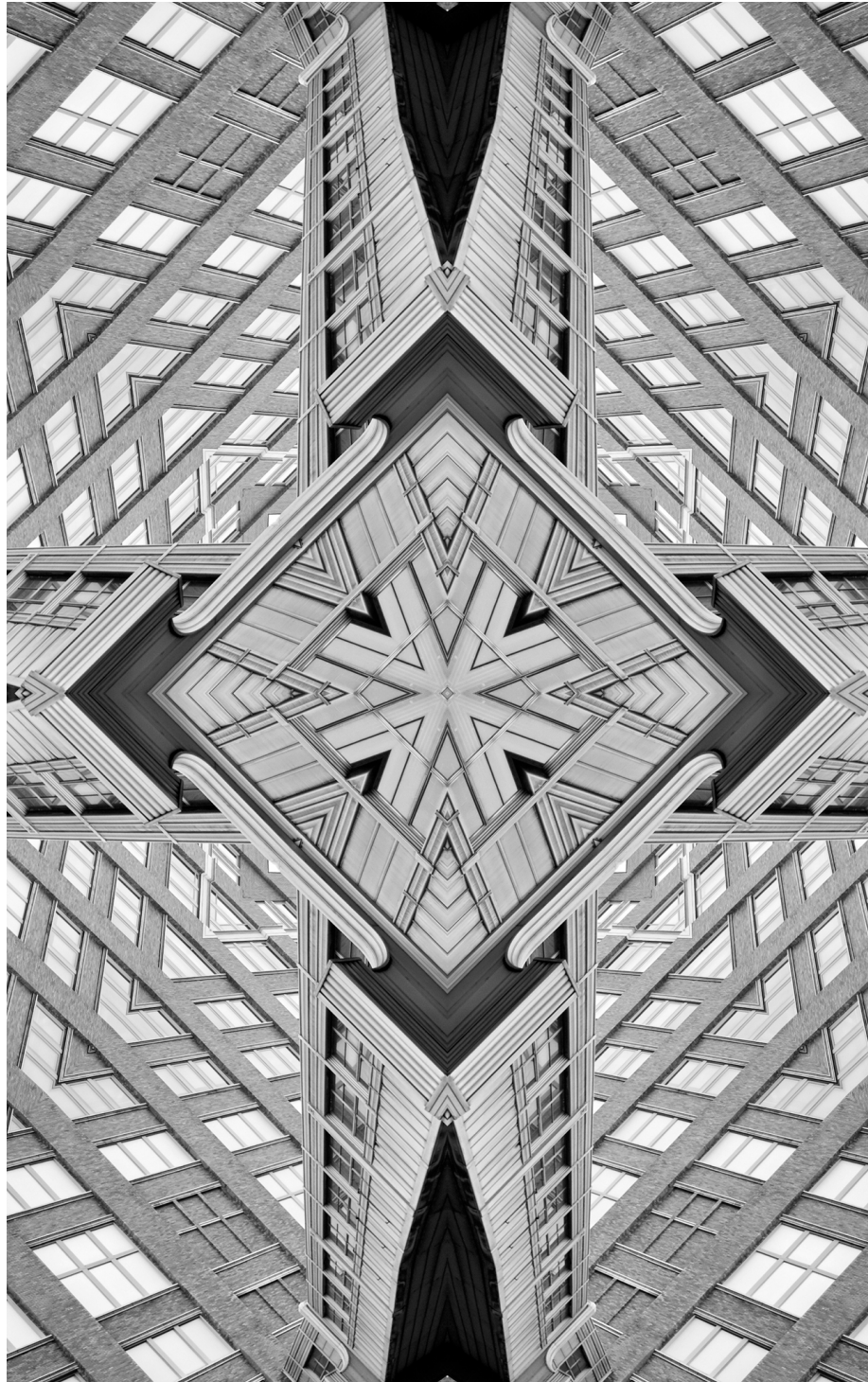


# Issue Brief

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# The Missing Heartbeat: Why Atmanirbharta in India's Shipbuilding Requires Indigenous Marine Engines

