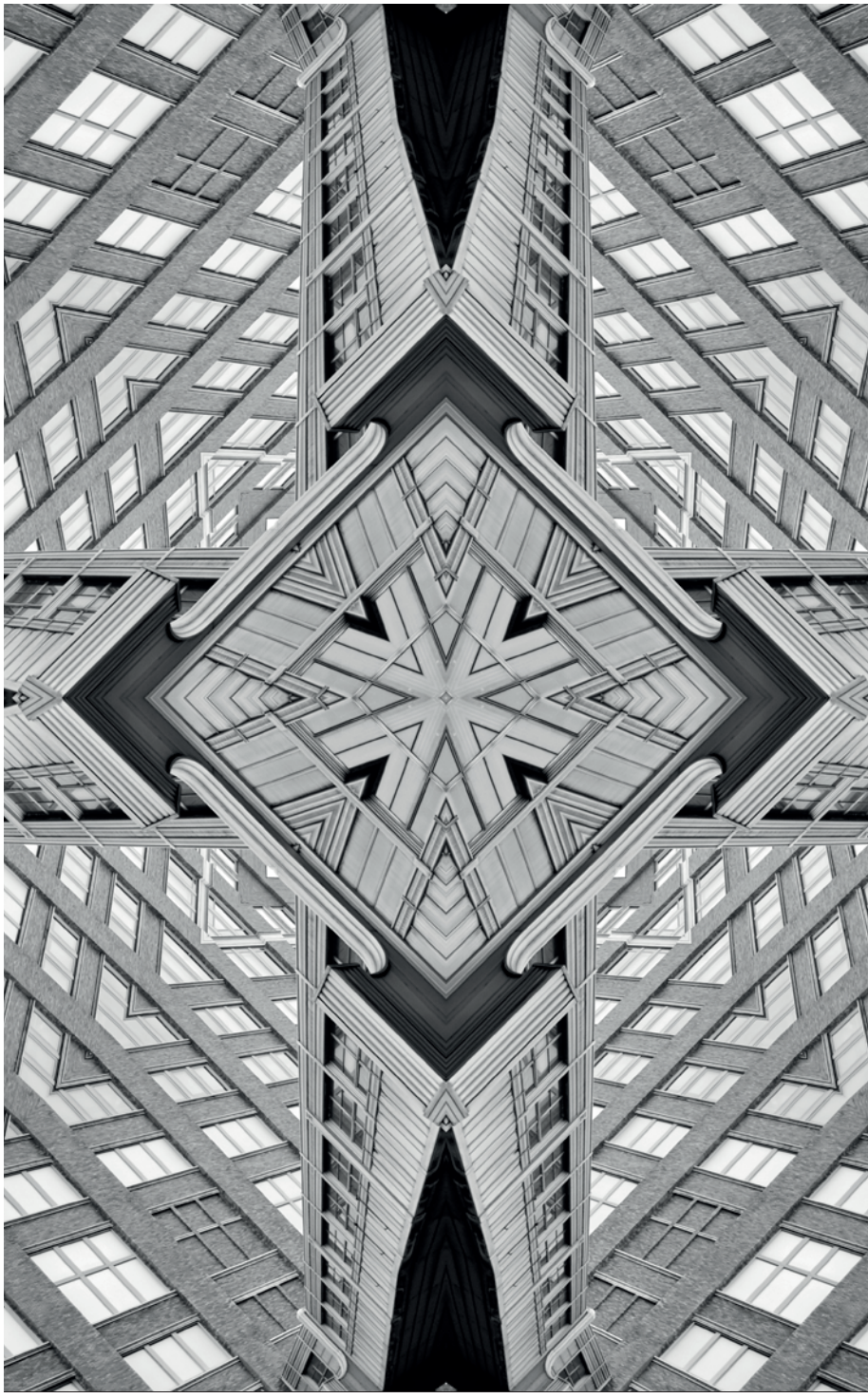
Issue Brief

ISSUE NO. 795
APRIL 2025

OBSERVER RESEARCH FOUNDATION



Addressing The IAF's Fighter Engine Conundrum

Sujan Chinoy

Abstract

The Indian Air Force (IAF) plays a critical role in securing India amidst a world in flux. For this massive task, India must possess indigenously produced fighter aircraft engines to power its fighter aircraft variants over the next 50 years without falling into undue dependency on foreign suppliers. As the timely delivery of fighter aircraft to the IAF is linked to the security of supply chains, this brief underlines the need for both the development of indigenous capabilities and technological collaboration to proceed simultaneously. Equally important is the creation of indigenous testing and certification facilities, as well as the transfer of technology.

