

## CHAPTER II : PROJECT PROGRESS

**Objective: To examine the execution of the LCA project to assess the achievement of Air Staff Requirement and Weaponisation for LCA.**

### 2.1 FSED Phase-I

Cabinet Committee on Political Affairs approved (Feb 1991) in principle, execution of the LCA project in two Full Scale Engineering Development (FSED) phases as detailed below:

FSED Phase-I closed without achievement of milestones

FSED Phase-I: Building and limited flight testing of two LCA Technology Demonstrator (TD1 and TD2) aircraft to demonstrate confidence levels in critical technologies<sup>1</sup> through 210 hours of test flying and parallel development of other technologies<sup>2</sup> and proving them on ground rigs/ flying test beds.

FSED Phase-II: Building further five prototypes and integration of other technologies developed in parallel in Phase I, Integration of Kaveri engine, Flight-testing and weapon integration to achieve IOC and FOC.

Accordingly, FSED Phase-I was sanctioned (June 1993) by GoI at a cost of ₹2188 crore<sup>3</sup> [including Foreign Exchange (FE) ₹873 crore] for development and limited flight testing of two LCA Technology Demonstrators (TD1 & TD2) and parallel development of other technologies by June 1998.

It was however seen in audit from the approval (November 1995) of the General Body, ADA, that during the course of FSED Phase-I, ADA had, on the ground of accelerating the development process of LCA, advanced the manufacture of two prototypes (PV1 and PV2) from FSED Phase II to FSED

<sup>1</sup> Fly-by-wire control system, Composite technology, computer controlled Electro Mechanical System & Glass Cockpit.

<sup>2</sup> Multi-Mode Radar (MMR), Internal Self-Protection Jammer (SPJ)/Radar Warning Receiver (RWR).

<sup>3</sup> This amount was inclusive of ₹560 crore sanctioned in August 1983.

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Phase-I so as to utilise the savings in FSED Phase-I occurred due to shifting of certain systems<sup>4</sup> from import list to indigenous development list. ADA's decision was in contravention of the Cabinet approval for Phased development, wherein the building of PVs was to be taken up in FSED Phase-II only after TDs had been built and flight tested for 210 hours to demonstrate confidence levels in critical technologies.

As a result of ADA's decision, the two PVs (viz. PV1 and PV2), building of which was taken up even before the first flight of TDs<sup>5</sup> and development of other technologies, could not be integrated with systems such as Multi-Mode Radar<sup>6</sup> (MMR), Internal Self Protection Jammer<sup>7</sup> (SPJ)/Radar Warning Receiver<sup>8</sup> (RWR) (other technologies) which had not been developed by then (1995-2006). These systems were required to be developed and proved on ground rigs/flying test beds in FSED Phase-I and integrated on the PVs in FSED Phase-II as per the phased development sanctioned in June 1993.

Subsequently, as per the sanction (November 2001) for FSED Phase-II, remaining three PVs and eight Limited Series Production (LSP) aircraft were to be manufactured and the LSPs were required to be delivered (May 2006-May 2008) to IAF. Besides, the PVs were also required to be integrated with the other technologies (MMR, SPJ, RWR).

However, we observed that decision of ADA to advance the development of PV1 and PV2 had a cascading effect on the remaining PVs (PV3, PV4 (converted as PV6<sup>9</sup>) and PV5), which were also rendered deficient of these systems (MMR, SPJ, RWR). As a consequence of this, ADA had to resort to utilisation of even the LSP aircraft (which were to be handed over to IAF) towards flight testing/evaluation as discussed under Para 2.2. The decision to advance building of two PVs was got ratified by ADA from GoI (January 1998).

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<sup>4</sup> Carbon Fibre Composite Wing, Jet fuel Starter and Aircraft Mounted Accessory Gear Box.

<sup>5</sup> First flight was made on January 2001.

<sup>6</sup> Used for tracking targets from Air to Air, Air to Surface including sea. It facilitates all weather launching of weapons.

<sup>7</sup> Internally mounted electronic warfare system that detects and interprets radar signals and automatically selects the proper countermeasure to jam or deceive them.

<sup>8</sup> Alerts pilots of the various types of hostile emitters employed by other countries and enables pilots to initiate suitable action to minimize attrition.

<sup>9</sup> Discussed at Para 2.3.1.

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The development of other technologies (MMR, SPJ, RWR) and development of Kaveri engine was also delayed as discussed in sub Para 2.3.4 and Chapter III.

