



REFORMS FOR ATMANIRBHARTA IN INDIAN NAVAL AVIATION



RAJIV KUMAR NARANG



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REFORMS FOR
ATMANIRBHARTA IN INDIAN
NAVAL AVIATION

RAJIV KUMAR NARANG



MANOHAR PARRIKAR INSTITUTE FOR
DEFENCE STUDIES AND ANALYSES

मनोहर परिकर रक्षा अध्ययन एवं विश्लेषण संस्थान

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LIST OF ABBREVIATIONS

ADA	- Aeronautical Development Agency
ADE	- Aeronautical Development Establishment
ADG	- Aviation Design Group
AESA	- Airborne Electronically Scanned Radar
AEW	- Airborne Early Warning
AEW&C	- Airborne Early Warning and Control
AI	- Artificial Intelligence
AINATR-2047	- <i>Atmanirbhar</i> Indian Naval Aviation Technology Roadmap -2047
ALH	- Advanced Light Helicopter
AoN	- Acceptance of Necessity
AMCA	- Advanced Medium Combat Aircraft
ASR	- Air Staff Requirement
ASW	- Anti-Submarine Warfare
ATOL	- Automatic Take off and Landing
AUW	- All up Weight
BEL	- Bharat Electronics Limited
BVR	- Beyond Visual Range
CABS	- Centre for Air Borne Systems
CAG	- Comptroller and Auditor General
CATOBAR	- Catapult Assisted Take Off but Arrested Recovery
CBF	- Carrier Based Fighter
CCS	- Cabinet Committee on Security

CEMILAC	- Centre for Military Airworthiness and Certification
CNS	- Chief of Naval Staff
CSIR-NAL	- Council for Scientific and Industrial Research, National Aerospace Laboratory
CUAS	- Counter-Unmanned Aircraft Systems.
CWP&A	- Controller of Warship Production and Acquisition
DAC	- Defence Acquisition Council
DAP	- Defence Acquisition Procedure
DBMRH	- Deck-Based Multi-Role Helicopter
DCCM	- Directorate of Cost and Contract Management
DCNS	- Deputy Chief of Naval Staff
DEW	- Directed Energy Weapons
DNC	- Directorate of Naval Construction
DND	- Directorate of Naval Design
DRDO	- Defence Research and Development Organisation
DSP	- Directorate of Ship Production
DSR	- Directorate of Staff Requirements
DTCL	- Defence Trade Controls Licensing
EoI	- Expression of Interest
EW	- Electronic Warfare
FMS	- Foreign Military Sale
FOC	- Final Operational Clearance
FOEM	- Foreign Original Equipment Manufacturer
HALE	- High Altitude Long Endurance
HDB	- Helicopter Design Bureau

HF-24	- Hindustan Fighter-24
HTT-34	- Hindustan Turbo Trainer-34
IC	- Indigenous Content
IDDM	- Indigenously Designed, Developed and Manufactured
IDS	- Integrated Dynamic System
IGA	- Inter-Governmental Agreement
IMRH	- Indian Multi-Role Helicopter
IN	- Indian Navy
INAS	- Indian Naval Air Squadron
INIP	- Indian Naval Indigenisation Plan
IOC	- Initial Operational Clearance
ISR	- Intelligence Surveillance and Reconnaissance
IT	- Information Technology
JV	- Joint Venture
JSQR	- Joint Services Qualitative Requirements
LCA Mk-1	- Light Combat Aircraft Mark-1
LPD	- Landing Platform Deck
LOA	- Letter of Offer and Acceptance
LRMR	- Long Range Maritime Reconnaissance
LRU	- Line Replaceable Unit
LUH	- Light Utility Helicopter
L&T	- Larsen and Toubro
MALE	- Medium Altitude Long Endurance
MCTF	- Military Civil Technology Fusion
MGB	- Main Gear Box
MINAS	- Manual for Indigenisation of Air Stores
ML	- Machine Learning

MLA	- Manufacturing License Agreement
MoCA	- Ministry of Civil Aviation
MR	- Maritime Reconnaissance
MRMR	- Medium Range Maritime Reconnaissance
MRCBF	- Multi Role Carrier Based Fighter
MRO	- Maintenance, Repair and Overhaul
MUMT	- Manned-Unmanned Teaming
N-AMCA	- Naval - Advanced Medium Combat Aircraft
NAIR	- Naval Aviation Indigenisation Roadmap
NASR	- Naval Air Staff Requirement
NAY	- Naval Aircraft Yard
N-CATS	- Naval-Combat Aerial Teaming System
NFTC	- National Flight Testing Centre
N-LCA	- Naval-Light Combat Aircraft
NIIO	- Naval Innovation and Indigenisation Organisation
NMRH	- Naval Multi Role Helicopter
NSCS	- National Security Council Secretariat
NP-1 & NP-2(LCA)	- Naval Prototype-1 & Naval Prototype-2 (LCA)
NPT	- Naval Project Team
NUH	- Naval Utility Helicopter
OEM	- Original Equipment Manufacturer
ORCA	- Omni Role Combat Aircraft
PDC	- Probable Date of Completion
PDR	- Preliminary Design Review
PLAAF	- People's Liberation Army Air Force
PLAN	- People's Liberation Army Navy

PSO	- Principal Staff Officer
PTN (ALH)	- Prototype Navy (ALH)
QR	- Qualitative Requirements
Rafale-M	- Rafale-Marine
RCS	- Radar Cross Section
RFI	- Request for Information
R&D	- Research and Development
RWR&DC	- Rotary Wing Research and Design Centre
SBTF	- Shore Based Test Facility
SRMR	- Short Range Maritime Reconnaissance
SRUAV	- Short Range Unmanned Aerial Vehicle
STOBAR	- Short Take Off But Arrested Recovery
SWIFT	- Stealth Wing Flying Test Bed
TASL	- Tata Advanced Systems Limited
TD	- Technology Demonstrator
TEDBF	- Twin Engine Deck Based Fighter
ToT	- Transfer of Technology
UAV	- Unmanned Aerial Vehicle
UCAV	- Unmanned Combat Aerial Vehicle
UTM	- Unmanned Aerial Vehicle Traffic Management
VCNS	- Vice Chief of Naval Staff
WDB	- Warship Design Bureau

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VERNACULAR WORDS/PHRASES

Atmanirbhar	- Self-reliant
Atmanirbharta	- Self-reliance
Atmanirbhar Drone Hub@2030	- Self-reliant Drone Hub by 2030
Raksha Mantri	- Defence Minister
Sashakt	- Strong
Viksit	- Developed
Viksit Bharat	- Developed India
Viksit Bharat@2047	- Developed India by 2047
Viksit and Sashakt Bharat	- Developed and Strong India
Viksit and Sashakt Bharat@2047	- Developed and Strong India by 2047

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PREFACE

This study intended to examine the challenges facing the indigenous development of Light Combat Aircraft Mk-1 (Navy) or LCA Mk-1 (Navy) Carrier Borne Fighter (CBF) of the Indian Navy (IN). A deeper inquiry and research into the subject led to the discovery of structural, policy and ecosystem gaps that become a limitation in achieving *atmanirbharta* (self-reliance) in naval aviation.

India's indigenous CBF development program is facing an impasse due to indecision, inconsonance and lack of ownership. The IN's withdrawal of consent for the LCA Mk-1 (Navy) and LCA Mk-2 (Navy) development project in 2016 and 2017 respectively,¹ lack of limited acquisition of LCA Mk-1 (Navy), non-participation in the Advanced Medium Combat Aircraft (AMCA) development project, and lack of approval, technological obsolescence and supply chain support challenges for the Twin Engine Deck Based Fighter (TEDBF) indicate inconsonance in the *atmanirbharta* trajectory of Indian naval aviation. The incoherences in the self-reliance trajectory of CBF extends to MR, Airborne Early Warning (AEW) aircraft, helicopters and UAV segments. This impasse and incoherence could lead to India foregoing the technological gains made in the last two and half decades of LCA Mk-1 (Navy) CBF development efforts. Although the IN is steadily transforming from a 'buyers navy' to a 'builders navy' in ship and submarine building, it continues to remain a predominantly a 'buyers navy' with regard to naval aviation. This raises a few questions:

- (a) Why has the IN, which is known for leading self-reliance in ship and submarine building, struggled to achieve self-reliance in naval aviation?

¹ 'It's Official: Indian Navy Wants 57 Carrier Borne Fighters', *Livefist Defence*, 25 January 2017, <https://www.livefistdefence.com/its-official-indian-navy-wants-57-carrier-borne-fighters/>, accessed on 16 August 2025.

- (b) Do naval aviation *atmanirbharta* plans and roadmaps of the IN have the scope and commitment similar to that of ship and submarine building?
- (c) Are the IN's organisational structures, policy and technology development initiatives oriented towards self-reliance in naval aviation?

The above questions are the guiding elements of this study. The development and induction of fifth and next generation fighter aircraft by China and increasing collusion between Pakistan, China and Turkey, has changed the threat dynamics for India. The proposed development of TEDBF, aimed at enhancing range and payload to meet the challenges posed by the People's Liberation Army Navy (PLAN) in the Indian Ocean, faces the risk of technological obsolescence vis-à-vis fifth- and next-generation Chinese fighter aircraft. TEDBF would struggle to retain a technological edge in its envisaged life span of thirty to forty years following its earliest possible induction sometime around 2035. The import of 26 Rafale-Marine (Rafale-M) fighter aircraft from France in April 2025² has further reduced the IN's requirement of CBF from 87 to 61 aircraft for its envisaged fleet of two aircraft carriers. Further procurement or Transfer of Technology (ToT) of Rafale-M could have an impact on the technological sovereignty, viability and sustainability of indigenous CBF development projects and thus, needs to be factored in the *atmanirbharta* calculus.

The manpower, resources and costs associated with the design, development, testing, certification, manufacturing and providing life cycle support to a small number of TEDBF necessitate the alignment of IN's requirements with the Naval-Advanced Medium Combat Aircraft (N-AMCA). The LCA Mk-2, primarily designed for the naval roles with the commonality of supply chains and shorter development

² Shivam Patel and Surbhi Misra, 'India Signs \$7.4 Billion Deal to Buy 26 Rafale Fighter Jets', *Reuters*, 28 April 2025, <https://www.reuters.com/world/india/india-signs-74-billion-deal-with-france-buy-26-rafale-fighter-jets-2025-04-28/>, accessed on 16 August 2025.

timelines, is best suited for the development as an interim naval fighter till N-AMCA is operationalised. However, the transformation of AMCA into CBF would require significant design modifications to undertake the envisaged naval missions.

The Indian CBF development programme is at a crucial juncture. Timely decisions on the limited induction of the LCA Mk-1 (Navy) as a supplement to and replacement for Hawk as a carrier borne naval jet fighter trainer and air defence fighter, the induction of the LCA Mk-2 (Navy) as an interim 4.5-generation fighter, and the launching of the N-AMCA development program, are essential to address the current impasse, meet emerging challenges posed by the fifth and next-generation Chinese fighters and maintain the *atmanirbharta* trajectory in CBF.

The analysis of inconsonance in India's CBF programme and the near absence of Maritime Reconnaissance (MR), Anti-Submarine Warfare (ASW) aircraft, helicopters and Medium Altitude Long Endurance (MALE), High Altitude Long Endurance (HALE) unmanned aerial vehicle (UAV) development programmes with the IN's ownership, on the lines of shipbuilding, indicates lack of enabling policies, structures and naval aviation technology development initiatives. India's quest for *atmanirbharta* in naval aviation requires substantive structural, policy and ecosystem reforms in the IN and MoD. Also, indigenous naval aviation development programmes need to be reoriented and revitalised. The IN's participation as an equal development partner in indigenous naval aviation projects could prove crucial to realise the goal of self-reliance.

The learnings from the study led to the articulation of a way forward, comprising three structural reforms, nine policy reforms and fifteen technology initiatives. The three structural reforms comprise creation of a Defence and Aeronautics Commission or a similarly empowered higher body; the formation of an Aviation Design Group (ADG) on the lines of ship and submarine design in the Indian Navy; and the consolidation of aircraft carrier design and naval fighter aircraft design under one PSO - either the Vice Chief of Naval Staff (VCNS) or the Deputy Chief of Naval Staff (DCNS) at the Naval Headquarters level.

The nine policy reforms aim to address policy, procedural and execution level gaps while bringing ownership, accountability and rationality in the atmanirbharta trajectory. The proposed structural and policy reforms can stimulate and elevate self-reliance in naval aviation while addressing inter-organisational and intra-organisational incoherence, indecisions and inactions at the same time. The fifteen naval aviation technology initiatives aim to expand the self-reliance trajectory, create jobs, prevent migration of intellectual capital out of India, and reduce import and trade imbalance. The aero-engine remains a crucial vulnerability in the indigenous air force and naval fighter aircraft development programmes. The development of 80 kN (Kaveri-2) and 90-100 kN (Kaveri-3) variants of Kaveri engines through a Public-Private Partnership (PPP) mode could be launched to replace GE-404 and GE-414 engines on completion of their service life sometime from 2035 and 2040 onwards, respectively. In addition, feasibility of integration of French M88 or M88 T-REX engines with LCA Mk-1 (Navy) or LCA Mk-2 (Navy) respectively, can be examined to provide alternate options and mitigate future vulnerabilities. If required, maximum AUW of respective fighter aircraft may be reduced marginally to match engine performance and payload limitations. A small weight reduction could be a worthy tradeoff to mitigate potential vulnerabilities.

The increasing participation of private sector and global collaborations has raised concerns about the creation of low-value assembly lines in India. Foreign Original Equipment Manufacturers (FOEMs) retaining control over Intellectual Property Rights (IPR) and critical technologies in collaboration with Indian entities could become a limitation during war and contingencies. Therefore policy, structure and mechanisms are needed for scientific assessment of their contribution to atmanirbharta. The Indigenous Content (IC) certification and technology-wise indigenisation roadmap are needed to provide scientific and transparent mechanisms for validating and monitoring self-reliance in core and critical technologies developed in IDDM as well as collaborated projects. These measures can be applied to both public- and private-sector entities, including through ToT, collaborations, and joint ventures (JVs) with FOEMs.

The Ministry of Defence (MoD) had declared 2025 as the year of defence reforms. These reforms can pave the way for the creation of

enabling organisational structures formulation of a naval aviation self-reliance roadmap, aid in the launch of technology development initiatives, enhance accountability and contribute in overcoming limitations and building an *atmanirbhar* naval aviation force for Indian Navy by 2047. While this study addresses challenges of Indian naval aviation, it does not examine challenges of achieving *atmanirbharta* in aviation for the IAF and the IA. These have their own unique and complex challenges and impact trajectory of *atmanirbharta*, and are therefore important subjects for further research.

Gp Capt RK Narang

INTRODUCTION

After its launch in 2003, India's indigenous CBF development programme reached an impasse due to three factors: (1) the IN's withdrawal of consent for LCA Mk-1 (Navy) in 2016 and lack of acquisition of LCA Mk-1 (Navy) by IN; (2) its non-participation in the LCA Mk-2 (Navy) and N-AMCA development programmes; and (3) its pursuit of TEDBF development. The LCA Mk-1 (Navy) project was approved by the Cabinet Committee on Security (CCS) in March 2003, two years after the first flight of LCA Mk-1 (IAF) that took place on 4 January 2001.³ The LCA Mk-1 (Navy) Naval Prototype-1 (NP-1) was piloted by Cmde J A Maolankar along with Wg Cdr Prabhu, Flight Test Engineer and undertook its maiden flight on 27 April 2012.⁴

The development of LCA Mk-1 (Navy) was India's first attempt to indigenously develop CBF and achieve self-reliance. The acquisition of a limited number of LCA Mk-1 (Navy) was proposed; however, it is yet to be fructified. The LCA Mk-2 (Navy) was developed to enhance payload, increase range and overcome limitations of the LCA Mk-1 (Navy). The Indian Air Force (IAF) decided to join the LCA Mk-2 (Navy) development project as an interim solution until the fifth-generation AMCA fighter is developed. However, the IN withdrew its consent from LCA Mk-1 (Navy) and LCA Mk-2 (Navy) projects

³ 'Aircraft Certification, Light Combat Aircraft (LCA) - Tejas - AF Mk1 -Final Operational Clearance', Defence Research and Development Organisation, <https://www.drdo.gov.in/drdo/aircraft-certification>, accessed on 15 August 2025.

⁴ 'Maiden Flight of Light. Combat Aircraft-Navy (NP1)', Press Information Bureau, Government of India, Ministry of Defence, 27 April 2012, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=82764>, accessed on 15 August 2025.

in 2016 and instead sought development of TEDBF in 2019. The withdrawal of the IN from both LCA Mk-1 (Navy) and LCA Mk-2 (Navy) projects brought the indigenous carrier borne naval aircraft development programme to a standstill and created opportunities for import.

The suitability of the TEDBF came under scrutiny due to its limited requirement, resource constraints, economic viability and life support challenges. Its operational utility degraded further with the technological advances made by China with the operationalisation of fifth-generation naval fighter in 2024 and first flight of next-generation (fifth-generation plus) J-36 and J-50 fighter aircraft in December 2024. These developments increased the vulnerability and reduced the operational utility of TEDBF, which was expected to remain in service for thirty to forty years after its induction. The procurement of 26 Rafale-M in 2025 reduced the total number of TEDBF required by the IN for two aircraft carriers from 87 aircraft to 61 aircraft.

The initiation of the TEDBF project for a small number of aircraft requires design review, testing, certification and creation of separate supply chains, while also creating uncertainty about its economic and operational viability. In addition, TEDBF certification and induction timelines are expected to be similar to or later than that of N-AMCA. Even if approved at this stage, TEDBF's earliest induction would take place well after 2035, which makes its approval challenging. Also, TEDBF, being a 4.5-generation aircraft, faces early technological obsolescence as there are concerns about its ability to provide technological edge during its expected service life of three to four decades after its induction.

The 5.5-generation AMCA being developed for the IAF is a promising aircraft, with its development progressing well. However, there are apprehensions that the merging of the Qualitative Requirements (QRs) of the AMCA (IAF) with N-AMCA without addressing concerns of the IN could compromise its operational effectiveness as a naval fighter and thus requires deep deliberations. The unique operational requirements of CBF necessitate significant design changes in AMCA. The trajectory of self-reliance in Indian naval aviation has been

challenging due to variety of factors and this study makes an endeavour to test the following three hypotheses:

- (a) IN lacks ownership, organisational structures and technology development initiatives for design and development of naval aviation platforms on the lines of ship and submarine building.
- (b) The lack of enabling policies and procedures, and import and ToT of similar systems have significant impact on indigenous naval aviation development projects.
- (c) The structural and policy gaps in the IN and MoD contribute to incoherence in the naval aviation atmanirbharta trajectory.

The endeavour has been to study opportunities, variables and challenges, and provide options for developing indigenous naval aviation platforms including CBF in India. The indigenous naval fighter aircraft programme is now experiencing the most crucial and vulnerable phase, where delays, inaction or indecision could lead to the shutdown of the naval fighter aircraft development project, with India poised to lose the gains made during the two decades of LCA Mk-1 (Navy) development and flight test efforts. Delays in the induction of LCA Mk-1 (Navy) and the lack of development programmes for LCA Mk-2 (Navy) and N-AMCA may have an adverse impact on the future trajectory of self-reliance in deck based fighter aircraft.

India has a long history of aeronautics project closures without induction, delayed induction or induction in limited numbers. It is imperative to deeply examine the factors contributing to the closure of indigenous development projects and institute corrective measures to achieve the successful development of the indigenous CBF project. Therefore, it is important that the single engine carrier borne LCA Mk-1 (Navy) and LCA Mk-2 (Navy) and the twin engine TEDBF and N-AMCA projects are reviewed to ascertain the challenges, articulate a way forward and institute necessary course corrections.

Indigenous unmanned aerial projects such as TAPAS and Stealth Wing Flying Test Bed (SWIFT), a scaled-down model of Ghatak Stealth Aircraft, are also making slow progress. The IN's involvement in such projects is not that of an equal partner as in the case with ship and

submarine building. The IN, unlike the IAF, has not taken the initiative to collaborate with the Centre for Air Borne Systems (CABS), a Defence Research and Development Organisation (DRDO) laboratory, to develop indigenous MR or AEW aircraft.

The challenges and incoherences in CBF and the absence of a self-reliance programme in naval aviation were unexpected discoveries, considering the IN's record in leading and supporting self-reliance in ship and submarine building. The dissonance in CBF needs to be examined from the point of view of gaps in existing policies and the availability of organisational structures within the IN to support the indigenous development of naval aviation platforms. The learnings from the study are used to propose course corrections in CBF programme, institute structural and policy reforms and formulate a roadmap for *atmanirbharta* in naval aviation. The study examines the Single Engine CBF programmes, Twin Engine CBF programme, lack of naval aviation design group, non-availability of aeronautics commission or an equivalent higher empowered body, other structural gaps and challenges to *atmanirbharta* in CBF in particular and naval aviation in general before proposing a way forward.

SINGLE ENGINE CARRIER BORNE FIGHTER: LCA MK-1 (NAVY) AND LCA MK-2 (NAVY)

India's *atmanirbharta* trajectory with regard to CBF commenced with the launch of LCA Mk-1 (Navy) as a replacement of single engine carrier borne Sea Harrier air defence fighter aircraft. The LCA Mk-1 (Navy) development project was launched in 2003, two years after the first flight of LCA Mk-1 (IAF). Although the endurance and payload-carrying capacity of LCA Mk-1 (Navy) was comparable to Sea Harrier, IN withdrew consent to pursue a fighter with a greater range and payload-carrying capability. Therefore, the larger single engine LCA Mk-2 (Navy), with a more powerful engine, was designed to accommodate the specific requirements of IN. However, IN withdrew from the LCA Mk-2 (Navy) as well to pursue the development of a twin engine CBF, bringing the CBF development programme to a standstill. The trajectory and challenges in the development of carrier borne LCA Mk-1 (Navy) and LCA Mk-2 (Navy) single engine CBF are deliberated next.

LCA MK-1 (NAVY) AS POTENTIAL REPLACEMENT FOR SEA HARRIER

The LCA (IAF) was approved in 1983⁵ and obtained its Initial Operational Clearance-1 (IOC-1) on 10 January 2011⁶ and IOC-II on

⁵ Unstarred Question No 1286, Progress in Production of Tejas Aircraft, Rajya Sabha, Ministry of Defence, Government of India, 30 July 2018.

⁶ 'Development of Tejas LCA', Ministry of Defence, 14 March 2012, <https://www.pib.gov.in/newsite/erelcontent.aspx?relid=80909®=3&lang=2>, accessed on 25 December 2025.

20 December 2013.⁷ The Naval Air Staff Requirements (NASRs) for the LCA Mk-1 (Navy) were first formulated in 1985. In 1986, the Naval Headquarters requested the Aeronautical Development Agency (ADA) to undertake a feasibility study for developing a naval version of the LCA as a replacement for the Sea Harrier fighter aircraft. The feasibility study was undertaken between 1989 and 1992 and submitted to the IN. After the preliminary design study was approved in 1995, revised and new NASRs for the development of a naval variant of LCA for deck operations were formulated in 2003, with the CCS approving the project in the same year.⁸

The LCA Mk-1 (Navy) is powered by the GE-404 engine of General Electric, USA. It is designed for Ski-Jump Take Off But Arrested Recovery to operate from the short runway of an aircraft carrier.⁹ A Shore Based Test Facility (SBTF) was specially created in 2014 at the Naval Air Station, Goa, to replicate an aircraft carrier with ski jump for launch and arresting gear for deck recovery.¹⁰ The control laws of the LCA Mk-1 (Navy) were specifically developed to reduce pilot workload.¹¹

⁷ 'LCA Tejas Gets Initial Operational Clearance for the Induction into IAF IOC of LCA A Major Milestone in Self-Reliance: Antony', Press Information Bureau, Ministry of Defence, 20 December 2013, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=102056®=3&lang=2>, accessed on 25 December 2025.

⁸ Doraibabu and Godbole (2023), *A Decade of Transformation, The Indian Navy 2011-2021*, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

⁹ 'Aircraft Certification, Light Combat Aircraft (LCA) - Tejas - AF Mk1 -Final Operational Clearance', Defence Research and Development Organisation, <https://www.drdo.gov.in/drdo/aircraft-certification>, accessed on 15 August 2025.

¹⁰ 'Maiden Flight of Light. Combat Aircraft-Navy (NP1)', Press Information Bureau, Government of India, Ministry of Defence, 27 April 2012, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=82764>, accessed on 15 August 2025.

¹¹ Doraibabu and Godbole (2023), *A Decade of Transformation, The Indian Navy 2011-2021*, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

WITHDRAWAL OF CONSENT FOR LCA Mk-1 (NAVY)

The IN withdrew its consent for the LCA Mk-1 (Navy) project in October 2016, resulting in a setback for the self-reliance trajectory of CBF development in India.¹² The withdrawal came at a crucial and vulnerable phase when LCA Mk-1 (Navy) had completed its first flight and ski jump take off, and preparations were underway for the arrester hook landing trials.

The ADA, under the guidance of Cmde CD Balaji, a former naval engineer who served as the designer and project director of LCA Mk-1 (Navy), and Cmde Maolankar and his team of test pilots took on the mantle of continuing the development of LCA Mk-1 (Navy) as a Technology Demonstrator (TD). They provided much needed support when the IN's withdrawal of support cast uncertainty about the project's future.¹³ Their concerted efforts played a key role in CEMILAC issuing airworthiness clearance for two LCA Mk-1 (Navy) aircraft comprising one Naval Prototype-1 (NP-1), a two-seat trainer aircraft, and one Naval Prototype-2 (NP-2), a single seat CBF, for developmental trials.¹⁴

¹² 'It's Official: Indian Navy Wants 57 Carrier Borne Fighters', *Livefist Defence*, 25 January 2017, <https://www.livefistdefence.com/its-official-indian-navy-wants-57-carrier-borne-fighters/>, accessed on 16 August 2025.

¹³ Doraibabu and Godbole (2023), *A Decade of Transformation*, The Indian Navy 2011-2021, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

¹⁴ 'Aircraft Certification, Light Combat Aircraft (LCA) - Tejas - AF Mk1 -Final Operational Clearance', Defence Research and Development Organisation, <https://www.drdo.gov.in/drdo/aircraft-certification>, accessed on 15 August 2025.



Figure 1. LCA Mk-1 (Naval Prototype-2)

Tejas taking off from Shore Based Testing Facility at INS Hansa, Goa, on 20 December 2019.¹⁵

The LCA Mk-1 (Navy) performed its first ever ski jump launch (take-off) on 20 December 2014 (Figure 1) and its first ever arrested landing at the SBTf, INS Hansa, Goa on 13 September 2019.¹⁶ The launch and arrested landing at SBTf laid the foundation for the actual landing and take-off of the LCA Mk-1 (Navy) from an aircraft carrier [see Figures 2(a) and 2(b)].



