sensors and propulsion systems. Within core technologies, we really need to concentrate on aero engines. This is something which even China is struggling with. And once China masters and makes a capable aero engine, we are in trouble.”

“Self-reliance in defence production provides a country with immense flexibility to commit resources in a calibrated manner and to modify and customize the deliverables to the requirement of time,” the former Navy Chief said.

In other words, he felt that domestic capability in defence production would give us independence, and in the absence of it, dependence on external factors will continue to limit our strategic choices in the future.

Thirdly and lastly, Admiral Lanba stressed on the need to leverage our partnerships by enhancing inter-operability between militaries of the region.

“This should be one of the key military parts, given the dynamic and diverse nature of challenges the region faces today. It would be imperative to maintain a high degree of military-to-military cooperation. Along with enhanced interoperability, I also feel a strong need to focus on establishing a robust, reliable and real-time information sharing mechanism with partner states. This aspect assumes special significance given the speed at which local security threats can assume a national, regional or even a global character,” he emphasised.

Information sharing, he felt, was not only important but essential for our collective security interest. He shared the example of Information Fusion Center for the Indian Ocean Region (IFC-IOR) of the Indian Navy which was commissioned in December 2018, to further India's commitment towards achieving collective maritime security in the IOR.

“Given the facility has significant potential for enhancing the security of the entire Indian Ocean Region, 20 country and multinational constructs are already partnering with the Indian Navy initiative, making it a one-time convergence centre for the entire Indian Ocean Region maritime activity. The centre brings out a fortnightly bulletin which is shared with everybody who is a member of the initiative. It brings out information about the merchant navy traffic, the ships in the waters, shows fishing activity, and also where all illegal fishing is going on. This information is available to all partners. This collaborative initiative highlights the tangible gains derived from trusted partnerships.”

Admiral Sunil Lanba concluded by saying that “federation” was the new world order today, considering the trends in motion that spell trouble.

“What we are seeing today resembles the mid-nineteenth century in important ways. But I strongly believe that the world is not yet on the edge of a systemic crisis. It is upon those in the policymaking to make sure the crisis never materializes. Be it as an outcome of competing interests, hyper-nationalism or even cumulative effect of climate change, all I can say that even in an uncertain world, our collective endeavour should be to aim for a certain future.”

<http://www.defencenews.in/article/Admiral-Sunil-Lanba-on-the-three-essentials-for-our-secure-future-757795>

Tue, 05 Nov 2019

Rajnath Singh reaches out to diplomats of 80 countries, pushes for Indian defence equipment

Defence Minister Rajnath Singh on Monday addressed top diplomats of over 80 countries showcasing India as a major exporter of defence equipment.

The Ministry of Defence organised the Ambassadors' Round Table conference with aim to brief missions on the upcoming DefExpo 2020.

The Round Table was aimed at briefing the representatives of foreign missions based in New Delhi about the arrangements being made for DefExpo and elicit suggestions from them to further improve the experience.

"Heads of Missions and Defence Attaches of over 80 countries participated in the conference indicating the growing stature of the 11th mega biennial event, to be held in Uttar Pradesh capital Lucknow from February 5-8, 2020," the Ministry of Defence said.

Addressing the conference, Defence Minister Rajnath Singh said that the event will not only provide countries with the opportunity to showcase their equipment and platforms, but also be able to explore the strengths and capabilities of India's defence industry for meeting operational goals.

"DefExpo is an opportunity to foster partnerships and be part of shared prosperity. These strong ties can boost investment, expand manufacturing, raise the level of technology and accelerate economic growth of our respective countries," Rajnath Singh said.

Rajnath Singh stressed that India's defence sector has matured and is exploring mutually beneficial partnerships with friendly countries to set up industries in India and abroad.

He said the DefExpo 2020 will showcase the government's intent to achieve a turnover of \$26 billion in aerospace and defence goods and services by 2025.

Rajnath Singh added that the event will showcase India's plans for Defence Industrial Corridors in Uttar Pradesh and Tamil Nadu where investment commitments of about \$1 billion have already been received.

More than 100 business events and seminars are being planned with over 1,000 exhibitors expected at the mega event.

Rajnath Singh also urged the ambassadors to impress upon the leaders of their respective defence industries to participate in DefExpo 2020 so as to "dive deep into the strategic and business opportunities available and to establish strategic partnerships".

He also listed out various policy reforms in critical areas, including simplifying industrial licensing process and hike of Foreign Direct Investment cap to 49 per cent.

Due to the policy reforms undertaken by the government, defence production in both public and private sectors reached a record volume of Rs 80,502 crore in 2018-19. Rajnath Singh set the target of Rs 90,000 crore for 2019-20.

