



TEJAS

THE INDIAN LIGHT COMBAT AIRCRAFT





Tejas-Indian Light Combat Aircraft (LCA), is the smallest and lightest Multi-Role Supersonic Fighter Aircraft of its class. This single engine, Compound-Delta-Wing, Tailless Aircraft is designed and developed by ADA with HAL as the principal partner along with DRDO, CSIR, BEL, DGAQA and IAF to meet diverse needs of the Indian Air Force (IAF).

Tejas is an amalgamation of contemporary concepts and technologies such as relaxed static-stability, fly-by-wire Flight control, advanced glass cockpit, integrated digital avionics systems and advanced composite materials for the airframe.



LCA-Fighter (Indian Air Force)



LCA Navy Trainer (Indian Navy)



LCA Trainer (Indian Air Force)



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ADA



The nucleus of Tejas Aircraft is Aeronautical Development Agency (ADA) whose principal partner is Hindustan Aeronautics Limited. Indian Air Force, Indian Navy, DGAQA, BEL, various DRDO and CSIR Laboratories, Private and Public Sector undertakings and several academic institutions have actively participated and contributed to this truly national venture which has directly and indirectly bridged major technological gaps in several disciplines.

Today we have two Technology Demonstrators (TDs), Four Prototype Vehicles (PVs) which includes One Twin Seater / Trainer and Seven Limited Series Production Vehicles (LSP) undergoing Flight Trials. Initial block of flight testing of Naval variant of LCA was successfully completed. Progress is well marked by completion of Tejas Initial Operational Clearance (IOC). The programme is triumphantly moving towards certification for Final Operational Clearance (FOC).



PERFORMANCE

- Max speed Supersonic at all altitudes
- Service Ceiling 50,000 ft
- 'g' Limits +8/-3.5

DIMENSIONS

- Span 08.20 m
- Length 13.20 m
- Height 04.40 m

WEIGHT

- Take-off Clean 9800 kg
- Empty 6560 kg
- External Stores 3500 kg

POWER PLANT

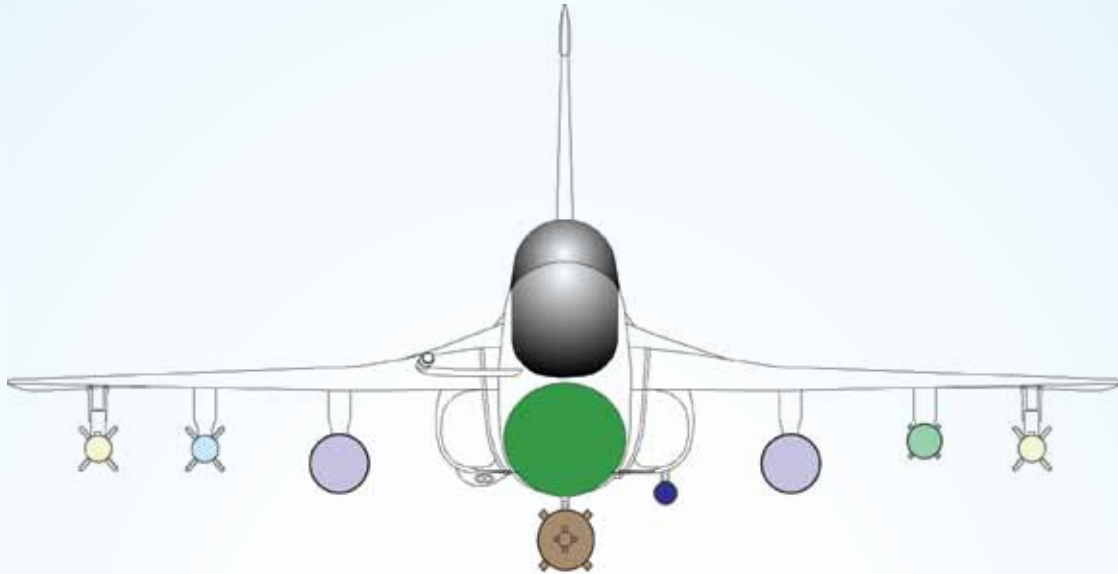
F404-GE-IN20

SPECIAL FEATURES

- > Compound Delta Planform
- > Relaxed Static Stability
- > Composite Structure
- > Fly-by-wire Flight Control

