

जुलाई  
July  
2023

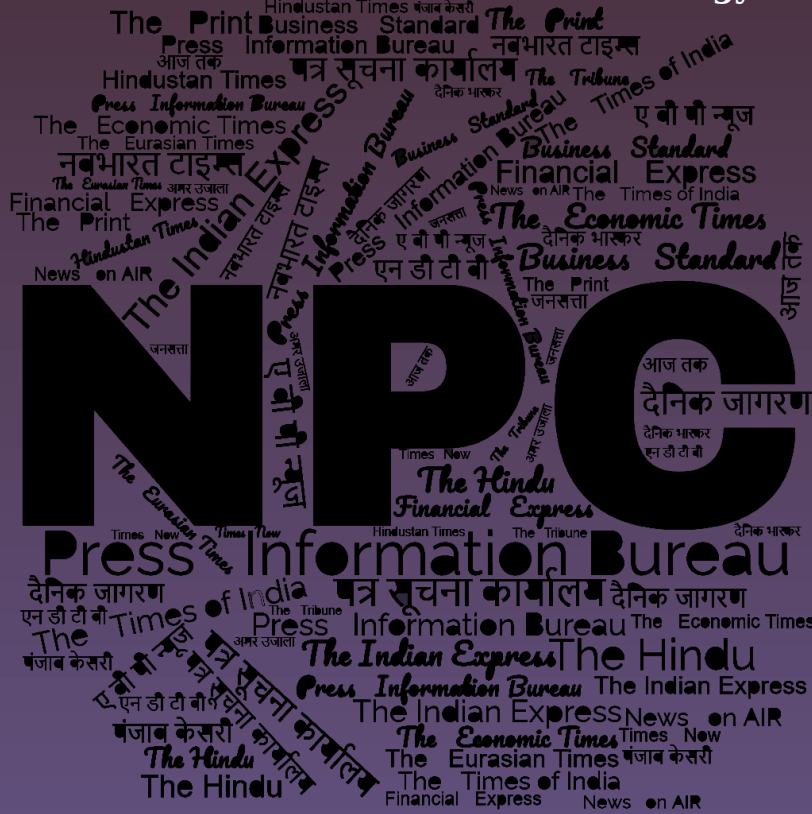
खंड/Vol. : 48 अंक/Issue : 135

19/07/2023

# समाचार पत्रों से चयित 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

**A Daily service to keep DRDO Fraternity abreast with DRDO Technologies, Defence Technologies, Defence Policies, International Relations and Science & Technology**



रक्षा विज्ञान पुस्तकालय

Defence Science Library

रक्षा वैज्ञानिक सूचना एवं प्रलेखन केंद्र

Defence Scientific Information & Documentation Centre

मेटकॉफ हाउस, दिल्ली - 110 054

Metcalfe House, Delhi - 110 054

# CONTENTS

S. No.	TITLE		Page No.
	<b>Defence News</b>		<b>1-9</b>
	<b>Defence Strategic: National/International</b>		<b>1-9</b>
1.	India, Argentina Discuss Probable Tejas, BrahMos Deal	<i>The Economic Times</i>	1
2.	India-Argentina Sign Agreements to Strengthen Cooperation in Defence	<i>Telangana Today</i>	1
3.	'Negotiations on': Why India-France didn't Announce New Rafale, Scorpene Deals	<i>Hindustan Times</i>	2
4.	India, France to Develop New Generation Military Equipment: French Envoy	<i>Deccan Herald</i>	3
5.	India, Russia Hold Military to Military Talks on Spare Parts & Maintenance Issues	<i>The Economic Times</i>	4
6.	India, Kyrgyzstan to Intensify Partnership to Counter Terror and Combat Radicalization	<i>The Economic Times</i>	5
7.	India-US Defence Relationship Robust, Increasing in Scope and Sophistication, Says General Brown	<i>The Economic Times</i>	6
8.	China's Defence Minister, Kissinger Hold Talks on Sino-U.S. Relations	<i>The Hindu</i>	6
9.	Taiwan Considers to Buy Air Defence System from US	<i>Hindustan Times</i>	7
10.	North Korea Fires Two Ballistic Missiles into Sea	<i>The Economic Times</i>	8
11.	USA Sending Fighter Jets, Warship to Gulf Region to Protect Ships from Iranian Seizures	<i>The Economic Times</i>	9
	<b>Science &amp; Technology News</b>		<b>9-11</b>
12.	Third Orbit-Raising Manoeuvre of Chandrayaan-3 Successful: ISRO	<i>The Hindu</i>	9
13.	After LVM-3, what? How ISRO is Working on Next Generation Rockets	<i>Business Line</i>	10