"We have achieved an export turnover of around Rs 10,700 crore in 2018-19, with the target of this year pegged at Rs 15,000 crore," Rajnath Singh added.

<http://www.defencenews.in/article/Rajnath-Singh-reaches-out-to-diplomats-of-80-countries,-pushes-for-Indian-defence-equipment-757793>

Why unlocking defence land bank to meet military's needs isn't a bad idea

GoI's step to amend the terms of reference of the 15th Finance Commission (FC) so as to address “serious concerns regarding the allocation of adequate, secure and non-lapsable funds for defence and internal security of India” is unprecedented. It has opened doors to previously uncharted territory — the raising of funds from other sources for India’s defence.

Until now, things were fairly straightforward. The Centre was responsible for India’s defence and would, come what may, meet the necessary needs. It was never enough. There was continuous haggling as financial stress increased with growing demands of acquiring state-of-the-art weapons and a bulging pension bill.

For a military that depends on imports for most of its cutting-edge weaponry, capital acquisition costs are usually prohibitive. The Indian defence-industry complex, for all its little successes, has failed to emerge as a credible option. And the private sector has only just been allowed to enter this pristine space. So, what we have are incredible sums of money becoming increasingly difficult to apportion.

Consider some numbers. There’s been a consistent 25% shortfall between allocations and defence ministry projections. The total projection for both capital and revenue expenditure in 2017-20, according to the defence ministry’s calculations made after changes in the FC’s terms of reference, was a little over Rs 13.4 lakh crore. What it has actually got, taking into account the last three budgets, was about Rs 8.39 lakh crore. This is an approximate shortfall of Rs 5 lakh crore.

The annual committed liabilities for all three services and joint commands, based on capital acquisition contracts signed until April 1, 2019, work out to about a little over Rs 4.91 lakh crore over next five years until 2024. And, by defence ministry estimates, the defence plan projection, both revenue and capital, for 2020-25 would be around Rs 33.8 lakh crore, while the finance ministry’s medium-term expenditure framework caters for Rs 20-21 lakh crore.

More a Cantonmint ::

So, it’s clear that a cumulative shortfall amounting to about Rs 13-14 lakh crore over a five-year period is imminent. To add to this, there’s the financial burden of the One Rank, One Pension (Orop), the Ex-Servicemen Community Health Scheme (ECHS), and the pressing requirements of residential quarters for married soldiers and officers.

GoI, particularly the finance ministry, will need to be pragmatic. The armed forces are, for instance, sitting on big real estate, acquired largely during British rule. These were mostly cantonment land located well outside city premises. But cities have expanded, and these cantonment areas are now prime real estate — be it in Delhi, Mumbai, Chennai, Pune, Bengaluru or Kolkata. There is a legitimate view that the military should give territory for civilian and industrial purposes. But who will get the booty?

North Block believes it belongs to the Consolidated Fund of India (CFI). South Block, particularly the forces, contest this view. They cite examples like buying armoured personnel carriers (APCs) for the Indian contingent posted at the UN Peacekeeping Force (UNPKF) in Congo. While the purchase is made from the defence budget, the UN compensation apparently doesn’t come back to the forces.

So, where to begin? What’s available upfront are huge tracts of land with military farms, which the armed forces are now shutting down. But the armed forces will resist the idea of transferring this land

for civilian purposes. This stalemate will be difficult to resolve politically unless there's an incentive built into the process.

Can the money raised from auctioning this land not be used for the military's benefit? Back-of-the-envelope calculations suggest that up to Rs 25,000 crore can be raised from this effort. This is a healthy corpus, which could be invested in secure financial instruments, if possible.

Come to think of it, the army is assigned about Rs 10,000 crore annually for ammunition servicing as well as accommodation. This corpus could be utilised more for building accommodation for married officers and soldiers. Also, the three wings of the armed forces may want to combine their living space to occupy lesser land. It's impractical, and constitutionally unfeasible, to think that state budgets will reflect defence expenditure.

Much as the Indian armed forces may build their case on providing security to state government assets, the fact is, it's embarrassing for the Centre to ask states to pay up for their defence and security.

Similarly, the idea that GoI could levy a 0.5% defence cess on taxpayers may, first, require a constitutional amendment. Security is the duty of any nation state and the first right over taxes collected. Second, it's just bad for perception. What could be done is to set aside the amount required for defence and then get the FC to devise a formula to apportion the remainder of the money between Centre and states.