Figure 2 (a) LCA Mk-1 (Naval Prototype-2)

¹⁵ 'LCA (Navy) Crosses Path Breaking Milestone', Press Information Bureau (PIB), Ministry of Defence, Government of India, 30 September 2019, <https://www.pib.gov.in/newsite/Printrelease.aspx?relid=193509>, accessed on 18 August 2025.

¹⁶ 'Year End Review – 2019', Ministry of Defence, Press Information Bureau, Government of India, Ministry of Defence, 27 December 2019, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=196160>, accessed on 15 August 2025.



Figure 2 (b) LCA Mk-1 (Naval Prototype-2)

Tejas landing on INS Vikramaditya on 11 January 2020¹⁷

The LCA Mk-1 (Navy), piloted by naval test pilot Cmde JA Maolankar, carried out its first landing on Indian Naval Ship (INS) Vikramaditya on 11 January 2020, marking an important milestone in India's indigenous development of CBF. This was followed by the ski-jump take off on the next day, i.e. 12 January 2020.¹⁸ The LCA Mk-1 (Navy), piloted by Cmde Shivnath Dahiya, achieved another milestone when it carried out a landing on India's indigenously built aircraft carrier INS Vikrant on 6 February 2023.¹⁹ The DRDO was hopeful that LCA Mk-1 (Navy) would be inducted into the service by 2026 despite the IN's withdrawal from the project.²⁰ With the successful landing of

¹⁷ LCA Navy prototype NP-2 landing on aircraft carrier INS Vikramaditya, https://twitter.com/DRDO_India/status/1215956287105585152/photo/1, 11 January 2020, accessed on 18 August 2025.

¹⁸ 'The Developmental Naval LCA Achieves Major Technological Milestone', Ministry of Defence, 12 January 2020, Press Information Bureau, Delhi. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1599210>, accessed on 15 August 2025.

¹⁹ CD Balaji (2024), *Paper to Flight: The Story of India's Carrier Borne Fighter*, New Delhi: Pentagon Press, 2005, pp. v–xi.

²⁰ 'The Developmental Naval LCA Achieves Major Technological Milestone', Press Information Bureau, Ministry of Defence, 12 January 2020, <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=1599210®=3&lang=2>, accessed on 25 December 2025.

LCA Mk-1 (Navy) on both the operational aircraft carriers of the IN, i.e. INS Vikramaditya and INS Vikrant, demonstrated the ability of Indian designers and test pilots to develop the CBF, which is a rare feat.

CHALLENGES FACING LCA Mk-1 (NAVY)

Technology development is a complex domain in which challenges are an essential part of the journey. The ability of a nation and its leadership at various levels to carry out the successful implementation of indigenous technology development projects lies in their ability to deal with challenges and institute timely course corrections. The Minister of Defence, in a statement to the Lok Sabha on the LCA Mk-1 (Navy) on 18 July 2014, highlighted the following challenges that contributed to delays in the development and operationalisation of naval fighters.

- (a) **Technology Development Challenges.** Such challenges were significantly higher for the LCA MK-1 Navy than was originally envisaged.
- (b) **Technology Denial.** There was technology denial by the technologically advanced countries. The production facilities at Hindustan Aeronautics Limited (HAL) were inadequate.
- (c) **Unexpected Complexities.** Unanticipated complexities were faced during structural design.
- (d) **Delay in LCA Mk-1 (IAF).** Delay in development of LCA Mk-1 (IAF) contributed to the delay in LCA Mk-1 (Navy) due to shared resources of the ADA.²¹

The Minister, in his statement, highlighted few key challenges that were observed at the highest level; however, detailed analyses indicate that there are many more challenges faced by the various entities involved in the development process, some of which are deliberated next.

²¹ Question No 161, DRDO Projects, Lok Sabha Debates, Second Session, Sixteenth Lok Sabha, Vol. II, No. 10 dated 18 July 2014, https://eparlib.sansad.in/bitstream/123456789/758768/3/lsd_16_02_18-07-2014.pdf, accessed on 5 September 2025.

INTRICACIES OF CBF DEVELOPMENT

LCA Mk-1 (IAF) was developed for operations from land, and its conversion into CBF posed its own intricacies and challenges. The modification of land-based LCA Mk-1 into carrier borne LCA Mk-1 (Navy) required redesign and significant modifications, including:

- (a) Provision of additional nose droop to achieve higher over-the-nose vision for improving pilot visibility for carrier operations.
- (b) An additional control surface called Leading Edge Vortex Control (LEVCON) was fitted on the front end of the aircraft wing, operated by a concealed rotary actuator with aerodynamics profiling to reduce landing speed and achieve good controllability.
- (c) An arrester hook was installed to stop aircraft at short distance.
- (d) The landing gear had to be strengthened to absorb five times higher loading than the IAF version of LCA.
- (e) The undercarriage and systems were designed to withstand high shocks created due to high sink rate of 7.1 m/s and flareless landing with engine to full throttle till arrested by deck cable.
- (f) The axial loads due to arrested recovery imposed a loading of 4.5 g deceleration on the LCA Mk-1 (Navy). This necessitated many Line Replacement Units (LRUs), components and associated systems to undergo re-certification to ensure fail-safe operations.²²
- (g) Extra structural re-enforcements and wider track was needed to utilise the Restraining Gear System (RGS) on the carrier.²³

²² 'Maiden Flight of Light. Combat Aircraft-Navy (NP1)', Press Information Bureau, Government of India, Ministry of Defence, 27 April 2012, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=82764>, accessed on 15 August 2025.

²³ CD Balaji, (2024), *Paper to Flight: The Story of India's Carrier Borne Fighter*, New Delhi: Pentagon Press, 2005. pp. v-xi.

The above modifications resulted in increase in weight and drag, which had to be addressed.

NAVAL ENGINEER IN LCA Mk-1 (NAVY) DEVELOPMENT

After the first flight of LCA Mk-1 (AF) in 2001, the Naval Headquarters deputed the then Capt (IN) CD Balaji (later Cmde Balaji), a naval aeronautical engineer with experience in aviation squadron, as the IN's representative to the ADA in 2002 to take up LCA Mk-1 (Navy) development. Cmde Balaji played a pivotal role in the development of LCA Mk-1 (Navy). By July 2002, the Indian government was considering a full-scale engineering development proposal for the design, development, building and ground testing of two naval variants of LCA, a structural test specimen and flying of 400 hours towards operational clearance.²⁴ This was a challenging endeavour, considering India did not have past experience. The challenges encountered in the development of LCA (Navy) were captured by the Cmde CD Balaji (Retd) in his book *Paper to Flight: The Design Story of India's Carrier Borne Fighter*. Cmde Balaji worked in various capacities at the ADA in the LCA Mk-1 development project, including as Project Director. His book provides valuable details on the development of LCA Mk-1 (Navy) from approval to first flight, describing various activities that took place during his service in the IN and later at the ADA.²⁵

WHY IS LIMITED INDUCTION OF LCA Mk-1 (NAVY) IMPORTANT?

The LCA Mk-1 (Navy), a single engine fighter with an All up Weight (AUW) of 13.5 tonnes, was slated to replace the single engine Sea

²⁴ 'Production of Light Aircraft', Ministry of Defence, 18 July 2002, <https://archive.pib.gov.in/archive/releases98/lyr2002/rjul2002/18072002/r1807200214.html>, accessed on 25 December 2025.

²⁵ CD Balaji, (2024), *Paper to Flight: The Story of India's Carrier Borne Fighter*, New Delhi: Pentagon Press, 2005. pp. v-xi.

Harrier CBF. The LCA Mk-1 (Navy) was developed by incorporating several design modifications in the land variant, following multiple challenges. However, the IN felt that the (approximately 3 tonnes) payload-carrying capacity of the LCA Mk-1 (Navy) was inadequate to meet its current operational requirements and therefore, decided to pursue the development of twin engine naval fighter, later named TEDBF. However, following the successful landing of LCA Mk-1 (Navy) at aircraft carriers and considering the need for gaining experience and generating operational data that was needed for developing future fighter aircraft, the IN began deliberating on the idea of the acquisition of a limited number of LCA Mk-1 (Navy) (12–15 aircraft) for the training and technology development squadron in 2023.²⁶ The DRDO also proposed the acquisition of a limited number (8–10) of Naval LCA Mk-1 aircraft by the IN in 2024.²⁷

Need for Limited Induction of LCA (Navy). The induction of LCA Mk-1 (Navy) in limited numbers is essential to maintain the trajectory of development of indigenous CBF, while non-induction of LCA Mk-1 (Navy) could become a setback to indigenous development endeavours. Operation of the aircraft by naval test pilots under ideal conditions would not generate the desired operational flying data required to inform necessary changes in aircraft design and maintenance support. The LCA Mk-1 (Navy) needs to be flown by squadron pilots with varying levels of experience, and under diverse weather and sea-state conditions, to generate valuable operational data. The induction would push LCA Mk-1 into full rigours of naval aviation beyond the protective controls of naval test pilots. This in turn will help bridge the gap between the prototype and operational fighter

²⁶ 'Indian Navy Considering Small N-LCA Order', *Livefistdefence.com*, 18 April 2023, <https://www.livefistdefence.com/indian-navy-considering-small-n-lca-order/>, accessed on 17 August 2025.

²⁷ Raghav Patel, 'DRDO Proposes 8-10 Naval LCA Mk-I for Indian Navy to Gather Valuable Data for Future TEDBF Program', *Defence.in*, 23 September 2024, <https://defence.in/threads/drdo-proposes-8-10-naval-lca-mki-for-indian-navy-to-gather-valuable-data-for-future-tedbf-program.10129/>, accessed on 10 April 2025.

contribute to identifying technology, maintenance and operational gaps and institute suitable corrective measures in the CBF. Cmde Maolankar observed that detailed CBF design criteria must be derived from actual usage patterns and hence, there is vital need to generate sufficient launch/recovery data via LCA MK-1 (Navy) to improve future design.²⁸

Adm Arun Prakash, former Chief of Naval Staff and a fighter pilot, opined in September 2024 that “This may not be a bad idea, a carrier borne Tejas flight/ squadron could undertake fleet air-defence role, while generating valuable data for TEDBF. But with HAL struggling to meet IAF orders, how long will it take?”²⁹ He supported the idea of the induction of LCA Mk-1 (Navy) for air defence role, while simultaneously raising concerns about HAL’s ability to fulfil these orders due to various challenges.

The MoD reviewed its policy in early 2025 to provide equal opportunity to the public and private sector entities to bid either independently or as a joint venture (JV) or consortia on competitive bases. This new policy would be adopted in the AMCA project.³⁰ The policy is likely to help expedite aircraft manufacturing by the private sector. However, the ability of both public and private sector entities would be constrained when supply chains are impacted by delays in the supply of critical systems and components by FOEMs, which needs to be systematically addressed.

Cmde CD Balaji, in a post on the social media platform X on 22 August 2025, observed that “It has been my recommendation that a couple of Squadrons of NLCA (LCA Mk1 [Navy]) would be a prudent way forward, pending a decision and development of next

²⁸ Cmde Maolankar, in a chat with the author on 16 November 2025.

²⁹ Adm Arun Prakash (Retd.), former Chief of Naval Staff, Indian Navy, and a fighter pilot (@arunp2810) in a post on X on 23 September 2024, <https://x.com/arunp2810/status/1838210064324415584>, accessed on 17 August 2025.

³⁰ ‘Atmanirbhar Bharat: Raksha Mantri approves Advanced Medium Combat Aircraft Program Execution Model through Industry Partnership’, Ministry of Defence, PIB Delhi, 27 May 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2131528>, accessed on 18 August 2025.

version of indigenous aircraft. Let us not waste away hard and useful lessons learned in the development of Deck Based fighter".³¹ The induction of LCA Mk-1 (Navy) will help in generating operating data, undertaking design improvements, validating sea-worthiness, maintainability, and using this data for development of future variants. The LCA Mk-1 (Navy) fighter variant can be deployed on an aircraft carrier for air defence roles. Its twin seat variant can be used as a carrier fighter trainer. Adm Arun Prakash observed that the prototype N-LCA itself can be inducted to undertake deck operations for generating developmental data.³²

Continuity Training on STOBAR Operations. Indian naval pilots go abroad for training in Short Take Off But Arrested Recovery (STOBAR) operations. The induction of LCA Mk-1 (Navy) could reduce the IN's dependence on foreign countries for training its pilots for carrier borne operations and STOBAR training.³³

LCA MK-2 AS A CBF

The design and development of LCA Mk-2, an upgraded variant of the LCA Mk-1 with a more powerful engine and possessing a greater range and payload-carrying capability, was sanctioned in 2009 at an initial estimated cost of Rs 2431.55 crore, with a Probable Date of Completion (PDC) in December 2018. The LCA Mk-2 (Navy) was aimed at overcoming the limitations of LCA Mk-1 (Navy). The two naval prototypes, i.e. NP-3 and NP-4 in LCA Mk-2 (Navy) configuration were approved with higher thrust to weight ratio, incorporation of niche technologies and greater payload-carrying

³¹ CD Balaji (@CDBalaji119096) in a post on X on 22 August 2025, <https://x.com/aarkayn/status/1958434336702627899>, accessed on 22 August 2025.

³² Adm Arun Prakash (Retd), former Chief of Naval Staff, Indian Navy, and a fighter pilot, in a chat with author on 14 August 2025.

³³ 'Indian Navy Considering Small N-LCA Order', *Livefistdefence.com*, 18 April 2023, <https://www.livefistdefence.com/indian-navy-considering-small-n-lca-order/>, accessed on 17 August 2025.

capability. However, the project could start only in December 2013 due to the delay in the GE-414 engine contract finalization, and the maiden flight of the first prototype and operational clearance was expected by December 2019 and December 2022, respectively.

The LCA Mk-2's preliminary design studies were finalised in 2014 and the detailed design phase commenced in 2015, with its first static display at the Aero India 2019.³⁴ The LCA Mk-2 is an improved and larger variant of LCA that is equipped with many advanced systems, including avionics, among other upgrades.³⁵ The design of LCA Mk-2 was finalised in 2019.³⁶

The development of the LCA Mk-2 full scale prototypes was sanctioned for an amount of Rs 9,000 crore (including Rs 2,500 crore that was already spent) by the CCS on 1 September 2022.³⁷ However, the IN did not join the LCA Mk-2 project to develop its naval variant and instead used this funding to ask ADA to undertake studies for the development of TEDBF. The IN's pursuit of twin engine fighter aircraft led to uncertainty regarding the LCA Mk-2 (Navy) development programme.

³⁴ Huma Siddiqui, 'HAL to Develop LCA Mk2 at a Total Cost of Rs 9000 Crore: A Game Changer', *Financial Express*, 5 September 2022, <https://www.financialexpress.com/business/defence-hal-to-develop-lca-mk2-at-a-total-cost-of-rs-9000-crore-2656351/>, accessed on 21 November 2025.

³⁵ 'Schedule for Induction of Tejas Mark II Aircraft into Service', Press Information Bureau, Government of India, Ministry of Defence, 4 August 2015, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=124301>, accessed on 6 September 2025.

³⁶ 'Tejas-1 (LAH) and Tejas Mk2 (MWF) Aircraft', PIB Delhi, Ministry of Defence, 2 December 2019, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1594523>, accessed on 6 September 2025.

³⁷ Huma Siddiqui, 'HAL to Develop LCA Mk2 at a Total Cost of Rs 9000 Crore: A Game Changer', *Financial Express*, 5 September 2022, <https://www.financialexpress.com/business/defence-hal-to-develop-lca-mk2-at-a-total-cost-of-rs-9000-crore-2656351/>, accessed on 21 November 2025.

GE-414 INS6 Engine ToT. A Memorandum of Understanding (MoU) on ToT of GE-414 engine by GE, USA, with Hindustan Aeronautics Limited (HAL) was negotiated during the visit of the Indian prime minister to the United States on 6 June 2023. The deal was aimed at increasing the level of indigenisation of critical technologies.³⁸ The GE F414-INS6 engine generates 22,000 lbs thrust, an airflow of 170 lb/sec and pressure ratio of 30:1.³⁹ HAL formed a Contract Negotiation Committee and initiated negotiations with the GE on 3 December 2024 to conclude the GE-F414 deal. The deal involves manufacturing of engine parts representing 80 per cent of the value of engines that will be licensed through ToT. The US government required GE, the Indian MoD and other stakeholders to sign the Manufacturing License Agreement (MLA) and Form DSP-83⁴⁰ (Non-Transfer and Use Certificate).⁴¹ The signing of Form DSP-83 is stipulated as part of the Defence Trade Controls Licensing (DTCL) mechanism of the US Directorate of Defense Trade Controls, which functions under the US Department of State.⁴² The signing of contract for the supply of GE-414 engine and ToT was still awaited as of February 2026.

³⁸ 'Prime Minister Flies in the Indigenously Designed, Developed and Manufactured Twin Seater Fighter Aircraft, LCA Tejas', Ministry of Defence, PIB Delhi, 25 November 2023, <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=1979812>, accessed on 6 September 2025.

³⁹ F414 Engine, GE Aerospace, <https://www.geaerospace.com/military-defense/engines/f414>, accessed on 26 November 2025.

⁴⁰ DSP-83, A Non-Transfer and Use Assurances, Code of Federal Regulations, <https://www.ecfr.gov/current/title-22/chapter-I/subchapter-M/part-123/section-123.10>, accessed on 20 March 2026. .

⁴¹ 'HAL Forms Panel to Negotiate GE F414 Deal with US, Aims to Ink It by March 2025', ANI, 31 December 2024, <https://www.aninews.in/news/national/general-news/hal-forms-panel-to-negotiate-ge-f414-deal-with-us-aims-to-ink-it-by-march-202520241231215329/>, accessed on 25 November 2025.

⁴² Defence Trade Control Licensing (DTCL), Directorate of Defence Trade Controls, Directorate of Defence Trade, U.S. Department of State, https://www.pmdtcc.state.gov/ddtc_public?id=ddtc_kb_article_page&sys_id=02bbbbc4dbc7bf0044f9ff621f9619ac, accessed on 26 November 2025.



Figure 3. LCA Mk-2.⁴³

The development of LCA Mk-2 (IAF) is progressing well [Figures 3(a) and 3(b)], however, there is no progress in LCA Mk-2 (Navy) after the IN's decision to withdraw from LCA Mk-1 (Navy) and LCA Mk-2 (Navy) projects. The LCA Mk-2 (Navy) was designed for naval requirements and would have met the operational requirements of the IN and been in service within a relatively short period of time.⁴⁴

Single Versus Twin Engine Naval Fighter. The abandoning of LCA Mk-2 (Navy) and focus on TEDBF was the result of the classic debate between single engine and twin engine fighter aircraft configuration.⁴⁵ Cmde Maolankar – who was involved in the N-LCA development project – commented on the single engine versus twin engine naval fighter debate and the relevance of LCA Mk-2 (Navy), stating that the decision to develop a 4.5-generation TEDBF, a twin engine naval fighter to meet medium-term challenges, was always going to be challenging, with an adverse impact on the self-reliance trajectory.

⁴³ Photograph by Gp Capt RK Narang, Aero India-2025 on 11 February 2025.

⁴⁴ Cmde JA Maolankar (Retd.) in a discussion on *Atmanirbharta* in Naval Fighter at MP-IDSA, New Delhi on 24 October 2025.

⁴⁵ Cmde CD Balaji, former Project Director LCA Mk-1 (Navy) and Director ADA in a text message to author on 10 December 2025.

On the other hand, the perception that LCA Mk-2, a single engine aircraft, would be less safe compared to TEDBF was not correct, considering the IN had been flying single engine aircraft like Sea Harrier for decades with a reasonably sound flight safety record.⁴⁶ Moreover, the F-35 fifth-generation fighter developed by the United States is also a single engine fighter. Therefore, LCA Mk-2 (Navy) would have been as safe as any other fighter aircraft and have served as an interim naval fighter till the development of the next-generation naval fighter.

N-LCA LESSONS IN N-AMCA

The formulation of the QRs for LCA Mk-1 (Navy) was challenging amid limited information and uncertainty with regard to indigenous capabilities. The non-availability of internet in the 1980s and paucity of information added to challenges in formulation of NASRs for LCA Mk-1 (Navy).⁴⁷ According to Cmde Maolankar, the NASRs were predominantly Air Staff Requirement (ASR) of the LCA Mk-1 (AF) plus naval-specific QRs. This resulted in a sub-optimal design, as some of the QRs were difficult to achieve.⁴⁸

The IAF, considering its envisaged operational requirements, sought the development of LCA Mk-2 with 17.5 tonne AUW under Phase 2 of the LCA project to enhance range and payload-carrying capability. The LCA Mk-2 (AF) version was modified by incorporating design learnings from LCA Mk-1 (Navy) in 2015–16.⁴⁹ The LCA Mk-2 (AF) and the aborted LCA Mk-2 (Navy) designs in due course became entirely different due to differences in operational requirements.

⁴⁶ Observations made by Cmde Maolankar, former test pilot of LCA Mk-1 (Navy) In a chat with the author on 16 August 2025.

⁴⁷ Cdr Mamik (Retd.) involved in formation of initial QRs during 1986, in discussion with the author on 24 October 2025.

⁴⁸ Cmde Maolankar, former test pilot LCA Mk-1 (Navy) and Vice President New Space Research and Technologies (NSRT) in a chat with author on 16 November 2025.

⁴⁹ Gp Capt H V Thakur, Test Pilots, HAL, in interaction with author on 30 September 2025.

The LCA Mk-2 (AF) programme was initially defined as AF Mk-1 with higher thrust and maintainability improvement modifications.⁵⁰ The LCA Mk-2 (Navy), on the other hand, comprised expansive revisions that included re-interpretation, revision and rationalisation of the NASRs. The LCA Mk-2 (Navy) required a fresh look at the design, while some of the common elements such as wings and subsystems architecture were retained. The proposed LCA Mk-2 (Naval) aircraft design involved the rearrangement of fuselage structure, which would have resulted in significant improvement in load profile instead of being the bandaged design profile of the LCA Mk-1 (Navy), minimising ballast, etc.⁵¹ The large display area proposed for the LCA Mk-2 (AF) led to an increase in cockpit width. Also, a thicker canopy and windshield for the air force variant led to an increase in the cross-section area and enhanced profile drag. The increased cross section becomes crucial at transonic and supersonic speeds due to increase in wave draft, and it needs to be balanced by increasing the length of the fuselage to maintain wave drag within limits, which sometimes may not be feasible. These changes were not proposed to be included in the LCA Mk-2 (Navy) as these could have resulted in compromises in its performance.⁵² Therefore, changes in weight, volume, design, configurations, etc., must be backed by suitable studies to minimise adverse impact.

The approach seeking minimal changes to the LCA Mk-1 (AF) and restricting changes to centre fuselage created challenges in making the LCA Mk-1 (Navy) ship worthy. The need for long undercarriage high hook load and steep glide path made LCA Mk-1 (Navy) inefficient and overweight, which necessitated the introduction of leading edge lift devices, etc. An effort was made to incorporate these lessons in LCA Mk-2 (Navy). These mistakes should not be repeated in the next CBF design, be it TEDBF or N-AMCA. The CBF design must incorporate lessons from inefficient design iterations of LCA Mk-1 (Navy) to obtain optimum performance.⁵³

⁵⁰ Cmde Maolankar, former test pilot LCA Mk-1 (Navy) and Vice President New Space Research and Technologies (NSRT) in a chat with author on 16 November 2025.

⁵¹ Ibid.

⁵² Ibid.

⁵³ Ibid.

TWIN ENGINE CARRIER BORNE FIGHTER: TEDBF, MRCBF AND N-AMCA

The challenges faced in the development of LCA Mk-1 (Navy), increased security threat from China and the necessity to protect India's long maritime boundary are some of the considerations that led to the development and acquisition of twin engine CBF. The IN's decision to withdraw from LCA Mk-1 (Navy) and LCA Mk-2 (Navy) in 2016 and 2017 respectively, non-participation in N-AMCA and lack of approval of TEDBF resulted in a stalemate with regard to the indigenous CBF programme, while opening the window for the import of Rafale-M. The dilemma in developing a twin engine CBF, i.e. TEDBF or N-AMCA, needs to be overcome to end the current stalemate. The trajectory, limitations and challenges in the development and acquisition of twin engine CBF are deliberated next.

WHY MRCBF?

Multi Role Carrier Based Fighter (MRCBF) was the name assigned by the IN to a CBF (such as Rafale-M or Boeing F/A-18E/F Super Hornet) that was proposed for acquisition from a foreign OEM as an interim measure till an indigenous TEDBF could be developed. The MRCBF was meant to complement MiG-29K fighter aircraft. Whereas TEDBF refers to indigenous twin engine deck-based (carrier-based) naval fighter, MRCBF is the term used for the procurement of naval fighters from the global market. The Request for Information (RFI) for 57 MRCBF was issued by the IN on 25 January 2017⁵⁴; however, these numbers were reduced, and an order for 26 Rafale was placed in

⁵⁴ Carrier-Borne Fighter Jets for the Navy, Unstarred Question No 2920, To be Answered on the 28 March 2017, Rajya Sabha, 20 November 2025.

early 2025.⁵⁵ The TEDBF and MRCBF are almost the same class of fighters, as both are expected to be multi-role, day-night fighters that operate from aircraft carriers. It is unclear as to why the term MRCBF was coined while it served the same purpose as TEDBF and both were of the same class of CBF.



Figure 4. Twin Engine Deck-Based Fighter (TEDBF) at Aero India 2025.⁵⁶

TEDBF. The IN formally withdrew from the LCA Mk-2 (Navy) project in October 2016.⁵⁷ Cmde Balaji observed, “I superannuated from ADA in March 2017, when ADA was actively conducting the Preliminary Design Review (PDR) of LCA Mk-2 (Navy). I am given to understand that after my retirement, IN in one of the subsequent reviews, proposed that there should be twin engine CBF, which became the genesis of emergence of TEDBF”.⁵⁸ According to Cmde Maolankar, the development of TEDBF was first proposed by the IN sometime towards the end of tenure of then Defence Minister

⁵⁵ Doraibabu and Godbole (2023), *A Decade of Transformation, The Indian Navy 2011-2021*, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

⁵⁶ TEDBF at Aero India-2025, Picture by the author

⁵⁷ Doraibabu and Godbole (2023), *A Decade of Transformation, The Indian Navy 2011-2021*, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

⁵⁸ Cmde CD Balaji, former Project Director LCA Mk-1 (Navy) and Director ADA in a text message to author on 10 December 2025.