# THE ECONOMIC TIMES

Wed, 19 Jul 2023

## India, Argentina Discuss Probable Tejas, BrahMos Deal

Visiting Argentinian defence minister Jorge Enrique Taiana met his Indian counterpart Rajnath Singh on Tuesday and discussed probable purchase of Tejas fighter jets and BrahMos missiles.

Taiana is on a four-day visit to India. He is accompanied by secretary, international affairs, in Argentina's defence ministry, Francisco Cafiero. The South American nation had expressed interest in the indigenous light combat aircraft Tejas for the Argentine Air Force in 2022.

In June, India's ambassador to Argentina, Dinesh Bhatia, and the chief of Argentine Air Force, Brigadier General Xavier Isaac, discussed cooperation in Tejas combat aircraft and a variety of helicopter options manufactured by Hindustan Aeronautics Limited (HAL). "EAM, acknowledging Argentine interest in the Made in India Tejas fighter aircraft for Argentine Air Force, highlighted importance of the proposal in enhancing strategic quotient of the bilateral relationship," said the joint press statement released after the joint commission meeting during the visit of external affairs minister S Jaishankar to Argentina last year.

Both sides agreed to promote the exchange of visits between armed forces, defence training and collaboration for joint production of defence-related equipment. The Argentine defence minister visited BrahMos Aerospace here. He will also travel to Bengaluru and visit the HAL facilities and separately interact with the defence startups in an event organised by Innovations for Defence Excellence. India-Argentina relations were elevated to level of strategic partnership in 2019.

<https://economictimes.indiatimes.com/news/defence/rajnath-singh-holds-talks-with-his-argentine-counterpart-focus-on-defence-industrial-partnership/articleshow/101873575.cms>

## Telangana Today

Tue, 18 Jul 2023

## India-Argentina Sign Agreements to Strengthen Cooperation in Defence

Argentina's Defence Minister Jorge Taiana held a bilateral meeting with his counterpart Rajnath Singh on Tuesday and announced the signing of a Memorandum of Understanding between both countries and the signing of a Specific Agreement on Academic Cooperation for peacekeeping.

Taiana also invited Minister Singh to the II Latin American Conference of United Nations Peacekeeping Operations (ALCONU) that will take place in Argentina on September 12.

In a press statement, Argentina's Defence Minister said, We are here to perfect and deepen the agreements we have and sign some others. One of them is a Memorandum of Understanding that is richer in content and concrete possibilities than the one currently in force."

"I think we have a concrete opportunity in the field of Defense, where we can give a quality leap in cooperation between the two countries," he added.

The head of the portfolio added that the world is rapidly changing, but nevertheless, Latin America has some characteristics that make the region stand out the first is the absence of weapons of mass destruction and the non-existence of conflicts between states; the second is the enormous variety of natural resources; and the third is the existence in some countries of significant development in strategic areas with high potential for cooperation and the establishment of joint ventures.

During the meeting, the officials discussed issues related to defence cooperation and exchange in areas of training and training of officers and cadets. They also analysed the global geopolitical situation and Argentina's minister highlighted the importance that the country attaches to the vision of a bicontinental country and its projection towards the South Atlantic and Antarctica.

Another point of the meeting was the Malvinas Question, where Minister Taiana thanked India for its support in the United Nations Decolonization Committee.

Earlier, on Tuesday, Jorge Taiana, who arrived in India the day before, laid a wreath at the National War Memorial in the national capital on Tuesday and paid homage to the fallen heroes. During his visit, Argentina's Defence Minister is also scheduled to visit Bengaluru.