Various milestones under FSED Phase-I and their actual achievements are indicated in Table I below:

**Table I**

<b>Sl No</b>	<b>Milestone</b>	<b>Scheduled date of completion</b>	<b>Actually date of completion</b>
1	Roll out of first aircraft (TD1)	June 1995	November 1995
2	First flight of first aircraft (TD1)	December 1996	January 2001
3	First flight of second aircraft (TD2)	September 1997	June 2002
4	First flight of PV1 <sup>10</sup>	December 1999	November 2003
5	First flight of PV2 <sup>11</sup>	June 2000	Shifted to FSED Phase II
6	Completion of 210 hours of flying (TD1 and TD2)	June 1998	124 hours completed by 31 March 2004 and balance shifted to FSED Phase II

Department of Defence R&D, MoD had requested (April 2005) approval of Cabinet Committee on Security for post-facto closure of FSED Phase-I with effect from 31 March 2004 and within the sanctioned cost of ₹2,188 crore while the remaining flight testing of TDs, flight testing of PV2 and completion of development of Multi-Mode Radar (MMR) would be carried out as part of LCA FSED Phase-II. Based on CCS approval, GoI accorded post-facto sanction (July 2005) for the closure of FSED Phase-I with effect from 31 March 2004. ADA also carried forward (August 2005) balance work of 42 ongoing work packages valuing ₹65.16 crore as on 31 March 2004 to FSED Phase-II. These 42 work packages pertained to development of MMR, Flight control System actuators, Digital Flight Control Computer, Jet Fuel Starter, Drop Tanks, etc (delay in development of these systems has been discussed in sub-para 2.3.4, 2.4.2 and Chapter III).

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<sup>10</sup> As per GoI ratification of January 1998.

<sup>11</sup> As per GoI ratification of January 1998.

Thus, in spite of the fact that FSED Phase-I was delayed by six years and treated as completed in March 2004 as against the scheduled completion of June 1998, the intended objectives of the phased development were not met completely. ADA's decision (1995) to advance two PVs from FSED Phase-II to FSED Phase-I in order to accelerate the LCA programme failed to yield the desired results, as other technologies (MMR, SPJ, RWR) to be integrated on PVs were yet to be developed and proved.

## 2.2 FSED Phase-II

FSED Phase-II ongoing with delayed completion of mile-stones

While FSED Phase-I was in progress, MoD, Department of Defence R&D submitted (November 1999) a Note to CCS seeking an interim sanction of FSED Phase-II towards developing remaining three prototypes including one trainer variant (PV-3, PV-4 and PV-5) at a cost of ₹666.34 crore, on the ground that some of the work centres had already completed the activities assigned to them under FSED Phase-I and it was necessary that the remaining tasks were also assigned to them to avoid idling of facilities. Accordingly, GoI accorded sanction (February 2000) for Interim FSED Phase-II, specifying that this sanction would merge with the final FSED Phase-II sanction.

Later, Department of Defence R&D, MoD submitted (October 2001) a Note to CCS for sanction of FSED Phase-II which included apart from the three prototypes sanctioned under Interim FSED Phase-II, completion of Initial Operational Clearance (IOC) and Final Operational Clearance (FOC) using all the LCA prototypes by December 2008. The Note also sought (October 2001) creation of production facilities at HAL at the rate of eight aircraft *per annum* and concurrent production of eight Limited Series Production (LSP) aircraft (for IAF use), in order to address technology transfer issues involved in the transition from development to production and also to reduce production lead time. GoI sanctioned (November 2001) the proposal of DRDO for FSED Phase II at a total cost of ₹3301.78<sup>12</sup> crore (FE ₹1526.49 crore) with a probable date of completion (PDC) by end December 2008.

Various milestones under FSED Phase-II and their actual achievements are indicated in **Table II** below:

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<sup>12</sup> Including interim sanction of ₹666.34 crore.

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**Table II**

Sl No	Milestone	Original date of completion (November 2001)	Revised date of completion (November 2009)	Actually achieved date
1	PV2- first flight (Carried forward from Phase-I)	December 2002	-	December 2005
2	PV3-first flight	July 2003	-	December 2006
3	PV4 <sup>13</sup> -first flight	December 2003	Jan-Feb 2010	November 2014
4	PV5-first flight (Trainer)	October 2004	August 2009	November 2009
5	Achievement of IOC	December 2005	December 2010	December 2013
6	Creation of facilities for achieving LSP of 8 aircraft per annum at HAL	May 2006	May 2006	Facilities created at HAL only for manufacture of four aircraft
7	Manufacture of eight LSP standard LCA by HAL and delivery to IAF	May 2006 - May 2008	May 2006 - May 2008	HAL manufactured seven LSP aircraft <sup>14</sup> during April 2007 to March 2013
8	Achievement of FOC	December 2008	December 2012	Not achieved

It is evident from the above Table that building of PVs was completed three to eleven years beyond the scheduled date. This further contributed to delay in achieving of IOC, which was achieved in Dec 2013, against the sanctioned date of December 2005.