Shri Manohar Parrikar in late 2017.⁵⁹ On 9 September 2019, ADA, on the request of the IN, formally proposed the development of a 26-tonne AUW 4.5-generation TEDBF by 2028 as an interim CBF (Figure 4). This was to be followed by the development of the fifth-generation fighter to replace MiG-29K by 2032.⁶⁰ However, lack of approval of TEDBF, and the IN's non-participation in the fifth-generation CBF (naval variant based on AMCA) development has brought the indigenous CBF programme to a halt. This opened a window for the import of Rafale-M from France.

Rafale-M: Two Variants and Self-Reliance. India decided to procure Rafale-M, which itself is an example of France's commitment to self-reliance as it opted to indigenously develop and manufacture Rafale-M aircraft rather than import F/A-18 from the United States. The Rafale programme also demonstrated that both land and naval fighter aircraft can be developed in parallel. The development of Rafale fighter aircraft by the French was aimed at achieving "strategic autonomy" in CBF manufacturing technology. The development contract for testing for its first variant, i.e., Rafale-A, was awarded in 1988. Its prototype flew its first flight in 1990 and was retired in 1994.

The Marine Nationale (French Navy) was about to select the already available F/A-18 Hornet CBF from the United States, but the decision of the French government to support its domestic aeronautics industry ensured the continuation of Dassault Rafale. This in turn led to the development of a dedicated naval variant, i.e. Rafale-M, for carrier operations. The Marine Nationale received its first Rafale in December 2000, with the first deployment occurring in 2002, even before the embarked Rafale-M was declared fully operational in June 2004. The French Air Force, Armee de l'Air, received its first Rafale in 2005 that became fully operational later in 2007.⁶¹

⁵⁹ Cmde Maolankar, former test pilot LCA Mk-1 (Navy), in text message to author on 9 December 2025.

⁶⁰ Doraibabu and Godbole (2023), *A Decade of Transformation, The Indian Navy 2011-2021*, Harper Collins, https://indiannavy.gov.in/sites/default/files/Navy_Book_Low.pdf, accessed on 15 August 2025.

⁶¹ Adrea Doll, 'Dassault Rafale', *The Aviationist*, 28 November 2024, <https://theaviationist.com/2024/11/28/dassault-rafale/>, accessed on 22 August 2025.

The situation of the French Navy and Air Force was akin to the IN and IAF. The French government prevailed and was instrumental in handholding their industry by opting for the acquisition of indigenous Rafale fighters over the F/A-18 CBF from the USA. The handholding through early induction for data generation, seeking operational inputs and following a spiral development trajectory is a global practice that needs to be studied and suitably adopted in the India to reduce indigenous aeronautics project closures.

Import of Rafale-M as MRCAF. TEDBF is an indigenous twin engine 4.5-generation CBF while MRCAF is a term used for imported fighter aircraft of similar capability. The IN had published a RFI for the purchase of 57 MRCAFs for its aircraft carriers in January 2017 after it decided to formally withdraw from both LCA Mk-1 (Navy) and LCA Mk-2 (Navy) in October 2016.⁶² In January 2022, the IN revised its requirements from 57 to 26 aircraft due to budget constraints and other challenges. The ski jump trials at SBTF, Goa, were conducted during the 2022 to evaluate two shortlisted contenders; the Rafale-M, France, and F/F/A-18 E/F Super Hornet, Boeing, USA.⁶³ The Defence Acquisition Council (DAC) granted Acceptance of Necessity (AoN) approval for the procurement of 26 Rafale-M aircraft for IN under the Inter-Governmental Agreement (IGA) in July 2023.⁶⁴ The Indian

⁶² 'It's Official: Indian Navy Wants 57 Carrier Borne Fighters', *Livefist Defence*, 25 January 2017, <https://www.livefistdefence.com/its-official-indian-navy-wants-57-carrier-borne-fighters/>, accessed on 16 August 2025.

⁶³ 'Indian Navy's MRCAF Procurement: A Timeline of Key Milestones', Indian Defence Research Wing, 14 August 2025, <https://idr.org/indian-navys-mrcbf-procurement-a-timeline-of-key-milestones/>, accessed on 16 August 2025.

⁶⁴ 'Ministry of Defence- Year End Review 2023', Press Information Bureau (PIB), Ministry of Defence (MoD), 22 December 2023, <https://idr.org/indian-navys-mrcbf-procurement-a-timeline-of-key-milestones/>, accessed on 16 August 2025.

government signed under the IGA for the procurement of 26 Rafale-M fighter aircraft for Rs 63,000 crores (approx. US\$7.4 billion) on 28 April 2025.⁶⁵ The 26 Rafale-M aircraft deal comprised 22 fighter and 4 twin seat trainer aircraft (not deck based). The deal includes simulator, training, associated equipment, weapons and five-year performance-based logistics.⁶⁶ The option to integrate Indian weapons was included in the deal. The Rafale aircraft would be delivered between 37 and 65 months (about 5.5 years). They would be equipped with 70 km range Exocet AM 39 anti-shiping missiles, 300 km range Scalp air-to-ground cruise missiles and 120–150 km range Meteor air-to-air missiles. The 26 Rafale would complement the 40 Russian MiG-29K fighter aircraft fleet of IN that were acquired in 2009.⁶⁷

Cost of Fighter Aircraft. The initial PDC of LCA Mk-1 (Navy) was December 2010, which was later revised to December 2014. The details of timelines of development of the LCA Mk-1 (Navy), and allocation and utilisation of funding till July 2014 is shown in Table 1.⁶⁸

⁶⁵ Shivam Patel and Surbhi Misra, 'India Signs \$7.4 Billion Deal to Buy 26 Rafale Fighter Jets', Reuters, 28 April 2025, <https://www.reuters.com/world/india/india-signs-74-billion-deal-with-france-buy-26-rafale-fighter-jets-2025-04-28/>, accessed on 16 August 2025.

⁶⁶ 'Inter-Governmental Agreement Inked with France for 26 Rafale-Marine Aircraft for Indian Navy', Ministry of Defence, Press Information Bureau, New Delhi, 28 April 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2124851>, accessed on 16 August 2025.

⁶⁷ 'India, France Sign Rs 63,000 Crore Mega Deal to Buy 26 Rafale Marine Aircraft', *The Times of India*, 28 April 2025, <https://timesofindia.indiatimes.com/india/india-france-sign-rs-63000-mega-deal-to-buy-26-rafale-marine-aircraft/articleshow/120691233.cms>, accessed on 16 August 2025.

⁶⁸ Question No 161, DRDO Projects, Lok Sabha Debates, Second Session, Sixteenth Lok Sabha, Vol. II, No. 10 dated 18 July 2014, https://eparlib.sansad.in/bitstream/123456789/758768/3/lcd_16_02_18-07-2014.pdf, accessed on 5 September 2025.

Table 1. Funding of LCA Mk-1 (Navy) from 2011–12 to 2014–15⁶⁹ and 2015–16⁷⁰

Project	Probable Date of Completion (PDC)		Sanctioned Cost (Rs in Cr)	Expenditure Incurred During			
	Original	Revised		2011-12	2012-13	2013-15	2014-15
LCA Mk-1 Navy	Dec 2010	Dec 2014	1714	117.56	283.07	144.50	74.97

IAF had earlier placed an order for 40 LCA Mk-1 aircraft, which included 20 in IOC Standard and 20 in Final Operational Clearance (FOC) Standard. The final price included the cost of additional Line Replaceable Units (LRUs), consumables, tooling, etc., that were added later during the negotiations for induction by the IAF. The details of procurement of Rafale (IAF), Rafale-M (IN)⁷¹, LCA Mk-1⁷², 83 LCA Mk-1A in 2023⁷³ and 97 LCA Mk-1A in 2025⁷⁴ are shown in the (Table 2).⁷⁵

⁶⁹ Ibid.

⁷⁰ Unstarred Question No.969, DRDO Projects, Ministry of Defence, Defence Research and Development Organisation, 22 July 2016, <https://sansad.in/getFile/loksabhaquestions/annex/9/AU969.pdf?source=pqals>, accessed on 7 September 2025.

⁷¹ 'Rafale-Marine: Enhancing India's Naval Strength, Security', Backgrounder ID:154353, 29 April 2025, <https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=154353&ModuleId=3>, accessed on 6 September 2025.

⁷² 'Production of Tejas Aircraft', Press Information Bureau, Government of India, Ministry of Defence, 6. August 2018, <https://www.pib.gov.in/Pressreleashere.aspx?PRID=1541715>, accessed on 6 September 2025.

⁷³ 'Prime Minister Flies in the Indigenously Designed, Developed and Manufactured Twin Seater Fighter Aircraft LCA Tejas', PIB Delhi, 25 November 2023, <https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=1979812>, accessed on 6 September 2025.

⁷⁴ 'MoD Signs Rs 62,370 Crore Contract with HAL for Procurement of 97 LCA Mk-1A Aircraft for IAF', PIB Delhi, 25 September 2025, <https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2171108>, accessed on 28 September 2025.

⁷⁵ 'Production of Tejas Aircraft', note no. 72.

Table 2. Details of procurement of Rafale (IAF), Rafale-M (IN), LCA Mk-1, 83 LCA Mk-1A and 97 LCA Mk-1 A

Procurement of Fighter Aircraft by India							
Aircraft Numbers & Type	Details	Country of Origin	No of Aircraft	Generation of Aircraft	Year of Purchase	Cost (Rs in Crores)	Approx Cost per aircraft (Rs Crore)
36 Rafale for IAF		France	36	4.5	2016	59,000	1,638
26 Rafale-M for IN		France	26	4.5	2025	63,000	2,423
40 LCA Mk-1 for IAF	With IOC	India	20	4	2018	5,362	268
	With FOC	India	20	4	2018	5,989	299
83 LCA Mk-1 A for IAF (AESA Radar, BVR ms1, EW Suite & AAR) 250 out of 344 sys indigenous	73 LCA Mk-1A Fighter+ 10 LCA Mk-1 Trainer aircraft	India	83	Near 4.5	2023	36,468	439
97 LCA Mk-1A for IAF with 68 additional items over earlier LCA Mk-1A contract (incl. Uttam Radar, Swayam Raksha Kawach, Control Surface Actuators)	68 Fighter +29 twin seaters	India	97	Near 4.5	2025	62,370	643

The CCS had approved the acquisition of 83 LCA Mk-1 that included 73 single seat fighter aircraft and 10 two seat trainer aircraft for Rs 45,969 crore in 2021. The LCA Mk-1A is an Indigenously Designed, Developed and Manufactured (IDDM) fighter in which 500 Indian companies are working with HAL for production. LCA Mk-1A will be equipped with Airborne Electronically Scanned Radar (AESA) radar, Beyond Visual Range (BVR) missiles, Electronic Warfare (EW) suite and AAR.⁷⁶ The cost was later renegotiated by the IAF with HAL and brought down to Rs 36,468 crores.

The cost rationalisation achieved during the negotiation between the IAF and HAL in this deal indicates the relevance and significance of cost-plus models in the products developed by the Indian public- and private-sector entities. The cost-plus model holds significance to ascertain the reasonability of costing in single-vendor situations, considering the increasing participation of the private sector in Indian aeronautics manufacturing in the future.⁷⁷ It can be argued that Rafale (for IAF) and Rafale-M are a different class of aircraft than LCA Mk-1 and LCA Mk-1A, being twin engine aircraft with higher payload-carrying capabilities. A fair comparison of Rafale-M would be with the 4.5-generation TEDBF, having similar payload-carrying capability if it had been approved. Despite the differences, the above cost comparison does indicate that the indigenous LCA Mk-1A aircraft provides a significant cost advantage and the ability to scale up manufacturing at a much lower cost when required.

Why TEDBF?

IN sought the development of TEDBF towards the end of 2017 (Figure 5), citing India's increased challenges with the expansion and

⁷⁶ 'Cabinet Approves. Procurement of 83 Light Combat Aircraft (LCA) Tejas from HAL for IAF', Cabinet, 13 January 2021, PIB Delhi, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1688287>, accessed on 6 September 2025.

⁷⁷ 'Prime Minister Flies in the Indigenously Designed, Developed and Manufactured Twin Seater Fighter Aircraft LCA Tejas', PIB Delhi, 25 November 2023, <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=1979812>, accessed on 6 September 2025.

modernisation of the Chinese Navy and the increasing forays of Chinese ships and submarines in the Indian Ocean. Chinese aircraft carriers could also pose challenges for India in future. Therefore, aircraft like TEDBF, with higher range and payload-carrying capacity, was projected to be a better option. The TEDBF, being a twin engine naval variant of LCA, was expected to take a shorter development and manufacture timeline than the fifth-generation naval fighter aircraft (N-AMCA); however, this was not the case.

Figure 5. Twin Engine Deck Based Fighter (TEDBF).⁷⁸



WHY N-AMCA?

The N-AMCA, redesigned for naval operations with advanced design, stealth, super cruise advanced sensors and enhanced capabilities, is a more capable and survivable aircraft than TEDBF. In September 2025, Former Naval Chief Adm Arun Prakash called for merging of AMCA and TEDBF projects of the IN and formulating Joint Services Qualitative Requirements (JSQRs) to harmonise the requirements of both the IAF and IN. TEDBF's viability is at risk as it may not achieve

⁷⁸ Government of India, GODL-India <https://data.gov.in/sites/default/files/Gazette_Notification_OGDL.pdf>, via Wikimedia Commons, 6 February 2025, accessed on 18 August 2025

economies of scale due to high costs and limited numbers required by the IN.⁷⁹

Dr. Jadhav, ADA director, in an interview in September 2025, observed that AMCA has advanced features like low Radar Cross Section (RCS) design equipped with radar absorbent stealth materials, Artificial Intelligence (AI), Machine Learning (ML), digital fly by wire quadruplex computer, advanced actuator, conformal antennas and non-poisonous green technologies. The LCA ecosystem has helped create 100 design work centres, with 350 industries in the private sector onboard the AMCA project.

J-35 and Changed Threat Dynamics. The induction of J-20 and J-35 fifth-generation fighter aircraft by the People's Liberation Army Air Force (PLAAF) and PLAN, respectively, and flight testing of J-36 and J-50 fifth-generation-plus fighter aircraft by China in December 2024 has changed the threat dynamics for India.⁸⁰ This could make the 4.5-generation TEDBF fighter aircraft vulnerable or less potent in the long run, considering the fighter aircraft remains in service for thirty to forty years. The operationalisation of the J-35 fifth-generation fighters by PLAN on its Fujian aircraft carriers has provided new capability to China that requires the IN to review the development of TEDBF and explore joining the development of indigenous fifth-generation N-AMCA.⁸¹

⁷⁹ 'Admiral Arun Prakash's Call to Merge AMCA and TEDBF: A Joint SQR for N-AMCA Could Revive TEDBF Project', 23 September 2025, <https://idrw.org/admiral-arun-prakashs-call-to-merge-amca-and-tedbf-a-joint-sqr-for-n-amca-could-revive-the-tedbf-project/>, accessed on 28 September 2025.

⁸⁰ Vasudha Mukherjee, 'China Steps Up Testing of Sixth-gen Stealth Fighters Amid Tensions with US', *Business Standard*, 21 April 2025, https://www.business-standard.com/external-affairs-defence-security/news/china-j36-j50-stealth-fighter-tests-us-f47-jet-race-defence-sector-125042100816_1.html, accessed on 8 November 2025.

⁸¹ 'Catapult Launch and Arrested Landing of China's J-35', *New China TV*, <https://www.youtube.com/watch?v=06z6trsMLYw>, accessed on 28 September 2025.

TEDBF Approval. TEDBF is yet to complete the design reviews and approval process, which will add to its development and operationalisation timelines. TEDBF, being a separate project, would need to undergo the complex and time-consuming process of integration of various systems, prolonged testing and certification.

Number of Aircraft Carriers. The IN initially wanted to build naval fleet based on three aircraft carriers, which has not been accepted by the government. It has reviewed its plan and now wants to work on the second indigenous aircraft carrier as a replacement of INS *Vikramaditya*.⁸² The IN put forward a proposal for 145 naval fighters (TEDBF) based on their envisaged future deployment in the three aircraft carriers that it expects to possess in future. It had identified 14 upgrades, including Automatic Take off and Landing (ATOL), which the current LCA Mk1 (Navy) aircraft lacks. The requirement for 145 aircraft seems to be higher and requires review, considering the small size of current aircraft carriers and since the third aircraft carrier has not yet been approved.⁸³ The proposal was examined by the National Security Council Secretariat (NSCS) and awaits approval. The IN currently has only two aircraft carriers.

Reduced Requirement for Naval Fighters. There was a view that the IN should project the requirements of CBF based on two aircraft carriers, which roughly works out to be 87 aircraft. This figure appears to be on the higher side. Out of the envisaged requirement of 87 aircraft, the IN has already placed the order for 26 Rafale-M aircraft with France, which further reduces the requirement of naval fighters to 61 aircraft, too few to be creating a parallel development and manufacturing line for TEDBF for the IN, along with three ongoing

⁸² 'India Decides It Will Not Operate A Third Aircraft Carrier, Here is Why', *Business Standard*, 4 February 2025, https://www.business-standard.com/external-affairs-defence-security/news/india-decides-it-will-not-operate-a-third-aircraft-carrier-here-is-why-125020400853_1.html, accessed on 1 November 2025.

⁸³ Ibid.

indigenous fighter aircraft projects, i.e. LCA Mk1/1A, LCA Mk-2 and AMCA of the IAF.⁸⁴

Obsolescence of TEDBF. The reason that TEDBF is a twin engine variant of LCA and therefore can be developed within short timelines is no more applicable. The relevance or effectiveness of a 4.5-generation TEDBF in the era of fifth- or sixth-generation naval fighter aircraft is eroding. The first prototype of AMCA is likely to be rolled out sometime in 2027–28, its flight testing could commence nine months to one year after its prototype rollout, i.e. in 2027–28. Its first variant, i.e. AMCA Mk-1, could be ready for user induction by 2034, and although testing may continue for some more time, it would not prevent induction of AMCA Mk-1.⁸⁵ TEDBF approval, design, development, integration of systems, testing, certification and induction timelines are likely to coincide with, or more likely exceed, the timelines of the AMCA programme. The progress in AMCA and delay in TEDBF approval will make the latter less relevant due to technological obsolescence.

MRO and Supply Chains Duplication. The development of TEDBF will require the creation of separate supply chains. This in turn would lead to duplication in Maintenance, Repair and Overhaul (MRO) and supply chains. A separate TEDBF project would require the creation of separate supply chains, which will add to complexities in inventory management and life cycle support for a limited number of aircraft. Therefore, AMCA would be a better choice since it has an added advantage of being the next-generation fighter aircraft. Table 3 provides a brief summary of the basic capabilities of the current and envisaged CBF for IN.

⁸⁴ Snehesh Alex Philip, 'As India & France Get Ready to Sign 7 bn Euro Deal for Rafale Marine, 87 TEDBFs Emerge in Shadow', *The Print*, 5 December 2024, <https://theprint.in/defence/as-india-france-get-ready-to-sign-7-bn-euro-deal-for-rafale-marine-87-tedbf-emerge-in-shadow/2388615/>, accessed on 16 August 2025.

⁸⁵ 'AMCA Latest News | India's Stealth Challenge: When Will the AMCA Fighter Be Ready', NDTV, 27 September 2025, <https://www.youtube.com/watch?v=UvbsLY4wweE>, accessed on 28 September 2025.

Table 3. Basic features of LCA Mk-1, LCA Mk-2, TEDBF, Rafale-M and AMCA fighter aircraft.

	LCA Mk-1	LCA Mk-2	TEDBF	Rafale-M	AMCA
All Up Weight (AUW) in Tons	13.5	17.5	26	24.5	25
No. of Engines	Single	Single	Twin	Twin	Twin
Generation of Fighter	4	4.5	4.5	4.5	5.5
Stealth	No	No	No	No	Yes

Resource Constraints. The manpower and resources available with the ADA to design, National Flight Testing Centre (NFTC) to undertake flight testing and Centre for Military Airworthiness and Certification (CEMILAC) to accord certification to TEDBF are limited. Also, additional manufacturing facilities and resources are needed for the production of TEDBF. The development, testing, certification and production of TEDBF along with LCA Mk-2 and AMCA would lead to duplication in effort, manpower and resources, which are limited and should be avoided as far as possible.

CATOBAR and STOBAR. The Catapult Assisted Take Off But Arrested Recovery (CATOBAR) and STOBAR are two types of fighter aircraft launch and recovery mechanisms from an aircraft carrier. Indian aircraft carriers are equipped with the STOBAR launch system. In CATOBAR, additional assistance provided by a catapult during the take-off enables an aircraft carrier to launch lower thrust-by-weight ratio aircraft with higher payload and fuel. However, CATOBAR is only a launch mechanism, not an operational capability. STOBAR overcomes the limitations of short distance take-off by a CBF by having a ski jump design on an aircraft carrier. The decision to develop either a CATOBAR or STOBAR launch system is taken based on

aircraft carrier design, size and optimisation of various systems.⁸⁶ AMCA can be modified for STOBAR operations by incorporating lessons from TEDBF design.⁸⁷ The next indigenous aircraft carrier and AMCA Mk-2 can be designed for CATOBAR launch mechanism.

Lack of IAF's Interest in ORCA. The development of land-based variant of TEDBF named Omni Role Combat Aircraft (ORCA) was also proposed; however, the IAF has not shown interest in the 4.5-generation TEDBF as it decided to join the development of 4.5-generation single engine LCA Mk-2 and advanced 5.5-generation AMCA, which reduces the viability of TEDBF.⁸⁸

N-AMCA. There is a need to review the TEDBF and instead examine the feasibility of joining the development of Naval AMCA (N-AMCA) due to the arrival of fifth- and fifth-generation-plus generation fighters in India's neighbourhood. IAF joined the development of 4.5-generation LCA Mk2 a decade earlier. However, IN sought the development of a 4.5-generation twin engine variant (TEDBF) with enhanced range and payload-carrying capabilities to meet the challenges envisaged at that time. The IAF, in the meantime, started working with ADA for the development of 5.5-generation AMCA (IAF) (Figure 6). AMCA is expected to have stealth and other fifth-generation technologies as well as a few sixth-generation technologies. The LCA Mk-2 and AMCA projects have already been approved by the Indian government, and the IN does not require approval for joining the AMCA project. However, lack of approval of the TEDBF and IN's non-participation in the development of the naval variant of AMCA (N-AMCA) could be a setback to the self-reliance trajectory with regard to CBF in India.

⁸⁶ 'Why the Indian Navy prefers TEDBF Over N-AMCA: Decoding the Choice for CATOBAR AMCA & Rejection of STOBAR AMCA'. Indian Defence Research Wing, 13 September 2024, <https://idr.org/why-the-indian-navy-prefers-tedbf-over-n-amca-decoding-the-choice-for-catobar-amca-and-rejection-of-stobar-amca/>, accessed on 13 January 2025

⁸⁷ 'Admiral Arun Prakash's Call to Merge AMCA and TEDBF'.

⁸⁸ Ibid.

Figure 6. Advanced Medium Combat Aircraft (AMCA) at Aero India 2025.⁸⁹



N-AMCA Stealth Challenge. There are concerns about the viability of developing stealth Naval AMCA (N-AMCA) as there is a view that fighter stealth coating and other stealth features are meant for land fighters and it may be difficult to maintain stealth features of N-AMCA over sea. Also, it is argued that the modification of stealth AMCA for carrier operations will require extensive modifications that may be difficult and thus, India should focus on the development of TEDBF. However, it is pertinent to note that both AMCA and TEDBF have similar AUW and thus will require a similar launch system. Also, N-AMCA, being a higher-generation aircraft, is likely to have better operational capability and survivability.⁹⁰ The view that the Stealth N-AMCA will not be suitable for operations in salty water environment over the sea may not be entirely true as the US has been operating the naval variant of its F-35 stealth fighter from its aircraft carrier. Similarly, China has operationalised the J-35 naval stealth fighter from its aircraft carrier.⁹¹

⁸⁹ Picture by Gp Capt RK Narang, Aero India-2025, 11 February 2025.

⁹⁰ Jaideep Maolankar, 7.24 AM, 23 September 2025, https://x.com/JA_Maolankar/status/1970305829816676401, accessed on 28 September 2025.

⁹¹ 'Why the Indian Navy prefers TEDBF Over N-AMCA: Decoding the Choice for CATOBAR AMCA & Rejection of STOBAR AMCA'. Indian Defence Research Wing, 13 September 2024, <https://idrw.org/why-the-indian-navy-prefers-tedbf-over-n-amca-decoding-the-choice-for-catobar-amca-and-rejection-of-stobar-amca/>, accessed on 13 January 2025.

CBF and Aircraft Carrier Design Synergy. The sixth-generation fighter aircraft are expected to be equipped with high-powered Directed Energy Weapons (DEWs), Swarm UAVs and Manned-Unmanned Teaming (MUMT) systems that would require more powerful, efficient and advanced propulsion systems. Therefore, it is important that India starts planning the contours of N-AMCA Mk-2 next-generation CBF and aircraft carriers. The future CBF would be required to meet the higher power requirements of electronics systems, improved cooling and integration of hypersonic weapons, DEWs and other high-power systems. The excess power of two engines provide the flexibility to carry large payloads and strike targets at long ranges. Though the single engine LCA Mk-1 and LCA Mk-2 were not unsafe and could have undertaken certain roles, the increasing challenges of the coming decades necessitate that future carrier borne naval aircraft are able to carry higher payloads and possess greater range, higher power onboard and multi-role operations capabilities. This would require future fighter aircraft not only be twin engine but also be equipped with more powerful engines and advanced sensors and shooter systems.

Stalemate due to Indecisiveness. India's quest for an indigenous naval fighter has been at a standstill for almost a decade due to indecisiveness, and early course corrections are needed. India will need to take a decision regarding the indigenous CBF while restricting the import of CBF to a bare minimum, so that it does not have adverse impact on the *atmanirbharta* trajectory. It still leaves space for limited induction of single engine LCA Mk-1 (Navy) or LCA Mk-2 (Navy) as combat trainer and interim CBF.

EXTERNAL AND INTERNAL DISTRACTIONS

India's indigenous fighter development programme, including CBF, is likely to face several distractions and challenges. Potential challenges include the restriction or obstruction of India's indigenous fighter aircraft development programmes. All instruments possessed by global OEMs and their governments would be used to dissuade, disrupt or delay the development programme. There could also be proposals to work on co-development and co-production. The American F-35 fifth-generation fighter aircraft and the Russian Su-57 would be potential

contenders for the near-term and next-generation fighter aircraft co-development proposals on a long-term basis. Political, diplomatic, trade, media and other levers would be at play. Efforts could also be made to discredit or dismiss indigenous fighter aircraft development programmes. However, India must remain focused on its self-reliance trajectory by assessing indigenous capabilities, ascertaining the impact of ToT and collaborations on self-reliance, ownership of IPR and rights to modify, upgrade and develop future variants.