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## Abstract

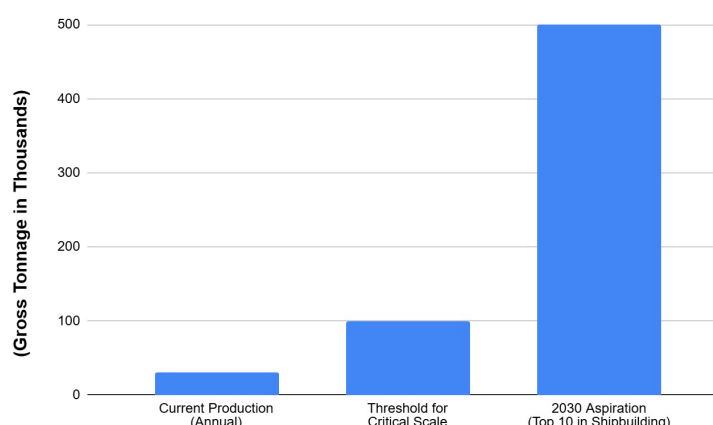
Despite India's growing shipbuilding capabilities, its heavy dependence on imported marine engines reflects an inherent weakness in the maritime sector. Without indigenous propulsion, India's ambitions for its blue economy remain dependent on foreign suppliers.<sup>1</sup> Indigenous marine engines are not just technical assets, but the missing heartbeat of a truly 'atmanirbhar' Indian maritime economy. This brief argues that true self-reliance in the marine sector requires an indigenous propulsion system to safeguard national security, reduce economic outflows, and enhance technological sovereignty. It draws on lessons from the Indian Railways, ISRO, and international maritime leaders. It outlines a roadmap to developing homegrown marine engines through strategic research and development, phased manufacturing, and industry-academia collaboration.

# The Current Landscape of India's Maritime Industry

India's maritime industry is seen as an essential component of the country's national development goals. The Maritime India Vision (MIV) 2030 lays out strategies for India's ambition to be a global maritime leader by strengthening port-led growth, bolstering coastal infrastructure to global standards, expanding domestic shipbuilding capability, and powering India's vessels through indigenous propulsion systems.<sup>2</sup> The MIV is further complemented by the Maritime Amrit Kaal Vision 2047, which aims to link port-led growth with an economic target of US\$5 trillion by 2025.<sup>3</sup>

The strategies built on the 'Make in India' initiative have enhanced indigenous shipbuilding capabilities, helping the domestic shipbuilding industry grow at a 7.8 percent CAGR between 2018 and 2023.<sup>4</sup> India is positioned as the 16th-largest shipbuilding country in the world, with around 39 registered shipyards. The prominent ones are Cochin Shipyard Limited (CSL), Mazagon Dock Shipbuilders Limited, and Garden Reach Shipbuilders & Engineers Limited. These shipyards construct a variety of vessels, from fishing trawlers to indigenous naval warships, such as the INS Vikrant (commissioned in 2022),<sup>5</sup> stealth corvettes like INS Kamorta (2010), and stealth destroyers like INS Surat (2022).

**Figure 1: India's Shipbuilding Vision for 2030**



Source: Maritime India Vision 2030 Report<sup>6</sup>

*Note: India's current annual shipbuilding production stands at 30k gross tonnage (GT), significantly below the critical scale threshold of 100k GT needed to make the industry globally competitive. To position itself among the top 10 shipbuilding nations by 2030, the country has set an ambitious production target of 500k GT annually.*

# The Current Landscape of India's Maritime Industry

Despite this growth, there is a glaring gap in the country's narrative of self-reliance in shipbuilding, with the industry still largely dependent on foreign technology in marine engines. India still imports more than 95 percent of the marine engines installed on commercial ships, primarily from countries like Germany, Finland, Japan, and South Korea. CSL alone spent about INR 450 crore on imported engines during 2022-2023, highlighting the significant capital outflow toward foreign engine manufacturers.<sup>7,8</sup>

This void of indigenous marine engine development technology hampers both our economic independence and maritime safety, particularly in an era marked by geopolitical uncertainty and disruptions in global and regional supply chains.



# Indigenous Marine Engines: A Strategic Imperative and Economic Opportunity

As India moves forward in its course through the Amrit Kaal phase, the emphasis on indigenously developed engines powering domestically built ships must be seen not just as a quest for unattainable maritime supremacy but as a pragmatic pillar of economic opportunity, national resilience, and technological sovereignty.