- > Computer based monitor and control of Electro Mechanical Systems
- > Glass Cockpit
- > Multi-Mode Radar

WEAPON STATIONS



6 4 2 7 L I 3 5

	6	4	2	7	L	I	3	5
BVRM								
CCM								
DROP TANKS								
SPL SENSORS								
BOMBS								
LGB								

EXTERNAL STORES

- > Air-to-air Missiles
- > Air-to-ground Missiles
- > Anti-ship Missiles
- > Laser Guided Bombs

- > Conventional Bombs
- > GSh-23 Gun
- > Drop Tanks

ACHIEVEMENTS



Tejas has participated in Hot Weather, Cold Weather, Iron Fist, Weapon Trials comprising of Bomb releases in CCRP/CCIP, R73E missile launching in MMR/HMDS Guided Mode, Stick bombing and separation trials of emergency Jettison of multiple stores/Drop tank conducted at various location in India.



- Air superiority missions with R73E CCM guided by MMR/HMDS successfully demonstrated.
- Operational Air Support Missions with 1200/800 Ltr Drop tank & 1000 LB bombs in CCRP/CCIP modes completed.
- Laser guided missions with Litening POD demonstrated for IOC envelope.
- Multi role capability demonstration during IRON FIST by simultaneous release of Laser guided bomb, Chaff & Flare dispensation and R73E missile within a span of 100 secs.
- Night Flying.
- Wake Penetration.

ACHIEVEMENTS



LCA Under Hot weather Trial at The Hottest Part of India (Temperature >48° C)

- Successfully completed more than 2430 flights.
- Sensor evaluation of MMR, Litening POD, HMDS, RWR, TACAN, IFF, VOR-ILS successfully completed.
- Spool down engine relight successfully demonstrated.
- Envelope expansion upto 24 deg AOA completed.
- Chaff & Flare dispensation integrated with RWR successfully completed.
- Operational Readiness Platform scramble readiness demonstrated.
- Fuel System, Brake Management System and General Systems performance demonstrated.
- Production Equipment Standard of Preparation & Drawing Applicability Lists (SOP/DAL) released.



LCA Under Cold Weather Flight Trials at Leh

LCA-VARIANTS

LCA Development Programme has accomplished the design and development of Fighter / Two Seater Trainer Aircraft for Indian Airforce. The success of Tejas Programme for IAF induced confidence in the Indian Navy to entrust ADA with the design and development of Naval version of LCA for Carrier based operations.



LCA Trainer (IAF)



LCA Navy Trainer (IN)



Technology Demonstrator

Prototype Vehicle

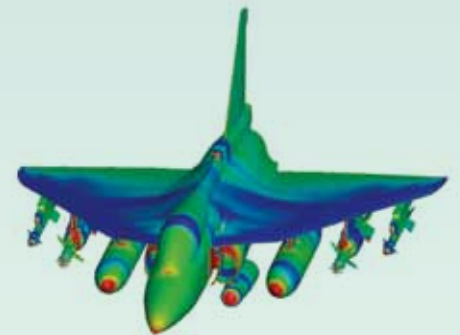
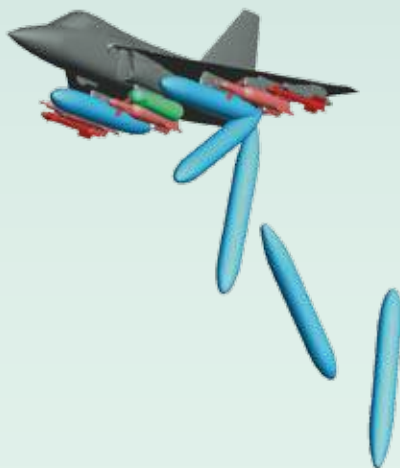
Limited Series Production

AERODYNAMICS AND PERFORMANCE

Tejas is a highly maneuverable and agile combat aircraft designed for air defence and offensive roles. It features aerodynamically unstable tailless compound delta wing configuration which is culmination of an intense design exercise involving extensive Computational Fluid Dynamics studies and Wind Tunnel testing. An additional control surface, Leading Edge Vortex CONTROLLER (LEVCON) is incorporated in LCA Navy to enable operations from a carrier.