Unlock the Land Bank ::

These are tricky questions with constitutional ramifications and may not be easily resolved. Which is why recognising the unique colonial legacy — in terms of land rights — of the Indian armed forces, and permitting them to leverage it to raise resources through, say, a special purpose vehicle (SPV) may just provide the way forward.

Considerable amount of homework has gone into this line of thinking. At a time when the government stares at a resource crunch, this may be best way to start unlocking a huge amount of real estate while addressing India's security concerns.

<http://www.defencenews.in/article/Why-unlocking-defence-land-bank-to-meet-militarys-needs-isnt-a-bad-idea-757801>



Tue, 05 Nov 2019

India, Russia likely to ink logistics deal

New Delhi: Expanding military cooperation between India and Russia will take a new turn as the two countries will possibly sign the Reciprocal Logistics Support Agreement (RLSA). It will allow the militaries on either side to use the bases and ports for repair and maintenance of equipment, warships and planes, besides seek refuelling and logistics from each other.

This comes three years after India and the United States signed the Logistics Exchange Memorandum of Agreement (LEMOA). The RLSA will mirror the mandate of the LEMOA. The agreement is to come up during the three-day (November 5-7) visit of Defence Minister Rajnath Singh to Russia.

Rajnath Singh is scheduled to co-chair 19th India-Russia Inter-Governmental Commission on Military and Military Technical Cooperation (IRIGC-M&MTC). Defence Minister of Russian Federation General Sergei Shoigu will be co-chairing the meeting on military-to-military cooperation and defence industrial cooperation. The minister will also be visiting the plant that produces the air defence missile S-400. India will get five systems of the missile from Russia.

Rajnath Singh will also open the India-Russia Defence Industry Cooperation Conference. The conference will discuss ways to promote defence industrial cooperation between India and Russia, technology transfer and investment in India in defence industry under the “Make in India” programme.

Rajnath Singh is scheduled to visit St Petersburg where he will place wreath at the Piskarevsky Memorial Cemetery honouring the soldiers and civilians who lost their lives during the Second World War. The minister may also visit Russian defence production facilities in and around St Petersburg. This will be Rajnath Singh’s first visit to Moscow as Defence Minister.

The agreement

- The Reciprocal Logistics Support Agreement will allow the militaries on either side to use bases and ports for repair and maintenance of equipment, warships and planes, besides seek refuelling and logistics from each other

<https://www.tribuneindia.com/news/india-russia-likely-to-ink-logistics-deal/856370.html>

Daily Times

Tue, 05 Nov 2019

Pakistan Navy gets a big boost against Indian Navy in Arabian Sea

According to a press release of Pakistan Navy Media Directorate published recently, the steel cutting ceremony of two Type 054 A/P multi-role Frigates, being built for the Pakistan Navy, was held at Hudong Zhonghua Shipyard in China.

China recently started the construction of an export version of one of its advanced frigate and will deliver it to Pakistan as part of a major arms deal. The ship is a version of the Chinese Navy’s most advanced guided-missile frigate Type 054AP.

According to the Pakistani Navy, the ship’s class is Type 054AP, which means it is based on the Type 054A of the People’s Liberation Army Navy. According to Chinese source, four frigates had been ordered by Pakistan.

The Pakistan Navy has ordered four Type 054AP frigates and the last two orders were announced on 1 June 2018. The ships are expected to enter service by 2021.

With these new ships, the Pakistani Navy will have one of the most technologically advanced platforms of Pakistan Navy that would strengthen its capability to meet future challenges and maintain peace, stability and power equilibrium in the Indian Ocean Region.

The Type 054A frigate is a class of Chinese multi-role frigates, the first of which entered service with the People’s Liberation Army Navy Surface Force in 2007. It is a development of the Type 054 frigate, using the same hull but with improved sensors and weapons. This ship has a crew of 165 sailors including officers.

The Type 54A is equipped with 32 vertical launcher systems able to fire the HQ-16 medium-range air defence missiles and anti-submarine missiles, 2×4 C-803 anti-ship/land-attack cruise missiles and two Type 730 seven-barrel 30 mm Close-in Weapon Systems (CIWS) guns, 2×3 324mm Yu-7ASW torpedo launchers, 2×6 Type 97 240mm anti-submarine rocket launchers and 2 Type 726-4 18-tube decoy rocket launchers.

The stern helicopter deck features a single landing spot for supporting the missions of a medium-size helicopter. The heli-deck is fitted with helicopter handling system and can accommodate a Kamov Ka-28 Helix or a Harbin Z-9C helicopter.