CARRIER BORNE FIGHTER: *ATMANIRBHARTA* CHALLENGES

India is at crossroads as uncertainly looms over its CBF development programme. The systematic approach and continuity in the indigenous development of CBF is essential for achieving *atmanirbharta* in Indian naval aviation. Therefore, the trajectory, nuances and challenges in the development of CBF need to be studied to identify challenges and introduce course corrections.

The technological challenges in CBF development emerge due to the unique requirements of naval operations. Therefore, the transformation of land-based fighter aircraft into CBF faces varied and complex challenges that would need to be factored in the CBF development programme. The development of CBF is also impacted by the aircraft carrier design. The size and weight of weapons also impacts naval fighter configuration and thus needs to be factored in while designing the CBF. Thus, synergy among the aircraft carrier, CBF and weapons design is crucial for optimally leveraging their respective capabilities.

TRAJECTORY OF LCA Mk-1 (NAVY), LCA Mk-2 (NAVY) AND TEDBF

The decisions and development milestones of LCA Mk-1 (Navy) and LCA Mk-2 (Navy) from concept formulation to prototype development had an impact on the lack of operationalisation of indigenous CBF. The timelines of key milestones of LCA Mk-1 (Navy) (Table 4), LCA Mk-2 (Navy) and TEDBF (Table 5) provide a snapshot view of trajectory of their development, and challenges .

Table 4. Timeline of LCA Mk-1 (IAF/ IN)

Timeline of LCA Mk-1 (IAF/IN)	
1983	LCA (IAF) approved
1985	IN formulates NASRs for LCA Mk-1 (Navy)
1986	IN requests ADA to undertake feasibility study of LCA Mk-1 (Navy)
1989-92	Feasibility study undertaken on LCA Mk-1 (Navy)
1995	Preliminary Design Study approved
2001	First flight of LCA Mk-1 (IAF)
2002-	Cmde Balaji, a serving naval aeronautical engineer, deputed to ADA to take up development of LCA Mk-1 (Navy)
2003	Revised NASRs formulated & CCS approval accorded
2009	LCA Mk-1 (Navy) sanctioned
2011	LCA Mk-1 (IAF) obtains Initial Operational Clearance-1 (IOC-1) on 10 January
2014	Shore Based Test Facility (SBTF) set up at Naval Air Station, Goa First Ski Jump Take Off from SBTF, Goa, on 20 December
2016	IN withdrew its consent for LCA Mk-1 (Navy) project ADA decides to continue with development and validation of LCA Mk-1 (Navy) and related technologies.
2019	First arrester landing at SBTF, INS Hansa, Goa on 13 September
2020	First landing on INS Vikramaditya on 11 January & take off on 12 January
2023	First landing and take-off from INS Vikrant on 6 February IN examined procurement of limited number of LCA MK-1 (Navy) Production of LCA Mk-1A (IAF) was in progress and no orders had been placed by December 2025

Table 5. Timeline of LCA Mk-2 and TEDBF

Timeline of LCA Mk-2 and TEDBF	
2009	Approval of LCA Mk-2 included design of two naval prototypes, i.e. Naval Prototype-1 & 2 (NP-1 & 2)
2014	LCA Mk-2 preliminary design studies finalised
2015	Commencement of detailed design phase
2017-18	The IN, during the design review phase towards the end of 2017, withdraws from LCA Mk-2 (Navy) and the proposed development of TEDBF. Thereafter, use of funding allocated for detailed design of LCA Mk-2 (Navy) was discontinued and ADA was asked to divert it towards initial design of TEDBF
2019	Design of LCA Mk-2 finalised & displayed during Aero India airshow
2019	ADA, on the request of the IN, formally proposed development of TEDBF on 9 September
2022	Project sanctioned for the development of full-scale prototype of LCA MK-2 (IAF) at an estimated cost of Rs 9,000 crore (including Rs 2,500 crore that had already been spent on its design) on 1 September
2023	ToT of GE-414 engine agreed in principle in 2023 Development of LCA Mk-2 (IAF) is in progress & there is no progress on the LCA Mk-2 (Navy) due to the IN's withdrawal from the project

Table 6. Development cost of LCA as of 2014⁹²

Cost of LCA Mk-1 (IAF/IN) & LCA Mk-2 (IAF/IN) (As of 2014)	
Program	Cost (in Crore Rs)
Light Combat Aircraft (LCA) Phase-I	2,188.00
Light Combat Aircraft (LCA) Phase-II	5,777.56
Light Combat Aircraft (LCA) Phase-III	2,431.55
LCA Navy Mk-1	1,714.98
LCA Navy Mk-2	1,921.11
Total	14,033.2

An examination of the timelines and cost of LCA Mk-1 (Navy) and LCA Mk-2 (Navy) indicates that significant efforts had been expended towards the design, development, testing and certification of LCA Mk-1 (Navy) and LCA Mk-2 (Navy) by 2014.⁹² (Table 6). However, a study of the funding pattern and development milestones – such as arrester landing from SBTF, Goa, in 2019, and landing and take-off from its two aircraft carriers, i.e. INS Vikramaditya and INS Vikrant in 2020 and 2023, respectively – indicate the ability of Indian designers to design, develop, validate and certify LCA Mk-1 (Navy) as the CBF, which can be deployed despite its range and payload limitations. Also, learnings from LCA Mk-1 (Navy) can be leveraged to achieve self-reliance with the synergy and support of stakeholders. However, there has been some incoherences in the indigenous design and development of CBF, which are deliberated next.

CBF DEVELOPMENT INCOHERENCE: LCA MK-1, LCA MK-2, N-AMCA AND RAFALE-M

The incoherent approach of the IN towards the indigenous CBF development programme was witnessed during the four decades of its development, starting from launch of LCA (IAF) in 1983. Some of the activities that indicate dissonance in the indigenous development of CBF and the self-reliance trajectory of naval aviation are deliberated next.

Delay in Joining the LCA Mk-1 (Navy) Project. IN did not participate in the LCA project despite possessing a similar single engine Sea Harrier CBF. The LCA project for the IAF was progressing as planned; however, the IN delayed joining the LCA project to 2003, which was two years after the first flight of LCA (IAF) in 2001, seven years after the LCA Mk-1 (Navy) project was approved in 2009 and 20 years after the LCA (IAF) project approval in 1983.

⁹² 'Development Cost of LCA Project', Press Information Bureau, Ministry of Defence, 12 December 2014, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=103546®=3&lang=2>, accessed on 25 December 2025.

Consent Withdrawal from LCA Mk-1 (Navy). IN's withdrawal of consent midway during the indigenous LCA Mk-1 (Navy) development project in 2016 adversely impacted trajectory of self-reliance, considering it was at the critical stage of development. The ADA's initiative with regard to the creation of shore-based testing facility and testing of ski launch and arrested landing – the two critical technologies needed for any indigenous CBF development – ensured continuity in the technology development and validation. The withdrawal from LCA Mk-1 (Navy) was unexpected, considering LCA Mk-1 (Navy) would have matched and met the payload-carrying capability of Sea Harrier.

Withdrawal from LCA Mk-2 (Navy). The decision to withdraw from the LCA Mk-2 (Navy) project was taken sometime in late 2017 or early 2018, about nine years after the initial approval of the detailed design phase in 2009, and while the final approval for full-scale development of LCA Mk-2 (Navy) was awaited. The IN asked the ADA to utilise the funding earmarked for the detailed design of NP-3 and NP-4 models of LCA Mk-2 (Navy) to design a TEDBF. Although the withdrawal of consent for LCA Mk-2 (Navy) did not attract much attention since it was still in design phase, it was unexpected, considering this aircraft was a 4.5-generation fighter that matched the performance of contemporary CBFs on offer to IN. Also, LCA Mk-2 (Navy) was designed specifically to undertake the roles and missions that were required to be undertaken by the IN. In fact, the development of the IAF variant was an afterthought, which the IAF readily accepted as an interim fighter as it had the necessary requirements that could serve its interests till AMCA could be developed. As per observations of naval experts, LCA Mk-2 (Navy) could have served as an interim 4.5-generation CBF till the N-AMCA (naval stealth fighter) was developed.

Withdrawal from N-AMCA Project. IN's decision to withdraw from the 5.5 generation N-AMCA development brought the CBF programme to a complete standstill, creating an adverse impact on the trajectory of *atmanirbharta* in Indian naval aviation.

Impact of Procurement of Rafale-M. The acquisition of 26 Rafale-M in 2025 – when LCA Mk-1 (Navy) had already demonstrated its ability to operate from its aircraft carriers in 2020 and 2023; LCA Mk-2 (Navy) development was suspended at the design review phase in

2017; and LCA Mk-2 (IAF) was in the advanced stage of full-scale prototype development – reduced the number of aircraft required to such a low level that the need for a separate TEDBF project became unviable.

VIABILITY OF TEDBF

The proposed development of TEDBF was unlikely to be approved, considering the few number of aircraft required for the IN, paucity of resources and manpower; and non-viability in creating separate supply chains and life support by the production entity. The factors that impact viability of TEDBF are covered next.

Cost Constraints. The requirement of 61 naval aircraft for two aircraft carriers makes TEDBF economically unviable. The AMCA has been allocated Rs 15,000 crore, and by taking into account inflation and cost escalations of various systems, the initial funding required for TEDBF would be approximately Rs 20,000–25,000 crores.

Resource Limitations. It would be difficult for the DRDO and the testing and manufacturing entities to spare the meagre resources for the design, development, testing, certification and production of a separate TEDBF. The limited manpower and finite resources will limit ability of ADA to undertake design and development projects. Also, manpower and resources required for aircraft testing and certification by CEMILAC are also limited. These limitations would need to be factored in while making a plan for the development of CBF.

Scaling Up Challenge. The IN's requirement for a small number of aircraft makes scaling up production unrealistic. The set up of design and manufacturing facilities for a new project has its own complexities. Scaling up production entails acquiring land, establishing manufacturing facilities, procuring additional machinery and testing tools, hiring extra manpower and training them for increased output, all of which involve substantial costs. Therefore, such expenditure becomes economically viable only if the order book spans about eight to ten years and a minimum orders is upwards of 300 aircraft with scope for higher orders in future. This is the practice followed by most OEMs around the world and needs to be closely studied.

LCA MK-2 (NAVY) FOR NEAR-/ MID-TERM CHALLENGES

The LCA MK-2, TEDBF and Rafale-M can meet near-term threats as Chinese fifth- and sixth-generation fighter aircraft are under operationalisation and development, respectively. However, these aircraft, in their current form, would struggle to maintain technological edge over J-20 and J-35 fifth-generation and J-36 and J-50 fifth-generation-plus fighters as their technology matures and they gain experience in using them under real-time operational conditions. Out of the three 4.5-generation technologies, Rafale-M would have inherent dependencies and does not contribute to indigenous design and development capabilities.

The development of a separate TEDBF would require enormous funding, resources and creation of separate supply chain support ecosystem. The LCA Mk-2 (Navy) is a viable fighter that can be developed with available resources, follow a spiral development trajectory and provide operational experience for elevating fighter development to fifth- and sixth-generation technologies. Also, supply chains and life cycle support of LCA Mk-2 (Navy) can be aligned with that of LCA Mk-2 (IAF).

A number of challenges can be reduced by bringing coherence between land and naval fighter variants. Therefore, the IN needs to review its TEDBF proposal, considering its economic viability, survivability, supply chain and life support challenges as compared to LCA Mk-2 (Navy) and N-AMCA. The LCA Mk-2 (Navy) can be developed as an interim CBF. The development of future CBF based on the basic AMCA core design would mitigate and minimise the above challenges and limitations.

CBF DEVELOPMENT CHALLENGES

The development of CBF has its own nuances and challenges. The experience gained during the development of LCA Mk-1 (Navy) and LCA Mk-2 (Navy) provides an opportunity to take lessons and incorporate learnings into the next CBF. Some of the factors that could impact the development of the next CBF are deliberated next.

Design for Carrier Operations. The CBF's design has to take into account operations in saline water environment, short take-off and landing strip, heavy axial loads, high rate of descent during landing, sharp nose drop during landing, inability to use composite materials having magnesium due to its low corrosion resistance and challenges in fighter aircraft operations from an aircraft carrier operating over water with six degrees of motion. This may require naval-specific design and strengthening of structures for heavy and arrested landing, which may lead to increase in AUW.

Modifying Land Fighters. The modification of a land fighter variant to suit naval operations requires several design improvements. The naval fighter for carrier operations is more robust and thus may have higher empty weight, which may not be required for land operations and thus lead to underperformance. On the other hand, even a small reduction in weight enhances the capability of a fighter aircraft and therefore significant in land fighter design. Therefore, the unique requirements of carrier-based fighter aircraft necessitate significant design modifications in the land fighter.

Cmdr Maolankar, in discussing the nuances of development of LCA Mk-1 (Navy) from LCA (IAF), observed that the modification of a land-based fighter aircraft to a CBF was challenging. There is a need to institute corrective measures in the future carrier-based fighter aircraft development programmes. Even one of the most successful World War II (WWII) fighter, i.e. the Spitfire, was unsuccessful as a naval fighter when it was modified for carrier operations without taking into account challenges associated with carrier-borne operations. Therefore, it is necessary to strike a balance between robustness for landing and the mission characteristics (manoeuvre/acceleration, etc.) However, there are exceptions: F18 was initially developed as an air force aircraft (YF17) before being adopted by the US Navy. In the case of Rafale, both land and naval variants were developed simultaneously, and the former was tested first; however, Rafale-M was inducted into service a year earlier.⁹³

⁹³ Observations made by Cmdr Maolankar, former test pilot of LCA Mk-1 (Navy) in a chat with the author on 16 August 2025.

Anti-Ship Role. The naval fighter will be required to undertake anti-ship and anti-submarine operations. The size and weight of these missiles and bombs is larger than those required for striking land targets. Therefore, CBF need to be accordingly designed to carry heavier payloads of larger dimensions.

CBF as a Dual Fighter. There is an ongoing debate over whether TEDBF or other CBF should be developed to serve as dual-purpose aircraft (as both land and naval fighter) or if separate fighter variants are required for land and naval operations. The TEDBF is aimed at developing a distinct naval aircraft for the use by the IN, and a few of these requirements are different from the requirements of the IAF. Some argue that fighter aircraft designed for operations from land do not succeed as naval fighters, although there are some examples of dual fighter designs having both land and naval fighter variants, such as Rafale, SU-33 and F-35. It is apparent that land fighter would have to be redesigned for naval fighter operations from an aircraft carrier and for carriage of heavier weapons of larger dimensions for anti-shipping strike roles.

Merging of QRs. The merging of QRs of naval and air force stealth fighters is challenging, since a stealth aircraft carries its weapons in internal bays. Although a land stealth fighter would be able to undertake naval air defence roles, it will not be able to carry anti-ship missiles internally. The carriage of anti-ship missiles on external pylons in stealth aircraft would compromise its stealth configuration, which is its core strength. The carriage of large weapons for naval missions by stealth aircraft would require redesign not only to strengthen the structure but also to increase internal weapon carriage space.

Challenge in Redesigning AMCA. The transformation of the AMCA into a full-fledged CBF would require significant design changes, or even a complete redesign. Therefore, a detailed design review could be undertaken by a joint team of the IAF, IN, ADA and other stakeholders to arrive at the desired configuration. The AMCA-based stealth CBF will provide greater operational employability, flexibility, commonality of supply chains and reduced approval and certification timelines.

The land fighter variant would most likely be a lighter aircraft having higher payload-carrying capacity compared to the naval variant. Therefore, the air force and naval users and aircraft designers need to sit together to agree on an optimum design with least differences and maximum operational utilisation. Thus, the transformation of a land-based fighter aircraft into CBF faces varied and complex technological challenges that would need to be factored in the follow-on CBF programme.

AIRCRAFT CARRIER, NAVAL FIGHTER AND WEAPON DESIGN SYNERGY CHALLENGE

The naval fighter design is influenced or constrained by the design of the aircraft carrier and the weapons carried by it. The aircraft carrier, CBF and weapon design synergy is essential to achieve harmony and obtain the optimal performance of a CBF.⁹⁴ In addition, the design, size, weight and capability of aircraft carriers; the type, size, propulsion and launch mechanism of CBF; and the weight and size of onboard weapons need to be aligned with the envisaged operational requirements of IN.

An important lesson from the development of LCA Mk-1 (Navy) was that the maximum feasible challenges faced in CBF design should be mitigated by making changes in the design of aircraft carrier. However, incoherence between the design of aircraft carrier and CBF becomes a limitation in expanding the operational envelope of the CBF. The aircraft carrier, CBF and weapons development and acquisition verticals of the IN need to work with the respective design and manufacturing entities of the industry to achieve synergy in planning, design, development, manufacturing and induction of indigenous naval systems.

⁹⁴ Vice Adm Shekhar Sinha (Retd.) in Fellow Paper discussion at Manohar Parrikar Institute for Defence Studies and Analyses (MP-IDSA) on 24 October 2025.

Organisational Structures for Synergy in *Atmanirbharta*. The naval aircraft carrier and CBF design and development in the IN are currently placed under the DCNS and VCNS, respectively. The design incoherences in an aircraft carrier often have an impact on the development and induction of CBF. The placement of designs and the development of these two critical platforms under two different Principal Staff Officers (PSOs) of the IN results in dissonance, which can be rectified by placing both under a single PSO.⁹⁵

The IN was a latecomer to the LCA project; withdrew consent for LCA Mk-1 (Navy) and LCA Mk-2 (Navy) in 2016 and 2017, respectively; proposed TEDBF development in 2017–18; opted out of the N-AMCA programme; and placed an order for 26 Rafale-M in 2025, thereby bringing the indigenous CBF programme to a standstill. The nuances and challenges associated with CBF development, along with a lack of synergy between carrier development, CBF and onboard weapons, require special attention. The trajectory of CBF development needs course corrections to achieve India's *atmanirbharta* goals in naval aviation.

⁹⁵ Cmde Maolankar, former test pilot LCA Mk-1 (Navy) and Vice President, New Space Research and Technologies (NSRT) in a chat with author on 16 November 2025.

TRANSFORMATION OF THE INDIAN NAVY: FROM BUYERS TO BUILDERS

This chapter aims to identify the key pillars required to transform the IN from a buyers' to a builders' navy. The lessons derived from this chapter will be leveraged in the next chapter to identify corresponding gaps, if any, to achieve self-reliance in naval aviation. The IN has been at the forefront of self-reliance in ship and submarine building; however, its contribution to naval aircraft design and manufacturing has been negligible, inconsistent and incoherent. The decision to join LCA MK-1 (Navy) in 2003, two years after first flight of LCA Mk-1 (IAF) in 2001, despite initiating a study on naval fighter in 1986 (three years after the launch of LCA project in 1983), indicates slow pace of decision-making in IN. The IN withdrew early from LCA Mk-1 (Navy) in 2016 just after its first flight in 2012 and first ski jump launch from STBF, Goa, in 2014. However, its development continued in ADA, which led to the first arrested landing on ground in Goa in 2019 and on aircraft carriers in 2020 and 2023.

The development of J-20, J-35, J-36 and J-50 fifth- and fifth-generation plus fighter aircraft by China in 2024 and import of 26 Rafale-M CBF by IN in 2025 further reduced the viability of TEDBF. These developments indicate delays, indecisions and incoherences in decision-making on self-reliance in CBF development.

It is important to examine why IN, which has been traversing the path of self-reliance in naval ship and submarine building, struggled to articulate and steer the path of self-reliance in aircraft design and development. In order to understand the differences between the self-reliance trajectory of naval ship/submarine building and naval aircraft, it is important to examine the pillars of naval ship and submarine building versus naval aircraft design and manufacturing. Since Independence, the IN has never articulated a roadmap for self-reliance in aircraft design and manufacturing, which raises following questions:

- (a) Was it because there was no need? or
- (b) Was it because there were no organisational structures in the IN to articulate, lead and support self-reliance in naval aeronautics manufacturing?

Therefore, an endeavour has been made to examine the existing policies and structures for ship and submarine design and development in IN vis-à-vis availability/paucity of similar structures for naval aircraft design and development. In addition, the IN's self-reliance trajectory in shipbuilding is studied to draw lessons for self-reliance in naval aviation manufacturing.

VISION

IN's shipbuilding planning and design structures have ensured a steady rise in indigenous design and development of ships and submarines. IN's *Vision 2047* outlines a structured pathway towards it becoming a fully indigenous, technologically advanced and *atmanirbhar* force. This vision is anchored on three core drivers: sustained innovation, systematic indigenisation and the integration of emerging technologies into naval operations. However, it does not include *atmanirbharta* in naval aeronautics fleet. Thus, there is a need to include and articulate self-reliance in Indian naval aircraft manufacturing in this vision.⁹⁶

HIGHER ORGANISATIONAL STRUCTURES

The IN has multiple directorates that are involved in the construction and monitoring of shipbuilding in India. The VCNS is responsible for activities leading up to sanction and construction of warships, while the monitoring of ship construction is carried out by the Controller of Material Monitoring, with both reporting to the Chief of Naval Staff (CNS). The Assistant Chief of Naval Staff (Policy and Plan) or ACNS (P&P), placed under VCNS, is responsible for the promulgation of all

⁹⁶ 'Sailing Towards Self-Reliance: The Indian Navy's *Aatmanirbhar* Bharat Journey', PIB Delhi, 3 December 2025, <https://www.pib.gov.in/PressNoteDetails.aspx?id=156310&NoteId=156310&ModuleId=3®=3&lang=2>, accessed on 4 December 2025.

perspective, force level, financial and infrastructure plans and programmes of the IN. The Directorate of Staff Requirements (DSR) under the ACNS (P&P) is responsible for the formulation of staff requirements of ships, on-board weapons, etc. The engineers of Directorate of Naval Design (DND) are responsible for naval ship design, and the Directorate of Ship Production (DSP) acts as the project manager for each ship. Budget controls and signing of the contract are coordinated by the Directorate of Cost and Contract Management (DCCM). The DND, DSP and DCCM are placed under the Controller of Warship Production and Acquisition (CWP&A), who reports to the VCNS. The Controller of Material Monitoring, on the other hand, is responsible for the management of various types of equipment onboard ships.⁹⁷

CAPABILITY AND INDIGENISATION PLANS

The Maritime Capability Perspective Plan for the IN was formulated in 2005. It projected a requirement of 160-ship-strong navy, including 90 frontline combat platforms. The plan indicates the concerted efforts of IN in articulating indigenous design and development of ships and submarines.⁹⁸ The Indian Naval Indigenisation Plan (INIP) 2015-2030 was formed amid global disruptions in supply chains and intensifying threats to India. Its core objective was to transition from partial import dependence to enable the domestic development of advanced shipborne systems through a structured, long-term 15-year roadmap. It identified capability gaps, especially in high-end weapons, sensors, propulsion systems, gear boxes and underwater technologies, with a forecast of future requirements to stimulate indigenous R&D and production. The emphasis was on indigenous construction of frigates, warships and submarines under *Atmanirbharta* Bharat and the IN's

⁹⁷ Warship Building, Chapter-1, Report No 32 of 2010-11, Comptroller and Auditor General of India (CAG), https://cag.gov.in/uploads/download_audit_report/2011/Union_Performance_Defence_Indigenous_Construction_Naval_Warships_32_2010_chapter_1.pdf, accessed on 4 December 2025.

⁹⁸ Ibid.

transformation into a ‘Builder’s Navy’. IN’s *Swavlamban 3.0* Indigenisation Plan was released in 2023, which provides a roadmap for indigenous development of naval platforms, systems and subsystems by the industry and academia.⁹⁹

CAPITAL ACQUISITION BUDGET

The IN’s share of defence budget, especially the capital acquisition budget, witnessed a significant increase in the last few years. The revenue budget increased from Rs 22,934 crore in 2021 to Rs 38,194.80 crore in 2025–26, with its revenue expenditure share moving up from 6.5 per cent to 7.5 per cent. Capital expenditure too witnessed a significant rise, from Rs 26,688.28 crore in 2020–21 to Rs 62,545 crore in 2025–26, an increase from 8.26 per cent to 13.75 per cent. A large part of the defence acquisition budget has gone to the domestic industry in the last few years.¹⁰⁰

The 2023 indigenisation plan of IN categorised the machinery fitted on the ships into three segments, i.e. float, move and fight, which have been indigenised by about 90, 60 and 50 per cent, respectively. Float, move and fight are naval terms, wherein float refers to systems that enable the ship to stay afloat; move refers to the propulsion system or engine that helps it to move; and fight relates to offensive and defence systems onboard a ship that help it to survive and neutralise adverse threats.¹⁰¹

SHIPYARDS

The MoD has three major shipyards – the Mazagaon Dock Ltd. (MDL) in Mumbai, involved in construction of major warships like stealth frigates, submarines and destroyers; Goa Shipyard Limited (GSL) in Goa, which builds medium-size sophisticated vessels for the IN; and Garden Research Shipbuilders & Engineers Ltd (GRSE) in Kolkata,

⁹⁹ ‘Sailing Towards Self-Reliance: The Indian Navy’s Aatmanirbhar Bharat Journey’, PIB Delhi, 3 December 2025, <https://www.pib.gov.in/PressNoteDetails.aspx?id=156310&NoteId=156310&ModuleId=3®=3&dang=2>, accessed on 4 December 2025.

¹⁰⁰ Ibid.

which is engaged in building warships and vessels for the IN and Coast Guard. The IN is closely integrated into the ship and submarine building process; while the navy undertakes the design, production is carried out by the shipyards, in collaboration with IN officers and personnel. However, the arrangement between IN and HAL, ADA and ADE on naval aircraft development is not of comparable scale and scope.¹⁰² Unlike shipbuilding, IN does not have an aircraft design vertical. Also, its engineers are not members of the aircraft design team, with an exception of Cmde Balaji, who joined ADA in 2002 to support the development of LCA Mk-1 (Navy) and was later absorbed into ADA.

INDIAN NAVY IN WARSHIP DESIGN

Indian Navy, through its Warship Design Bureau (WDB), has been at the forefront of designing naval warships, including aircraft carriers. India's shipbuilding heritage dates back to 2300 BC, coinciding with the nation's dominance over the Indian Ocean. However, the Portuguese invasion at the end of the fifteenth century and British East India Company's arrival in the seventeenth century contributed to the diminishing of India's marine control. The East India Company set up a shipyard for repairing and manufacturing of ships, which was shifted from Surat to Bombay in 1735, now known as Naval Dockyard. After Independence, India's first Chief of Naval Staff, Sir Mark Pizey, floated a ten-year replacement plan for naval ships in 1951 and later formed the Directorate of Naval Construction (DNC) in October 1954,¹⁰³ with Capt L Kirkpatrick as the first DNC. In 1956, Corps of Naval Constructors was set up in 1956¹⁰⁴ and a full-fledged Central Design Office was set up in 1964 to achieve self-sufficiency in warship design.

