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ELECTRO MAGNETIC AIRCRAFT LAUNCH SYSTEM

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Introduction

Keeping abreast of the latest technologies in the field of maritime warfare has become inescapable for any Navy of the world. Indian Navy too is always looking to adopt latest state of the art systems towards modernization of its ships and aircraft. In this endeavor, *IN* is likely to take a technological leap in the field of aircraft carrier operation. A beginning has been made during the visit of US President Obama, to acquire a path breaking technology of Electro Magnetic Aircraft Launch System for the new carrier (Indigenous Aircraft Carrier-II- INS Vishal) , which is at the initial stage of design and development.

Unlike ground based air operations, where a fixed wing aircraft uses required length of runway for takeoff/ landings, the same cannot be replicated on board a ship. Due to the space restrictions, various types of assisted take off/ landings are resorted to. The history of assisted take offs is as old as the invention of aircraft. In 1904, the Wright Brothers used a weight and derrick styled catapult system to assist launch of their early aircraft. The credit of first catapult launch goes to Lt. Ellyson who, in 1912, took off in a naval aircraft from a coal barge.

Assisted Take off Systems: CATOBAR & STOBAR

Aircraft Carriers, all over the world, generally use two types of technologies for launch of its aircraft. These are CATOBAR (catapult assisted take-off but arrested recovery) and STOBAR (short take-off but arrested recovery) systems. A CATOBAR system uses steam catapult for launch of aircraft. This system was also used for launch of aircraft from the deck of INS Vikrant, the first carrier of Indian Navy. Currently, only three countries operate aircraft carriers equipped with CATOBAR system; the U.S. Nimitz-class, France's Charles De Gaulle, and Brazil's São Paulo. [1]

In the STOBAR system, no catapult system is used for assisted takeoff from the deck. Presently, India's both aircraft carriers, INS Viraat and INS Vikramaditya have angled ski-jumps for fighters to take off under their own power. Only Russian, Indian, and Chinese carriers use this system for their aircraft carriers. Surprisingly, the Americans have never adopted this technique for their carriers. Technically, a STOBAR system is simpler in construction and installation than a CATOBAR system. However, only a few types of aircraft can be launched from carrier decks using STOBAR operations. A major limitation of STOBAR system is that it is capable of launching aircraft that have a high thrust to weight ratio.

Although a STOBAR system is considered cheaper in cost and inexpensive to maintain; a CATOBAR system wins this race because of its operational flexibility. No doubt, for the advantages such as; ability to launch bigger/ heavier aircraft (AWACS/ AEW & C and fully armed naval interceptors) and that too in a quick fashion, makes the CATOBAR system a preferred choice.

The Electro Magnetic Aircraft Launch System

The Electromagnetic Aircraft Launch System (EMALS) is the latest technology being inducted by the US Navy for assisted takeoffs, using CATOBAR system, from a carrier. The system is being developed by M\s General Atomics, for the future Gerald R. Ford-class aircraft carriers which are being built to replace the good old Nimitz class ships.[2]

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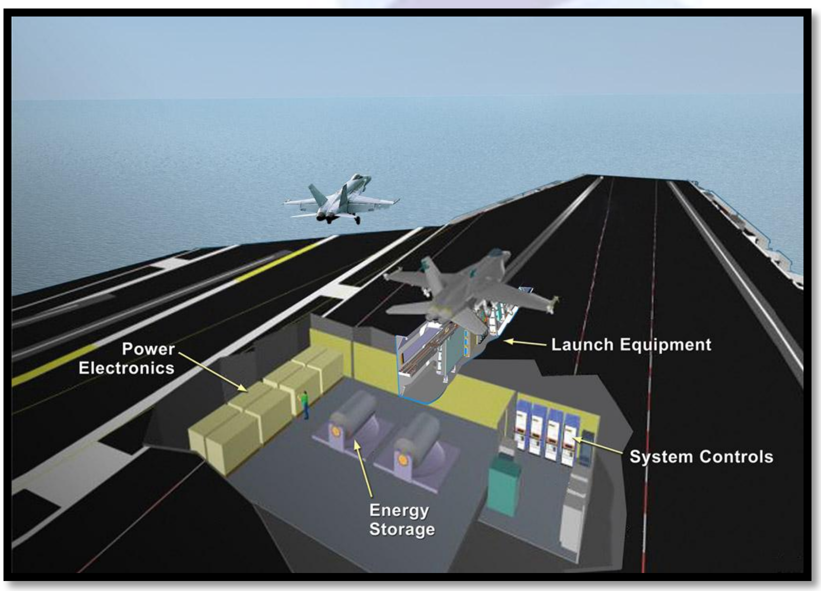
All US Navy carriers, so far, have been using steam catapults to launch aircraft from deck. Steam catapult, however, has a major drawback that it does not cater for all types of aircraft ie light as well as heavy. With the increase in variety of carrier borne aircraft, and the future requirement to have a versatile system capable of launching light to heavy aircraft (including UAVs and AWACS), without any restrictions, has driven the move towards this new technology.