<https://dailytimes.com.pk/494642/pakistan-navy-gets-a-big-boost-against-indian-navy-in-the-arabian-sea/>

If India and Pakistan went to war, these 10 weapons would shape the future of the world

While the world continues to focus on the U.S. presidential election, a massive hurricane off the coast of America, the showdown in Syria and tensions in the South China Sea, another crisis is fast developing between India and Pakistan. And if bullets start flying, considering the stakes on both sides, and the atomic arsenals involved, it could very well eclipse what is going on in the news cycle at a moments notice.

Both sides are heavily armed with some of the world's most deadly weapons of war, from submarines and aircraft carriers to the ultimate weapon of war that could instantly kill millions and spread radioactive terror around the globe: nuclear weapons.

But what nation has the advantage? Who has the stronger military? Which nation has the best equipment?

In 2014, Kyle Mizokami, a regular contributor to this publication, analyzed the 5 most lethal weapons India and Pakistan held in their arsenals and which systems each side should consider closely in any military contest. For your reading pleasure, we have packed both pieces into this one post. Let the debate begin.

Recently India alleged a series of ceasefire violations—in the form of automatic weapons fire—by Pakistan on the border between the two countries. According to India, it was the sixth attack in just five days. Such events are a reminder that tension remains high on the Indian subcontinent.

The nuclear arsenals of both sides—and the red lines that would trigger their use—have made conventional war much more risky to conduct. The 1999 Kargil War is considered the closest the world has come to a nuclear war since the Cuban Missile Crisis. If India were to use its superiority in ground forces to seize a sizable amount of Pakistani territory, Pakistan could respond with nuclear weapons.

It's distinctly possible that any future war between India and Pakistan would involve limited action on the ground and full-scale fighting at sea and in the air. India has the upper hand in both, particularly at sea where it would have the ability to blockade Pakistani ports. Pakistan imports 83% of its gasoline consumption, and without sizable reserves the economy would feel the effects of war very quickly. An economic victory, not a purely military one might be the best way to decisively end a war without the use of nuclear weapons.

With that scenario in mind, let's look at the five Indian weapons Pakistan would fear most in a war.

1. INS Vikramaditya Aircraft Carrier ::

Commissioned in November 2013, INS Vikramaditya is the newer and more modern of India's two aircraft carriers. In the event of war, Vikramaditya would lead an offensive at sea designed to sweep the Pakistani Navy from the field. The nightmare scenario for Pakistan would be Vikramaditya parked off the coast of Karachi, Pakistan's largest port, enforcing a naval blockade.

Originally built for the Soviet Navy as the anti-submarine aviation cruiser Baku, Vikramaditya was mothballed in 1996 after it became clear post-Cold War Russia could not afford to operate her. The ship was purchased by India in 2004, to be upgraded by Russian shipbuilders to a true aircraft carrier complete with angled flight deck. The updated design deleted all cruiser armament, including two 100mm deck guns, 192 SA-N-9 surface to air missiles and 12 SS-N-12 Sandbox anti-ship missiles.

Vikramaditya is 282 meters long and displaces 44,000 tons, making it less than half the displacement of American supercarriers. Nevertheless Vikramaditya's powerful air wing is capable of executing air superiority, anti-surface, anti-ship and anti-submarine warfare. The carrier air wing is expected to consist of 24 MiG-29K or Tejas multi-role fighters and 10 anti-submarine warfare helicopters. India has ordered 45 MiG-29Ks, with the first squadron, 303 "Black Panthers" Squadron, stood up in May 2013.

2. INS Chakra Nuclear Attack Submarine ::

While INS Vikramaditya would be the visible symbol of a naval blockade, perhaps the real enforcers would be India's force of 14 attack submarines. The most powerful of India's submarines is INS Chakra, an Akula-II nuclear-powered attack submarine.

INS Chakra would be able to fulfill a variety of wartime tasks. It would be a real threat to Pakistan's Navy, particularly her 11 frigates and eight submarines, only three of which are reasonably modern. Chakra is also capable of covertly laying mines in Pakistani waters and conduct surveillance in support of a blockade.

Construction of the submarine that would become Chakra began in 1993, but stalled due to lack of funding. In 2004 the Indian Navy agreed to fund the sub to completion—at a cost of \$900 million—in exchange for a future 10 year lease with an option to buy. Delivery to the Indian Navy was supposed to take place in 2010, but transfer was delayed after a 2008 accident that killed 20 Russian Navy personnel and wounded another 21.

At 8,000 tons displacement, Chakra is as large as U.S. Virginia-class nuclear submarines. It has a maximum speed of 30 knots with a maximum operating depth of reportedly 520 meters. The sub not only has a customary large sonar hydrophone array on the bow, but also active and passive arrays scattered over the rest of the hull. Chakra also features a pod-mounted towed hydrophone array.