The Argentine Defence Minister visited BrahMos Aerospace and is scheduled to interact with leading think tanks in Delhi. He will also travel to Bengaluru and visit the Hindustan Aeronautics Ltd (HAL) facilities and separately interact with the defence start-ups in an event organised by Innovations for Defence Excellence (iDEX), read India's Defence Ministry press release.

<https://telanganatoday.com/india-argentina-sign-agreements-to-strengthen-cooperation-in-defence>



*Tue, 18 Jul 2023*

## **‘Negotiations on’: Why India-France didn’t Announce New Rafale, Scorpene Deals**

India and France are yet to conclude negotiations on technical and commercial aspects of deals for the Indian military's planned acquisition of 26 Rafale Marine combat jets and three Scorpene submarines, people familiar with the matter said on Tuesday.

The defence acquisition council (DAC) cleared the Indian Navy's proposals to acquire 26 Rafale M jets and three submarines from France on July 13, the day the Indian Prime Minister Narendra Modi began a two-day visit to Paris. It had been widely anticipated that formal announcements about the deals would be made during the visit.

The people, who spoke on condition of anonymity, said too much should not be read into the two deals not figuring in a 25-year roadmap issued at the conclusion of Prime Minister Narendra

Modi's visit on July 14. India, they said, is "very clear" about acquiring the Rafale M jets and Scorpene submarines.

Negotiations will now be done by entities on the two sides, including French firms and the Indian defence ministry's department of procurement, to finalise technical and commercial aspects of the deals before final contracts are signed, the people said.

France's Naval Group and state-run Mazagon Dock Shipbuilders Limited (MDL) signed a framework memorandum of understanding (MoU) on July 6 on building three Scorpene submarines in India. Naval Group signed another agreement with the Defence Research and Development Organisation (DRDO) in January for fitting air-independent propulsion (AIP) systems on the submarines. This will be a follow-on order to an earlier deal whereby MDL built six Scorpene or Kalvari-class submarines with technology from Naval Group under a ₹23,562-crore programme called Project-75.

Since the original deal was concluded in 2005, further discussions are required on pricing, the people said. The deals for the Rafale M jets and Scorpene submarines are on track, though the two sides have to negotiate issues such as pricing, date of delivery and the "Make in India" component, the people said.

The two deals are estimated to have a combined value of €9 billion to €10 billion, though the final price will be determined after complex negotiations between India and France.

The people sought to make a distinction between the move by General Electric and Hindustan Aeronautics Limited (HAL) to manufacture GE F-414 jet engines in India for the Light Combat Aircraft Mark 2 and plans for joint development of a new engine by France's Safran Group and DRDO to power India's next generation advanced medium combat aircraft (AMCA).

In the case of the GE F-414, the Indian side is purchasing an engine developed in the 1970s and will manufacture 80% of it in the country but won't have access to 20% of it, including "very critical technology", the people said. Safran Group proposes to work with DRDO to develop an engine that will be akin to a bespoke suit and meets the specific requirements of AMCA, they said.

This is in line with France's plans to design the next generation of military equipment with India, rather than simply transferring technology. The Indian side will be able to export this new engine and will also be well placed to develop the following generation of engines without anybody's help, the people said.

<https://www.hindustantimes.com/india-news/india-and-france-yet-to-finalize-deals-for-acquisition-of-rafale-jets-and-scorpene-submarines-negotiations-ongoing-101689668927455.html>



*Tue, 18 Jul 2023*

## **India, France to Develop New Generation Military Equipment: French Envoy**

India and France agreed to develop new generation military equipment as part of a long-term roadmap during Prime Minister Narendra Modi's visit to Paris, French Ambassador Emmanuel Lenain said on Tuesday. The envoy also said that there is "real" political consensus in France on enhancing ties with India as he cited Modi's meetings with President of the French Senate Gérard

Larcher, President of French National Assembly Yaël Braun-Pivet and Prime Minister Élisabeth Borne. "It shows that when it comes to India in France, there is real consensus. There is no difference. Everybody is so supportive and that is one of the trademarks of this partnership," Lenain said at a media briefing.