¹⁰¹ Ibid.

¹⁰² Warship Building, Chapter-1, Report No 32 of 2010-11.

¹⁰³ 'From Drawing Board to Dominating the Ocean: Shaping India's Maritime Destiny', #IndianNavy's Warship Design Bureau, 27 July 2025, <https://www.facebook.com/IndianNavy/videos/from-drawing-board-to-dominating-the-oceans-shaping-indias-maritime-destinyindia/1763387810934385/>, accessed on 7 December 2025.

¹⁰⁴ Cmde KN Vaidyanathan, 'Design and Conduction of Wardships', IDR News, 11 April 2012, <https://indiandefencereview.com/design-and-construction-of-warships/>, accessed on 4 December 2025.

It was renamed as Directorate of Naval Design (DND) in 1970.¹⁰⁵ The DND was rechristened as Warship Design Bureau (WDB) in 2022.¹⁰⁶

Human Resource for Warship/Submarine Design. The Indian Navy has a Naval Architect branch that specialises in warship and submarine construction. It is involved in the design, quality control, repair and construction of naval vessels. BE/BTech graduates in Mechanical (with Automation), Civil, Aeronautical, Aerospace, Metallurgy, Naval Architecture, Ocean and Marine Engineering, Ship Technology, Shipbuilding and Ship Design are inducted into this branch. They undergo a Naval Orientation Course at the Indian Naval Academy, Ezhimala, Kerala. This is followed by professional training at naval training establishments, units or ships. Some officers are selected to pursue post-graduate studies or specialisations.¹⁰⁷ The first non-uniformed naval architect was Padmashri S Paramanandhan and the first uniformed Naval Architect was Cmde VP Garg. As of July 2025, the WDB had 80 IN officers and more than 300 civilian design engineers in July 2025, who play a major role in achieving self-reliance in ship and submarine building, thereby saving billions of dollars in foreign exchange.¹⁰⁸

¹⁰⁵ 'Indian Navy to Host Shipbuilding Seminar – "Nation Building Through Shipbuilding"', PIB Delhi, Ministry of Defence, 22 July 2025, <https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2146753®=3&lang=2>, accessed on 4 December 2025.

¹⁰⁶ Annexure to Compendium of Proceedings, Inaugural Address, Vice Admiral Vinod Pasricha PVSM, AVSM, NM, IN (Retd.), Indian Maritime Foundation Seminar 2022, 15 September 2022, <https://indianmaritimefoundation.org.in/wp-content/uploads/2022/10/IMF-Seminar-Annexure-to-Compendium-SECURED.pdf>, accessed on 4 December 2025.

¹⁰⁷ Naval Constructor, Indian Navy, <https://www.joinindiannavy.gov.in/en/page/naval-architecture-engineering.html>, accessed on 7 December 2025.

¹⁰⁸ 'From Drawing board to Dominating the Ocean, Shaping India's Maritime Destiny', #IndianNavy's Warship Design Bureau, 27 July 2025, <https://www.facebook.com/IndianNavy/videos/from-drawing-board-to-dominating-the-oceans-shaping-indias-maritime-destinyindia/1763387810934385/>, accessed on 7 December 2025.

TRANSFORMATION FROM BUYER TO BUILDER

The Government of India has taken several initiatives in the construction of warships under the Make in India strategy, to which the IN has made significant contributions by taking the lead in warship and submarine design. Some of the measures taken to stimulate warship and submarine building in India and increase the indigenous capability include:

- (a) Strengthening shipyard infrastructure of Defence Public Sector Undertakings (DPSUs);
- (b) Adoption of modular construction to reduce construction timelines and improve interoperability of systems;
- (c) Policy interventions to enhance participation of private shipyards in naval projects;
- (d) Policy interventions for stimulating and supporting indigenisation of imported equipment for warships; and
- (e) Promoting use of AI in shipbuilding.¹⁰⁹

INS Vikrant, India's first indigenous aircraft carrier, was designed by WDB, manufactured by Cochin Shipyard Limited (CSL) and commissioned on 2 September 2022. The aircraft carrier is equipped with MiG-29 K fighter jets, Kamov-31, MH-60R multi-role helicopters and Advanced Light Helicopter (ALH) and is capable of accommodating LCA (Navy).¹¹⁰

INS Vikrant serves as the replacement for India's first aircraft carrier, also named INS Vikrant (R11 with 19,500 tonnes of displacement),

¹⁰⁹ 'Warship under Make in India', Ministry of Defence, 26 June 2019, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1575779®=3&lang=2>, accessed on 7 December 2025.

¹¹⁰ 'The Glorious History of India's Aircraft Carriers', PIB, Govt of India, 6 September 2022, <https://www.pib.gov.in/FeaturesDeatils.aspx?NoteId=151135®=3&lang=2>, accessed on 2 December 2025.

which was purchased from Britain in 1957 and commissioned in 1961. It was equipped with Alize and Seahawk aircraft that played an important role in Goa Liberation Operations in 1961 and India–Pakistan War in 1971. It was modified for the operation of Sea Harrier Vertical/Short Take Off and Land (V/STOL) aircraft and was decommissioned on 31 January 1997.¹¹¹

IN acquired the HMS Hermes aircraft carrier (28,700 tons displacement) on 24 April 1986 and commissioned it as *INS Viraat* on 12 May 1987.¹¹² Then, it acquired the Admiral Gorshkov aircraft carrier, refurbished it in Russia and inducted it into service as *INS Vikramaditya* on 16 November 2013. It was equipped with MiG 29 K fighter aircraft and KA 31 AEW, Sea King and Chetak helicopters.¹¹³

The new *INS Vikrant* is 262.5 meters long with a displacement of approximately 45,000 tonnes. It is equipped with the STOBAR system, which allows aircraft to take off using a ski-jump and land with the help of arrestor wires. The IN played a key role in achieving 76 per cent indigenous components in *INS Vikrant*. Indian shipyards delivered over 40 indigenous warships and submarines to the IN between 2014 and 2025. A total of 133 ships and submarines were built in India by December 2024, and the IN played a key role in the growth of the Indian shipbuilding sector.¹¹⁴

The warship building sector has benefitted significantly from policy interventions and handholding by the IN; however, the scope and extent of involvement of the IN to lead, design and develop naval aircraft, components, sensors and payloads has been limited in comparison to naval shipbuilding.

¹¹¹ Ibid.

¹¹² Ibid.

¹¹³ Ibid.

¹¹⁴ 'INS Vikrant: India's First Indigenous Aircraft Carrier and a Landmark in Naval Capability', PIB Headquarters, Delhi, 24 October 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2182277®=3&lang=2>, accessed on 2 December 2025.

NAVAL AVIATION *ATMANIRBHARTA*: A MISSING LINK

The air arm serves as a sword arm of the IN and currently comprises a fleet of MiG-29K, Hawk 132, Boeing P-8i, Dornier-228, ALH Mk-III, MH-60 R, Sea King 42 B/C, Kamov KA-28, Kamov KA-31, Chetak helicopters and Heron Remotely Piloted Aircraft (RPA), which are divided into 24 squadrons.¹¹⁵ The aviation arm of the IN came into existence with the induction of ten Sealand aircraft in 1953 and has since evolved into a robust force.¹¹⁶ Table 7 presents the History of the evolution of Indian Naval Aviation.

Table 7. History of Evolution of Indian Naval Aviation¹¹⁷

1948	Directorate of Naval Aviation formed
Sea Land Amphibious Aircraft	
Early 1953	Ten Sealand amphibious aircraft inducted
11 May 1953	INS Garuda established at Kochi, signifying commitment of Naval Air Arm & acting as 'alma mater' of naval aviation
1958	Armed Firefly aircraft inducted
1959	Indian Naval Air Squadron (INAS) 550 formed with ten Sealand, Ten Firefly and three HT-2 aircraft

¹¹⁵ 'Indian Naval Air Squadrons', Naval Aviation, Indian Navy, <https://indiannavy.gov.in/indian-naval-squadrons>, accessed on 6 December 2025

¹¹⁶ 'Naval Aviation', Indian Navy, <https://indiannavy.gov.in/naval-aviation>, accessed on 13 December 2025.

¹¹⁷ Doraibabu and Godbole, *Indian Naval Aviation: A Decade of Transformation*, pp. 110–150.

1971 India-Pakistan War	Seahawk and Alize played a key role in the war
November 1976	Five Super Constellation MR aircraft inducted
1978	Seahawk aircraft de-inducted
1980	Kamov 25 helicopter (from Soviet Union) inducted
Sea Harrier	
1983	Sea Harrier inducted Super Constellation aircraft de-inducted
11 May 2016	Sea Harrier aircraft were de-inducted
Dornier-228 (Do-228)	
1983	HAL bought production licence for Dornier 228 (Do-228)
1985	HAL began production of Do-228 in 1985
1989	Five Do-228 procured by IN
1989	Ten Do-228 procured by IN
2005	Eleven Do-228 procured by IN
December 2016	Contract signed for supply of 12 Maritime Reconnaissance Information Warfare (MRIW) Do-228 (supplied by 2020).
Ka-28/ Ka-31/ Sea King 42B	
1986	Kamov 28 inducted in 1986
Late 1980s	Sea King 42B upgraded with improved sensors and anti-shipping strike capability & Sea King 42C inducted
1991	IN inducted SR MR Do-228
2002	Heron and Searcher UAVs for ISR inducted
2003	Kamov 31 inducted

MiG-29 K & KUB (2004-2021)	
2004	Contract for acquisition of 16 MiG-29 K/ KUB (12 single engine and four two-seater aircraft) signed
2009	MiG-29 K inducted
March 2010	Contract signed for 29 more aircraft comprising 12 MiG-29 K and one MiG-29 KUB for Indian Aircraft Carrier-1 and the balance 16 aircraft for INS Vikramaditya
2011	16 aircraft were inducted into the IN
February 2014	MiG-29 deck operations commenced
2021	Last of the contracted MiG-29 received in 2021
P-8I (Based on Boeing 737)	
1 January 2009	Signed deal for procurement of eight P-8I (I for India) ASW, ASuW & ISR missions
May 2013- Nov 2015	Eight P-8i inducted into Maritime Patrol (MP) to replace TU142 M
March 2022	Four more P-8i delivered under option clause
Tu-142M	
April 1988	Eight Tu-142M inducted into service
March 2017	Retired from service
IL-38/ IL-38SD	
After 1971 War	Procurement of IL-38 MR aircraft approved
1977	IL-38 inducted into service
January 2022	First IL-38 SD was decommissioned
Microlight Aircraft Virus SW 80 'GARUD'	
October 2015	Signed contract for procurement of 12 Virus SW 80 'GARUD' Microlight aircraft for new field surveillance & bird activity monitoring

Chetak (Alouette III)	
1962	HAL- Helicopter Division started manufacturing Chetak helicopters in India
1965	First Alouette III delivered in 'fly away' condition
18 August 2017	IN signed contract with HAL for supply of eight Chetak helicopters. All helicopters inducted in 2019-20
MQ-9B Sea Guardian	
2020	IN inducted two Sea Guardians on lease
ALH Mk-3/ Dhruv	
2003	ALH commenced flight testing at INS Garuda, Kochi
2013	First Dhruv Squadron commissioned at INS Garuda, Kochi
2017	IN placed order for 16 ALH Mk-3 with surveillance radar, EO/ IR, NVG Gen III compliant cockpit,
Advanced Jet Trainer (AJT) Hawk	
July 2010	Contract for supply of 17 AJT Hawk Mk132 signed between HAL & IN
6 November 2013	17 Hawk aircraft inducted into INAS 551 IN & 40 Hawk for IAF. It is based at INS Dega, Vishakhapatnam. Hawk is used for basic and advanced aerial weapons training
MH-60R Helicopters	
2020	Placed order for 24 MH-60R Helicopters with Lockheed Martin
6 March 2024	First Squadron INAS 334 formed at Kochi, Kerala
17 December 2025	Second Squadron INAS 335 formed at Goa

The IN has a long history, organisational structure, plan/roadmap and initiatives for self-reliance in ship and submarine building. It created the Naval Innovation and Indigenisation Organisation (NIIO) to leverage innovation and indigenisation potential of Indian start-ups, MSMEs, industry and academia.¹¹⁸ However, the IN does not have corresponding structures for naval aviation design and development of complex and large naval aviation systems, i.e. CBF, Long Range Maritime Reconnaissance (LRMR) aircraft, helicopters, UAVs, critical systems, sub-systems, sensors, payloads, etc.¹¹⁹ The Advanced Light Helicopter (ALH) is the only indigenous aviation platform in its inventory. It does not have a plan, roadmap and focused initiatives for developing indigenous aviation systems on the lines of ship and submarine building.

MINAS/ NAIR. The IN has taken initiatives for the indigenisation of naval aviation sub-systems and components. The first Manual for Indigenisation of Air Stores (MINAS) was released in 2009, covering all aspects of indigenisation process of air stores, including DPM-09. The IN next published the Naval Aviation Indigenisation Roadmap (NAIR) in 2017 for a period covering 2017–2022. A revised NAIR was published for the period 2022–27 on 30 March 2022.¹²⁰ This was updated, and the revised version was released in 2023 by DCNS.¹²¹

¹¹⁸ ‘Sailing Towards Self-Reliance: The Indian Navy’s Aatmanirbhar Bharat Journey’, PIB Delhi, 3 December 2025, <https://www.pib.gov.in/PressNoteDetails.aspx?id=156310&NoteId=156310&ModuleId=3®=3&lang=2>, accessed on 4 December 2025.

¹¹⁹ Ibid.

¹²⁰ Swavlamban 3.0 Indigenisation Plan, Indian Navy, 2024, <https://www.ddpmo.gov.in/sites/default/files/41235140a03694a7eed4d3e2721a5cea70b8520427defe677852c6043e4b75de/8be04e6bdc02d771e69e5eed86f73c2cb6e027e1cd5c2a3b495f925a0b6b1a66.pdf>, accessed on 13 December 2025.

¹²¹ ‘Indian Naval Aviation Industry Engaged Over 100 Industry Partners in its ‘Innovate- Integrate-Indigenise’ Outreach Programme At Kolkata’, *FL360aero*, 11 April 2023, <https://fl360aero.com/detail/indian-naval-aviation-industry-engaged-over-100-industry-partners-in-its-innovate-integrate-indigenise-outreach-programme-at-kolkata/1316>, accessed on 12 December 2025.

Indian Naval Indigenisation Plan (INIP 2015-2030). The IN's naval aviation indigenisation commenced in 2005. The Naval Aviation section of the INIP 2015-2030 was divided into three parts: Micro, Macro and Futuristic. The Micro section was aimed at obsolescence management; Macro section was aimed at reducing dependence on foreign OEMs by manufacturing components of imported equipment; and the Futuristic section was aimed at Major Indigenisation Projects and Buy and Make Projects. The Futuristic section did not include indigenisation design and development project and only proposed both Naval Utility Helicopter (NUH) and Naval Multi Role Helicopter (NMRH) under Buy and Make category. As a whole, the INIP was focused on component and sub-system level indigenisation, and there was no programme for design and development of aviation platform.¹²²

Swavlamban 1.0 to 4.0. The first *Swavlamban* document with the indigenisation plan for the IN was released in August 2020. The responsibility for Indigenisation of Air Projects and Plans rested with Directorate of Air Projects and Plans of the Indian Navy. *Swavlamban* 2.0 was released in October 2023¹²³ and, like INIP, it was divided into three categories: Micro, Macro and Futuristic. The Futuristic section of *Swavlamban* 2.0 mentioned Strategic Partnership Model, Buy (Indian-IDD), Buy and Make (Indian) concepts for NUH and NMRH.¹²⁴

¹²² 'Indian Naval Indigenisation Plan (INIP) 2015-2030', *Bharatshakti*, <https://bharatshakti.in/wp-content/uploads/indian-naval-indigenisation-plan-INIP-2015-2030.pdf>, accessed on 13 December 2025.

¹²³ Major Announcements by Raksha Mantri During the Plenary Session of 'Swavlamban 2.0', Ministry of Defence, 4 October 2023, <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1964272®=3&lang=2>, accessed on 13 December 2025.

¹²⁴ *Swavlamban* 2.0, Indigenisation Plan, Directorate of Indigenisation, Integrated Headquarters, Ministry of Defence (Navy), Indian Navy, https://www.ddpmod.gov.in/sites/default/files/2024-08/swavlamban-2.0_0_0.pdf, accessed on 13 December 2025.

The 2024 Indigenisation Plan under *Swavlamban* 3.0¹²⁵ and *Swavlamban* 4.0¹²⁶ also did not include a plan for the indigenous development of naval aircraft with active participation of naval engineers in aircraft design. The *Swavlamban* documents suggest that future induction in the IN would be largely based on the Strategic Partnership Model, Buy Indian-IDDm, and Buy and Make (Indian) concept such as NUH and NMRH. However, there was no clarity about the IN leading or participating in IDDm project as a development partner for achieving self-reliance at the higher platform level.

Naval Aviation and Indigenisation Challenges. The IN unveiled the *Atmanirbhar* Indian Naval Aviation Technology Roadmap 2047 (AINATR-2047) in February 2025.¹²⁷ This study makes an effort to identify the gaps in the development and induction of indigenous naval aviation platforms in the IN and the need for course corrections. The induction of LCA Mk-1 (Navy) and development of LCA Mk-2 (Navy), TEDBF and N-AMCA have already been deliberated. The other aviation platforms held by the IN and those proposed to be acquired by the IN in the AINATR-2047, are examined to identify potential areas for indigenous development and are deliberated below:

- (a) **Single Engine ALH.** The IN has indigenous ALH Mk-III helicopters equipped with advanced radar and weapon systems for surveillance, transportation, logistics supply and sea rescue

¹²⁵ *Swavlamban* 3.0, Indigenisation Plan, Indian Navy, 2024, <https://www.ddpmod.gov.in/sites/default/files/41235140a03694a7eed4d3e2721a5cea70b8520427defe677852c6043e4b75de/8be04e6bdc02d771e69e5eed86f73c2cb6e027e1cd5c2a3b495f925a0b6b1a66.pdf>, accessed on 13 December 2025.

¹²⁶ *Swavlamban* 4.0, Indigenisation Plan, Indian Navy, 2025, <https://www.ddpmod.gov.in/sites/default/files/3cdfecfa200dda61b854ef640b08a02ba085ac817b5bb7ae2c79b71eb2c54c6/b93f5e2bac9250b4ee7504226d9b7f54532b4c20352fe33a93547c937eb595fe.pdf>, accessed on 13 December 2025.

¹²⁷ *Atmanirbhar* Indian Naval Aviation Technology Roadmap 2047 (AINATR-2047), Indian Navy dated 12 February 2025

¹²⁸ 'Sailing Towards Self-Reliance: The Indian Navy's *Atmanirbhar* Bharat Journey', PIB Delhi, 3 December 2025, <https://www.pib.gov.in/PressNoteDetails.aspx?id=156310&NoteId=156310&ModuleId=3®=3&lang=2>, accessed on 4 December 2025.

missions.¹²⁸ The task of the development of ALH was given to HAL. The project began with HAL collaborating with M/S Aerospatiale of France, then known as Société Nationale Industrielle Aérospatiale (SNIAS), to develop a single engine Advanced Light Helicopter of 2500–3000 Kg category in early 1970s. The Helicopter Design Bureau (HDB) team, under the leadership of Mr S. R. Teleng of HAL, with the support of collaboration partner's design and project experts, prepared a detailed project report for single engine helicopter. The design work for single engine ALH was approved in February 1976 and first mock-up conference was held at Bangalore in April 1977.¹²⁹

- (b) **Twin Engine ALH.** The IAF, after analysing the air power used in the Vietnam War, sought change in the ALH configuration from single engine to twin engine, which was approved by the Indian government in January 1979. The IAF issued revised ASR 2 of 79 (ASR 2/79),¹³⁰ and the IN issued Naval Staff Requirement 12 of 1983 (NSR 12/83). The representatives of the defence services, including the IN, were involved in the negotiations on the development of technologies and configuration.

The MoD signed collaboration agreement with the Messerschmitt Bolkow Blohm (MBB) of West Germany for the development of six ALH in July 1984,¹³¹ and HAL was assigned to execute this

¹²⁸ Wg Cdr CD Uppahdyay, VrC, rotary test pilot who was involved in ALH development testing since its inception in early 1970s, in his draft article titled, Taming the Tides: The 30 Year Legacy. And Engineering Evolution of the Naval Dhruv, shared with author on 24 January 2026.

¹³⁰ Production and Supply of Advanced Light Helicopter, Hindustan Aeronautics Limited, Ministry Defence, Report No 10 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Commercial_Activities_Public_Sector_Undertakings_10_2010_chapter_3.pdf, accessed on 26 January 2026. p22.

¹³¹ Production and Supply of Advanced Light Helicopter, Hindustan Aeronautics Limited, Ministry Defence, Report No 10 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Commercial_Activities_Public_Sector_Undertakings_10_2010_chapter_3.pdf, accessed on 26 January 2026. p22.

agreement in August 1984. The development of specific role variants of ALH was taken up by the HAL Research and Development (R&D) centre. Subsequently, TM-333B engine of Turbomeca, France, was selected to power ALH, and two agreements on the licence production and purchase agreements were concluded with Turbomeca and assigned to HAL in September 1986. The first MBB team arrived in India in November 1984, and later some Indian engineers were sent for implant training at MBB facilities in West Germany. The ASR/NSR requirements to have four main rotor blades with elastomeric bearing and large offset to match the Integrated Dynamic System (IDS) and Main Gear Box (MGB) developed by MBB was a tall order. The technical consultancy ceased with MBB in 1995,¹³² even though certain systems were yet to be developed, validated and integrated after four prototypes of ALH were built.¹³³

- (c) **Skid and Wheeled ALH.** The HAL independently continued with the further development of ALH thereafter. The ALH, till this stage, was in wheeled configuration, and the IAF and IA decided to go for skid variant, which required redesign. It was decided to build five more ALH. The development of the IAF/IA (PTA-Skid) and IN (PTN-with retractable wheels) variants was taken up, which was to be followed up with the development of Civil (PTC) variant of ALH. A total of 1,420 hours of prototype testing was planned to achieve military certification. The PT-1 first flew on 20 August 1992, PT-2 on 8 April 1993 and PTA on 28

¹³² Production and Supply of Advanced Light Helicopter, Hindustan Aeronautics Limited, Ministry Defence, Report No 10 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Commercial_Activities_Public_Sector_Undertakings_10_2010_chapter_3.pdf, accessed on 26 January 2026. p22.

¹³³ Wg Cdr CD Upadhyay, VrC, rotary test pilot who was involved in ALH development testing since its inception in early 1970s, in his draft article titled, 'Taming the Tides: The 30 Year Legacy And Engineering Evolution of the Naval Dhruv', shared with author on 24 January 2026.

December 1994.¹³⁴ The five prototypes of ALH were certified in 2003.¹³⁵

- (d) **Naval ALH and the US Sanctions.** The IAF, IN and IA variants of ALH progressed in parallel with the consent of all the users. The development of ALH with a capability to land at 6 Km with useful payload for the IA and IAF, and ALH that hovered efficiently for the IN was challenging due to contradictory requirements for the blade designers. The naval ALH Prototype Navy (PTN) flew the first flight with a different engine (LHTEC T-800) on 26 December 1995, and the engine of PTN had to be changed to TM-333 after 250 hours due to the US sanctions in 1998.

A Naval Project Team (NPT) was positioned in RWR&DC. Thereafter, the ALH (PTN) and ALH Mk-III (Marine) systematic transformation from a land variant into a sea-borne platform involved overcoming ground resonance challenges, flotation gear inflation and flight handling, corrosion testing, ship deck trials in pitching and rolling conditions (March 1998), sonar dunking and torpedo firing (2001–02), segmented blade folding, limit load trials, etc. (Figure-7). These trials had proven the ability of the ALH as a utility and weaponised helicopter that is going to be useful for the development of Indian Multi Role Helicopter (IMRH) into a ship-borne naval helicopter.¹³⁶

¹³⁴ Ibid.

¹³⁵ ‘Production and Supply of Advanced Light Helicopter’, Hindustan Aeronautics Limited, Ministry Defence, Report No 10 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Commercial_Activities_Public_Sector_Undertakings_10_2010_chapter_3.pdf, accessed on 26 January 2026. p22.

¹³⁶ Wg Cdr CD Uppahdyay, VrC, rotary test pilot who was involved in ALH development testing since its inception in early 1970s, in his draft article titled, ‘Taming the Tides: The 30 Year Legacy and Engineering Evolution of the Naval Dhruv’, shared with author on 24 January 2026.

Figure 7. Advanced Light Helicopter (ALH), Dhruv Naval Variant¹³⁷



- (e) **Non-Freezing of ALH QRs.** Wing Commander CD Upadhyay observed that the HAL had invested significant time and resources towards the design, development, testing and certification of the naval variant of ALH to accommodate requirements of the IN. On the other hand, the CAG report of 2010 made an observation that the HAL, by not freezing the configuration, had to accommodate increasing demands of the customers for latest and additional requirements that comprised 363 modifications in 34 helicopters out of 74 supplied to the defence forces by 2010.¹³⁸ The meeting of diverse requirements of the IAF, IA and IN was

¹³⁷ 'HAL_Dhruv_of_Indian_Navy', Wiki commons, <http://www.indiannavy.nic.in/naval-fleet/aircraft?page=0%2C5>, accessed on 15 January 2026

¹³⁸ Production and Supply of Advanced Light Helicopter, Hindustan Aeronautics Limited, Ministry Defence, Report No 10 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Commerical_Activities_Public_Sector_Undertakings_10_2010_chapter_3.pdf, accessed on 26 January 2026. p22

not easy; and utmost endeavours were made towards meeting the requirements of the sea-borne helicopter of the IN.¹³⁹

- (f) **DBMRH.** HAL is developing 13 ton class Indian Multi-Role Helicopter (IMRH) for the IAF and IA (Figure-8), and 12.5 ton class Deck-Based Multi-Role Helicopter (DBMRH) for IN with blade folding for ship deck operations. The configuration studies of DBMRH was expected to complete in early 2026.¹⁴⁰ Three variants of DBMRH viz., Anti Submarine Warfare and Anti Ship Warfare (ASW), Air Early Warning and Special Operations are planned to be developed.¹⁴¹ The DBMRH would be developed by HAL with its own funding and IN can participate as a development partner to fill the gaps and expedite its development.