Audit observed that delays pertaining to achievement of milestones of FSED Phase II were mainly on account of continued design modifications on LCA (discussed at Chapter IV Para 4.5.1) and low availability of aircraft (discussed at Chapter IV Para 4.2.3).

As per the MoU (June 2002) entered into between HAL and ADA, HAL was to manufacture and supply eight LSP aircraft between 2006 and 2008. Against this, HAL supplied seven LSP aircraft during April 2007-March 2013 with a delay ranging from 4 to 51 months, mainly due to design changes by ADA, which resulted in equipping each of the LSPs with different configuration (as discussed in Chapter IV Para 4.5.1). We also observed that ADA had utilised these LSP aircraft towards flight testing/evaluation for achieving IOC/FOC,

LSPs built for IAF use were utilised by ADA towards flight testing /evaluation purposes

<sup>13</sup> PV4, which was a fighter version was re-designated as a Trainer Version, PV6 in December 2005, thus rendering one fighter prototype deficient for flight testing/evaluation against the initially planned four fighter prototypes (PV1 to PV4).

<sup>14</sup> LSP-6 was planned for 2015-16.

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instead of handing over these aircraft to IAF, in contravention to the commitment given (October 2001) while obtaining GoI sanction for building these LSPs under FSED Phase II.

When reasons for using the LSPs for flight testing/evaluation instead of handing them over to IAF were enquired (July 2014) in audit, ADA stated (October 2014) that due to shortcomings on TD/PV aircraft (discussed in Para 2.1), LSP aircraft were built in a phased manner with specific capabilities. As such the transfer of technology to the production agency (HAL) was executed in batches by identifying the LSP-1 to LSP-8 to resolve design issues and conduct the flight test towards finalization of standard of preparation (SOP) for production.

Reply of ADA confirms the audit view that building of PVs before development of other technologies resulted in these aircraft having shortcomings, compelling ADA to utilise even the LSPs towards flight testing of LCA.

Thus, the purpose of manufacturing of LSPs for the usage by IAF has not yet been met (January 2015) and these aircraft have been used by ADA as additional prototypes for evaluation purposes, in contravention to the commitment given (October 2001) while obtaining sanction for building these LSPs.

In November 2009, GoI extended the milestones of LCA project up to end of December 2012 (IOC-December 2010 and FOC-December 2012) and additional amount of ₹2475.78 crore (FE ₹581.92 crore) was sanctioned to cover extended programme cost, expenditure towards Programme Management, maintenance and operational cost of 15 aircraft (2 TDs, 5 PVs and 8 LSPs), foreign flight test consultancy for optimizing the flight testing, spares for LSP aircraft, etc. Out of this, the major portion of the cost towards maintenance of 15 aircraft (₹187.78 crore) during this extended period was due to ADA utilising the LSP aircraft along with TDs/PVs towards flight testing/evaluation.

However, even these extended timelines could not be adhered to by ADA as LCA achieved IOC only in December 2013 and FOC is yet to be achieved (January 2015). In response to an audit observation (December 2014) regarding non-accomplishment of FOC, ADA stated (January 2015) that FOC of LCA had been rescheduled to December 2015.

Thus, LCA programme sanctioned in 1983 and taken up (1993) as phased development for completion by 2004, is yet to be completed (January 2015). This had impacted the manufacture of 20 IOC standard LCA and 20 FOC standard LCA, for which contracts had been awarded by the Ministry to HAL in 2006 and 2010 (as discussed in Chapter IV Para 4.6.1 and Para 4.6.2) and induction into IAF to tide over the depletion of combat squadrons (as discussed in Chapter IV Para 4.7 and 4.9).

### **2.2.1 Inadequate expertise in flight testing and consequent flight test consultancy with a foreign firm**

An Empowered Committee (EC) was constituted (November 2006) with Chief of Air Staff as its chairman to monitor the flight development activity and all issues for smooth induction of LCA on a quarterly basis. It is seen in Audit from the minutes of the very first meeting of the EC (December 2006) that there was inadequate expertise in flight testing within the Indian design community; and therefore EC felt that consultancy with reputed design centres in advance nations would be needed for flight testing to meet the IOC and FOC schedules.