Prime Minister Modi visited Paris on July 13 and 14 during which both sides reaffirmed their commitment to expand overall strategic cooperation including in defence.

"Defence cooperation has always been very important for the two countries as we feel that in order to be independent, we have to be secure. And in order to be secure, we need good equipment and technologies," Lenain said.

The Defence Acquisition Council, headed by Defence Minister Rajnath Singh, on July 13 accorded the approval for the purchase of 26 Rafale-M (naval variant) and the three-Scorpene submarine from France.

The envoy said the two countries are working on a roadmap to produce next-generation military equipment and technologies. "We have decided to work and co-develop the next generation of equipment. And we are working on a roadmap in the defence field," he said without elaborating.

At the same time, Lenain said the defence cooperation between the two sides was much beyond one or two platforms as both sides are looking at expanding it significantly. Ambassador Lenain described Modi's visit to Paris as a reflection of "trust and strong partnership" between the two countries. "It was a very good and significant visit to send a strong message of trust and friendship," he added.

On the 1650 MW nuclear power project in Jaitapur in Maharashtra, the envoy said there has been some progress on it. Both sides are engaged in talks to resolve all issues including those relating to civil nuclear liability, cost and techno-commercial matters.

During Modi's visit, both sides agreed to adopt a 25-year roadmap to set the course for the bilateral relationship up to 2047 to celebrate the centenary of India's independence and the centenary of the diplomatic relations between the two countries. "The roadmap for the next 25 years will mean one century of bilateral relations. The roadmap is very very ambitious," Lenain said.

He said the two sides are committed to expanding cooperation in the Indo-Pacific as well. Following talks between Modi and French President Emmanuel Macron, the two sides unveiled an India-France Indo-Pacific roadmap for boosting cooperation in the region. "Our two countries believe in a free, open, inclusive, secure and peaceful Indo-Pacific region," the roadmap noted.

"We believe that the India-France partnership will be a crucial pillar of the inter-connected and intersecting arrangements in the Indo-Pacific region and indispensable for a peaceful and prosperous future for the Indo-Pacific region," it said.

<https://www.deccanherald.com/national/india-france-to-develop-new-generation-military-equipment-french-envoy-1238306.html>

## THE ECONOMIC TIMES

*Tue, 18 Jul 2023*

### **India, Russia Hold Military to Military Talks on Spare Parts & Maintenance Issues**

The third Meeting of the Working Group on Military Cooperation of the Indian-Russian Intergovernmental Commission on Military and Military Technical Cooperation (IRIGC-M&MTC)

is being held at Manekshaw Centre in Delhi on Tuesday and Wednesday to discuss the issue of spare parts and maintenance issue of Russian origin defence equipment used by India.

The meeting is being chaired by Lt Gen Johnson P Mathew, CISC HQ IDS from the Indian side and Lt Gen Dylevskii Igor Nikolaevich, Deputy Chief of the Main Operational Directorate of the General Staff of the Armed Forces of the Russian Federation from the Russian side. The Working Group Meeting is a forum established to progress defence cooperation between the two countries.

India that heavily uses Russian defence equipment discussed the issue of spare parts & maintenance with the visiting team amid the ongoing Ukraine war, it has been learnt. From Sukhoi fighter jets to tanks to the Navy, Russian origin equipment are key elements of Indian armed forces.

The Russia-Ukraine war has impacted military supplies to India. Besides challenges over the payment mechanism, Russia's own requirements slowed down supplies to India. However, it has been learnt that the Russian defence industry has bounced back and is focusing on production of various defence items. Russian state run news agencies reported earlier this year that Russia had supplied India with \$13 billion worth of arms in the past five years. Since the start of the Ukraine war in February 2022, India has maintained that dialogue and diplomacy are necessary to end the Russia-Ukraine conflict, and has boosted its trade ties with Moscow.