Figure-8: Indian Multi Role Helicopter (IMRH)¹⁴²



¹³⁹ Wg Cdr CD Uppahdyay, VrC, rotary test pilot who was involved in ALH development testing since its inception in early 1970s, in his draft article titled, 'Taming the Tides: The 30 Year Legacy and Engineering Evolution of the Naval Dhruv', shared with author on 24 January 2026.

¹⁴⁰ IMRH, HAL, <https://hal-india.co.in/research-development-details/imrh>, accessed on 12 January 2026.

¹⁴¹ *Atmanirbhar* Indian Naval Aviation Technology Roadmap 2047 (AINATR-2047), Indian Navy dated 12 February 2025

¹⁴² Indian Multi Role Helicopter (IMRH), Hindustan Aeronautics Limited,, <https://hal-india.co.in/research-development-details/imrh>, accessed on 7 February 2026.

- (g) **MH-60R.** India placed an order for 24 MH-60R Seahawk helicopters from Lockheed Martin Corporation under the Foreign Military Sale (FMS) programme of the US Government in February 2020.¹⁴³ The deal was valued at US\$ 2.6 billion (approximately Rs 14,000 crore).¹⁴⁴ The IN received the first two MH-60R Multi Role Helicopters from the US Navy at North Island, San Diego, on 16 July 2021.¹⁴⁵ It commissioned the first MH-60R in the Indian Naval Air Squadron 334 (INAS 334) in Kochi, Kerala, on 6 March 2024. ‘The Ospreys’, the Indian Naval Air Squadron-335 (INAS 335) based in Goa, was the second squadron to be equipped with MH-60R helicopters on 17 December 2025.¹⁴⁶ The MoD signed a Letter of Offer and Acceptance (LOA) with the US Government for the sustained support of Indian Navy’s fleet of MH-60R helicopters, covering follow-on support and follow-on supply support for a period of five years, at an approximate value of Rs 7,995 crore.¹⁴⁷

¹⁴³ ‘MH 60R “Seahawks” to be Commissioned into the Indian Navy as the Inas 334 Squadron’, Ministry of Defence, 3 March 2024, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2011073®=3&lang=2>, accessed on 19 December 2025.

¹⁴⁴ ‘US Approves Sale of 24 MH-60R Seahawk Helicopters to India for USD 2.6 Billion’, *Business Standard*, 3 April 2019, https://www.business-standard.com/article/pti-stories/us-approves-sale-of-24-mh-60r-seahawk-helicopters-to-india-for-usd-2-6-billion-119040300386_1.html, accessed on 19 December 2025.

¹⁴⁵ ‘Indian Navy Accepts First Batch of Two MH-60R Multi Role Helicopters (MRH)’, Ministry of Defence, 17 July 2021, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1736365®=3&lang=2>, accessed on 19 July 2025.

¹⁴⁶ ‘Indian Navy Commissions Second MH-60R Helicopter Squadron INAS 335 at INH Hansa in Goa’, Ministry of Defence, 17 December 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2205487®=3&lang=2>, accessed on 19 December 2025.

¹⁴⁷ ‘MoD Inks Letters of Offer & Acceptance with US for Sustainment Support of Indian Navy’s Fleet of MH60R Helicopters through Follow on Support and Follow on Supply Support worth approximately Rs 7,995 crore’, Ministry of Defence, 28 November 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2195822®=3&lang=2>, accessed on 19 December 2025.

- (h) **P-8i LRMR Aircraft.** The IN acquired US P-8i LRMR aircraft and inducted it into the INAS 312 Naval Air Squadron.¹⁴⁸
- (i) **Medium Range Maritime Reconnaissance (MRMR) Aircraft.** IN is planning to induct C-295 MRMR aircraft to be developed by CABS, DRDO.¹⁴⁹
- (j) **Short Range Maritime Reconnaissance (SRMR) Aircraft.** IN operates HAL built Dornier-228 SRMR aircraft.¹⁵⁰
- (k) **AEW, AAR & Amphibious Aircraft.** IN plans to induct carrier borne Airborne Early Warning and Control (AEW&C), Air to Air Refueller (AAR) and Amphibious aircraft. It does not have a plan for the development of above aircraft as well as indigenous LRMR or AEW aircraft. The IAF, on the other hand, has taken for the first step and collaborated with CABS to develop Netra-1 AEW aircraft on Embraer-145 aircraft (Figure-9) and Netra-2 AEW&C system on A-330 aircraft.¹⁵¹ However, there is no collaboration between IN and CABS to develop an LRMR or AEW&C variant. Therefore, IN can leverage the expertise available in-house to build Indian LRMR and later AWE&C aircraft.

¹⁴⁸ INAS 312, Naval Air Squadron, <https://indiannavy.gov.in/indian-naval-squadrons>, accessed on 13 December 2025.

¹⁴⁹ *Atmanirbhar* Indian Naval Aviation Technology Roadmap-2047 (AINATR-2047), Indian Navy dated 12 February 2025

¹⁵⁰ Ibid.

¹⁵¹ NETRA, Defence Research and Development Organisation, <https://www.drdo.gov.in/drdo/en/offerings/products/netra>, accessed on 13 December 2025.

Figure 9. Netra AEW aircraft of the IAF¹⁵²

- ① **Kiran, Hawk Mk-132 and LCA (Navy).** In September 1957, the IN established the Naval Jet Flight at Sullur, Tamil Nadu, with four Vampire aircraft to train naval pilots in tactical flying and air combat on the Vampire before they transitioned to Seahawks. It has served as a feeder squadron to naval aviation and was reconstituted as INAS 559A in June 1959 and as INAS 551 on 5 September 1961. Indigenous Kiran Mk-I and Mk-II jet trainer aircraft were inducted in 1986. In 1990, INAS 551 was bifurcated into two flights, with INAS 551 A operating Kiran trainer aircraft and INAS 551 B operating Sea Harrier fighter aircraft, for conversion training of naval pilots before they join INAS 300.¹⁵³ This squadron conducts naval orientation courses for pilots before they progressed to Sea Harrier (in the past) and MiG-29K aircraft. It also conducts Pre-Qualified Flying Instructor's Course training for the Navy and the Coast Guard.¹⁵⁴ The squadron, equipped

¹⁵² Venkat Mangudi, KW3555 AWACS IAF, 16 February 2017, CC BY-SA 2.0 <<https://creativecommons.org/licenses/by-sa/2.0/>>, via Wikimedia Commons, downloaded on 15 January 2026

¹⁵³ 'Vanguard of the Skies and the Seas: INAS 300', Maritime History Society, <https://mhsindia.org/all/vanguard-of-the-skies-and-the-seas-inas-300/210107/>, accessed on 13 December 2025.

¹⁵⁴ Hawk Mk 132, Naval Aviation, Indian Navy, <https://indiannavy.gov.in/content/hawk-mk-132-0>, accessed on 13 December 2025.

with Kiran and Hawk aircraft, continues to train budding naval fighter pilots.

(m) **MQ-9B, Drishti-10 and TAPAS/ Archer-NG MALE UAV.**

India signed a deal for the acquisition of 31 MQ-9B UAVs, out of which 15 Sea Guardian UAVs were meant for MR requirements of the IN and eight Sky Guardian UAVs each are meant for Intelligence Surveillance and Reconnaissance (ISR) roles of the Indian Army (IA) and IAF.¹⁵⁵ The deal was worth US\$ 3 billion (Rs 32,000 crore).¹⁵⁶ The AINATR-2047 describes Drishti-10 MALE RPA supplied by M/S Adani Defence Systems and Technologies Limited (M/S ADSTL) as the indigenously built RPA, however, whether critical systems of Drishti-10 were manufactured in India, needs to be validated. Also, whether Indian entities can modify and upgrade such systems without the approval of the FOEMs. In addition, does the Indian entity have a plan with timelines and milestone for the development of indigenous variants? This approach is essential to leverage collaborations for capability building in critical technologies as well as identify Indian companies who create IPR and contribute meaningfully to *atmanirbharta*.¹⁵⁷ Therefore, a mechanism is needed for validating indigenously manufactured systems in terms of components, materials and software by Indian public and private sector entities in collaboration with FOEMs. Also, the IN, like the IAF and IA, has not been able to leverage the capabilities of indigenous TAPAS and Archer-NG

¹⁵⁵ 'India, US Sign Deal Worth Rs 32,000 Crore for Buying 31 MQ-9B Drones', DD News, 15 October 2024, <https://ddnews.gov.in/en/india-us-sign-deal-worth-rs-32000-crore-for-buying-31-mq-9b-drones/>, accessed on 13 December 2025.

¹⁵⁶ Oishee Majumdar, 'India Signs Contract to Procure MQ-9B', *Janes*, 15 October 2025, <https://www.janes.com/osint-insights/defence-news/air/india-signs-contract-to-procure-mq-9bs>, accessed on 20 December 2025.

¹⁵⁷ *Atmanirbhar Indian Naval Aviation Technology Roadmap-2047 (AINATR-2047)*, Indian Navy dated 12 February 2025

¹⁵⁸ 'Aero India 2023 from Made-in-India Tapas UAV's Lens', *ANI News*, 2023, <https://www.youtube.com/watch?v=CceeEkLF9qU>, accessed on 13 December 2025.

MALE UAVs. TAPAS has demonstrated 18 hours of endurance and operations up to 27,000 feet altitude, including live coverage of aerobatics display during the Aero India 2023;¹⁵⁸ however, it could not achieve the desired parameters of 24 hours endurance and 30,000 feet maximum altitude (see Figure 10). Archer-NG, an armed MALE UAV, is under development. Simultaneously, Indian private sector companies are exploring the feasibility of manufacturing MALE UAVs through JVs with global OEMs. However, whether they would have control over the IPR and which of the critical components like the engine, hydraulics, engine oil, GCS, software, data link, sensors and payloads, would be made in India. The indigenisation of critical systems, control over IPR and ability to modify, upgrade and develop future variants remain critical vulnerabilities for India.

Figure 10. Rustom-2 or TAPAS MALE UAV¹⁵⁹



¹⁵⁹ Rustom_flight_2_(cropped), Government of India, 16 November 2016, https://twitter.com/DRDO_India/status/798863779874410496, accessed on 15 January 2026

- (n) **Ghatak and SWIFT.** Ghatak, an indigenous flying wing stealth Unmanned Combat Aerial Vehicle (UCAV) has been under development. The SWIFT (see Figure 11), a scaled-down variant of Ghatak, has demonstrated its ability to fly a flying wing design jet engine UAV. SWIFT has also demonstrated its Automatic Take Off and Landing capability. The approval of Ghatak's full-fledged development is pending. Also, there is no plan to develop a naval variant of Ghatak or SWIFT as of now.

Figure 11. Stealth Wing Flying Testbed (SWIFT)¹⁶⁰



- (o) **Light Utility Helicopter (LUH).** IN has been operating French Alouette-III (called Chetak in India), which is a three ton class single engine helicopter. HAL developed a single engine Light Utility Helicopter (LUH) as a replacement of Chetak/ Cheetah helicopters. LUH is a single engine three ton weight category helicopter. The folding mechanism was developed for LUH to meet the ship borne operations requirements (Figure 12).¹⁶¹ However, it has not

¹⁶⁰ LUH at AeroIndia 2925), Government of India, 8 February 2025, <https://pib.gov.in/ShowAlbum.aspx?albumid=188821>, via Wikimedia Commons, downloaded on 13 January 2026

¹⁶¹ 'Air Mshl Anil Chopra, HAL Light Utility Helicopter All Set for Induction: A Big Milestone for Military Self-reliance', *First Post*, 19 February 2025, <https://www.firstpost.com/opinion/hal-light-utility-helicopter-all-set-for-induction-a-big-milestone-for-military-self-reliance-13864755.html>, accessed on 11 January 2026.

been accepted by IN as it did not meet the requirement of a twin engine helicopter, which was aimed at addressing the safety concerns associated with single engine helicopter operations. However, IN has been operating Chetak helicopters for more than five decades and their safety record has been as good as twin engine helicopters.¹⁶²

Figure 12. LUH at Aero India 2025¹⁶³



- (p) **Utility Helicopter Maritime (UHM).** The AINATR 2047 describes Utility Helicopter Maritime (UHM) as a smaller and more manoeuvrable air transportation cargo carrying, medical evacuation, search and rescue and reconnaissance helicopter, being developed by the HAL. The twin engine ALH and single engine LUH could fall in this category, however; AINATR 2047 indicates

¹⁶² Mayank Singh, 'HAL's UH-M Chopper On Course for Induction into Indian Navy', *The New Indian Express*, 10 January 2026, <https://www.newindianexpress.com/nation/2026/Jan/10/hals-uh-m-chopper-on-course-for-induction-into-indian-navy>, accessed on 11 January 2026

¹⁶³ LUH at AeroIndia 2025, Government of India, 8 February 2025, <https://pib.gov.in/ShowAlbum.aspx?albumid=188821>, via Wikimedia Commons, downloaded on 13 January 2026

that IN is also exploring options for acquisition of UHM from foreign OEMs to design and develop these helicopters either independently or through joint ventures. The dual track approach of AINATR 2047 on acquisition of indigenous UHM developed by HAL or through foreign OEMs indicates lack of involvement of the IN as the development partner, which is unlike its *atmanirbharta* endeavours in shipbuilding.¹⁶⁴

The IN has made significant contributions to ship and submarine building, which has raised expectations in achieving and even surpassing its contribution to self-reliance in naval aviation. Therefore, the following issues need attention:

- (a) Can LCA (Navy) twin seat variant with Generation four plus features, take on the task of training budding naval fighter pilots on aerial armament, combat and carrier flying training? Can't the LCA (Navy) be upgraded with desired features of LCA Mk-1A for air defence and advanced combat training roles?
- (b) Can the IN take the lead in creating an indigenous UAV roadmap by leveraging the existing indigenous capabilities of Indian public and private sector industry as well as exploring viability in the modification and upgradation of TAPAS and Archer-NG to develop and induct indigenous MALE UAV for naval operations? Will the IN steer and guide indigenous development and manufacturing of critical systems in India by Indian entities?
- (c) Can the IN become a partner in Ghatak and Swift, involve its engineers and become partner / co-owner of the project as it has been doing in naval ship and submarine building?.
- (d) Can the IN partner with CABS to develop indigenous LRMR aircraft similar to Netra Mk-2 being developed by IAF?

¹⁶⁴ *Atmanirbhar* Indian Naval Aviation Technology Roadmap 2047 (AINATR-2047), Indian Navy dated 12 February 2025, p.28

The need for re-orientation of IN's approach to self-reliance and integration of diverse systems, including those acquired from different OEMs has been highlighted by domain experts, which results in the sub-optimal utilisation of naval aviation assets.¹⁶⁵ There is a need for better integration of ASW and Intelligence Surveillance and Reconnaissance (ISR) and naval combat assets and development of indigenous aviation systems to increase the strength of aviation assets.

Need for Aviation Self-Reliance Audits. The Comptroller and Auditor General (CAG) Report No.7 of 2010-11 made certain observations that indicate gaps in planning and induction of aviation systems by the IN. The statement in the CAG report, 'While encouragement and support to the indigenous effort should be continued and limitations, if any, of such effort should be clearly recognised and should not be at the cost of operational preparedness', indicates that the audit criteria was on the force levels, acquisition, upgradation, modernisation, training and MRO. The report dwelled extensively on operational and maintenance aspects, including gaps and challenges of existing equipment, organisational structures, planning, serviceability, flying tasks, accidents, incidents, etc.¹⁶⁶ Therefore, the focus of the audit was predominantly on the operational preparedness and not on self-reliance in naval aviation.

The development of an integrated sonar systems project, at a cost of Rs 11.99 crore, became infructuous due to the non-availability of a platform for trials. Its non-induction by IN due to obsolescence indicates the need for audit of high-technology equipment by techno-finance experts to identify specific challenges and institute course corrections to overcome them.¹⁶⁷ While the 2010 CAG Audit Report made observations regarding the delays in the development and poor track

¹⁶⁵ R Adm Sudhir Pillai (Retd.), 'Reach is Power', Force, 16 December 2025, <https://forceindia.net/blog/reach-is-power>, accessed on 16 December 2025.

¹⁶⁶ CAG Report No 7 of 2010-11, https://cag.gov.in/uploads/download_audit_report/2010/Union_Performance_Defence_Union_Government_Air_Force_and_Navy_7_2010_chapter_2.pdf, accessed on 6 December 2025.

¹⁶⁷ Ibid.

record of HAL, it did not identify the causes of such delays, which could have provided a better understanding and helped in instituting corrective measures. Also, while the report highlighted challenges faced by all aircraft in IN's inventory, it made no mention of the progress or challenges in LCA MK-1 (Navy) programme being developed by ADA. The delays and challenges confronting the indigenous naval aircraft development programmes require thorough audits by technical experts, accompanied by in-depth analysis, to enable the implementation of corrective measures to stimulate self-reliance in naval aviation.

Concessions/Exceptions for Foreign Systems/OEMs. There are cases in which concessions have been granted to platforms, equipment and systems developed by foreign OEMs, while similar concessions were not extended to indigenously designed platforms, equipment and systems. The FOEMs have been accorded exceptions for delays, indigenous content, testing, certification, technological vintage, MRO and other essential and desirable performance and technical compliances sought from indigenous manufacturers. A few of the examples are covered next.

- (a) **UH-3H as a Substitute for ALH.** The IN acquired six UH-3H along with training and support facilities at an approximate cost of 182.14 crore as an integral part of the Landing Platform Deck (LPD) under the US Foreign Military Supply (FMS) programme in November 2006. These helicopters were inducted into the IN as interim solution for the onboarding of helicopters on INS Jalashwa pending acceptance of indigenous ALH for deck operations. The UH-3H was inducted despite having been manufactured in or before 1965, decommissioned in 2005 and extending their airframe life. Also, only two helicopters were subjected to the minimum strip conditions for inspection, and flight evaluation of all six helicopters was not carried out before acceptance by the IN. These helicopters were bought 'as is where is' condition without weather / surface surveillance radars, with many defects, including Category A, and no support for defective and obsolete rotables.¹⁶⁸ The 2017 CAG report observed that the

¹⁶⁸ Ibid.

UH-3H helicopters fleet was unable to maintain the desired level of serviceability in six out of seven years of operations since commissioning despite reduction in Unit establishment of helicopters from four to three. There was unwarranted dependence on foreign agency for maintenance support and repairs due to lack of training of naval technicians. The deck-based flying remained significantly low, ranging from 2.7 to 34 per cent of total day flying, and zero to 52.08 per cent of the total night flying due to non-availability of depot-level servicing facility and spares.¹⁶⁹

- (b) **MiG-29.** A contract was signed for the acquisition of MiG-29 CBF along with a refitted aircraft carrier (earlier known as Admiral Gorshkov) that were to be delivered by 2007–08. The delay in supply of MiG-29 was accepted and concessions were granted for the induction of MiG-29 CBF, even though these aircraft had not yet received certification from Russian certification agencies.¹⁷⁰
- (c) **Seaking 42-B Recovery.** IN gave the contract to FOEM, M/S Westland Helicopters, UK, on a turnkey basis to recover/repair seven Seaking 42-B helicopters at a total cost of Rs 256 crore despite possessing in-house capability to undertake repair at the Naval Aircraft Yard (NAY), Kochi.¹⁷¹
- (d) **Seaking 42-B Repair and Overhaul Facility.** Limited facilities were set up for repair and overhaul facilities proposed for Seaking 42-A and Seaking 42-B helicopters at NAY Kochi and HAL Bangalore. These did not include facilities for overhaul, which became a limitation when US imposed sanctions following the

¹⁶⁹ Report No 20 of 2017, Report of Comptroller and Auditor General of India for the year ended March 2016, Union Government (Defence Services) Navy and Coast Guard, https://cag.gov.in/webroot/uploads/download_audit_report/2017/Report_No_20_of_2017_Comptroller_and_Auditor_General_Defence_Services_Navy_and_Coast_Guard.pdf accessed on 17 January 2025.

¹⁷⁰ Ibid.

¹⁷¹ Ibid.

Pokhran nuclear test in 1998. The transmission system overhaul facility was approved in 2002 and commissioned in 2004. The defence forces' approach of being full dependent on OEMs has created challenges during periods of adverse relations.¹⁷²

Self-Reliance Roadmap. The IN has been using imported aviation platforms. Its vision document '*Atmanirbhar* Indian Naval Aviation - Technological Roadmap 2047' was touted as a credible pathway towards realising the vision of *Atmanirbhar* Bharat. It is meant to be a guiding document for R&D institutions, DPSUs, industry partners, MSMEs, start-ups and academia to attain the vision of *Atmanirbhar* Bharat for naval aviation by 2047.¹⁷³ It also conducted a seminar 'Transition to *Atmanirbhar* Indian Naval Aviation - 2047 and its Associated Ecosystem' on 12 February 2025.¹⁷⁴

As regards to indigenous naval aircraft development programmes, the IN does not have a roadmap for the systematic indigenous design, development and manufacturing of aviation platforms such as fighter, maritime reconnaissance aircraft, helicopters and UAVs on the lines of ship and submarine building. The lack of roadmap for *atmanirbharta* in naval aircraft adds to the incoherence and inconsistency in self-reliance in naval aviation. Cmde Balaji observes that the IN urgently needs a roadmap for self-reliance in naval aviation at the broader level. The naval aviation self-reliance roadmap is currently at the sub-system/component level and it needs to expand to 'system level indigenisation and complete design' with the ownership of the IN akin to shipbuilding design programmes.¹⁷⁵

¹⁷² Ibid.

¹⁷³ Transition to *Atmanirbhar* Indian Naval Aviation-2047, Indian Navy, <https://indiannavy.gov.in/content/transition-aatmanirbhar-indian-naval-aviation-2047>, accessed on 12 December 2025.

¹⁷⁴ 'Indian Naval Aviation Marching Towards "*Atmanirbharta*"', Aero India 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2101182®=3&lang=2>, accessed on

¹⁷⁵ Cmde CD Balaji (Retd.) former project director of LCA Mk-1 (Navy), Director of Aeronautical Development Agency (ADA) in reply to the author question on 2 December 2025.

Aero-Engine Challenge. The scaling up of production and export of indigenous land fighter and CBF in the global market are likely to be constrained by the non-availability of indigenous aero-engines. The inordinate delay in the supply of GE 404 engines for LCA Mk-1 between since 2023, and USA imposing 50 per cent tax on India in 2025 created apprehensions about scaling up production of LCA Mk-1 to fill the depleted fighter fleet of the IAF. The export potential of LCA Mk-1/1A could remain challenging due to perceived vulnerabilities in critical supply chains. It also raises concerns about the reliability of supply chains, maintenance and spare parts support during contingencies.¹⁷⁶

The delay in the supply of the GE-404 engine for almost three years (since 2023) and suspense over future of this deal should ideally have led to reemphasis on reviving, improving and expediting development of the indigenous aero-engine (i.e. Kaveri) with the support of all stakeholders, especially the private sector. However, launching of such initiative for the upgradation/modification of the Kaveri engine to mitigate potential disruption and delays in the supply of the GE-404 engine is awaited. This could have expedited the development and integration of an afterburner variant of the Kaveri engine with LCA Mk-1/ Mk-1A.

The afterburner Kaveri engine had achieved 72 kN thrust against the requirement of 80 kN. The non-afterburner Kaveri engine, i.e. Kaveri Derivative Engine (KDE), is being developed as a power plant for the Ghatak UCAV; however, this engine, without the afterburner, cannot be used in LCA in its current form unless the challenges related to the afterburner section are addressed.¹⁷⁷ Therefore, there is a need to launch

¹⁷⁶ Shivani Sharma, 'Tejas Mk1A hit by GE Engine Delays, First Delivery to Air Force Pushed to 2026'. *India Today*, 11 December 2025, <https://www.indiatoday.in/india/story/tejas-mk1a-hit-by-ge-engine-delays-first-delivery-to-air-force-pushed-to-2026-2834611-2025-12-11>, accessed on 18 January 2026.

¹⁷⁷ Sanjib Kumar Baruah, 'The Kaveri Programme has Moved on to Stealth From Jet', *The Week*, 14 September 2025, <https://www.indiatoday.in/india/story/tejas-mk1a-hit-by-ge-engine-delays-first-delivery-to-air-force-pushed-to-2026-2834611-2025-12-11>, accessed on 18 January 2026.

the Kaveri engine upgradation programme at the earliest to fill this critical technology and capability gap. This will not only ensure our current requirements are met but also increase its export potential.

Need for Aviation Design Vertical. The IN's aviation technical officers are deputed to premier institutions such as the Indian Institute of Sciences (IISc) and Indian Institute of Technology (IIT) to pursue post-graduation or Master's degree in Technology (M Tech). However, the choice of specialisation is left to the officer's discretion. While higher technical qualifications facilitate participation in aircraft design, there is no specific intent of these courses to develop an aircraft design background. The naval aircraft have specific design requirements and the indigenous development of these platforms requires engineers with specialisation in aviation design and a dedicated design vertical to lead, steer and support self-reliance in naval aviation.

Cmde Balaji observes that IN needs to develop a DNA of aviation design and development, rather than being limited to 'operators and maintainers'. There is a merit in having a separate Naval Aircraft Design group to meet the goals of aircraft design and development, aircraft carrier interface, better understanding of operations and maintenance, Ground Support Equipment (GSE)/ Ground Handling Equipment (GHE) development, etc.¹⁷⁸

¹⁷⁸ Cmde CD Balaji (Retd.), former project director of LCA Mk-1 (Navy), Director of Aeronautical Development Agency (ADA), in reply to the author question on 2 December 2025.

CHALLENGES TO *ATMANIRBHARTA*

The Indian naval aviation self-reliance trajectory is less ambitious as its focus is limited to the indigenisation of sub-systems and components, and not on aviation platforms and critical systems. The lack of a holistic platform- and systems-level plan and roadmap has already been deliberated. The absence of an aviation design group adds to self-reliance challenges in naval aviation. In addition, indigenous aviation development projects are also impacted by other factors, such as import or licence manufacturing of similar platforms and system, inactions, indecisions, delayed decisions, delays in procurement, procurement in smaller numbers and absence of follow-on orders.

IMPACT OF IMPORT AND LICENCE MANUFACTURING

The import and licence manufacturing of foreign-origin aircraft often have an adverse impact on the corresponding indigenous design and development programmes due to limitations of funding, reduction in the requirement of CBF, reduced cost-competitiveness and challenges in providing maintenance support to small number of indigenous aircraft during the thirty- to forty-year-long lifespan. IN's decision to acquire the Rafale-M in 2025 reduced the requirement for an indigenous CBF, affecting its economic viability and increasing supply chain challenges. This, in turn, weakens the case for pursuing a separate programme for the development of an indigenous CBF. There are concerns that this could result in justifying a case for licence manufacturing of Rafale-M, thereby contributing to the possible closure of the indigenous CBF development programme.¹⁷⁹

¹⁷⁹ @JA_Maolankar, on X, 1 November 2024, 9:02 PM, https://x.com/JA_Maolankar/status/1852373065633550484, accessed on 17 August 2025.