Wind Tunnel Testing of Scale Models



CFD Simulations

Prediction of Trajectories of Drop-tanks, Bombs & Missiles

AIRFRAME

MAJOR DESIGN FEATURES

- Cost-effectiveness and weight saving achieved by use of advanced composites which constitute 43% by weight of the airframe
- Optimized Structural Design taking into account strength, buckling and Aero-Servo-Elastic requirements for carriage of heavy external stores
- Concurrent Design Practice employing Digital Mock-Up (DMU)



MATERIALS & PROCESSES

- Design, Fabrication and Qualification of **Composite Radome** and **Drop Tanks**
- Indigenous availability of Type Approved materials for aircraft application now above 70%



Scanning of Composite Wing Skin using Ultrasonic C-Scan System



Drop Tank Functional Test

TESTING

- Strength Test of Leading Edge Vortex CONTroller (LEVCON) for LCA Navy
- Successful Flight trials with indigenously designed and qualified Composite Drop Tanks
- Flight flutter tests for Operational Clean and Heavy Stores Flight Envelope expansion



Main Airframe Static Test Rig



LEVCON Strength Test



Ground Vibration Test Rig

PROPULSION

- Successful Integration and Flight Testing of GE-F404-F2J3 and IN20 Engines
- Upgradation of Jet Fuel Starter with GTSU-110 M1 for LCA Mk1, and Development of high power GTSU-127 for LCA Mk2
- The Onboard Engine Condition Monitoring System provides real time Engine Status in the Cockpit and Logs the Engine Usage Data to Compute Life Usage Indices of Life limited Parts. It also tracks Vibration Monitoring System
- Up-gradation of Engine Ground Test Facility to test IN20 engine
- Alternate engine program for LCA Mk2



GE-F404-IN20 Engine



Jet Fuel Starter



Engine Test Rig

GENERAL SYSTEMS

Major Mechanical System includes Microprocessor Controlled Brake Management System, Environment Control System, Fuel System, Nose Wheel Steering System, Landing Gear System, Hydraulic System, Secondary Power System, Life Support System, Escape System.

Major LRUs Developed by ADA are Aircraft Mounted Accessories Gear Box, Filters, Up Locks, QDCs, NRV's, Depressurisation Cock, Gimble joints, Ten different types of Heat Exchangers. All LRUs have been productionised to facilitate Equipping of Series Production.

Aircraft Mounted Accessories Gear Box (AMAGB)



AMAGB is a single input, multi output gear box, which receives its input drive from the engine through Power Take-Off and drives four aircraft accessories on its output pads viz., two hydraulic pumps, one generator and one starter unit. AMAGB is designed and developed by CVRDE, Chennai and production center is HAL - Engine Division, Bangalore.

Carbon-Carbon Composites for Aircraft Brakes



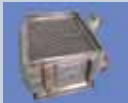
- Provide drag
- Absorb Kinetic Energy by converting into heat
- Hold Aircraft stationary against Engine thrust
- Carbon-Carbon Brakes are Developed by ASL, Hyderabad and Production Center Graphite India Ltd, Bangalore

Canopy Severance System (CSS)



- CSS Successfully developed to provide Pilot Escape during Aircraft Emergency
- CSS is Developed by ARDE and HEMRL, Pune

Heat Exchangers



Successfully designed, developed by BHEL-HPVP (Formerly BHPV) and flight qualified 10 types of compact plate-fin heat exchangers for LCA-TEJAS aircraft.

Up Lock



To lock the undercarriage (U/C) and its doors on retraction in the up position. Locking is mechanical and unlocking is controlled hydraulically. M/s Turbo Tech India Pvt Ltd., Bangalore is the Production Center.

Hydraulic Filters



Hydraulic Filters: Hydraulic system is fitted with 9 filters of 6 types to control the particulate contamination in the system. Filter element is developed by M/s Mikro Flo Filters, Hyderabad. Production Center is M/s CTTC, Bhuvaneshwar.

The high performance hydraulic filters are qualified to meet requirements of MIL-F-8815D.

Gimbal Assembly with Venturi



Gimbal Assy. with venturi is designed for Max. Operating temp :650°C with Max. Operating Pressure :37bar'g' and Movement : ± 10 mm (Three axes). M/s Metallic Bellows, Chennai and M/s Veekay Industries, Mumbai are the Production Centers.