Accordingly, ADA concluded (March 2009) a consultancy contract with M/s EADS, Germany at a cost of 18.5 Million Euros (₹127.65 crore) which comprised two Phases:

- Phase I of the consultancy contract was to be completed by July 2011 along with the achievement of IOC of LCA and
- Phase II of the consultancy contract was to be completed by January 2013 along with the achievement of FOC.

ADA could not implement all the recommendations of the consultancy contract pertaining to both Phase-I and II during its currency by January 2013 as detailed below:

- Pertaining to IOC Release Sequence of carrier Bomb, Light Stores
- Pertaining to FOC
  - i. System test philosophy, test process, rig test environment,
  - ii. BVR Missile and usage of Air-to-Air Identification of Friend or Foe,
  - iii. ADA Rig improvements using the Test Support System

ADA could not complete flight testing activities for FOC during the currency of the consultancy contract and had to go in for a second consultancy contract for completing these activities

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However, ADA signed (March 2013) the Closure Report of the consultancy contract treating the contract closed with retrospective effect from January 2013, as PDC of consultancy contract had since expired in January 2013.

In response to an audit observation seeking (October 2014) the reasons for not implementing the recommendations of the consultant and acceptance of the closure of the contract, ADA clarified (October 2014) that it could not implement the consultant recommendations during the period of the contract as IOC schedules were shifted because of major safety related snags, ejection related issues, etc. ADA further stated (January 2015) that task wise recommendations of consultant were since implemented for achieving IOC and in respect of Phase II of the contract (FOC), it was stated that these were understood and work was in progress.

Audit further observed (October 2014) that ADA concluded (August 2014) another contract with the same firm viz. EADS, Germany for consultancy in flight testing for achieving FOC and Post-FOC activity for a period of 16 months with consultation charges of 3.7 Million Euros (₹30.34 crore). The scope of work included consultancy for (i) Flight test envelope expansion and carefree maneuvering and (ii) separation of weapons and stores from LCA and (iii) design improvement of the Crew Escape System. Out of the three tasks, two tasks at (i) and (ii) were already included as part of the scope of the first consultancy contract (March 2009).

Audit enquired (October 2014) reasons for conclusion (August 2014) of another contract with the same firm for two tasks which should have been completed under the first contract. In response, ADA while admitting the fact of re-inclusion of the two tasks in the scope of work, clarified (October 2014) that the Phase III included not only FOC related tasks, which would be completed within six months, but also post-FOC activity related to design improvements of Crew Escape System.

The fact remains that all the recommendations of consultant under the first contract (March 2009) were not implemented. The financial impact on account of re-inclusion of the two tasks of the first contract again in the second contract could not be quantified in Audit as there was no task wise price in the above contracts. Also, the very purpose of going in for flight consultancy for timely meeting of the IOC/FOC schedule was also not met.



### **2.3 Shortfall in accomplishment of Air Staff Requirement (ASR)**

Air Staff Requirement (1985) prescribes the physical parameters of LCA such as aircraft weight, fuel capacity, load carrying capacity of weapons, missiles, survivability, navigation, etc and features like single point defueling, pilot protection system, all weather operations, fuel system protection etc. to make the aircraft capable of performing its role of multi mission fighter aircraft and have increased survivability against battle damage. The ASR also envisages timeline for induction of LCA, quantity of LCA fighter and trainer required. There were no revisions to the ASR by IAF, except in respect of weapon requirements, as discussed in Para 2.3.2.

The Project Definition Phase (PDP) document of LCA prepared by ADA (December 1988) had been reviewed by Air HQ (March 1989) who found it deficient in the crucial parameters of aerodynamic configuration, volume and weight as set in ASR, particularly with reference to significant increase in weight of LCA, which could adversely affect performance. To resolve the deadlock, it had been decided (March 1990) that the development may be executed as Full Scale Engineering Development (FSED) in a phased manner.

We however observed during the course of audit that LCA which had achieved (December 2013) IOC did not meet the ASR in terms of increased weight, reduced internal fuel capacity, non-compliance of all-weather operations, non-achievement of single point defueling, fuel system protection, pilot protection, etc., for which, ADA obtained (December 2013) from Air HQ altogether 53 temporary concessions/permanent waivers.

To an audit observation (June 2014) regarding operational impact of the concessions/ waivers, IAF replied (December 2014/February 2015) that the concessions/permanent waivers would adversely impact the operational performance.