<https://economictimes.indiatimes.com/news/politics-and-nation/india-russia-hold-military-to-military-talks-on-spare-parts-maintenance-issues/articleshow/101881436.cms>

## THE ECONOMIC TIMES

Wed, 19 Jul 2023

### **India, Kyrgyzstan to Intensify Partnership to Counter Terror and Combat Radicalization**

India and the Central Asian state of Kyrgyzstan have agreed to intensify partnership to counter terror and combat radicalization and enhance defence cooperation.

The decision to boost bilateral security cooperation was taken at the second security dialogue in Bishkek. Deputy National Security Advisor, Vikram Misri led the Indian delegation at the two day (July 17 and 18) dialogue while Marat Mukanovich Imankulov, Secretary of the Security Council of the Kyrgyz Republic.

Misri also called on Zheenbek Kulubaev, Foreign Minister of the Kyrgyz Republic.

According to a Press release issued by the Embassy of India in Bishkek, the discussions at the security dialogue focussed on bilateral, regional and international issues of mutual concern, the threats and challenges being faced by both the countries, including the situation in Afghanistan.

The Indian embassy said that both sides hailed the similarity of views on these matters and agreed that further steps need to be taken to increase bilateral security cooperation between the concerned organizations.

This includes cooperation in the field of counter-terrorism, combating radicalization, narcotics control and defence cooperation.

Kyrgyzstan has been part of all Central Asia NSA level dialogue hosted by India.

<https://economictimes.indiatimes.com/news/defence/india-kyrgyzstan-to-intensify-partnership-to-counter-terror-and-combat-radicalization/articleshow/101882557.cms>

## **India-US Defence Relationship Robust, Increasing in Scope and Sophistication, Says General Brown**

Describing India as a strategic partner to the United States, a top American general has told lawmakers that the India-US military-to-military relationship is robust and increasing in scope and sophistication. "India is a strategic partner to the United States. Our military-to-military relationship is robust and increasing in scope and sophistication," General Charles Q. Brown told members of the Senate Armed Services Committee during his confirmation hearing for Chairman of the Joint Chiefs of Staff.

"If confirmed, my strategy would be to continue to bolster the Major Defence Partnership with India by expanding our existing bilateral military-to-military dialogues and defence industrial and technology cooperation," Brown said in written response to a question.

The Quadrilateral Security Dialogue or "Quad" with the US, Japan, India, and Australia as its members is designed to uphold the international rules-based order, ensure freedom of navigation, promote democratic values, improve information sharing, and enhance technological collaboration, he said.

The Quad, he said, has emerged as a significant forum for mobilizing a collective commitment to peace, security, and prosperity in the Indo-Pacific among like-minded partners. "Members are increasingly willing to address security challenges, especially in the maritime domain".

"The Quad offers a platform to ensure Maritime Domain Awareness, transparency, and resilience across the greater Indo-Pacific. Quad member states, while increasing cooperation amongst themselves, bring significant benefit to non-member countries," Brown said.

<https://economictimes.indiatimes.com/news/defence/india-us-defence-relationship-robust-increasing-in-scope-and-sophistication-says-general-brown/articleshow/101911218.cms>

## **China's Defence Minister, Kissinger Hold Talks on Sino-U.S. Relations**

The United States should exercise sound strategic judgment in dealing with China, China's defence minister Li Shangfu said while meeting veteran U.S. diplomat Henry Kissinger in Beijing on Tuesday.

China has been committed to building stable, predictable and constructive Sino-U.S. relations, and hopes the United States can work with it to promote the healthy development of relations between their two militaries, the defence ministry quoted Mr. Li as saying.

Mr. Li's remarks followed recent visits to China by senior U.S. officials, including U.S. Secretary of State Antony Blinken and Treasury Secretary Janet Yellen, which aimed to smooth over tensions between the two superpowers.



The talks took place as high-level defence dialogue between China and the United States remains frozen and military deployments across East Asia intensify.

Mr. Li's meeting with Kissinger expounded on Sino-U.S. relations. He said "some people on the U.S. side have failed to move in the same direction as the Chinese side, resulting in China-United States relations hovering at a low point since the establishment of diplomatic relations," according to a statement from China's Defence Ministry.