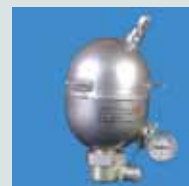
Mechanical System LRUs



ADA has Designed, Developed & Flight Qualified Mechanical System Line Replaceable Units (LRUs) for Hydraulic, Fuel, Environmental Control, Secondary Power Systems and other aggregates of Light Combat Aircraft (LCA). M/s GTTC, Bangalore and M/s CTTC, Bhuvaneshwar are the Production Centers.

These units have been qualified for aerospace applications as per MIL standards.

Fire Extinguisher Bottle



Fire Extinguisher Bottle is used to store and discharge fire extinguishant on initiation of cartridge by Push-button selection or automatically by a crash warning switch located in the airframe. Production Centers are M/s GTTC, Bangalore and M/s Veekay Industries, Mumbai.

QUALITY ASSURANCE AND SYSTEM EFFECTIVENESS

Quality Assurance and System Effectiveness plays a vital role in clearing Tejas aircraft for Airworthiness and Flight readiness and also ensuring safety of aircraft

- > Reliability and Maintainability
- > Survivability
- > System Safety and Air Worthiness
- > Quality Engineering

RELIABILITY &
MAINTAINABILITY

SURVIVABILITY

QUALITY
ENGINEERING

SYSTEM SAFETY &
AIR WORTHINESS



AVIONICS AND WEAPON SYSTEM



OAC MISSION & DISPLAY SYSTEM TEST FACILITY



AVIONICS INTEGRATION TEST FACILITY



GLASS COCKPIT

- Advanced Glass Cockpit with High Performance Graphics to Support Situational Awareness, Decision Support and Data Fusion
- Dual Redundant Open Architecture Mission and Display Computer
- UML Based Modeling, IEEE-12207, ADA-95 On-Board Flight Certified Avionics Application Software
- Computer Controlled Utility System and Management System (USMS)



WEAPON INTEGRATION TEST FACILITY



MULTI MODE RADAR TEST FACILITY

- Helmet Mounted Sight, Multi Mode Radar, Litening Pod and Radar Warning Receiver
- Digital Weapon Management System Compatible to Russian, Western and MIL-1760C Weapons
- Single Avionics Application Cater to Multiple Variants of Aircrafts
- Well Proven Air-to-Air, Air-to-Ground Attack Modes

PROTOTYPE VEHICLES AND PRODUCTION

Advanced Composites



- Development of engine parts - Bypass Duct, Nozzle Flap, Bullet Nose Cone
- Curing in both autoclave and press
- Indigenous resin
- Glass Transition Temperature in excess of 300°C
- Rear fuselage applications planned

Water Tightness Tests



- Technology developed to arrest water seepage into critical areas of aircraft
- Development of sealant templates and special test rig
- Implementation of design upgrades
- Successful testing of aircraft in test rig

Ground Handling Equipment



- Indigenous development
- Single trolley multiple operations
- Shorter flight readiness cycle time
- Loading trolleys for Drop Tanks, Weapons, Digital Flight Control Computer, Battery, Jet Fuel Starter, Landing Gears etc.

Lightning Test Facility



- Well established lightning test facility
- Both direct and indirect effects
- Lightning requirements of composite structures by means of explosive atmosphere tests

Autoclave Consumables

- Qualification of indigenous autoclave consumables like pressure sensitive tapes, vacuum bag sealants and release films for Carbon/Epoxy system

Productionisation

- Introduction of laser tracker, high speed machining, automated drilling and riveting technologies
- Application of DFMA concepts
- Production standard drawings
- Build quality improvement and cycle time reduction

Aircraft Paint System



- Indigenous aircraft paint system
- Characterisation to DEF STAN 80-216, BS 2X 33 & 34
- Application process fine tuned
- Currently being used for LCA

Automatic Cable Harness Tester



- Configured and commissioned Automatic Cable Harness Tester
- Megger & continuity checking capabilities
- Automated reports
- Considerable time savings during aircraft equipping

Digital Mock Up



- Production standard Digital Mock Up (DMU) including system pipelines and electrical looms
- Capabilities like GD&T, tolerance analysis and assembly sequencing being introduced