India encounters economic challenges due to its reliance on imported engine technology. The country's merchandise imports from April–December 2023 totalled US\$505.2 billion,<sup>9</sup> a massive amount for a country aiming to achieve a self-sustainable economy of US\$5 trillion.

Since imports of marine engines constitute a substantial share of this figure, developing indigenous marine propulsion systems is important for India's aim to establish itself as a contender in the global shipbuilding market and achieve a 5-percent market share by 2030, which today is only less than one percent.<sup>10</sup> Achieving this goal will foster economic development, as the marine engine sector is anticipated to expand at a compound annual growth rate (CAGR) of 3.29 percent, increasing from its 2024 value of US\$13.31 billion to US\$17.46 billion by 2032.<sup>11</sup>

Compared to other capital-intensive industries, investments in shipbuilding also yield employment benefits. For every INR 1 billion invested in the sector, approximately 600–800 direct jobs and 1,800–3,200 indirect jobs are created across steel, electronics, logistics, and ports. The Government of India projects an economic benefit of INR 3 trillion from 60 naval ships currently under construction, which are expected to generate around 840,000 jobs.<sup>12</sup> Growing indigenous marine engine production could potentially generate around 2.5 million direct and indirect jobs.

Apart from fostering economic and technological progress, investing in homegrown marine engines is a matter of national security, with these engines incorporating key proprietary designs and technologies, “control over propulsion systems signifies control over mobility, which is fundamental to naval power”.<sup>13</sup>

# Indigenous Marine Engines: A Strategic Imperative and Economic Opportunity

External dependence for marine engines can also compromise the nation's economic autonomy; China's financial investments in Sri Lanka's Hambantota Port illustrate how debt can translate into maritime leverage.<sup>14</sup> China's strategic lending not only secures its foothold in South Asia but also enables it to shape the maritime routes and trade policies of indebted countries. Such cases underscore the importance of safeguarding national interests and ensuring that foreign investments do not translate into undue external influence over critical infrastructure and sovereignty.



# Lessons from Other Industries

**T**he lack of domestic engine technology has presented roadblocks for other sectors in India in the past. These case studies serve as cautionary tales that highlight the need to address this gap in the marine sector as a matter of urgent imperative.

In the space sector, for instance, India's Geosynchronous Satellite Launch Vehicle project initially met with massive challenges because the Indian Space Research Organisation (ISRO) was reliant on engines from other countries. Initially, India had planned to acquire cryogenic engine technology from Russia, but US sanctions and Missile Technology Control Regime (MTCR) roadblocks prevented the transfer. This forced ISRO to develop the Vikas engine, an indigenous solution and an important step towards self-reliance.<sup>15</sup>

Similarly, in the aviation sector, though Hindustan Aeronautics Limited's (HAL) efforts have led to the development of platforms like the HAL Tejas Light Combat Aircraft, the core engine powering the Tejas, the General Electric F404, is of American origin. The home-grown Kaveri engine failed to meet thrust-to-weight targets, mainly due to shortfalls in metallurgy and single-crystal blade technology. GE Aerospace has committed to delivering 99 F404-IN20 engines to HAL for the Tejas Mk 1A,<sup>16</sup> underscoring the ongoing dependence on foreign propulsion systems even in critical defence applications.

## Key Takeaways

India can convert the tough-learned lessons from the space and aviation sectors into an action plan for gaining self-reliance in marine propulsion. The issues with the Kaveri engine demonstrate how difficult it is to get metallurgy, precision machining, thermal efficiency, and reliability together. These are the same problems involved in attempting to design and construct indigenous marine engines. Producing marine propulsion units for navy ships and commercial boats requires profound knowledge in metallurgy, precision engineering, and combustion dynamics—fields where India must create an end-to-end ecosystem. In the absence of this, scalability and performance will always remain constrained. To address this, India requires specialist propulsion research and development (R&D) centers with a materials and manufacturing technology focus, long-term startups, industry and academia partnerships, and focused incentives for indigenous engine design and production.

# Lessons from Other Industries

Further, in the space sector, as India looks to expand its capabilities, it is breaking the monopoly of ISRO by encouraging private startups such as Skyroot and Agnikul to develop their technology by offering them R&D resources and access to launch capabilities. Entities like NewSpace India and InSPACe have been empowered to deal with private entities.<sup>17</sup> This is an example of democratisation of space innovation, enabling the participation of potential private players, to encourage a new era of innovation in technology. Similarly, there is a need to expand India's commercial maritime sector by supporting private sector efforts in developing marine engines.