A close examination of a number of aeronautics licence manufacturing projects undertaken by India since Independence indicates that licence manufacturing by itself does not lead to self-reliance. The licence manufacturing of different variants of MiG-21 in the six decades of its service life between 1963 and 2025 did not make India self-reliant and it had to launch LCA programme to pursue its self-reliance trajectory.

Therefore, licence manufacturing is not desirable when indigenous fighter naval aircraft development programme has made significant progress, as it does not provide strategic independence. Therefore, an indigenous naval fighter programme needs to be pursued by launching the follow-on CBF development programme.

US SANCTIONS ON NAVAL ALH, AND DELAYS IN LCA AND HTT-40 AERO-ENGINES

The denial of aero-engine by the United Kingdom (UK) and India's inability to continue with its indigenous engine development program were the main reasons for the failure of India's first indigenous HF-24 (Marut) fighter aircraft development program during the 1960s and 1970s.¹⁸⁰

India is facing delays in the supply of GE-404-IN20 engines for LCA Mk-1A by the General Electric and TPE331-12B turboprop engines for HTT-40 by the Honeywell Technologies of the USA.¹⁸¹ The delay

¹⁸⁰ Sebastien Roblin 'The Story of India's Disappointing Marut Jet Fighter, The National Interest, 19 December 2020, <https://nationalinterest.org/blog/reboot/story-indias-disappointing-marut-jet-fighter-174732>, accessed on 18 February 2026.

¹⁸¹ 'Fresh Worry for Indian Air Force: Engine Supply Woes Force HAL to Cut LCA Mk-1A, HTT-40 Delivery Targets for FY26, Says Report', Moneycontrol, 12 December 2025, <https://www.moneycontrol.com/news/india/fresh-worry-for-indian-air-force-engine-supply-woes-force-hal-to-cut-lca-mk-1a-htt-40-delivery-targets-for-fy26-says-report-13722641.html>, accessed on 1 February 2026.

in supply of GE-404 aero-engine for LCA Mk-1/ 1A is not the first instance when the US has banned, curtailed or delayed the supply of aero-engines to India. The ALH powered by the LHTEC T800 engine undertook its first flight on 26 December 1995, and it had conducted 250 hours of prototype testing before technical support was withdrawn in 1998. A full flight envelope testing of ALH was carried out, which included validating airframe limits and developing specific flight control laws for the unique demands of maritime operations and ship deck trials on INS Ganga at maximum wind from all directions at Maximum All-Up Weight (AUW) in sea state two.

The US had withdrawn engineers and technical support for LHTEC T800 engine that was fitted on the Advanced Light Helicopter (ALH) Naval Prototype (PT-N) (IN901) after the May 1998 nuclear test by the India. The withdrawal of technical support for LHTEC T800 engine and denial of spares in 1998 threatened the indigenous naval ALH development program. The HAL took strategic decision to switch over to Turbomeca TM 333-2B2 engine from France and continue with the testing of Naval ALH. The switchover to French engine was made feasible due to inherent flexibility of the airframe developed by the design engineers of the Rotary Wing Research and Design Centre (RWR&DC) of HAL.¹⁸²

The withdrawal of technical support and restrictions on the supply of LHTEC T800 in 1998 and GE-404 engine from 2023 onwards, respectively, highlighted the need to factor in reliability of the partner country in the strategic technology collaboration projects. There is a need to create institutional mechanisms so that behavioural and reliability aspects of the collaborations partners and learning from the past indigenous aircraft development projects are factored in the strategic collaboration projects. Also, the need for pursuing indigenous aero-engine development projects in parallel need to be given utmost importance despite pursuing collaborations.

¹⁸² WC CD Upadhyay, 'The Engine Odyssey of the HAL Dhruv: An Experimental Test Pilot's Perspective', Rotary Wing Society of India, Jan-March 2026.

OTHER CHALLENGES TO SELF-RELIANCE IN AERO-ENGINES

The aero-engine development trajectory has been inconsistent as a number of projects had been closed without follow-on or spiral development programmes to make them successful. This not only impacted fighter aircraft but also helicopters, transport aircraft, UAVs, etc. The afterburner Kaveri engine achieved less thrust (about 72 kN), and a program for the development of non-afterburner Kaveri Derivative Engine (KDE) program for Ghatak UCAV was launched, which is currently under certification. There is no known plan to further develop or address challenges of afterburner Kaveri engine. DRDO scientists often proceed to Russia for testing fighter engines at high altitude wind tunnel and Flying Test Bed (FTB). This requires approvals, high cost of tests, and sometimes, there are delays in allocation of the testing facilities, notwithstanding the possible compromise of the testing data. This raises following questions:

- (a) Were the causes, challenges and limitations of closures of indigenous aero-engine development projects analysed to institute course corrections or launching of follow-on engine development programmes?
- (b) Was certification and induction of previous engines completed before launching the new engine development program?
- (c) Was any roadmap/ formal proposal for establishing high altitude wind tunnel or FTB, made/ put up?

There is a need to create a mechanism to address challenges and create an enabling ecosystem for the successful development of indigenous aero-engine projects, and to attribute responsibility and enhance accountability. India's aero-engine program is at a crucial phase and course corrections are urgently needed.

INDIGENOUS PROJECT CLOSURES AND IMPACT

The LCA Mk-1 (Navy) project could be facing closure unless corrective measures are taken. India has a long list of closure of indigenous aeronautics and defence design and development projects, and it would

be useful to look at some of them to understand challenges of indigenous design and development. Several indigenous aeronautics and defence projects have been shut down without induction into defence forces in 78 years of independent India. The closure of indigenous projects after making significant progress leads to wastage of resources, funding and research effort. The project closure has adverse impact on India's *atmanirbharta* trajectory.

Some of the indigenous aeronautics development projects that were closed without induction or limited induction include Hindustan Fighter-24 (HF-24), Hindustan Turbo Trainer-34 (HTT-34), Chetan helicopter, Saras (Mk-1) light transport aircraft, Avro AEW aircraft (modified Avro), Ajeet (upgraded Gnat), Nishant vehicle launch tactical UAV and Panchi tactical UAV. Some of the indigenous projects that could be closed if the course corrections are not done include Rustom Mk-1 Tactical UAV, Rustom Mk-2 (or TAPAS) MALE UAV, LCA Mk-1 (Navy), LCA Mk-2 (Navy) and N-AMCA. With the IN delinking from LCA Mk-1 (Navy), opting to not join LCA Mk-2 Navy and its absence of approval of TEDBF, the indigenous CBF development programme seems to be heading towards closure. India's indigenous aeronautics and defence equipment development projects face closures or lose their relevance or experience obsolescence due to the following challenges:

- (a) Closure as Technology Demonstrator (TD) projects
- (b) Closure after limited induction
- (c) Delayed induction
- (d) Indecisions or inactions
- (e) Inter-organisational incoherences
- (f) Lack of independent technical review to identify gaps, challenges and limitations
- (g) Lack of roadmap, timelines and funding for course corrections and follow on development.

The reasons for abandoning or closure of these projects could vary from systems failing to failure to meet QRs, technological obsolescence,

limitations in funding, etc. However, the fact remains that, with each indigenous project closure, India goes back to the drawing board in its technological development trajectory. The follow-on decisions on licence manufacturing and JVs without ownership of IPR create undesirable dependencies. Also, India has rarely leveraged licence manufacturing projects to develop indigenous variants. There is no higher technical and empowered entity in the defence and aeronautics sectors that carries out scientific review of these projects and takes decision to launch follow-on variants and pursue a spiral development approach to make them successful.

The defence and technological projects are high-value and complex projects with competition among OEMs. The failures and challenges of indigenous projects find prominent place in media and achievements of indigenous projects find lesser coverage. The projects are often closed, citing technological challenges, delays and failures without a roadmap to make them successful. The closure of indigenous defence and aeronautics projects sets back the Indian defence industry by decades. All the systems and subsystems developed during the project become irrelevant or obsolete with the passage of time or inaction. India loses technologically every time when an indigenous project is closed after decades of research and development effort

Factors Contributing to Closure of Indigenous Projects. The high attrition of indigenous defence and aeronautics technology development projects is detrimental to the self-reliance trajectory of India. The five factors that have significant influence on the closure of indigenous aeronautics development projects, are as follows:

- (a) **Naval Aviation Technology Ownership.** The ownership of technology by users can overcome the limitations imposed by indecisions, delays and inactions. The IN's ownership of naval shipbuilding has played a key role in achieving *atmanirbharta*. Therefore, it is recommended that the IN be empowered to take ownership of naval aviation technology development projects on the lines of naval shipbuilding.
- (b) **Lack of Spiral Development Policy.** The lack of a spiral development policy has been one of the limitations of the Indian aeronautics industry. The closure of HF-24 fighter, HIT-34 basic

trainer; Nishant, Panchi, Rustom-1 and Rustom-2 UAVs and Kaveri engine are some of the examples of project closures without resorting to spiral development to overcome their limitations and facilitate induction

- (c) **Understanding of Technology Trajectory.** The understanding of technology trajectory is important to make right and timely decisions to enhance the rate of success of the indigenous design and development projects. However, closures with induction, indecisions, inactions, delayed induction, limited inductions and ultimate closures are indicators of gaps in understanding of the technology trajectory in India. The high rate of closure of indigenous projects indicates a lack of understanding of the technology trajectory. The leadership of defence forces, along with bureaucrats, policy-makers, analysts and defence, finance and other stakeholders, must possess a strong understanding of technology trajectory, as their decisions, indecisions or delays significantly impact the self-reliance trajectory. Therefore, an understanding of technology trajectory needs to be cultivated and implemented by the leadership of stakeholders to become self-reliant in aeronautics technologies. The understanding of the technology trajectory would improve with the creation of Research and Development (R&D) structures.
- (d) **Users as Partners in Development.** Users are critical pillars on whom the success or failure of indigenous aeronautics technology development projects depends. A lack of user involvement in aeronautical development projects or their withdrawal midway indicates an unequal partnership, which adds to challenges of such projects. This is a critical gap that requires deep introspection and review of approach.
- (e) **Lack of an Empowered Higher Technical Body.** Project closures also occur due to lack of consensus and coherence among different stakeholders. India urgently requires an empowered higher technical body to take the following decisions/ actions:
 - (i) Choose between TEDBF and N-AMCA to end the current stalemate in indigenous CBF development programmes;

- (ii) Take decision on Kaveri 2.0 to reduce dependence on imported engines in the next ten years for LCA MK-1, LCA Mk-2 and AMCA;
- (iii) Ensure that collaboration with Safran systematically leads to self-reliance in aero-engine technologies including critical systems by 2035–40;
- (iv) Create Military Civil Technology Fusion (MCTF) in military and civil aeronautics and UAV technologies to propel India's self-reliance trajectory in a focused, systematic and time-bound manner with accountability;
- (v) Address challenges of Short Range Unmanned Aerial Vehicle (SRUAV), TAPAS, SWIFT, Ghatak and Indigenous MALE UAVs and Unmanned Traffic Management Systems and integration of UAVs in Indian Airspace; and
- (vi) Address inter-organisational incoherences, indecision and inactions.

Taking decisions among equals becomes a challenge. The lack of technical expertise among stakeholders is another challenge that contributes to indecision, delays and incorrect decisions. Therefore, there is a need to form a Defence and Aeronautics Commission or a higher technical body to take decisions when there is incoherence among equals, indecisiveness, delays or other challenges. This will enhance the success rate of indigenous development projects and elevate the trajectory of self-reliance.

PRIVATE SECTOR IN *ATMANIRBHARTA*: OPPORTUNITIES AND LIMITATIONS

The private sector is being seen as an alternative to the public sector to fill technology gaps and make India *atmanirbhar* in aeronautics. The private sector is known for its efficiency in production and applied research to improve production processes. However, it has certain limitations that needs to be factored in to make course corrections in the aeronautics manufacturing sector.

The limitations of the Indian private industry can be understood from its two premier industrial sectors, i.e. Information Technology

(IT) and automobile sectors. In the automobile sector, we have seen progress, such as Tata's acquisition of Jaguar Land Rover in the UK in 2008¹⁸³ and similar such initiatives by few other manufacturers. However, India is yet to develop globally competitive automobile products. In the IT sector, Indian software companies have been an essential element of value chains of global IT companies; however, the country still depends on imported software for design, testing and certification. An overview of these two sectors highlights the critical gaps in the approach of Indian companies and their inability to compete in the product segment at the global level.

Private Sector in Aeronautics Manufacturing. The private sector is a new player in the aeronautics manufacturing sector. The development of CNF-5 five-seater civil aircraft by Mahindra Aerospace in collaboration with Council for Scientific and Industrial Research, National Aerospace Laboratory (CSIR-NAL);¹⁸⁴ C-295 military transport aircraft manufacturing by Tata Advanced Systems Limited (TASL); and AMCA fighter aircraft manufacturing by the private sector are three major developments in the Indian aeronautics sector. Therefore, there is a need to carefully study these developments to identify gaps and incorporate provisions to address limitations and challenges of JVs/collaborations.

- (a) **Mahindra Aerospace.** Mahindra Aerospace was the first Indian company to acquire a civil aircraft manufacturing company in Australia and attempt the manufacture of five-seat aircraft in India. However, it struggled to capitalise on its acquisition due to lack of policies and structures in Ministry of Civil Aviation (MoCA) and an enabling ecosystem in India.¹⁸⁵ Mahindra and Mahindra sold its

¹⁸³ Tata Motors Completes Acquisition of Jaguar Land Rover, JLR, 2 June 2008, <https://media.jaguarlandrover.com/node/4917>, accessed on 8 November 2025.

¹⁸⁴ Council of Scientific and Industrial Research, National Aerospace Laboratories, Bangalore, India, https://www.nal.res.in/themes/stark/industry meet2019/logos/NAL_broc_6_pp_single.pdf, accessed on 8 November 2025.

¹⁸⁵ CNM-5, Gipps Aero, Aircraft Division, Operations, Mahindra & Mahindra Subsidiary Annual Report 2015-16, <https://www.mahindra.com/sites/default/files/resources/investor-reports/FY16/Annual Reports/Mahindra-Subsidiary-2016-Part-02-For-web.pdf>, accessed on 8 November 2025.

stake in the Gipps Aero Pty Ltd and its associated entities in November 2023.¹⁸⁶

- (b) **Manufacturing of C-295 by TASL.** The MoD selected TASL for setting up the final assembly line of Airbus C-295 transport aircraft. TASL would manufacture forty aircraft for Airbus at Vadodara, Gujarat, under the Make in India initiative.¹⁸⁷ This was the first contract wherein TASL, a private sector company, was designated as the Indian partner for the manufacturing of a C-295 military transport aircraft.¹⁸⁸ While this is a significant development, the following aspects of the C-295 contract need attention:
- (i) The main contract for acquisition of C-295 aircraft is between Airbus and MoD (IN) and not TASL, which is a sub-contractor and responsible to Airbus Industries for manufacturing of C-295.¹⁸⁹
 - (ii) The contract involves the manufacturing of structures and final assembly of C-295 by TASL in India. However, there is no known roadmap with timelines for manufacturing of critical systems and components, including undercarriage, engine, hydraulic systems, oil systems, sensors, payloads, etc., by TASL and other Indian entities in India.

¹⁸⁶ Cessation of Subsidiaries under Schedule III of SEBI Regulations -2015, Mahindra & Mahindra Ltd, 8 November 2023, https://www.mahindra.com/sites/default/files/2023-11/SE-Intimation-Cessation-of-Gipps-Aero-and-other--MAAPL-Subsidiaries-8th-November-2023-F_0.pdf, accessed on 8 November 2025.

¹⁸⁷ Prime Minister' Office, PIB Delhi, MJPS/SR/TS, Release ID: 2068793, 28 October 2024, <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2068793>, accessed on 8 November 2025.

¹⁸⁸ Tata Advanced Systems and Airbus Inaugurate C295 Final Assembly Line, The Tata Group, 28 October 2024, <https://www.tata.com/newsroom/business/tasl-airbus-c295-tata-aircraft-complex>, accessed on 8 November 2025

¹⁸⁹ Abhijeet Kumar, 'Tata's C-295 Complex Launch: Key Details about India's Aerospace Leap', Business Standard, 28 October 2024, https://www.business-standard.com/external-affairs-defence-security/news/tata-s-c-295-complex-launch-key-details-about-india-s-aerospace-leap-124102800208_1.html, accessed on 8 November 2025.

- (iii) TASL needs Airbus's permission to modify, upgrade, manufacture additional aircraft or develop future variants.

The C-295 is a replacement of Avro transport aircraft, which was manufactured in India by the IAF and later by the HAL with full ToT. The ownership of designs to modify and upgrade Avro rested with the HAL. The above developments indicates that shifting licence manufacturing to private sector may not automatically result in *atmanirbharta* unless there is roadmap for systematically increasing the IC and a mechanism for scientific verification of IC in terms of components, materials and software. The indigenisation of critical, vulnerable and complex systems by both the public and private sector remains an unaddressed challenge.

- (c) **Private Sector in AMCA Manufacturing.** In order to harness the production efficiency of the private sector, Raksha Mantri (Defence Minister), Rajnath Singh approved the AMCA Execution Model, under which both public and private sector companies will get equal opportunities to participate in mega defence projects to bolster indigenous defence capabilities. The private sector can bid independently or as JVs or consortia for such projects.¹⁹⁰ The production of five prototypes, followed by series production of AMCA, will be taken up by the private sector partner under the Make in India programme.¹⁹¹ The Expression of Interest (EOI) was issued by the Aeronautical Development Agency (ADA) on 18 June 2025.¹⁹² Seven companies, including TASL, Advanced Defence and Aerospace, Larsen and Toubro (L&T) with Bharat

¹⁹⁰ Ministry of Defence, PIB Delhi, VK/ Savvy, Release ID: 2131528, 27 May 2025, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2131528>, accessed on 22 October 2025.

¹⁹¹ Ibid.

¹⁹² 'ADA Kickstart Process to Build Made in India Fifth Generation Fighter Jet AMCA with Indian Firms', ANI, 18 June 2025, <https://www.aninews.in/news/national/general-news/ada-kickstarts-process-to-build-made-in-india-fifth-generation-fighter-jet-amca-with-indian-firms20250618213921/>, accessed on 22 October 2025.

Electronics Limited (BEL), Goodluck India along with Brahmos Aerospace, Thiruvananthapuram Ltd and Axiscades Technologies, and Bharat Forge Ltd in partnership with BEMIL ltd and Data Patterns, applied for the EOI. This will be evaluated by DRDO experts committee and submitted to a panel headed by Defence Secretary.¹⁹³ The result was awaited in January 2026. The AMCA Execution Model is a transformational development as it can expand fighter aircraft manufacturing base to private sector and speed up manufacturing of AMCA to fill fighter aircraft deficiencies of the IAF.

There is however, a need to articulate a scientific, transparent and unambiguous mechanism for the assessment of IC based on materials, components and software in licence manufacturing by both public and private sector entities. In addition, there is also a need to formulate a roadmap with timelines for the indigenisation of critical, complex and vulnerable components, materials and software in JVs, collaborations and licence manufacturing to support *atmanirbharta* in aeronautics manufacturing.

The silence surrounding indigenous aviation development projects by stakeholders when there is little progress or lack of interest shown by users or lack of demand for further funding by a developer can render the indigenous projects obsolete or irrelevant. Such conscious omissions indicate an absence of accountability and underscore the need for a higher-level empowered technical oversight and decision-making body. The closure of indigenous projects have been variously attributed to paucity or slow rate of funding, lack of an enabling ecosystem and other contributing factors.

¹⁹³ Rahul Singh, 'Two Top Govt Panels to Assess 7 Firms Vying for India's Stealth Fighter Jet Project', *Hindustan Times*, 14 October 2025, <https://www.hindustantimes.com/india-news/panels-to-assess-firms-vying-for-stealth-fighter-project-101760381489745.html>, accessed on 22 October 2025.

WAY FORWARD FOR *ATMANIRBHARTA* IN INDIAN NAVAL AVIATION

The view that the 4.5-generation TEDBF is salvageable while facing fifth- and fifth-generation-plus fighter aircraft threat from China is flawed, which could herald security vulnerabilities amid early obsolescence. The 4.5-generation TEDBF, being described by some observers as the fifth-generation-minus fighter, does not possess significant capabilities to undertake envisaged missions and maintain technological edge over fifth- and fifth-generation-plus fighters of adversaries in aerial combat in its lifespan of thirty to forty years. Cmde Maolankar opined that

[an] ideal approach would have been to develop a naval variant of LCA Mk-2, which was an offshoot of LCA Navy Mk-1 with key lessons learnt resulting in the most serious constraints being freed up, yet reusing most of the other stuff. By now it would have been close to induction. The roadmap proposed was LCA Mk2 to yield as inductable aircraft in a reasonable time frame followed by a proper fifth-generation navy fighter with enough time to make the IAF allow Navy to take lead or else develop a separate Naval 5th Generation fighter.¹⁹⁴

It is important that the IN participates in the development of indigenous fifth-generation fighter aircraft that would meet its operational requirements in the coming decades. The fifth-generation fighter should be upgradable to integrate emerging next-generation technologies. The

¹⁹⁴ Observations made by Cmde Maolankar, former test pilot of LCA Mk-1 (Navy) in a chat with the author on 16 August 2025.

way forward can be divided into three segments, comprising structural reforms, policy reforms and roadmap for *atmanirbharta* in naval aviation.

STRUCTURAL REFORMS

The incoherences in CBF and other naval aviation development projects can be addressed on a long-term basis by instituting structural reforms. Three proposed structural reforms are as follows:

1. **Defence and Aeronautics Commission or Empowered Higher Technical Body.** There is a need to create a Defence and Aeronautics Commission or any other empowered higher technical body to keep an oversight on indecisions, delays, inactions or to address lack of accountability. It should be empowered to take remedial measures to reduce project closures by conducting technical reviews, identifying course corrections and providing guidance on the launch of spiral development projects as required. The core responsibility of this body should be to expedite decision-making in complex technologies, prevent stalemate and correct inter-organisational incoherences in the development of defence and aeronautics technologies. It should lead and support a sustained approach to achieving technological excellence and providing India with indigenously developed, advanced and niche aeronautics and defence technology systems and solutions.
2. **Aircraft Carrier and Naval Aviation Integration.** Aircraft carrier and naval aviation development programmes need to be integrated to achieve coherence in planning, development and procurement of CBF and aircraft carriers. Therefore, it is suggested that both naval aircraft carrier and naval aircraft design be placed under one PSO at the Naval Headquarters, i.e. either VCNS or DCNS. This will enhance synergy in capability-building of these two complex and strategic naval combat assets.
3. **Aviation Design Group (ADG).** The IN may establish ADG on the lines of ship and submarine design groups of the Warship Design Bureau. The creation of ADG manned by domain experts will fill a critical gap and enhance IN's contribution towards indigenous aviation development projects.

POLICY REFORMS

Policy reforms are needed to address specific gaps in self-reliance in naval aviation. In addition, certain policy gaps are common for any *atmanirbharta* initiative. The following policy reforms are proposed to invigorate naval aviation self-reliance:

1. **Naval Aviation *Atmanirbharta* Roadmap.** The naval aviation *atmanirbharta* roadmap should elevate the self-reliance trajectory from indigenisation of sub-systems and components to design and development of platforms and systems. A roadmap for indigenous development of MR, CBF, AEW, ASW aircraft, helicopters and UAVs with timelines should be formulated. The roadmap may include indigenous development of critical, complex and vulnerable systems, sensors, payloads, software, components, etc.
2. **Indian Navy as a Development Partner.** IN should become a partner in naval aviation platform development projects to achieve technological sovereignty. Qualified personnel from the IN may become members of design and development teams of naval aviation projects, as is being done in ship and submarine building
3. **Spiral Development Policy.** A spiral development approach is recommended for the CBF development programme. If some technologies fail or become obsolete, suitable modifications in the design, equipment, software, components, etc., may be taken up in the follow-on project. The spiral development policy will minimise closure of indigenous aeronautics development projects. The reduced closure and course correction will contribute to higher success of indigenously developed aerospace systems would improve India's trajectory of *atmanirbharta*.
4. **Block Development Policy.** There is a need to formulate a block development policy for indigenous defence and aeronautics projects. In this policy, design features for a given block of fighter aircraft may be frozen at certain stage. Thereafter, further changes in design, equipment, components sensors or payloads may be taken up in the next block of indigenous aircraft and defence equipment. This will help in systematic design improvements and

upgradations without having an adverse impact on the timelines for induction.

5. **Indigenous Content (IC) Policy.** The opening of defence manufacturing and increasing collaborations with foreign OEMs created a need for formulating policy on bringing transparency in local manufacturing by Indian entities and their control over IPR. Formulation of a scientific, transparent and unambiguous mechanism for the assessment, validation and certification of IC based on materials, systems, components and software is recommended. The scientific assessment of IC will help in ascertaining the quantum of local manufacturing in such deals. The IC certification mechanism can be leveraged to monitor indigenisation of critical systems of manned and unmanned systems being developed/manufactured through ToT, JVs and collaborations with foreign OEMs in India by both public and private sector entities. The IC certification policy and mechanism can become the central pillar for scientific monitoring of *atmanirbharta* in core and critical technologies.
6. **ToT Considerations.** The ToT of CBF from foreign OEMs (e.g., Rafale-M) is not envisaged at this stage due to the development of similar generation (4.5) LCA Mk-2 and requirement of smaller numbers for the IN. The decision on ToT must take into account its impact on IDDM projects and technological sovereignty. Indian entities in a ToT need to have control over modifications, upgradations and development of future variants without needing approvals of foreign OEMs. Also, indigenous manufacturing of critical systems in India needs to be systematically enhanced within given timelines.
7. The view that ToT will provide design experience to Indian entities is flawed as it only provides understanding of “how” aspect of manufacturing of products and not the “why” aspect of the product design. Therefore, ToT creates dependencies and Indian entities would need to go back to foreign OEMs to modify, upgrade or develop indigenous variants.
8. **Import Considerations.** The cost of import of CBF and availability of funding for indigenous projects after import needs

to be factored in the self-reliance trajectory. The import of 26 Rafale-M, limited requirement and paucity of funding leaves little scope for further import of CBF from FOEMs at this stage.