INS Chakra is armed with not only four standard diameter 533 torpedo tubes but also another four 650mm torpedo tubes. Armament includes the VA-111 Shkval supercavitating torpedo, a high speed torpedo capable of traveling at 220 knots to ranges of up to 15 kilometers. Missile armament is in the form of 3M54 Klub anti-ship missiles. Chakra can carry up to 40 torpedo tube launched weapons, including mines. (Five merchant ships were struck by mines during the 1971 India-Pakistan War.) For defensive purposes, Chakra has six external tubes, each carrying two torpedo decoys.

According to the terms of the lease with Russia, Chakra cannot be equipped with nuclear weapons.

3. AH-64D Apache Longbow Block III Attack Helicopter ::

India's recent agreement to purchase the AH-64D Apache helicopter represents a quantum leap in land firepower for the Indian Army. The Apache's versatility means that it will be able to do everything from engage armored formations in a conventional war scenario to hunt guerrillas and infiltrators in a counterinsurgency campaign.

The Apache is one of the most battle proven attack helicopters fielded. Apache is capable of speeds of up to 171 miles an hour in high altitude environments, an important consideration in India's mountainous terrain. The rotor blades are resistant to 12.7mm machine gun fire and the cockpit is protected from shrapnel by Kevlar shielding.

The Apache Longbow is optimized to attack and destroy armor—the mast-mounted millimeter-wave radar is capable of detecting and prioritizing up to 128 vehicle targets in a matter of seconds, then attacking up to sixteen targets in quick succession. For counterinsurgency operations, the thermal imaging sensor allows crew members to pick out individuals in ground cover and concealment.

The helicopter has four external hard points, each of which can mount four Hellfire missiles. A 30mm cannon capable of engaging light armor, soft targets or personnel is mounted underneath the helicopter chin and slaved to an optical sight worn by the pilot and gunner.

In a contract worth \$1.4 billion dollars, in 2012 India agreed to purchase 22 Apache helicopters. Also included in the 2012 deal was a request for 812 Hellfire Longbow millimeter-wave radar guided

missiles for use against tanks and armored vehicles and 542 Hellfires optimized for use against hard, soft and enclosed targets. Also included in the deal were 245 Stinger Block I missiles to provide an air-to-air capability.

In August, India offered to buy a further 39 Apaches, in an attempt to drive the overall unit cost down.

4. Su-30MKI Fighter ::

The Indian Air Force's Su-30MKI air superiority fighter is meant to secure air superiority over Pakistan. The IAF has 200 Su-30MKIs in service with another 72 on order. A long-ranged, twin engine fighter with a powerful radar and formidable armament, the Su-30MKI will form the mainstay of the Indian Air Force.

The Su-30MKI is an evolution of the 1980s-era Su-27 Flanker. Thrust vectoring control and canards make the plane highly maneuverable, while the Zhuk active electronically scanned array radar makes it capable of engaging several targets at once. Complementing the Zhuk will be the Novator long-range air to air missile, capable of engaging targets at up to 300 to 400 kilometers.

The Su-30MKI has an impressive twelve hardpoints for mounting weapons, sensors and fuel tanks. The Su-30MKI is arguably superior to any fighter in the Pakistani Air Force, with the possible exception of the F-16 Block 50/52, of which Pakistan has only 18.

A portion of the Su-30MKI force has been modified for the strategic reconnaissance role. Israeli-made sensor pods reportedly give the Indian Air Force the ability to look up to 300 kilometers into Pakistan (or China) simply by flying along the border.

The Su-30MKI will grow even more lethal with the addition of the air-launched version of the BrahMos supersonic missile, currently under development. Each Su-30MKI will be capable of carrying a single BrahMos. BrahMos will give the Su-30MKI stand-off capability against ships and ground targets to ranges of 295 kilometers.

5. Indian Nuclear Weapons ::

India first tested a nuclear weapon in 1974, with the detonation of a 12 kiloton explosive device. The Indian government has been consistently tight-lipped on the status of their nuclear arsenal, and as a result a considerable amount of mystery surrounds India's nuclear weapons.

The exact size of the arsenal is unknown but estimated to be between 90 and 110 nuclear devices. Statements by officials have lead outsiders to believe the maximum yield of Indian weapons to be around 200 kilotons, or approximately ten times the destructive power of the Hiroshima bomb.