The 20 permanent waivers were granted for ASR parameters which the current configuration of LCA Mk-I with GE-F-404-IN20 engine cannot achieve. Also, the performance shortfalls applicable to 20 IOC aircraft under production at HAL will also be applicable 20 FOC aircraft as these waivers were granted for LCA Mk-I in its current configuration. The 33 temporary time bound concessions were granted for ASR parameters which are still under design/development and testing and would adversely affect LCA's combat potential.

LCA Mark-I achieved IOC in December 2013 with 53 waivers/ concessions due to shortfalls in meeting the ASR, impacting its operational utilisation by IAF

Thus, the views expressed by Air HQ as early as in March 1989 that the aircraft planned to be developed by ADA would be deficient in crucial parameters of aerodynamic configuration, volume and weight adversely affecting its performance have not been overcome in LCA Mk-I developed by ADA as it does not meet the requirements of IAF fully in terms of combat potential and survivability.

It was precisely with this forethought that the Empowered Committee headed by Chief of Air Staff had recommended in October 2007 for the building of LCA Mk II under FSED Phase III in order to meet the ASR parameters. Consequently, till the LCA Mk II is developed, manufactured and inducted into squadrons, the IAF would be constrained to use the LCA Mk-I (40 aircraft) with reduced operational capabilities.

### **2.3.1 Delay in development and supply of trainer aircraft and simulator**

In order to impart effective operational training in air combat and ground attack to IAF pilots, the ASR also specified delivery of a trainer variant of LCA and a full mission flight simulator, which are discussed below:

#### **A. Trainer aircraft**

LCA trainer aircraft is yet to achieve IOC/FOC, thus trainer aircraft cannot be produced by HAL and supplied to IAF, impacting the training requirements

The ASR envisaged a total requirement of 200 fighters and 20 trainer aircraft of LCA. The trainer variant of the LCA was to retain all attributes of the fighter variant except for the changes necessary to accommodate a second seat for imparting training to IAF pilots. The ASR had envisaged that the fighter and trainer aircraft should enter the IAF service by 1994.

Out of the five prototypes to be built under FSED Phase-II, PV5 was to be the trainer prototype. However, based on the requirement projected (December 2005) by IAF for an additional trainer prototype, ADA decided (March 2006) to convert PV4, a fighter variant prototype, to a trainer variant (as PV6). These trainer prototypes (PV5 and PV6) were also to be built and flight tested along with the fighter prototypes (PV1, PV2 and PV3) towards achieving IOC/FOC and consequent production of trainer aircraft against 20 IOC and 20 FOC contracts (2006, 2010) at HAL (each of these contracts included 4 trainers along with 16 fighters). However, first test flight of PV5 was achieved only in November 2009 and PV6 achieved its first flight only in November 2014. Consequently, trainer LCA is yet to achieve IOC/FOC

(January 2015). Air HQ had expressed in Empowered Committee meeting held in April 2013 that availability of operational trainer aircraft was essential for pilot training.

When Audit pointed out (May 2014) delays in attaining IOC/FOC of trainer prototypes and their consequent non-availability to IAF, Air HQ stated (December 2014) that non-availability of trainer aircraft would have adverse impact on pilot training. In response to an audit query (December 2014) regarding non availability of trainer LCA, ADA stated (January 2015) that PV-6 would be handed over to IAF for pilot training.

ADA's reply is not tenable as a prototype trainer is not a substitute for a production standard trainer which had undergone flight testing/certification towards meeting the operational standards.

Thus, HAL would not be able to produce production standard trainer aircraft (against IOC/FOC contracts) for IAF till the achievement of IOC/FOC of trainer aircraft and its finalization of Standard of Preparation (SOP). Thus, trainer variant as specified in ASR was yet to be handed over to IAF (January 2015), and resultantly, IAF would be constrained to induct fighter LCA without availability of trainer aircraft which would have adverse impact on pilot training.

## **B. Full Mission Simulator**

A flight simulator artificially re-creates aircraft flight and the environment in which it flies, for pilot training. It includes replicating how aircraft fly, how they react to applications of flight controls, the effects of other aircraft systems, and how the aircraft reacts to external factors such as air density, turbulence, wind shear, cloud, precipitation, etc.

ASR specifies that a full mission flight simulator of the LCA single seater variant was to be developed and delivered in advance of production aircraft (1994) as part of training requirement.

As a full mission simulator (FMS) required for training of IAF pilots is yet to be built by HAL and supplied to IAF at the LCA operating base, IAF pilots have to utilise the up-graded FMS at ADE, Bangalore

It was observed in audit that HAL forwarded (November 2006) a proposal for manufacture and supply of Full Mission Simulator (FMS) in respect of LCA to Air HQ. While the proposal was pending for clearance by MoD, ADA sanctioned (July 2010) a project to Aeronautical Development Establishment (ADE), Bangalore to upgrade the existing Real Time Simulator<sup>15</sup> (RTS) at their end to the standard of FMS at a cost of ₹4.50 crore in order to meet the training requirements of the IAF pilots.