"We have always been committed to building stable, predictable and constructive Sino-U.S. relations, and we hope that the U.S. will work with China to implement the consensus of the heads of State of the two countries and jointly promote the healthy and stable development of the relationship between the two militaries."

Mr. Kissinger said: "The United States and China should eliminate misunderstandings, coexist peacefully and avoid confrontation. History and practice have continually proved that neither the United States nor China can afford to treat the other as an adversary."

Mr. Kissinger, now aged 100, served as U.S. secretary of state and national security advisor in the administrations of president's Richard Nixon and Gerald Ford. He played a key diplomatic role in the normalisation of relations between Washington and Beijing in the 1970s.

<https://www.thehindu.com/news/international/chinas-defence-minister-kissinger-hold-talks-on-sino-us-relations/article67095473.ece>



*Tue, 18 Jul 2023*

## **Taiwan Considers to Buy Air Defence System from US**

Taiwan is looking to buy National Advanced Surface-to-Air Missile Systems, or NASAMS, from the United States to upgrade its air defence capabilities having seen how well they work in Ukraine, the island's defence minister said on Tuesday.

China, which claims Taiwan as its own territory, has stepped up military and political pressure over the past three years to try to force the democratically governed island to accept Beijing's rule.

NASAMS have been provided by the United States for use in Ukraine, with U.S. officials saying they have had a 100% success rate in intercepting Russian missiles.

The system, developed and built by Raytheon Technologies and Norway's Kongsberg Gruppen is a short- to medium-range ground-based air defence system that protects against drone, missile, and aircraft attack, which both Canada and Lithuania have also bought, or are buying for Ukraine.

Asked on the sidelines of parliament about Taiwan buying NASAMS, Defence Minister Chiu Kuo-cheng said "certainly" there was a proposal to get them.

"This work must be done in accordance with the enemy situation," he said. "We have seen from the Russia-Ukraine war that these weapons definitely have good performance."

However, Taiwan has not received any official notification from the U.S. that they will sell NASAMS to Taipei, Chiu said.

"But we need this work to be done as soon as possible."

The US, Taiwan's main foreign source of weapons, formally makes notifications to the island about the arms Washington is willing to sell.

The US is bound by law to provide Taiwan with the means to defend itself, despite a lack of formal diplomatic relations. China routinely denounces such arms sales.

Taiwan's military has been paying close attention to the war in Ukraine for lessons on defending against a much larger opponent, for example by the use of drones.

<https://www.hindustantimes.com/world-news/taiwan-considers-to-buy-air-defence-system-from-us-101689691320269.html>

# THE ECONOMIC TIMES

Wed, 19 Jul 2023

## North Korea Fires Two Ballistic Missiles into Sea

North Korea has fired two short-range ballistic missiles into the sea, Yonhap news agency reported Wednesday, hours after an American nuclear-armed submarine made its first South Korean port call in decades.

The launch was reported by South Korea's Joint Chiefs of Staff (JCS), according to Yonhap, who said they were fired early Wednesday from the Sunan area in Pyongyang, and flew some 550 kilometres (340 miles) before splashing into the East Sea, also known as the Sea of Japan.

The JCS condemned the launches as "acts of significant provocation" and a clear violation of UN Security Council resolutions.

Japan's defence ministry also recorded the launches.

"We are analysing details, but we estimated that they have fallen outside Japan's exclusive economic zone, east of the Korean Peninsula," it said in a tweet.

The launches are the latest in a series of weapons tests by Pyongyang, and come as Seoul and Washington ramp up defence cooperation in the face of soaring tensions with the North.

On Tuesday, they held the first Nuclear Consultative Group meeting in Seoul and announced an American nuclear submarine was making a port visit to Busan for the first time since 1981.

The move had been expected to trigger a strong response from North Korea, which baulks at having US nuclear assets deployed around the Korean peninsula.

The launches also come less than a week after North Korean leader Kim Jong Un personally oversaw the firing of the country's newest intercontinental ballistic missile, the solid-fuel Hwasong-18.

Diplomacy between Pyongyang and Seoul has stalled and Kim has called for ramping up weapons development, including tactical nukes.