Product Lifecycle Management (PLM)

- Implementation for all projects
- Complete product data management across work centers
- Pipelines and electrical looms data management
- Synchronization of data, query workflows from design through manufacturing
- Digital manufacturing and ERP interface
- Online design query management for faster disposition
- Real time status dash boards for effective tracking

INTEGRATED FLIGHT CONTROL SYSTEM

- State-of-the-art Full Authority Quadruplex Digital Fly-By-wire Flight Control System
- Fault Tolerant Digital Flight Control Computer with built-in Redundancy Management
- Fail Operational, Fail Operational, Fail Safe DFCS and Fail Operational, Fail Safe Air Data System
- Robust Control Laws for Stability and Command Augmentation, Carefree Manoeuvring, Autopilot Control and Ski Jump Functionalities
- Advanced Flight Control Actuators incorporating both Hydraulic and Electrical Redundancy
- Range of Ground Based Test Facilities for Integrated Flight Control System Development, Handling Qualities Evaluation, Non-Real Time Tests, Real Time Simulation, Hardware-in-loop Simulation, Structural Coupling Tests, Lightning Test, Ground Check out Systems and Flight Test
- Test Facilities equipped with State-of-the-art Flight Dynamic Simulator, Engineering Test Station, Air Data Test Station, High End Projection Systems, Data Acquisition, Analysis and Storage System



IRON BIRD



ENGINEERING IN LOOP SIMULATOR



REAL TIME SIMULATOR



LIGHTNING TEST FACILITY



MINI BIRD FACILITY



SYSTEM ANALYSIS & EVALUATION FACILITY

AIRCRAFT SYSTEMS MAINTENANCE SIMULATOR

MAINTENANCE SUPPORT DEVICE

Interactive parts browser to support logistics function and electronic browser to refer maintenance work card



TUTORING SIMULATOR

Dual display simulator providing dynamic projection to trainees and tutoring assistance to instructor



COCKPIT PROCEDURE TRAINER

Touch sensitive simulator for practising interactive cockpit drills



CAUSE AND EFFECT SIMULATOR

Interactive dual display simulator for enhancing analytical skills



I-MANUAL BROWSER

Touch sensitive electronic manual with hyperlink and dynamic simulation features



VERBO-VISUAL SIMULATOR

Interactive triple display simulator for procedure training and self study during Own Time Work



INDEPENDENT VERIFICATION AND VALIDATION

The Independent Verification & Validation (IV&V) laboratory at ADA has been set up to address the safety issues of software intensive systems of LCA, thereby obtaining a high level of confidence in the operations of new systems prior to their use.

IV&V plays a major role in the design and development of embedded software and aims at development of hazard free and mission-success oriented software employing modern CASE tools viz. Modelling and Simulation, Rapid Prototyping, Tool based analysis and Randomised Non Real Time testing (NRT). Seven safety critical and Twenty Three mission critical software systems of Tejas have been evaluated and close to 2000 successful sorties of Tejas have been completed adhering to IV&V practices.

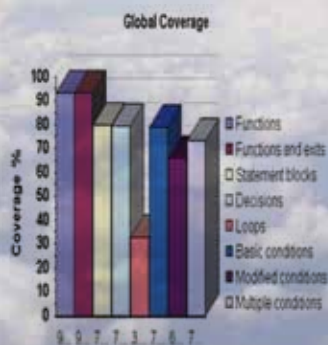
The IV&V process supports standards like IEEE-12207 and RTCA DO-178B. The IV&V process has evolved to support concurrent software development techniques using OOAD and Model Driven Development (MDD) methods for LCA applications.



Non Real Time Test Setup

NRT setup at IV&V lab has been developed in-house by using COTS s/w to do V&V and stress test of Safety Critical On Board s/w in Non Real Time mode on a target board.

Matlab/Simulink, Rhapsody, Rational Development Suite, AdaTest95, Logicscope, LDRA, Understand for Ada/C++, Beyond Compare and Clearcase are some of the tools used during various stages of software development to improve the product and make it robust apart from shortening the development and certification time.