The Indian Railways also presents a success story of transition from dependence on imported diesel and electric locomotives to expertise in license-built and later fully indigenous designs in plants such as Varanasi, Chittaranjan, and Patiala. Its units now produce sophisticated, world-class diesel-electric and electric locomotives.<sup>18</sup> The railway model of blending licensing, long-term R&D, and local production can be a case study in establishing a strong marine engine industry.

# Establishing Domestic Production of Marine Engines: Challenges

**M**ahindra Powerol has entered India's marine engine market with its Mahindra Seahawk series, featuring small engines ranging from 15 to 400 hp.<sup>19</sup> Most of these engines, however, end up in smaller boats and vessels that stick to the coast. Building the powerful engines needed for big ocean-crossing ships is where things get tricky. Marine engines, especially two-stroke, medium-speed diesel engines and specialised naval propulsion systems, represent intricate combinations of advanced materials, precise engineering, and complex control systems. The following are the main challenges associated with the endeavour of creating an indigenous production base for marine engines:

1. **Specialised Expertise:** Designing and manufacturing marine propulsion engines calls for deep maritime domain knowledge, which cannot simply be borrowed from automotive or stationary engine industries. Marine engines must deliver high power output continuously, withstand harsh sea environments, operate reliably over long voyages and integrate seamlessly with complex ship propulsion systems, including propellers, shafting and energy recovery systems.
2. **Complex Engineering:** The large marine engines used onboard ships are usually two-stroke, slow-speed diesels that involve highly sophisticated thermodynamic, tribological, and fluid dynamic designs. They require efficient turbocharging, fuel injections under high pressures, and efficient cooling systems for continuous high load operation and must comply with strict IMO emission norms (MARPOL Annex VI), thus needing extensive R&D and precision manufacturing. Even leading engine makers like MAN Energy Solutions and Wärtsilä have spent decades refining designs to balance efficiency, reliability, and regulatory compliance.
3. **Economic Viability:** Establishing indigenous production is capital-intensive. It requires heavy investment in foundries for large castings, precision machining for massive crankshafts and cylinder liners, advanced test beds, and skilled human resources. Further, prominent manufacturers of marine engines, such as MAN Energy Solutions, Wärtsilä, and Rolls-Royce, have dominated the global market for a long time, supplying shipbuilders and commercial fleets worldwide with advanced propulsion systems. Competing with established multinational giants, who benefit from economies of scale and global service networks, often results in low initial market share and long return-on-investment cycles.



# Global Best Practices

Countries like China, Japan, and South Korea have strategically invested in domestic R&D, robust manufacturing infrastructure, and strong intellectual property regimes to secure maritime self-reliance. South Korea's marine diesel engine market was valued at US\$1.5 billion in 2024, a figure projected to reach US\$2.1 billion by 2033 (i.e., a CAGR of 3.6 percent), driven by giants like Hyundai Heavy Industries and Samsung Heavy Industries.<sup>20</sup> Japan retains a significant global presence in the medium- and high-speed marine engine market, led by major industrial players such as Mitsubishi Heavy Industries and Kawasaki Heavy Industries, with Asia-Pacific capturing around 44 percent of global marine-engine revenues in 2024.<sup>21</sup> China, too, which operates the world's second-largest commercial fleet and produces 96 percent of shipping containers, expects its hybrid marine propulsion market to grow at a CAGR of over 14 percent through 2030, backed by state shipbuilders like China Shipbuilding Industry Corporation and COSCO.<sup>22</sup>

These countries' successful pursuit of the development of indigenous marine engines provides valuable insights for India:

**Japan:** Japan had begun working on its engine technologies before the First World War. Following the Second World War, businesses like Kawasaki Heavy Industries and Mitsubishi Heavy Industries acquired foreign technology licenses to expedite development. They then made large expenditures in domestic R&D, gradually moving away from licensed production and toward original concepts that satisfied domestic and global needs. Thanks to this deliberate strategy of leveraging licensed technology initially to gradually build its research capabilities, Japan became the world leader in the production of marine and automotive engines in under thirty years, demonstrating that long-term industrial self-reliance can be achieved with a defined policy of local innovation and technological adaptation.