Attribution: Sujan Chinoy, "Addressing The IAF's Fighter Engine Conundrum," *ORF Issue Brief No. 795*, April 2025, Observer Research Foundation.

Introduction

India's neighbourhood is fraught with military challenges and the strategic collaboration between China and Pakistan is deepening. Additionally, China is producing large numbers of the fifth-generation J-20 stealth fighter aircraft, as reports are emerging of Pakistan acquiring fifth-generation fighter aircraft from China.[1] These developments have lent increased urgency to meeting the needs of the Indian Air Force (IAF), especially since several of its existing frontline fighter aircraft will be due for replacement soon.

At the Aero India 2025 show in Bengaluru in February this year, Air Chief Marshal A.P. Singh lamented the delays in the delivery of the Tejas Mk-1 Light Combat Aircraft (LCA) to the IAF by Hindustan Aeronautics Limited (HAL).[2] The issues that have had an adverse impact on the IAF's operational needs should be viewed against the backdrop of evolving threats and challenges.

The IAF, which according to its own assessments should optimally have 42 fighter squadrons, currently has only 31 squadrons.[3] The IAF ordered the first batch of 40 Tejas Mk-1 Light LCA between 2009 and 2010, with induction starting in 2016.[4] The first order comprised 32 LCA fighters and eight LCA trainers. Nine years later, the order is yet to be fulfilled due to delays in the certification of the LCA trainer aircraft.[5] Various entities are involved in the certification process, such as the Aeronautical Development Agency, the Centre for Military Airworthiness and Certification under the Defence Research and Development Organisation (DRDO) of the Ministry of Defence, and the National Flight Testing Centre, which is manned by serving IAF officers.

In finalising the new qualitative requirements for the LCA Mk-1A fighter aircraft, the IAF sought the development and integration of four new systems comprising air-to-air refuelling, active electronically scanned array radar, electronic warfare suite, and beyond-visual-range missiles (i.e., Astra).[6] The subsequent acquisition order, comprising 73 LCA Mk-1A fighters and 10 LCA Mk-1A trainers (83 in total), was placed in 2021, with supplies to commence 36 months after the signing of the contract.[7] However, this raises the question of whether the timeframe stated in the contract accounted for design and development tasks for integrating four new additions and replacing some old systems with new ones.

Introduction

Following the 2021 agreement with General Electric (GE) for the delivery of F404-IN20 fighter jet engines for the Tejas LCA Mk-1 and the IAF's deal with HAL in the same year for 83 Tejas Mk-1A variants, fresh negotiations are underway for an additional 97 Mk-1A. The IAF is also looking to acquire 114 Multi-Role Fighter Aircraft (MRFA).[8] Reducing the quantity of the MRFA could be considered if the production of Tejas LCA Mk-1A is boosted, deliveries take place according to schedule, and the Tejas LCA Mk-2 meets the requisite timeline for development.

The delays in the delivery of Tejas Mk-1A by HAL can be attributed to GE's inability to provide the engines on time and the complexities in the integration and certification of the new systems sought by the IAF. HAL's production capacities are also a challenge; it has an annual production capacity of 16 Tejas aircraft in Bengaluru and eight in Nashik—or a total of only 24 fighter jets per year. HAL plans to set up another production line for eight aircraft per year at Nashik, but it could take another 18 months or so before this facility is established.[9] Considering these factors, a back-of-the-envelope calculation suggests that it could take almost six years to produce all the Tejas variants on order, provided there are no more delays on the part of GE or any other supply chains.

Additionally, the end user's requirements for modification, upgrade, and addition of new systems would involve further development, testing, and certification, all of which are time-consuming. Therefore, there is a need to introduce the "responsibility principle", i.e., the entity that is responsible for a delay should be identified and held accountable.[a] In the 'block' model for manufacturing fighter aircraft, there are well-defined limits to the systems that can be incorporated into existing platforms.[b] Freezing design changes and system additions can result in higher production rates.