India's first nuclear delivery systems were likely attack aircraft—first the Jaguar, then the MiG-27 and Mirage 2000. Although capable, the aircraft were vulnerable to Pakistan's air defense network and this vulnerability likely lead to the development of the land-based missiles. It is unknown whether nuclear weapons have been fitted to the Su-30MKI, but as a non-stealthily aircraft its ability to penetrate Pakistani defenses would not be dissimilar to a Mirage 2000.

Indian nuclear weapons are placed under the authority of the Strategic Forces Command. India's primary delivery systems are land-based missiles. The Prithvi I and II liquid-fueled missiles have ranges from 150 to 350 kilometers and need half a day to prepare for launch. The Agni I, II, III and IV solid-fuel missiles are medium to intermediate range ballistic missiles with a range of 700 to 4,000 kilometers.

India is also on the verge of fielding its first ballistic missile submarine, the Arihant. Based on the Akula-I attack submarine design, Arihant has been modified to carry 12 K-15 short-range missiles or 4 K-4 intermediate-range nuclear missiles. Arihant is significant in that it will be able to patrol far beyond the range of Pakistani anti-submarine warfare capabilities. This will essentially make India's retaliatory capability untouchable by Pakistan and thus a more credible deterrent.

India has a “no first use” policy regarding its nuclear weapons, reserving them solely for retaliation in the event of nuclear attack. Indian also adheres to a “minimum self defense” doctrine, in which the fewest nuclear weapons needed to maintain effective deterrence from attack are maintained.

Since 1947, Pakistan has played second fiddle to a larger, stronger India. Despite spending 50% more as a percentage of GDP on defense than India, Pakistan is militarily much weaker than India, and would lose in any conventional war. Like North Korea, Pakistan is a weakening state that invested in nuclear weapons as an inexpensive way to assure territorial integrity. An invasion of Pakistan is now likely extremely dangerous and one of the surest ways to a nuclear war. In that respect, Pakistan’s nuclear program can be considered a success.

Pakistan practices a particularly brutal form of realpolitik that involves constantly playing one party against another, to distract all parties from Pakistan’s own weakness. In support of such a policy it has evolved a wide spectrum of destructive tools, from terrorist groups to nuclear weapons. All of these tools are arrayed against India. From terrorism to nuclear war, India has to consider a wide array of contingencies it could face from Pakistan. Here are five of the most dangerous weapons India could face in any contingency.

1. JF-17 Thunder Fighter Bomber ::

A low-cost, single-engine multirole fighter, the JF-17 “Thunder” was jointly designed by the Chengdu Aircraft Industry Group (developers of the J-20 fighter) and the Pakistan Aeronautical Complex. Two hundred JF-17s may be built for the Pakistani Air Force, a significant upgrade over the existing Mirage III, Mirage V, and Chengdu F-7 fighters. The JF-17 is destined to become the backbone of the Pakistani Air Force’s fighter fleet.

Pakistan, traditionally a strong customer for American weapons, purchased several dozen F-16 Fighting Falcons in the 1980s and 1990s. The first 40 were delivered but a second batch of 28 was not, held up by American disapproval over Pakistan’s nuclear weapons program. This delay sparked an effort by Pakistan to diversify the sources of its weapons. The need for fighters coincided with China’s burgeoning military aviation industry, and the JF-17 Thunder was born.

The JF-17 outwardly appears similar to existing Pakistani Air Force fighters, in particular the French Mirage V and the American F-16 Fighting Falcon. This is probably not a coincidence, and hints at extensive Chinese study of both fighters. First flight for the JF-17 was in Chengdu, China in August 2003, with initial production in 2007.

JF-17 Thunder has an extensive suite of features common to modern fighters: a fly-by-wire control system, pulse-Doppler radar for detection and air to air engagement, in-flight refueling capability, a laser designator for ground attack, an advanced defensive countermeasures suite, and an ergonomic cockpit featuring a heads-up display and full-color digital displays. It continues to benefit from the breakneck pace of Chinese aerospace development, with new engines, a new electro-optical, helmet-mounted targeting system and avionics upgrades all planned for the near future.

The JF-17 has five weapons hardpoints that can carry a total of 8,000 pounds of fuel, equipment or munitions. Air-to-air weapons are supplied by China, with PL-5 and PL-9 short-range infrared missiles occupying the two wingtip hardpoints. For beyond visual-range engagements, the JF-17 would be equipped with the Chinese PL-12 active-radar homing missile. Air-to-ground weapons are less well known but would likely include various forms of unguided “dumb” bombs, laser-guided bombs, rocket pods, precision-guided missiles and anti-ship missiles.