The Electromagnetic Aircraft Launch System (EMALS) uses an electric motor driven aircraft catapult instead of the steam piston drive. The system uses a linear induction motor in which a magnetic field is generated by electric currents to propel a carriage along a track to launch the aircraft. The biggest advantage of this system is that it allows for graded acceleration, inducing less stress on the aircraft's airframe.[3] The induction motor, however, requires a large amount of electric power; more than the ship's own power source can provide. Finding an acceptable solution to this problem is considered a big challenge for the ship designers.



Electro Magnetic Aircraft Launch System
Source : http://en.wikipedia.org/wiki/Electromagnetic_Aircraft_Launch_System

The induction motor consists of a row of stator coils which act like an armature. When energized, the motor accelerates the carriage down the track. The system is quite similar to an electro-magnetic rail gun which is meant to accelerate the shuttle holding the aircraft. It provides a smoother launch, while holding up to 30% more (as compared to steam catapult) reserve energy capacity to cater for heavier aircraft. It is understood that the proposed EMAL system will be capable of accelerating a 45,000 kg aircraft to take off speeds up to 130 knots (240 km/h) over a 300-foot (91 m) track.[4] The turnaround is also very quick to launch aircraft every 45 seconds.

With this technology, the future US Navy carrier will be capable of operating variety of aircraft including the F-35 Joint Strike Fighter, F/A-18E/ F Super Hornet, E-2D Advanced Hawkeye,EA-18G Growler aircraft and UAVs /UCAVs.[5]

EMAL Vs Steam Catapult System

Steam catapults, though very useful and effective so far, have a big constraint regarding dependence on availability of huge quantity of steam. A typical steam catapult uses about 614 kilograms of steam per launch, and has extensive mechanical, pneumatic, and hydraulic subsystems.[6] Whereas, EMALS uses no steam, which makes it suitable for the future electric/ gas turbine or even nuclear propulsion ships.

EMALS is associated with numerous advantages which makes it an attractive option. Compared to steam catapults, EMALS weighs less and requires less manpower. It also has far lower space and maintenance requirements because it dispenses with the steam pipes, pumps, motors, control systems, etc. Further, it can control the launch performance with greater precision, allowing it to launch variety of aircraft, from heavy fighter jets to light unmanned aircraft. In fact, it has capability to provide a slower launch speed for unmanned air vehicles and allows a wider window of wind-over-deck speed required for the launch sequence. Because of the greater precision, it results in finer aircraft acceleration control, which can lead to lower stresses on the aircraft and pilots. With these advantages the EMAL system is destined to tide over the limitations of a conventional steam catapult system.

However, all these advantages come at a price. A major limitation of using EMALS catapult will be the huge quantity of electric energy required to generate the required magnetic field. Each three-second launch can consume as much as 100 million watts of electricity, about as much as a small town uses in the same amount of time.[7] For this very reason the EMAL system cannot be retrofitted in the existing Nimitz class aircraft carriers of the US Navy. This problem has been solved on board the future Ford class carrier by designing a dedicated energy-storage subsystem as a part of the EMALS. This sub system draws electric power from the ship's power generation plant, stores energy on rotors, and then releases that energy in 2–3 sec during aircraft launch. Dedicated power generation systems, having huge electric capacities, have been designed to meet the requirement.

Another drawback could be the problem of Electro Magnetic Interference (EMI) with the ship and/or aircraft electronic equipment caused due to high power electromagnetic emission. Adequate EMC measures will have to be taken to minimize these effects.

EMALS for Indian Navy

India has embarked on an ambitious project to construct its first aircraft carrier INS Vikrant at Cochin Shipyard, Kochi which is expected to enter service in 2017. The second ship of this project, a bigger carrier (65000 tons) named INS Vishal, is in preliminary stages of design/ development and expected to enter service by 2025-30. As per design, INS Vikrant will continue to be a STOBAR carrier, whereas the second ship in this series ie INS Vishal is expected to have a CATOBAR system with EMALS.