**China:** China faced problems like those currently plaguing India's maritime engine industry in the 1990s specifically, inadequate domestic design capabilities, reliance on imports, and technological gaps. China's aggressive strategy to overcome these included reverse engineering, mandatory technology transfer for foreign joint ventures (for instance, its China State Shipbuilding Corporation Marine Power (a subsidiary of China State Shipbuilding Corporation) rose to prominence by systematically absorbing

# Global Best Practices

licensed foreign technologies from original equipment manufacturers and gradually developing local capabilities), strategic acquisitions of foreign companies (for instance, Weichai's stake in European engine companies), and consistent investment in domestic R&D. This multifaceted approach allowed companies like Weichai Power and Shanghai Diesel Engine Co. to develop strong design and production capabilities. As of 2024, China's marine engine sector has progressed significantly. China State Shipbuilding Corporation, Marine Power, and Weichai Power together account for approximately a 15–20 percent share of the global marine engine market.<sup>23</sup>

**South Korea:** Through joint ventures and strategic investment in marine engines, South Korea transformed from a shipbuilding novice in the 1970s to a global leader within three decades, aided by strong state support, licensed engine designs, tech transfers, and a strong focus on R&D and skilled manufacturing.

These trajectories show that strategic collaboration of companies with established engine original equipment manufacturers, paired with indigenous innovation, is a proven path to self-reliance. India must follow the same path of sustained policy support, technology transfer, and long-term investments in education and shipbuilding ecosystems to build its indigenous marine engines.

# Establishing Domestic Production of Marine Engines: Strengths

India must leverage its current advantages to manufacture its marine engines. Engine design and testing expertise is held by organisations such as the Automotive Research Association of India (ARAI), the Gas Turbine Research Establishment (GTRE), and Naval Science and Technological Laboratory. In this regard, ARAI's efforts have led to the development of low-emission, fuel-efficient automobile engines, which have significantly benefited India's automobile industry. GTRE has demonstrated its ability to manage intricate propulsion systems through the development of gas turbines for aircraft. These accomplishments provide useful insights for marine applications. India can accelerate the design and production of dependable, reasonably priced domestic marine engines by successfully tying the knowledge acquired in automotive and aerospace propulsion to maritime needs.

Further, India's premier institutions—such as IIT Madras (National Centre for Combustion Research & Development, which hosts the Advanced Propulsion Technologies Laboratory), IIT Bombay (Energy Systems Lab), IIT Kharagpur (Centre for Ocean, River, Atmosphere and Land Sciences), IISc Bangalore (Interdisciplinary Centre for Energy Research), IIT Delhi (Thermo-fluids and Energy Systems Lab), and Indian Maritime University, Kolkata (Marine Engineering Workshop)—produce numerous skilled ocean and marine engineers annually, who can be utilised to drive the maritime industry. By establishing an industry-academia bond, these institutions can transition from theoretical research to practical implementations and advancements.

Finally, the Defence Research and Development Organisation (DRDO) has already initiated the Indigenous Marine Diesel Engine Project 76, which aims to design and develop indigenous diesel-electric submarines for the Indian Navy. DRDO wants to collaborate with different entities to increase the indigenous content by 90-95 percent.<sup>24</sup> This could mark a significant step towards building domestic capacity to produce marine engines.

# A Roadmap for *Atmanirbharta* in Ship Engines

India must adopt a coordinated approach to transform these strengths into tangible outcomes and realise complete *Atmanirbharta* in the marine sector by 2050:

1. Private companies and public bodies must collaborate to pool resources and expertise in engine technology R&D.
2. Specialised training initiatives must be established to build an enhanced manufacturing and engineering workforce. Establishing marine engine-specific R&D clusters linked to leading technical colleges can be a key step in this regard.
3. Strategically optimised tax breaks should be used to encourage design ownership and innovation in addition to production. R&D expenditures, industry-academia partnerships, and the establishment of specific testing and certification facilities for marine engines should be the main focus of targeted incentives. Tax benefits should also be linked to patents being owned by Indian firms and significant local job creation, ensuring sustainable industry growth and technological self-reliance.
4. Policy initiatives, however, must go beyond general tax breaks and subsidies to effectively stimulate this industry. The implementation of specific, doable initiatives rather than broad policy rhetoric is key. A well-calibrated industrial policy mandating at least 30 percent indigenous content in marine diesel engines can act as a catalyst. Such a mandate would incentivise domestic suppliers to develop key engine subsystems like cylinder liners, pistons, crankshafts, fuel pumps, and emission control modules within India. This would not only conserve foreign exchange but also create high-value engineering and manufacturing jobs, strengthen the domestic metallurgy ecosystem, and foster collaboration between shipyards, research institutions, and private industry. Over time, gradually increasing this indigenous content threshold from 30 percent to 50 percent would enable India to achieve full marine engine assembly and component self-sufficiency.
5. Global competitiveness and the development of domestic capabilities can be balanced by reducing import taxes on essential raw materials and enforcing phased localisation goals.
6. Long-term procurement commitments from the navy and merchant shipping companies would encourage manufacturers to invest confidently in domestic technologies.



# Strategic Actions for Self-Sufficiency

1. **Establishment of a National Engine Development Authority (NEDA):** A NEDA can be established to oversee collaboration between defence research institutions, universities, and private-sector companies, facilitating effective resource distribution and simplifying the process of producing the first homegrown marine engine.
2. **Investment in Specialised R&D Facilities:** Centers of excellence can be established dedicated to marine engine technology, where theoretical insights can be transformed into practical solutions through prototyping, testing, and refining, to advance modern marine engine technology, surpassing current market leaders.
3. **Adoption of a Phased Manufacturing Approach:** Countries like Germany, China, and Japan, which have steadily improved their capabilities through incremental advancement, rather than attempting risky technological leaps of faith, have shown that a phased manufacturing approach is the more sensible and successful way to develop indigenous marine engines. Ignoring foundational stages can result in unreliable performance, unviable prototypes, and renewed foreign dependence, undermining the very goal of self-reliance. To guarantee safety, dependability, and adherence to strict standards, maritime propulsion systems require decades of incremental expertise, established supply chains, and quality control. Such a phased approach also reduces the risks of expensive failures, allows vendors to develop with technology, and enables researchers and industries to acquire the requisite experience by beginning with smaller engines and progressively moving on to more complex designs. A phased approach thus builds confidence and sustainable indigenous capacity.
4. **Launch of a Comprehensive National Framework for Marine Engine Development:** Similar to flagship initiatives like the National Quantum Mission, IndiaAI Mission, and the National Space Policy, a national framework for marine engines should be set up, which would aim to encourage innovation-driven marine ecosystems. India's push for indigenous marine engines must go beyond the defence sector and strengthen the commercial maritime industry, the backbone of our trade, logistics, and energy security. To achieve this, we need clear local content rules, strong R&D support, and close industry-academia ties that can only be achieved through clear policy support.

The worldwide marine engine market is expected to increase from US\$13.92 billion in 2025 to US\$17.46 billion by 2032, demonstrating a CAGR of 3.29 percent throughout the projected period.<sup>25</sup> India, with its vast 11,000 km-long coastline and rich maritime heritage, can be a significant player in this expanding market, potentially becoming a competitive supplier of marine engines to developing maritime nations by building a strong export-oriented supply chain. This requires a methodical approach that includes investing in state-of-the-art R&D facilities, promoting industry-research collaborations, and developing a workforce with knowledge of marine propulsion systems.

Moreover, India's push for native engine platforms, whether for warships or merchant vessels, is not merely an engineering project; it is a national strategic undertaking. Such projects involve key design information, proprietary production techniques, and performance targets that comprise the foundation of our defence abilities and economic ability to endure into the future. Indigenous engine development, thus, has to be addressed as a strategic infrastructure project, similar to those delineated in Section 70A of the Information Technology Act, 2000. The information, designs, and milestones realised within such projects are strategic assets that need to be safeguarded against cyber-attacks, espionage, and disruption. Institutions such as the National Critical Information Infrastructure Protection Centre (NCIIPC) must be involved early on to protect these digital assets, defend against possible cyber warfare, and minimise the risk of Denial-of-Service attacks. By formalising such safeguards and prioritising long-term control over propulsion technologies, India can establish a platform that can withstand all international tensions. This way, the country will be able to take its path, minimise its exposure to external pressures, and establish itself as a reliable stakeholder in international trade and security. 

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