2. Khalid-Class Submarine ::

The Pakistani Navy is heavily outmatched by the Indian Navy in nearly all respects. The Indian Navy has more people, more ships and more planes. In terms of technology, it is far outstripping Pakistan. Pakistan’s most useful naval assets against India are its three Khalid-class diesel electric attack submarines. These submarines alone could practice an “anti-access, area-denial” (A2/AD)

strategy of their own against an Indian Navy attempting to impose a blockade on Karachi and ports west.

The three Khalid-class submarines are modernized versions of the French Agosta-class diesel electric submarines. Khalid, Saad and Hamza are relatively small, weighing in at 2,050 tons submerged. The Khalid class can make 12 knots surfaced and just over 20 knots submerged. All three submarines have been fitted with an air independent propulsion system, allowing them to stay submerged—where they are difficult to detect—for greater periods.

Armament for the Khalid class is in the form of four 533mm standard diameter torpedo tubes. The torpedo tubes can be used to launch French-made ECAN F17 Mod 2 wire-guided torpedoes. Capable of both active and passive homing, the F17 Mod 2 can deliver a 250kg warhead up to 20 kilometers. At longer ranges, the submarines can strike targets with the famous Exocet anti-ship missile. SM39, the submerged version of Exocet, has a range of up to 50 kilometers and a high explosive warhead of 165 kilograms.

3. Pakistani Nuclear Weapons ::

Pakistan resolved to build a nuclear arsenal after the 1971 war with India; the 1974 test of an Indian atomic device reinforced in Pakistan's view. Pakistan's nuclear program proceeded under the notorious Dr. A.Q. Khan, considered the "Father of the Pakistani Bomb." In 1998, Pakistan shocked the world by simultaneously detonating multiple nuclear devices that ranged in yield from sub-kiloton to up to a possible 36 kilotons.

The number of nuclear weapons Pakistan is thought to possess is unknown but estimated to be between 90 and 110, a number derived from the amount of fissile material Pakistan is thought to have produced. Pakistani nukes are thought to have two delivery systems: aircraft bombs and ballistic missiles. Early model Pakistani F-16 fighter-bombers were probably designated in the late 1990s to carry nuclear gravity bombs. From Pakistan's F-16 base at Sargodha, a nuclear armed F-16A could reach as far as central India. That is, if it can get through India's national air defense network.

Pakistan has two short-range tactical ballistic missiles, the Ghaznavi and Shaheen missiles. Pakistan is currently developing two more short range missiles, the Abdali and Nasr. For longer range strikes Pakistan has an unknown number of Ghauri-2 missiles, an intermediate range ballistic missile based on the North Korean Nodong missile. Not much is known about the Ghauri-2, which was first deployed in the 1990s. A liquid fueled, road mobile, single stage missile with a range of approximately 2,000 kilometers, it theoretically has the ability to hit eighty percent of India. A newer intermediate range ballistic missile, Shaheen-2, is solid-fueled and reportedly has a range of 2,000 kilometers.

Despite the proliferation of Pakistani nuclear weapons and delivery vehicles this does not particularly mean Pakistan has a secure or reliable nuclear arsenal. The physical security of Pakistani nuclear weapons—particularly against a military coup or terrorist attack—has been a source of concern for the West and the United States in particular. The proliferation of Pakistani nuclear missile designs suggests early designs have been less than successful.

4. Non-State Actor Terrorist Groups ::

Perhaps the most dangerous weapon in Pakistan's arsenal are terrorist groups.

The danger to India is that these groups—particularly those plotting and conducting attacks against civilians—could pressure the Indian government to retaliate militarily against Pakistan.

The larger danger of such groups is that they could prompt the Indian government to take measures that would lead to all-out war between the two countries. The activation of India's "Cold Start" conventional military doctrine, in which the Indian Army would defeat the Pakistani Army and then rapidly move into Pakistan, could trigger a nuclear response from Pakistan, leading to a nuclear exchange between the two countries.

5. Unmanned Aerial Vehicles (UAVs) ::

Given Pakistan's history of provocations against its neighbor India, the revelation that the Pakistani military is getting into drones is not exactly good news. Since 2008, Pakistan has fielded two small unmanned aerial vehicles for tactical reconnaissance, the Shahpar and Uqab. Although drones have legitimate battlefield uses, the thought of Pakistan possessing drones spurs thoughts of more nefarious purposes than providing reconnaissance and security for Pakistani troops.

The smaller of the two drones, Uqab, is described by Pakistani defense contractor Global Industrial Defence Solution (GIDS) as a "tactical UAV system which can be used for battlefield damage assessment, aerial reconnaissance, artillery fire correction, search and rescue, route monitoring, flood relief operations" and so on. Uqab has a range of 150 kilometers and an endurance of six hours. A twin-tailed design with a single push turboprop engine, Uqab is capable of speeds of up to 120 to 150 kilometers an hour. Navigating by GPS, Uqab has both a full color real-time camera and a thermal imager camera.