In response to an audit observation (September 2014) regarding the status of FMS, ADE stated (October 2014) that the existing RTS had been upgraded to FMS and was being used by NFTC<sup>16</sup>/HAL test pilots for evaluation and training.

When present position of HAL's proposal for supply of FMS submitted (November 2006) to Air HQ was enquired (February 2015) in audit, Air HQ stated (February 2015) that though technical evaluation of HAL's proposal had been accepted by MoD, a case for procurement of FMS from ADE is being processed as per the decision taken (July 2014) in the Empowered Committee.

Thus, IAF would be using the RTS upgraded as FMS at ADE, till a full fledged FMS is manufactured by HAL and supplied for the usage at LCA operating base.

### **2.3.2 Meeting of weapon requirement on LCA as per ASR**

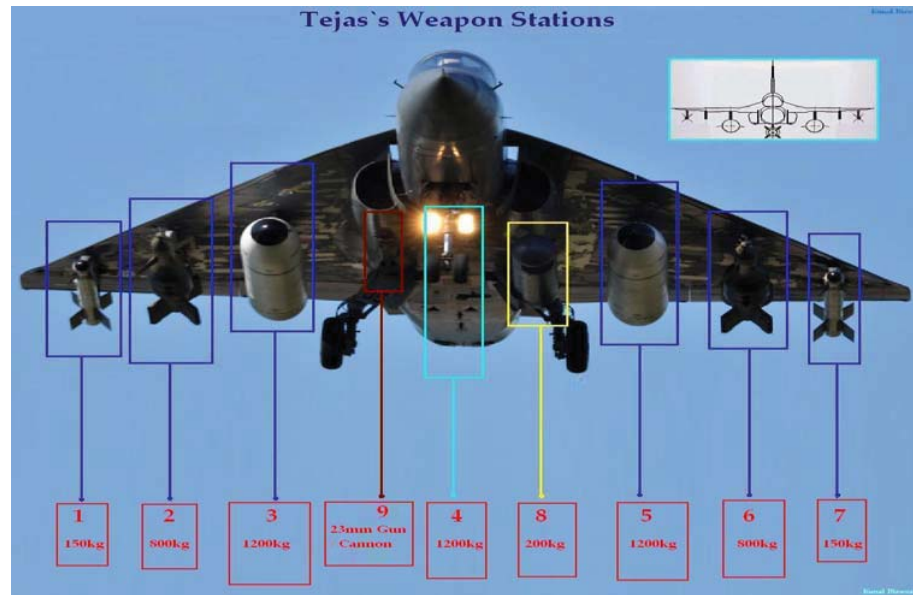
As per the ASR, LCA is required to be provided with seven under-wing/fuselage hard points for the carriage of bombs, rockets, missiles, Recce/laser designator pods and fuel tanks. The outboard stations were exclusively for the carriage of close combat missiles (CCMs). The aircraft should be able to carry a weapon load of at least 3000 kg.

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<sup>15</sup> RTS built under a work package sanctioned (March 2008) by ADA at a cost of ₹98 lakh, for evaluation of control law of LCA.

<sup>16</sup> National Flight Test Centre, Bangalore.

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Weapon stations load carrying capacity- Source: <http://defenceforumindia>

Revising the requirement of weapons on LCA by IAF periodically contributed to the delays in LCA programme

Audit observed (May 2014) that IAF had revised<sup>17</sup> the weapons requirement from time to time such as replacing R-60 missile with R-73E missile<sup>18</sup>, adding M-62 Russian Bombs, Counter Measures Dispensing System<sup>19</sup>, etc for integration on LCA. When impact of these changes on the LCA programme were enquired in audit, ADA stated (June 2014) that these changes had delayed the programme schedules as follows:

- Change of Close Combat Missile from R-60 to R-73E had resulted in redesign of integral wing and associated manufacturing and testing efforts involving delay of 14 months.
- Addition of Russian 500 Kg (M-62) bombs necessitated design and fabrication of adopter and software development which delayed the programme by 16 months.
- Addition of CMDS led to design modifications and software development with an additional time of 18 months.

When the above delays caused due to changes in the weapons by IAF as reported by ADA was pointed out (September 2014) in audit, Air HQ stated (December 2014) that the extended schedule of design and development of

<sup>17</sup> March 1997 and December 2009.