9. **Synergy Between Indigenous Aircraft Carrier, Naval Fighter and Weapons.** There is a need to create mechanisms for building synergy between naval planners and designers involved in the indigenous development of aircraft carriers, CBF and weapons.¹⁹⁵ Aircraft carrier designs should incorporate appropriate fighter launch mechanisms, storage area, lift and other systems. A similar approach is needed in indigenous development of air-to-ground and air-to-air weapon systems to meet the specific requirement of IAF and IN.

ROADMAP FOR NAVAL AVIATION *ATMANIRBHARTA*

The involvement of the IN in indigenous naval aviation design and development projects has been limited, and there is a need to enhance its scope and extent of involvement in indigenous development of aviation platforms. A few technology initiatives are proposed to address these gaps, undertake course corrections in existing projects and launch new project to elevate the trajectory in self-reliance in naval aviation.

Criteria for Selection of Next-Generation CBF. The decision on CBF has been pending for almost a decade. Indian planners are presented with two options for developing CBF indigenously, i.e. TEDBF and N-AMCA. Therefore, an objective assessment matrix has been proposed to ascertain suitability of either of the two CBF for naval operations. The following questions are proposed, and answers to these questions would help in making a choice between TEDBF and N-AMCA objectively:

- (a) Does the proposed CBF provide India with technological sovereignty?
- (b) Is it technologically advanced enough to take on the challenges posed by evolving fighter technologies of potential adversaries?

¹⁹⁵ Vice Adm Shekhar Sinha (Retd.), during interaction at MP-IDSA on 24 October 2025.

- (c) Does it provide technological edge over its adversaries in the envisaged life span of three to four decades of its service life after its induction (which itself is likely to take a decade)?
- (e) Is block development approach proposed to prevent unwarranted delays in induction?

Initiatives for *Atmanirbharta* in Naval Aviation. The above criteria would be a useful and objective template for making a choice if multiple options are presented, as is the case for TEDBF and N-AMCA. In addition, there is a need to articulate potential areas in which indigenous development needs to be pursued. Taking these into consideration, the following technology development initiatives are proposed for achieving *atmanirbharta* in CBF and naval aviation:

1. **LCA Mk-1 (Navy) as a CBF Trainer.** The induction of LCA Mk-1 (Navy) as a CBF trainer is proposed. It is important for maintaining the *atmanirbharta* trajectory of naval aviation platform development in India. However, its induction has to be viewed in right perspective while keeping the expectation realistic. Though the twin seat variant of LCA Mk-1 (Navy) with weight rationalisation and appropriate equipment selection can be deployed for air defence role in contingencies, it should not be viewed as a full-fledged naval fighter. The purpose of its limited induction of LCA Mk-1 (Navy) would be to act as CBF and combat trainer aircraft. In addition, its induction would generate operational and maintenance data. The generation of data through sustained operations of LCA Mk-1 (Navy) during the day and night, under different operational conditions, diverse weather conditions, different sea states, and by pilots with different experiences and flying qualifications would be useful for making design upgrades and building robust naval fighter platforms of future.
2. **LCA Mk-2 (Navy) as Interim CBF.** The full scale development of 4.5-generation LCA Mk-2 (Navy) as an interim CBF is recommended. Although the range and payload of LCA Mk-2 (Navy) is not equal to that of TEDBF or AMCA, it is technologically comparable to Rafale-M, is indigenous and has the ability to undertake all the naval operations required by the CBF. It is likely to have more range than MIG-29 and can prove to be a

capable CBF until the N-AMCA or next-generation CBF is developed. In addition, it will provide technological sovereignty and operational experience that would be invaluable for N-AMCA. Lastly, it will keep the indigenous naval fighter development programme in contention, lead to spiral development and help maintain the self-reliance trajectory.

3. **N-AMCA as Next-Gen CBF.** A spiral development approach can be adopted for progress of the indigenous naval fighter from LCA Mk-1 (Navy) to TEDBF/ N-AMCA. Accordingly, an action plan needs to be drawn to overcome challenges as well as incorporate lessons learned from the development and operation of LCA Mk-1 (Navy) and LCA Mk-2 (Navy). If the decision has to be made between TEDBF and N-AMCA, an objective approach would help in taking a rational decision. The decision should take India towards self-reliance while addressing India's security concerns posed by fifth- and fifth-generation-plus Chinese fighters. If N-AMFA is chosen to be the next CBF, the necessary design changes for naval-specific roles would have to be made, in consultation with the IAF, ADA and other stakeholders. This would help in enhancing interoperability and minimising supply chain divergences without compromising naval requirements.
4. **Aero-Engine Roadmap.** The failure of Hindustan Fighter-24 (HF-24), India's first jet fighter aircraft during the 1970s, is attributed to the non-availability of an indigenous jet engine. The delay in the GE-404 engine supply in 2023 highlighted the vulnerability of the LCA programme. The proposed co-development of AMCA aero-engine in collaboration with Safran, France, alone will not make India self-reliant due to few inherent limitations. The possibility of using 'core section' of the existing M88 aero-engine of France and development of some parts of the engine by the French engineers, could become a limitation in achieving self-reliance in aero-engine technology as Indian engineers would lack 'know whys' of the technologies developed by French engineers. Therefore, the joint development of the 120 kN engine for AMCA needs to be supplemented by the spiral development of the Kaveri engine through the participation of the private sector in a public-private partnership (PPP) mode. In addition, the gaps in testing ecosystem

and dependency on foreign countries often slow down engine development and introduce delays, rendering indigenous engine development projects irrelevant. Therefore, a three-pronged approach is recommended:

- i. **120 kN AMCA Engine.** Pursue co-development of the 120 kN engine for AMCA with Safran.
- ii. **80 kN Kaveri-2.** Undertake modification, upgradation and operationalisation of Kaveri to Kaveri-2 configuration with an enhanced thrust of a 80 kN thrust for the LCA Mk-1 aircraft in phase-I by GTRE in collaboration with an individual or a consortium of Indian private partners in PPP mode. The endeavour should target its induction before 2035. Kaveri-2 may require design modifications, which could take about six to eight years, which is roughly about the same time as the retirement of first batch of GE-404 engines fitted on LCA Mk-1 fighter aircraft. It will provide cushion of two to four years, if delays are experienced in the development phase
- iii. **100 kN Kaveri-3.** Take up development and operationalisation of 90–100 kN thrust Kaveri-3 engine for LCA Mk-2 in phase-II between 2035 and 2040 in collaboration with the private sector. The development of Kaveri-3 could be taken up in parallel to reduce development timelines.
- iv. **Parallel Development.** Kaveri-2 and Kaveri-3 engine projects could be given to two different private sector entities for parallel development in a PPP mode. The GTRE may transfer existing Kaveri engine technologies and provide technical support to both Indian private sector companies to expedite development of Kaveri-2 and Kaveri-3 engines as well as build aero-engine manufacturing ecosystem in the private sector.
- v. **High Altitude Wind Tunnel and FTB.** Set up Flight Test Bed (FTB) in collaboration with CABS, and High Altitude Wind Tunnel to obviate going abroad, protect valuable engine development data and reduce development timelines. The estimated cost of High Altitude Wind Tunnel and FTB could vary between Rs 6,000–9,000 crores and Rs 400–700 crores,

respectively. This is a measured expenditure considering the significance of the aero-engine technologies. These are essential for testing the series of aero-engines that are likely to be developed for indigenous fighter, transport, helicopters and UAVs.

- vi. **M-88 or M88 T-REX as an Interim Engine.** Examine the feasibility of integrating 75 kN thrust M88 engine and 88 kN thrust M88 T-REX engine from Safran, France¹⁹⁶ on LCA Mk-1 (Navy) and LCA Mk-2 (Navy), respectively. These engines would provide an interim solution till Kaveri-2 and Kaveri-3 engines are developed. These engines could provide an alternate option amid uncertainty over the supply of GE-404 and GE-414 engines by the US. If required, the maximum all of weight of LCA Mk-2 could be reduced marginally to match the desired performance. This option will not impact the current contract on the acquisition of GE-404 and GE-414 engines and yet can provide an alternate option for the future. The Rafale and Rafale-M fighter aircraft being acquired by the IAF and the IN, respectively, are equipped with M88 engines. Therefore, it should be feasible to provide MRO and spares support for the M-88 or M88 T-REX engines.
5. **MiG-29K Upgrade.** The MiG-29K CBF still has some service life left. The integration of advanced sensors and indigenous Astra Missiles can significantly enhance the capability of this fighter aircraft. The upgrade of MiG-29K could be explored to fill the time gap associated with the development and induction of next-generation CBF.
6. **TAPAS and Archer-NG MALE UAVs.** The development of TAPAS led to the creation of several enabling technologies that otherwise would create dependencies in imported or licence-

¹⁹⁶ Safran unveils higher-thrust version of M88 for future Rafale upgrades, 17 June 2025, <https://www.safran-group.com/pressroom/safran-unveils-higher-thrust-version-m88-future-rafale-upgrades-2025-06-17>, accessed on 18 January 2026.

produced UAVs. It also motivated ADE to develop armed Archer-NG MALE UAV; however, both of these UAVs are yet to be accepted and inducted. On the other hand, the private industry is exploring licence manufacturing of MALE UAVs in collaboration with FOEMs, which may bring in import dependencies. Therefore, the IN should explore collaborating with ADE and other industry players to steer development and induction of indigenous MALE UAV for naval applications with control over IPR and critical technologies.

7. **Naval ISR/Armed SWIFT UAV.** The IN should examine the transformation of the SWIFT prototype for EW, loitering or other naval applications from aircraft carrier, which will be challenging due to its limited endurance. However, if suitably modified, it will not only provide operational capability but also prove useful for the development of future carrier borne UCAV.
8. **N-Ghatak/N-CATS.** Formulate an action plan for the development of Naval Ghatak and Naval Combat Aerial Teaming System (N-CATS) being developed by ADE and HAL, respectively. The CATS Warrior, the unmanned UCAV; equipped with twin indigenous aero-engines and weighing approximately two ton could prove be more useful onboard platform than the SWIFT. The Ghatak and N-CATS could become force multipliers in the times to come.
9. **DBMRH.** IN should examine joining the development of Deck Based Multi-Role Helicopter (DBMRH) for AEW and ASW roles as a development partner on the lines of shipbuilding.
10. **Naval Netra (MR/ ASW) Aircraft.** Examine development of Embraer 145 and Airbus 330 or suitable platform based Naval Netra for MR and ASW roles in collaboration with CABS, DRDO.
11. **Naval ALH and LUH.** Examine expanding the envelope by integration of Counter-Unmanned Aircraft Systems (CUAS) systems on indigenous ALH and Light Utility Helicopters (LUH) for building offensive and defensive counter drone capability.
12. **Stealth HALE UAVs.** The IN operates the turboprop engine MQ-9 UAVs for long-range ISR and MR missions; however, there

is a need to plan for contingencies of countering PLAN aircraft carrier operations in the Indian Ocean during times of hostility. Therefore, it is recommended that the IN plans should include development of stealth High Altitude Long Range (HALE) UAVs for ISR and strike roles in future.

In the unmanned aviation segment, the Naval Innovation and Indigenisation Organisation (NIIO) of the IN has leveraged capability of Indian innovators and start-ups to develop small UAVs, and there is a need to expand its engagement with public and private sector aviation and UAV entities to develop complex and large manned and unmanned aviation technologies.

OPERATIONAL OPTIONS: ANC AND LAKSHADWEEP

Air power is viewed as sword arm as it provides offensive edge. Its mobility provides air defence and deep strike capability. The core concern for IN is to protect India's interests in Indian Ocean, Arabian Sea and other regions of interest when required. The current limitation imposed by two aircraft carriers can be mitigated by building requisite facilities for deploying air superiority and deep strike fighter aircraft on Andaman and Nicobar and Lakshadweep Islands. These bases could provide reach to protect India's interest while the fleet of two aircraft carriers can address the threats developing in territory beyond their reach.

The development of complex aeronautic technologies is challenging and success of IDDM projects largely hinges upon the stakeholders' understanding of the technology development trajectory. The abandoning of a number of indigenous aeronautics projects after developing several enabling critical technologies in the last seven and half decades requires deep introspection.

The way forward though structural, policy and other reforms as proposed above could make a small contribution in addressing critical gaps and challenges associated with naval aviation *atmanirbharta*, including lack of planning, higher level oversight, incoherences, indecisions and delays and undertaking timely course corrections in indigenous development projects to achieve self-reliance in naval aviation.

CONCLUSION

Former President Dr APJ Abdul Kalam's remarks on Make in India in 2015, are the guiding principles for *Atmanirbharta*. India quest for *Atmanirbharta* in technologies requires original research and innovations, especially by the young Indian entrepreneurs, Start ups and MSMEs; learning from technological advancements, and the ability to design, develop and manufacture in India. He cautioned against the limitations of license manufacturing, local manufacturing and ToTs, as these could make India a low technology low value assembly line of the world.¹⁹⁶

Rear Adm Sudhir Pillai (Retd.) observed that self-reliance in naval aviation pertains to sovereign control over design and supply chains to keep aircraft operational if technical technical support is withdrawn by foreign OEMs. Therefore, "*atmanirbharta*" in naval aviation is the ability to design critical subsystems, integrate indigenous equipment without foreign OEM permissions, and control the configuration roadmap over the platform's life. Design sovereignty is essential for integrating sensors, weapons, software, and upgrade systems without going back to FOEMs, The lack of design sovereignty would lead to dependence on FOEMs even when the airframe is notionally indigenous.¹⁹⁸

This study commenced with an aim of identifying the reasons for delays in induction of LCA Mk-1 (Navy), and led to the discovery of structural, policy and *atmanirbharta* initiative gaps in naval aviation. The IN is transforming from a 'buyers navy' to a 'builders navy' in ship and

¹⁹⁷ Kalam's word of caution on Make in India, Business Standard, 18 October 2015, https://www.business-standard.com/article/current-affairs/kalam-s-word-of-caution-on-make-in-india-115101800181_1.html, accessed on 7 March 2026.

¹⁹⁸ Rear Adm Sudhir Pillai NM (Retd.) in a communication to the author on 6 March 2026.

submarine building. However, the IN withdrew from LCA Mk-1 (Navy), LCA Mk-2 (Navy) and LUH projects, and did not participate in the N-AMCA project. There have also been issues regarding induction of ALH and TAPAS, lack of programmes to develop AEW and MR aircraft, extant fleet of imported and leased naval aircraft/ UAVs, and an absence of *atmanirbharta* roadmap for naval aviation platforms. The aforementioned factors indicate that the IN remains predominantly a 'buyers navy' in the naval aviation segment.

The literature review of the subject and deliberations during the course of the study raised a number of questions, a few of the critical ones being:

- (a) Why has the IN not leveraged the expertise of the CABS, DRDO, (having developed Netra AEW aircraft for the IAF) to develop indigenous MR and naval AEW aircraft?
- (b) Why has IN not been a development partner for the indigenous manned aircraft and UAVs?
- (c) Why has IN not been able to contribute to self-reliance in naval aviation despite making significant contribution to indigenous development of ships and submarines?

The following three hypotheses were tested and validated in the study;

- (a) IN lacks ownership, organisational structures and technology development initiatives for design and development of naval aviation platforms on the lines of ship and submarine building.
- (b) The lack of enabling policies and procedures, and import and ToT of similar systems have significant impact on indigenous naval aviation development projects.
- (c) The structural and policy gaps in the IN and MoD contribute to incoherence in the naval aviation *atmanirbharta* trajectory.

India's indigenous CBF development programme is passing through a phase of uncertainty and there is a lack of follow on CBF development programme with the involvement of users as partners. This could have an adverse impact on the naval aviation *atmanirbharta*. The scope of

the study was expanded to answer why the IN, is not leveraging indigenous defence aviation technology development initiatives. The study provided interesting facts and gave insight that helped in understanding the challenges and factors limiting the contribution of the IN in naval aviation *atmanirbharta*.

In order to understand these facets, the policies, organisational structures, ecosystem, funding and other challenges were examined and analysed. Taking learnings from these, course corrections were articulated that have been summarised as recommendations in the 'Way Forward' section of this monograph. These recommendations have been divided into three structural reforms, nine policy reforms and fifteen technology development initiatives under the 'Roadmap for Naval Aviation *Atmanirbharta*'.

The three structural reforms comprise formation of 'defence and aeronautics commission' at the ministerial or national level, creation of 'naval design group' and placing 'carrier and aviation design under a single PSO' at the Naval Headquarters level. These three structural reforms will fill the critical gaps at the apex level that limit self-reliance, contribute to incoherences, indecision, delays or inactions, and allow closures of strategic naval aviation projects without course corrections to make them successful.

The proposed nine policy reforms endeavour to address critical policy, procedural and execution related gaps that dilute self-reliance initiatives. These are aimed at bringing ownership and removing execution level impediments that directly or indirectly impact the trajectory of indigenous naval aviation development projects. Reforms such as elevating naval aviation *atmanirbharta* roadmap from 'sub-system level' to 'complete platform and systems level' roadmap, factoring impact of ToT and Import on indigenous development projects, calculating Indigenous Content in terms of critical technologies, introducing spiral development and block development policies, and synergising aircraft carrier, naval fighter and weapons development programs; have been proposed to address policy, procedural and execution level challenges.

The fifteen initiatives under the Roadmap for '*Atmanirbharta* in Naval Aviation' propose expansion of self-reliance trajectory and reduction in dependence on import/ lease of foreign aircraft and critical systems

in a systematic manner. The induction of LCA Mk-1 as a CBF trainer, development of LCA Mk-2 as interim CBF and N-AMCA as the next generation naval fighter, are aimed at making India self-reliant in CBF aircraft. The feasibility of upgradation of MiG-29 could be explored to mitigate the challenges posed by reductions in numbers and technological obsolescence.

The limited induction of LCA Mk-1 (Navy), development of LCA Mk-2 (Navy) as an interim fighter and approval of N-AMCA is essential to maintain the momentum of indigenous CBF development programme. Any further delay, inaction or stalemate may have long-term implications necessitating course corrections. However, there are apprehensions about the viability of induction of LCA Mk-1 (Navy) due to its limited payload carrying capability, paucity of space on aircraft carriers and limited budget allocation for indigenous development of naval aviation systems. What needs to be considered that the LCA Mk-1 (Navy) was being developed as a replacement of single engine Sea Harrier fighter. The continued development and limited induction of LCA Mk-1 (Navy) as a naval fighter trainer and air defence fighter is essential to maintain the indigenous development trajectory and pursue spiral development of CBF.

The LCA Mk-1 (Navy) can also be an able replacement of the old generation Hawk armament trainer aircraft operating from the IN bases located in the mainland. The induction of twin seat LCA Mk-1 (Navy) can also be used for providing carrier operations training to naval fighter pilots, which is currently lacking in IN due to non-availability of a dedicated naval DBF trainer. Its induction would also help in generating real-time operational utilisation and maintenance data that is needed for design improvements and upgradation of technologies in the follow-on CBF development programme.

The LCA Mk-2 (Navy), primarily designed for the naval role after taking into account the limitations of LCA Mk-1 (Navy), is best suited to be developed as an interim naval CBF. The development of LCA Mk-2 (AF) and LCA Mk-2 (Navy) has already been approved by the government, voiding need for additional approval. The first prototype of the air force variant is likely to undergo ground testing this year. The concurrent development of naval and air force variant will benefit

both projects as best learnings would be incorporated in the aircraft design. Their common supply chains would provide scale of manufacturing, cost competitiveness and service life support. The LCA Mk-2 can also undertake all the operational tasks of a naval CBF, including the anti shipping role. With air to air refuelling, this aircraft can provide significant firepower and range. Most importantly, the 4.5+ generation LCA Mk-2 (Navy) can be developed in a short timeframe and fill the naval fighter fleet gaps till indigenous next generation CBF (N-AMCA) is developed.

The proposed development of TEDBF as a CBF is likely to have certain limitations. While it would be easier to develop TEDBF (since the spadework on its configuration has already been done), we need to examine whether the 4.5+ generation TEDBF be able to provide technological edge in the three to four decades of its envisaged service life. Also, the TEDBF will need to be developed from the ground up, undergo rigorous testing and certification, which is time-consuming and resource-intensive. This will put additional burden on the ADA, NPTC, CEMILAC and production partners, who are already facing resource and manpower constraints. The creation of separate Maintenance Repair and Overhaul (MRO) facilities and supply chains for small number of TEDBF, may prove challenging and economically unviable especially for the sub-systems and components manufacturers. The ability of TEDBF to provide technological edge over adversary in its envisaged lifespan is more critical for the IN than the IAF due to limited number of aircraft on board an aircraft carrier.

The induction of fifth and next-generation fighters by China is a timely reminder for India to reassess its CBF development programmes. The decision to pursue development of fifth-generation CBF would be crucial to achieve parity and, if possible, obtain technological edge over adversaries with spiral developed approach. These issues need deep deliberations, especially when India has an option of developing N-AMCA, a naval version of 5.5-generation AMCA. If the decision is taken to develop N-AMCA as a CBF, significant design changes in the land variant of the AMCA are required to optimally exploit its potential for naval operations. The experience of the development of LCA MK-1 (Navy) would be useful in reducing the development timelines of N-AMCA. Also, adoption of spiral and block

development approach is essential to prevent induction delays. It will lead to common supply lines, maintenance support and life support with the IAF AMCA.

Adm Sunil Lamba (Retd.), former Chief of Naval Staff, observes that the LCA Mk-1 (Navy), in its current configuration, will not work as it cannot take off from an aircraft carrier with full fuel and weapon load. While he welcomes the development of AMCA, he raises pertinent concerns about its timelines.¹⁹⁹ Yet there is a growing understanding regarding the merits of limited induction of LCA Mk-1 (Navy) and IN joining AMCA project. Adm Arun Prakash, former CNS and a fighter pilot, highlighted the need to review the TEDBF project and observed, “We neither have the design/ test capacity, nor can we afford delays, expenses and the luxury of developing two parallel fighter projects. We might fail in both. It is time for the government or Chief of Defence Staff (CDS) to direct the two services to evolve JSQRs for the development of AMCA with IAF and IN versions, making compromises and adjustments on both sides.”²⁰⁰

Adm Pillai (retd.) noted that PLA Navy is steadily moving towards larger carrier air wings, improved deck cycles, and more capable carrier-borne fighters operating from both STOBAR and EMALS/CATOBAR platforms. As Chinese carrier groups begin operating further into the Indian Ocean and Western Pacific, the qualitative demands on India’s embarked aviation will only increase.²⁰¹ Therefore, indigenous fighter and other naval aviation development programmes should aim to equip Indian naval aviators with suitable capabilities to counter the threats posed by the potential adversaries. The increased security threats, future operational requirements, need for technological edge and sovereignty, are important considerations in decision-making

¹⁹⁹ Adm Sunil Lamba (Retd.) former Chief of Naval Staff, Indian Navy made observations in a chat with the author on 21 August 2025.

²⁰⁰ Adm Arun Prakash (Retd.), former Chief of Naval Staff, Indian Navy, and a fighter pilot, in a chat with author on 14 August 2025.

²⁰¹ Rear Adm Sudhir Pillai NM (Retd.) in a communication to the author on 6 March 2026.

for the future trajectory of naval aviation that is robust, advanced and self-reliant.

The study suggests measures to fill critical capability gaps and vulnerability mitigation. The formulation of an aero-engine self-reliance and vulnerability mitigation roadmap is proposed to address one of most critical vulnerability of Indigenous aviation industry. It comprises co-development of 120 kN AMCA engine, indigenous development of 80 kN Kaveri-2 and 100 kN Kaveri-3 in PPP mode, creation of high altitude wind tunnel and development of high altitude flight test bed; potential use of M88 and M88 T-REX as interim engines for LCA Mk-1 (Navy) and LCA Mk-2 (Navy). The IN joining / launching MALE UAV, Naval Swift, Ghatak NavalUCAV, Naval CATS, Naval Stealth HALE UAV, DBMRH, Naval Netra (MR/ ASW) aircraft and upgradation of ALH and LUH for CUAS roles, is proposed to stimulate naval aviation self-reliance. This can significantly reduce trade imbalances and vulnerabilities that emerge from import and lease of naval aviation systems. Additionally, these initiatives will create jobs by optimally utilising the innovation and technology development potential of thousands of Indian developers and engineers, who migrate to other countries and lead to loss of intellectual capital.

The development and induction of J-35 and J-20 fifth-generation fighters, flight testing of J-36 and J-50 fighters, and MUMT, ISR, Swarm and loitering drones; and other aviation systems by China; and increasing collaboration of Pakistan with China, Turkey and others, has changed the threat dynamics and increased challenges for India. The changing nature in global geo-political landscape has added to uncertainties faced by India. *Atmanirbharta* is the pillar that would help in seamless upgradation, development of future technologies and scaling up of manufacturing. The in-house endeavours will empower India to match the design and manufacturing capabilities of adversaries in wartime scenarios, without interruption or undue pressures from global players. The decisions taken now would equip future-generation Indian naval leaders to face the challenges posed by technologically advancing adversaries.

While this study addresses challenges of Indian naval aviation, it does not examine impediments in achieving *atmanirbharta* in aviation for

the IAF and the IA. These have their own unique and complex challenges and impact trajectory of *atmanirbharta*, and are therefore, important subjects for further research

The proposed policy interventions, structural reforms and technology initiatives are aligned with the vision of ‘*Atmanirbhar* and *Viksit Bharat*’. These recommendations should be examined to formulate a time bound action plan. The current situation demands pragmatism while maintaining the focus on developing indigenous naval aviation technologies. This will help in equipping IN for facing emerging threats amid volatile geopolitical challenges and uncertainties, thereby building an *atmanirbhar* and *sashakt*²⁰² naval aviation fleet by 2047.

²⁰² *Sashakt* is a Hindi word, which mean ‘strong’.

This monograph deliberates on reforms for achieving self-reliance in naval aviation. Indian Navy (IN) is at the cusp of transforming from a 'buyers navy' to a 'builder navy' in ship and submarine building; however, self-reliance in aviation remains a missing link. IN's withdrawal from LCA Mk-1 (Navy), LCA Mk-2 (Navy), non-approval of TEDBF and lack of participation of IN in Naval AMCA has brought its Carrier Based Fighter (CBF) program to a stalemate. The incoherences in the self-reliance trajectory of CBF extends to Maritime Reconnaissance (MR), Airborne Early Warning (AEW) aircraft, helicopters and UAVs. The structures, policies and initiatives need re-orientation/ reforms for naval aviation self-reliance. The proposed apex level structural and execution level policy reforms are aimed at bringing synergy, accountability and expediting decision making. Also, elevating naval aviation self-reliance trajectory from subsystems level to platform and systems level development initiatives can be a stimulant for change. In addition, measures for mitigating aero engine vulnerabilities, scientific mechanism for Indigenous Content (IC) validation, factoring impact of ToT and imports, and spiral development approach are essential prerequisites for *Atmanirbharta* in Indian Naval Aviation.



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