The Shahpar drone, also made by GIDS, is slightly larger and faster, about 15% bigger and capable of speeds up to 150 kilometers per hour. Some effort has been put into reducing the Shahpar's radar signature, although with a large push propeller attached to the rear of the drone that may be a forlorn hope. Endurance is increased to 7 hours, and the data link can transmit real-time video up to 250 kilometers. Shahpar is capable of autonomous takeoff, flying and landing, utilizing GPS.

India would fear the Shahpar and Uqab drones because they are the ideal complement to small armed groups—whether Pakistani Rangers or Lashkar-e-Taiba—sent to stir up trouble at a border outpost or in a large city. Drone surveillance could be used to reconnoiter objectives, screen flanks and provide security, and provide real-time intelligence. The Shahpar, capable of carrying payloads of up to 50 kilograms, could likely even be used to covertly deliver cargo.

<http://www.defencenews.in/article/If-India-and-Pakistan-Went-To-War,-These-10-Weapons-Would-Shape-the-Future-of-the-World-757800>



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Living skin with blood vessels can now be 3D printed

3D-Printing of Living Skin with Blood Vessels Made Possible by Biomedical Engineers

Scientists at Rensselaer Polytechnic Institute have now developed a way to 3D print living skin, complete with blood vessels. The advancement, published in *Tissue Engineering Part A*, is a significant step toward creating skin grafts that are more like the skin our body produces naturally.

Pankaj Karande, an associate professor of chemical and biological engineering & a member of the Center for Biotechnology and Interdisciplinary Studies (CBIS), who led this research at Rensselaer, said whatever is available as a clinical product is more like a fancy Band-Aid. This provides some accelerated wound healing, but eventually, it just falls off; it never really integrates with our host cells.

A significant barrier to that integration with the host cells has been the absence of a functioning vascular system in the skin grafts.

Pankaj Karande has been working on this integration challenge for several years, previously publishing one of the first papers showing that scientists could take 2 types of living human cells, make them into "bio-inks," & print them into a skin-like structure. Since then, he & his research team has been working with scientists from Yale School of Medicine to incorporate vasculature.

In this study paper, the scientists show that if they add key elements — including human endothelial cells, which line the inside of blood vessels & human pericyte cells, which wrap around the endothelial cells — with animal collagen and other structural cells typically found in a skin graft, the cells start communicating and forming a biologically relevant vascular structure within the span of a few weeks.

He said As engineers working to recreate biology, he and his team always appreciated and been aware of the fact that biology is far more complex than the simple systems they make in the laboratory. He added they were surprised to find that, once the team starts approaching that complexity, biology takes over & starts getting closer and closer to what exists in nature.

Once the Yale research team grafted it onto a special type of mouse, the vessels from the skin printed by the Rensselaer research team began to communicate and connect with the mouse's own vessels.

Karande added that it is extremely important because they know there is actually a transfer of blood and nutrients to the graft which is keeping the graft alive.

In order to make this usable at a clinical level, scientists need to be able to edit the donor cells using something like the CRISPR technology, so that the vessels can integrate and be accepted by the patient's body.

Karande said he and his team is still not at that step, but they are one step closer.

Deepak Vashishth, the director CBIS said this significant development highlights the vast potential of 3D bioprinting in precision medicine, where solutions can be tailored to specific situations & eventually to individuals. He added this is a perfect example of how engineers at Rensselaer are solving challenges related to human health.

Karande added more work will need to be done to address the challenges associated with burn patients, which include the loss of nerve & vascular endings. But the grafts his research team has created bring researchers closer to helping people with more discrete issues, like diabetic or pressure ulcers.

Karande said for those patients, these would be perfect because ulcers usually appear at distinct locations on the body and it can be addressed with smaller pieces of skin. Wound healing typically takes longer in diabetic patients, and this could also help to accelerate that process.

At Rensselaer, Karande's research team also includes Carolina Catarino, a doctoral student in chemical & biological engineering. The Yale researcher team includes Tania Baltazar, a postdoctoral researcher who previously worked on this project at Rensselaer; Dr. Jordan Pober, a professor of immunobiology & Mark Saltzman, a professor of biomedical engineering.

This study was supported by a grant from the National Institutes of Health.

<https://www.biotechnika.org/2019/11/3d-printing-of-living-skin-with-blood-vessels-made-possible-by-engineers/>