<sup>18</sup> An infrared-guided (heat-seeking) missile.

<sup>19</sup> A mission critical system to protect the aircraft against radar and heat-seeking missiles and Radar Guided Anti-Aircraft Missiles.

LCA had resulted in several weapons and systems becoming obsolete/out of stock/operationally irrelevant and to retain operational edge, newer weapons had to be included. It was also stated that ADA being the programme manager could have inducted additional resources to realize the integration of the changed weapons in time.

Thus, due to design and development of LCA programme getting extended from time to time, IAF had to opt for newer weapons to retain operational edge of LCA. This consequently had a further impact on the timelines of the LCA programme.

### 2.3.3 Status of integration of weapons on LCA

Audit observed that delayed identification/procurement of weapons/integration also contributed to delays in LCA programme as discussed below:

#### i. Integration of R-73E Missiles

R-73E is an infrared-guided (heat-seeking) missile capable of being targeted by a helmet-mounted sight allowing pilots to designate targets by looking at them. The R-73E is a highly maneuverable missile capable of making a significant difference in combat.

As per the ASR, R-60 a close combat missile was to be fitted on LCA. IAF revised (March 1997) the requirement to fitment of R-73E missile in place of R-60 missile. ADA concluded (August 2004) a contract with M/s Elbit, Israel, for integration of R-73E missile on LCA including consultancy thereon at a total cost of 3.69 Million USD (₹17 crore) to be completed within 24 months (August 2006). There were delays in integration of R-73E missile on LCA due to redesign of integral wing and associated manufacturing and testing efforts (necessitated due to change from R-60 to R-73 missile). In the meanwhile, Air HQ while revising (December 2009) the weapon requirements, further specified that R-73E should be integrated with Multi-Mode Radar<sup>20</sup> (MMR) and Helmet Mounted Display & Sight<sup>21</sup> (HMDS) as an IOC requirement. The delivery schedule was amended several times (eight times involving a total of

Delayed specifying of integrating the R-73E missile with MMR/HMDS contributed to the delays in achievement of IOC

<sup>20</sup> Used for tracking targets from Air to Air, Air to Surface including sea and facilitates all weather launching of weapons. Delay in development of MMR is discussed in Chapter III.

<sup>21</sup> HMDS is used for launching of weapons accurately. HMDS was procured from M/s Elbit Israel by ADA (Purchase Order dated August 2004 valuing 6.85 MUSD, items received in November/December 2011).

delay of 88 month) due to integration of R-73E missile with HMDS/MMR and related flight tests. The integration of R-73E missile with LCA was completed (December 2013) by ADA, after integration and release of R-73E using HMDS and MMR, and LCA achieved IOC (December 2013).

In response to audit observation (October 2014) regarding impact of delay in integration of R-73E missile on LCA on IOC schedule, ADA admitted (October 2014) that delay in integration of R-73E missile with HMDS and MMR had impacted the IOC schedule. ADA further stated (January 2015) that the avionics integration of R-73E missile with MMR and HMDS sensor was delayed due to delay in development and flight testing of MMR/HMDS.

Thus, IAF specifying additional requirement of firing the R-73E missile using HMDS/MMR sensors in December 2009, which was not specified earlier in the ASR (1985), contributed to slippage of IOC schedule beyond the planned date of December 2010, which was achieved only in December 2013.

#### **ii. Integration of Derby & Python-5 Missile**

Derby missile is a Beyond Visual Range<sup>22</sup> (BVR), medium-range (50 km) active-radar seeker, air-to-air missile built by the Israeli weapons manufacturer M/s Rafael Advanced Defense Systems. Python-5 is also a missile built by M/s Rafael with a range of 20 kms with an advanced electro optical imaging and infrared seeker.

ASR of 1985 broadly indicated the requirement of BVR configuration missiles on LCA without specifying any particular BVR missile. It was only in December 2009 the Air HQ communicated the requirement of specific BVR missiles viz. Derby and Python-5 Missiles on LCA as part of the FOC.

ADA placed (December 2011) a Purchase Order on M/s Rafael Advanced and Defence Systems Ltd, Israel for supply and Integration of Derby & Python Missile on LCA-Air Force / Navy at a total cost of 21.2 Million US dollars (equivalent to ₹99.64 crore) with a delivery schedule of 20 months which was revised (June 2013) to 34 months (i.e. up to October 2014). Audit also observed from the ADA records that ADA had attributed (October 2013) delayed identification of specific BVR missiles viz., Derby and Python-5 by IAF had resulted in revision of the FOC schedule beyond December 2008.