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a In essence, it means that those who are responsible for failing to meet contractual obligations, whether government or industry, must generally pay the costs.

b In fighter aircraft development, "block model" refers to a specific configuration or version of an aircraft, distinguished by a series of incremental upgrades, improvements, and changes made during production or after initial deployment. These block upgrades usually involve software, hardware or structural changes that enhance the aircraft's capabilities.

Atmanirbhar Bharat and Aircraft Engine Development

The delays in the IAF's expected supply of Tejas LCAs brings to the forefront the larger question about Atmanirbhar Bharat in defence manufacturing and the security of India's defence supply chains. Ramping up indigenous production of defence platforms, including fighter aircraft, is at the core of Atmanirbhar Bharat in defence manufacturing and the security of India's defence supply chains. While HAL has performed well in airframe design and development, the lack of an indigenous aircraft engine and the prolonged timelines for testing, certification, and production continue to be hindrances.

As far as domestic efforts are concerned, the afterburner GTX-35VS Kaveri engine, developed by the Gas Turbine Research Establishment (GTRE), has seemingly ground to a halt.[10] While some experts consider it a "good" engine, its afterburner thrust, at about 72 kiloNewton (kN), was deemed inadequate to power the LCA, resulting in India having to order GE engines of 78 kN thrust.[11] There are apparent limits to improving the Kaveri engine, and further changes would be tantamount to building a new engine. Additionally, the Dry Kaveri engine, with a lower thrust of 49-51 kN (without the afterburner), is currently being envisaged for unmanned combat aerial vehicles (UCAVs). However, the utility of the engine would be relevant only if the UCAV programme of the Aeronautical Development Establishment is approved.[12]

The lack of a flight testbed has compelled India to continue relying on a modified Russian IL-76 transport aircraft at the Gromov Flight Research Institute to validate the Kaveri engine. India needs its own high-altitude wind tunnel and multi-engine flight test aircraft to obviate the need for Indian aircraft designers to look to Russia for validation. Challenges such as the unavailability of testing slots would impact timelines.[13]

The LCA Mk-1 fighter aircraft uses the GE-404 IN-20 engine, which is also envisaged to be used in LCA Mk-1A. Thereafter, the future requirement of fighter aircraft engines appears to be at two levels: The first is for an engine of 98 kN afterburner thrust that would power about 120 LCA Mk-2 and the Advanced Medium Combat Aircraft (AMCA) Mk-1. The IAF is also expected to follow up the LCA Mk-2 order with another order of about 210 of the same aircraft, whereas media reports place the possible number of AMCA Mk-1 at 120 aircraft. According to projections, the GE-414 engine is expected to meet both levels of requirements.[14]

There were some discussions between the GTRE and Safran of France to co-develop a 98 kN fighter aircraft engine, but this appears to have been overruled in favour of the decision to acquire an engine with a level of Transfer

of Technology (ToT) that is critical for technology accretion and value addition for indigenous industry.[15] HAL has set up a panel to negotiate the deal for the GE-414 engine with GE.[16]

The second engine being sought for future needs is one with a 110 kN afterburner thrust to power the AMCA Mk-2 and, subsequently, the Twin Engined Deck Based Fighter Aircraft. This engine is likely to be co-developed in India with a foreign Original Equipment Manufacturer (OEM). While the precise number of aircraft required in both categories is not clear yet, experts estimate that it will be a decade before the first AMCA fighter planes can be inducted into the IAF.[17]

The indigenous manufacturing of fighter aircraft should be considered over the long term since all LCA and AMCA variants are expected to be in service for decades. While importing engines, India should consider engaging in a parallel effort to design and develop its indigenous fighter engine of 98 kN thrust in collaboration with an appropriate foreign consultant, as part of *Viksit Bharat*. This may entail a large outlay of funds, but this would be money well spent in the context of the future defence and security of the nation. Notably, all the Tejas variants—Mk-1, Mk-1A, and Mk-2—will require replacement engines over their decades-long life cycle. India has used the MIG-21 variants, with upgrades, for over 50 years. With some design modifications, even the Mk-1 and Mk-1A could be upgraded to be outfitted with a more powerful 98 kN engine that is produced indigenously. The 98 kN engine could be de-rated for this purpose. Having its own 98 kN engine will ensure that India is not affected by disruptions and delays in the external sourcing of engines, especially if the number of projected LCA variants increases in the future in light of emerging threats.