Independent Verification and Validation Test Facilities



FLIGHT TESTING

National Flight Test Center is the directorate of ADA dealing with flight testing of LCA. All the flight test and aircraft instrumentation related activities are planned, coordinated and executed by NFTC which is headed by a Test Pilot from Indian Air Force. NFTC has Indian Air Force and Indian Navy test pilots and flight test engineers along with the scientists and engineers for instrumentation who are professionally carrying out the flight testing of the LCA.



National Flight Test Centre

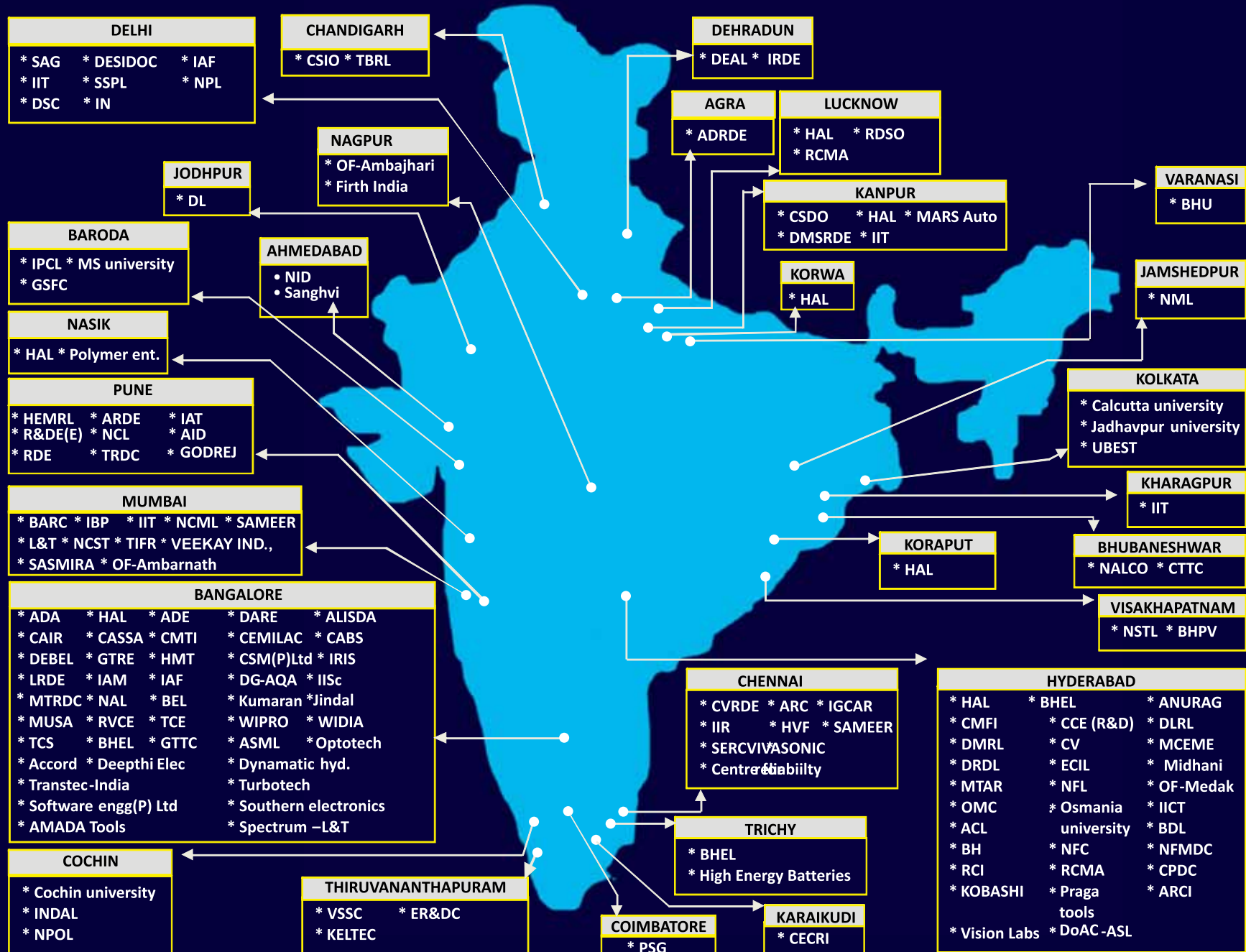


R73 E Missile Firing



LCA Flight Trials at Leh

WORK CENTRES OF LCA PROGRAMME







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