But why does India needs this complex system? Indian Navy has adequate experience of operating CATOBAR as well as STOBAR systems on board its carriers. IN aircraft Seahawk and Alize operated from the deck of INS Vikrant using steam catapult system. Presently, INS Viraat has been using STOBAR technique (with Ski jump) of assisted take offs for its integral Sea Harrier fighter aircraft. The same design is being followed on board INS Vikramaditya, where both Sea Harriers and MIG 29 K are being launched using Ski jump (STOBAR) technique. The Navy has not experienced any operational constraints so far, as it did not have any heavy aircraft in its inventory on these carriers. Even the new indigenous carrier, INS Vikrant is being constructed to operate fighter aircraft using ski jump. It is acceptable since the Navy may not have plans to operate any light (UAVs) or heavy aircraft from the carrier, in the near future. But the same limitations may not be acceptable for the carrier operations in 2025-30, by which time the Navy is expected to acquire heavier carrier borne aircraft and UAVs to meet its maritime needs.

Considering the inherent restrictions of a STOBAR system having limited capability to launch different type of carrier borne aircraft, it is natural for the Indian government to think about the other option ie catapult system for its next 65,000-tonne aircraft carrier, which is still on the drawing board. Further, once decided to go for a CATOBAR fitted carrier, it makes sense to consider the EMAL system, which is superior to the steam catapult system and capable of launching heavier as well lighter aircraft of the future. India, with its plans to have a blue water navy, certainly needs this capability to operate variety of carrier borne aircraft such as UAVs, AWACS, AEW & C aircraft and tankers, to support its ever expanding maritime surveillance requirements.

The offer made by the US firm may also be in line with the new ‘Make in India' policy initiated by the new Indian government as General Atomics is looking for local partners for development of the EMALS. Meanwhile, the US Defence Under-Secretary Frank Kendall, who now co-chairs the bilateral Defence Trade and Technology Initiative (DTTI), has stated that the

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Obama government would back the selling of General Atomics' EMALS (electromagnetic aircraft launch systems) and other key technologies to India. [8]

The Challenge Ahead

Induction of this new, state of the art, technology will certainly be a big challenge for the Navy. Besides incorporating the complex design features in the flight deck and its associated fittings, the Navy will have to make arrangements for uninterrupted electric supply to meet the enormous energy consumption requirements of the EMALS. It is well understood that the present day Diesel Alternators and other conventional power generation systems cannot meet the power supply needs of the EMALS. For this purpose, nuclear propulsion/ power generation may be the answer. In fact, the Indian Navy is also open to the idea of using nuclear power. The Director General of Naval Design admitted that they are working on the design of the second indigenous aircraft carrier which may be propelled by a nuclear-powered engine.[9]

It has been given to understand that M/s General Atomics is already in talks with the Indian government to offer the Electromagnetic Aircraft Launch System (EMALS). No decision has been announced but indications are that the system may be acquired under Transfer of Technology (ToT) under Defence Procurement Procedure (DPP). [10] It is expected that the proposal will be pushed and taken forward during visit of the new US Defence Secretary, in May 2015. A joint working group has already being formed to evaluate all aspects of the proposed system. However, on official front, no firm commitment on procurement has been made by the Navy. It is clarified that a protracted decision making system will be put into place to decide the design and fit of the new carrier and all options are being evaluated.[11]

Conclusion

India has taken a bold step in the field of maritime industry by embarking on the indigenous aircraft carrier project. Induction of such versatile platforms will certainly raise the bench mark for India’s defence industry. Adoption of the EMALS technology, if decided, for design and construction of the future carrier will surely benefit the Navy in the long run. However, thorough evaluation, systematic transfer of technology and complete understanding of the maintenance requirements will have to be incorporated in the acquisition procedure for smooth induction of such niche systems. Further, acquiring EMALS will not only be a technological jump for the shipyard but will also present new challenges in the future carrier operations.

The EMALS offers the increased energy capability necessary to launch the next generation of carrier based aircraft. This will provide a means of launching all present naval carrier based aircraft and those in the foreseeable future.[12] India, if decides to adopt this new technology, will start a new chapter in aircraft carrier flying operations. It will be interesting to watch the developments in this regard.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

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