In response Seoul and Washington have staged joint military exercises with advanced stealth jets and US strategic assets.

The launches also come as Washington confirmed Tuesday that a US soldier is believed to have been detained by North Korea after crossing the heavily fortified border.

<https://economictimes.indiatimes.com/news/defence/north-korea-fires-two-ballistic-missiles-into-sea/articleshow/101901563.cms>

## USA Sending Fighter Jets, Warship to Gulf Region to Protect Ships from Iranian Seizures

The U.S. is sending additional fighter jets and a warship to the Strait of Hormuz and Gulf of Oman to increase security in the wake of Iranian attempts to seize commercial ships there. The Pentagon said Monday that the USS Thomas Hudner, a destroyer, and a number of F-35 fighter jets will be heading to the area. The Hudner had been in the Red Sea.

Defense officials last week announced the deployment of F-16s to the area over the past weekend, and there have been A-10 attack aircraft there for nearly two weeks in response to the Iranian activity.

The latest deployments come after Iran tried to seize two oil tankers near the strait early this month, opening fire on one of them. The aircraft are intended to give air cover for the commercial ships moving through the waterway and increase the military's visibility in the area, as a deterrent to Iran.

The U.S. Navy said in both instances the Iranian naval vessels backed off when the USS McFaul, a guided-missile destroyer, arrived on the scene. The Navy said the McFaul remains in the Gulf region to continue protection of the shipping lanes.

Sabrina Singh, a Pentagon spokeswoman, said it is not clear how long the ship and the aircraft will remain in the region.

"In light of this continued threat and in coordination with our partners and allies, the department is increasing our presence and ability to monitor the strait and surrounding waters," Singh told Pentagon reporters during a briefing.

The U.S. Navy says Iran has seized at least five commercial vessels in the last two years and has harassed more than a dozen others. Many of the incidents have occurred in and around the Strait of Hormuz, the narrow mouth of the Persian Gulf through which 20 per cent of all crude oil passes.

<https://economictimes.indiatimes.com/news/defence/usa-sending-fighter-jets-warship-to-gulf-region-to-protect-ships-from-iranian-seizures/articleshow/101850848.cms>

## Science & Technology News

## Third Orbit-Raising Manoeuvre of Chandrayaan-3 Successful: ISRO

The third orbit-raising manoeuvre (Earth-bound perigee firing) of the Chandrayaan-3 mission was performed successfully at ISTRAC, Bengaluru on July 18. The next manoeuvre is planned for July 20, 2023, between 2 and 3 pm IST.

ISRO said that the moon mission is on schedule.

On July 17, ISRO successfully performed the second orbit-raising manoeuvre (Earth-bound apogee firing) to place the Chandrayaan 3 spacecraft in the 41,603 km x 226 km orbit.

<https://www.thehindu.com/news/cities/bangalore/third-orbit-raising-manoevre-of-chandrayaan-3-successful-isro/article67093667.ece>

## THE HINDU BusinessLine

*Tue, 18 Jul 2023*

### **After LVM-3, what? . How ISRO is Working on Next Generation Rockets**

With seven straight successful launches, the LVM-3 rocket that took the 3.9-tonne Chandrayaan-3 spacecraft to the drop-off point 180 km above the earth has proved to be a reliable one. Now ISRO, India's space agency, is working on upgrading it further so that it can carry 6-tonne heavy payloads up to Geostationary Transfer Orbits (GTO).

But a rocket like the LVM-3 is good only up to a point. To go further and faster, the LVM-3 will not do. Nor is LVM-3 quite the thing for bringing down the cost of launching satellites, for which purpose, you would need reusable launch vehicles and vehicles that use cheaper fuels.

The good news is, ISRO is working on a bunch of rocket technologies- some of which are sure to hit commercial service in a decade.

**Here is a quick look at some of them.**

#### **Air-breathing rockets**

ISRO's Chairman, Sreedhara Panicker Somanath, calls air-breathing rockets "a dream". Air-breathing rockets have scramjet engines that can accelerate by themselves during their flight through the atmosphere, conserving chemical fuels for use later.