In terms of building more LCA aircraft in the future or refurbishing existing ones, India should have an indigenous alternative fighter aircraft engine for the next 50 years. Assured engine supplies will increase the export potential of the LCA and strengthen the confidence of other countries in fighter aircraft produced by India. Therefore, to mitigate risk, a balance needs to be found between using United States (US)-made GE engines and indigenously producing engines.

To be sure, there may well be a convincing case for creating a more powerful 110 kN fighter aircraft engine and using that experience to build engines with lesser thrust. The trend is towards MRFAs that are bigger, faster, and have a heavier payload capacity, such that even a 110 kN thrust is now considered to be at the lower end of benchmarks. Therefore, the development of indigenous technologies and technological collaboration must take place simultaneously.

The Role of the Private Sector

The US is currently the world's largest manufacturer of defence equipment, including fighter aircraft, yet this was not always the case.[18] The mobilisation of US industry, technology, and materials production resulted from a collaboration between the Franklin Roosevelt administration[c] and dedicated industry leaders, resulting in a strong foundation of indigenous R&D, innovation, and industrial capacity, including in the aeronautical sector.[19]

In India, the involvement of the private sector in defence manufacturing is growing and is integral to the government's *Atmanirbhar Bharat* initiatives. Yet, the private sector, if involved in the production of the entire LCA airframe, will require several years to establish its vendor base and supply lines.

The manufacturing of some parts of the airframe of the LCA has already been outsourced to private companies, such as VEM Technologies, Dynamatic, L&T, Tata Advanced Systems Limited, Alpha-Tocol Engineering Services, and LMW Limited. On 9 March 2025, HAL representatives handed over the first rear fuselage for the Tejas Mk-1A, produced by the private sector, to Raksha Mantri Rajnath Singh.

As the private sector takes on more work, it is essential to ensure that there are no additional delays in supply chains that can adversely impact HAL's timelines. Delays in HAL's supply of fighter aircraft to the IAF can have reputational risks for India as a potential exporter of defence equipment, including the LCA, the Advanced Light Helicopter, and the Light Utility Helicopter.

The Empowered Committee for Capability Enhancement of the IAF set up by the Ministry of Defence submitted its report to the Raksha Mantri in 2025.[20] The report has identified key thrust areas and made short-, medium-, and long-term recommendations to address the needs of the IAF. Notably, there is an emphasis on enhancing indigenisation and promoting increased private-sector involvement in tandem with defence public sector undertakings (DPSUs) and DRDO.

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c At the beginning of the Second World War, the US began accepting drawings and designs from Great Britain and France to help produce aircraft and other equipment for the war in Europe, which had seen high rates of attrition. After the attack on Pearl Harbor by Japan in December 1941, the US directly joined the conflict. Roosevelt turned to several well-known industry figures like William Signius Knudsen of General Motors and Henry Kaiser to convert civilian production lines to manufacture large numbers of fighter aircraft, naval ships, guns, and other platforms for the war effort. By the end of the war, US companies were making thousands of such platforms. The US has since had the most prolific military industrial complex in the world.

Conclusion

Global powers have developed capabilities for the indigenous manufacturing of fighter aircraft and engines. India's ambitions of becoming an aerospace power will depend on whether it can make its own fighter aircraft engines in the coming decades. Continued dependence on foreign OEMs for fighter aircraft engines over the entire service life of platforms such as the LCA and AMCA would leave India in a vulnerable state. Even as India imports engines to power its indigenously designed and developed fighter aircraft, it must simultaneously develop a broad range of domestic capacities for manufacturing, testing, and certification as part of a broader risk mitigation strategy.

In this context, India must continue to invite increased participation from the private sector. In an uncertain world subject to geopolitical uncertainties, great-power contestations, and the ebbs and flows of transactional relationships, it is vital for India to have a reliable supply of indigenous fighter aircraft engines in the future in order to avoid possible disruptions. Given the myriad threats and challenges around India, it can ill afford to delay the planned induction of fighter aircraft or allow supply chain issues to adversely affect its operational capabilities and combat readiness.

India should negotiate the most favourable terms with OEMs to fulfil its planned order of 114 MRFA to secure ToT, especially for indigenous production of engines, thus giving a new thrust to the Atmanirbhar Bharat initiative in defence manufacturing.

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