To put it simply, 'scramjet', or supersonic ram jets, have funnel-like openings on their bodies, with the mouth of the funnel facing the direction of flight. During flight, air enters the funnels at very high speeds and gets compressed as it passes through the thin end of the funnel.

The compressed air is fed into the combustion chamber where it meets the vaporised fuel (as in an automobile engine) and self-ignites. This creates a thrust. In a ramjet, air is fed into the combustion chamber at speeds lesser than the speed of sound (subsonic); in a scramjet engine, it happens at supersonic speeds.

Ramjets and scramjets are commonplace in missile technology. India's Brahmos missile is fitted with ramjets; a supersonic variant has a scramjet engine. However, scramjets have not been successfully used in rockets, which need to travel not at supersonic speeds (1.2 to 5 Mach), but at hypersonic speeds (above Mach 5).

One Mach is the speed of sound, roughly 1,225 km per hour.

Some years ago, ISRO successfully tested an air-breathing engine on a sounding rocket, but it is now working on a bigger engine (called air-frame integrated air breathing engine) that can sustain longer durations in flight. The engine is actually under manufacture for testing, but even as this is happening, ISRO is in talks with the industry for producing the rockets.

## **LOx methane engines**

Methane engines are hot today, they take rocketry to the next level. The advantages are well known. Liquid methane—essentially LNG—is not as potent a fuel as hydrogen. But the temperature at which it needs to be kept in rocket tanks is much higher than hydrogen—about minus 161°C compared with minus 253°C for hydrogen.

Moreover, it does not leak—the methane molecule is a much bigger one than hydrogen. And, methane is a lot cheaper and abundantly available.

So, every space company is eyeing methane rockets—or, Liquid Oxygen-Methane (or LOx)--because you need an oxidizer for methane to burn. Yet, liquid methane rockets are not yet commonplace, because quite a few challenges must be first overcome.

One is the problem of ‘coking’, or ‘soot deposition’. As the gas approaches the combustion chamber, some of it splits into carbon and hydrogen and the carbon gets deposited on the insides of the tubes as soot, which creates a host of problems such as combustion instability. Researchers are trying to tackle this problem by developing soot-resistant materials, such as ceramics, and adding specially designed additives to the fuel.

Also, the industry needs to get familiar with this technology to develop confidence to put in money into manufacturing.

While practically everybody (SpaceX, Blue Origin, Rocket Lab, etc.) is working on methane rockets, the first to do a proper space flight with one is the Chinese company Landscape, whose Zhuque-2 rocket achieved the feat on July 11—three days before the Chandrayaan-3 launch.

Somanath had told this writer in 2019 that ISRO was working on a LOx methane (or, Methalox) rocket, but it is still under development. Its idea is to convert a cryogenic engine into a LOx-methane.

Jayant Patil, Member of Executive Council of Management, L&T, says that LOx-methane engines are ideal for reusable rockets. Compared with kerosene, liquified methane has 20 per cent lower relative density with the same calorific value and a slightly higher specific impulse—therefore, the fuel is a fifth less heavy than kerosene with a better thrust.

## **HAVA-India’s space shuttle**

ISRO is also working on a space shuttle—a vehicle that can deliver payloads to orbit. It is called HAVA, for Hypersonic Air-breathing Vehicle Assembly, which can deliver payloads of up to 500 kg to low earth orbit. Based on the ‘re-usable launch vehicle’ technology, which itself is under development, the HAVA is a space-shuttle-like vehicle, which will fly on the back of a GSLV, deliver the payload, and return to land on an airstrip, like an airplane. A prototype is expected to be ready for testing in a few years.

These are just a few technologies that ISRO is working on, but there are many more—such as vertical take-off and landing (V-TOL), electric propulsion, nuclear propulsion, not to speak of areas like additive manufacturing in space and research into functional materials.

<https://www.thehindubusinessline.com/business-tech/how-isro-is-working-on-next-generation-rockets/article67093249.ece>

© The news items are selected by Defence Science Library, DESIDOC from Print Newspapers and Authentic Online News Resources (mainly on DRDO, Defence and S&T)