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<sup>22</sup> BVR missile is an air-to-air missile which engages enemy target at 37 kms or above.

Delayed identification of BVR missiles by IAF impacted the FOC schedule of LCA

To an audit query (October 2014) with regard to present position of receipt of the missiles and integration on LCA, ADA stated (October 2014) that the missiles had been received in October 2014 and integration on LCA was in progress.

Audit sought (November 2014) the reasons for belated decision of IAF in identifying specific BVR missiles. In reply, Air HQ stated (December 2014) that correct choice of weapons on any platform was a critical decision and effectiveness of the platform was directly proportional to the weapons that it could employ. Thus, weapons were to be introduced when the aircraft was close to maturity to maintain an operational edge over the adversary. Air HQ also did not accept the contention of ADA that delay in identification of BVR missile by IAF resulted in extension of FOC schedule as even core issues such as design of avionics, all weather clearance, MMR evaluation, etc were required to be resolved.

ADA further replied (January 2015) that all weather clearance of the aircraft had no impact on BVR integration and avionics design did not have any issues. It was further stated that BVR integration activities were undertaken by them only after concluding contract in December 2011, after Air HQ had given (July 2011) go-ahead for integration of Derby and Python missiles.

The fact remains that delayed development of LCA by ADA, coupled with delayed identification/go-ahead of specific BVR missile by IAF had impacted the FOC schedule of LCA, which is now expected to be achieved by December 2015.

### **iii. Manufacture of Drop tanks and pylons**

Drop tanks are auxiliary externally mounted fuel tanks and Aircraft pylon is a vertical structure used to mount external equipment such as drop tanks and weapons (stores) on an aircraft. The MoU (June 2002) between ADA and HAL stipulated supply of eight aircraft sets of role equipment consisting of drop tanks<sup>23</sup> and pylons.

Delay in manufacture and supply of 725 litre drop tanks by HAL resulted in non-compliance of IOC requirement and concession had to be obtained by ADA

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<sup>23</sup> 1200 litres-16 Nos, 800 litres-16 Nos and 725 litres-8 Nos.



It was observed in audit (October 2014) that as against 64 pylons and 40 drop tanks to be supplied by 2008, HAL manufactured and supplied 49 pylons and 13 drop tanks between April 2007 and August 2014 thereby completing only 60 percent of the deliverables.

In response to Audit enquiry (October 2014) regarding delay in manufacture and supply of drop tanks and pylons, HAL stated (November 2014) that delay in manufacture of drop tanks and pylons were due to changes in design of components, process of manufacturing, non-availability of anodizing<sup>24</sup> plant facility in Composite Manufacturing Division (CMD), and delay in getting type approval for drop tanks and pylons.

HAL further stated (November 2014) that it had planned for completing the manufacture and supply of the balance drop tanks and pylons by 2015-16.

Thus, due to changes in design and delay in establishment of manufacturing facilities, HAL could not adhere to the committed delivery schedule. As a result, 725 litre drop tank was not integrated on LCA (IOC requirement) and ADA had to obtain concession towards this while achieving IOC (December 2013) (discussed at Para 2.3).

#### **2.3.4 Electronic Warfare capabilities for LCA**

Combat aircraft are equipped with Electronic Warfare (EW) capabilities to degrade the effectiveness of enemy radar and radio systems. ASR specified that LCA should be capable of carrying an Electronic Counter Measures (ECM) Pod. In addition, provision was to be made for an internally mounted Self Protection Jammer (SPJ) in the LCA with provision for future updates. Air HQ revised (March 1997) the EW capability on LCA to include SPJ, Radar Warning Receiver (RWR) and Counter Measures Dispensing System (CMDS).

LCA Mark-I will be deficient in EW capabilities as the SPJ developed by DARE cannot be fitted on it due to space constraints and RWR/CMDS are having unresolved performance issues, impacting operational utilisation of LCA

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<sup>24</sup> An electrochemical process that gives the metal surface a durable, corrosion-resistant finish.

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Details of development of these EW systems for LCA Mk-I by Defence Avionics Research Establishment (DARE), Bangalore – SPJ and RWR – and Bharat Dynamics Limited (BDL), Hyderabad – CMDS – are indicated in the Table below:

(₹ in crore)

Sl No.	Item Description	Role on the aircraft	Sanction No and date	Sanctioned cost/ Revised cost	Original PDC/ Revised PDC	Present position	Impact on LCA
1	Self-Protection Jammer	It radiates interfering signals toward an enemy's radar, blocking the receiver with highly concentrated energy signals.	No DARO/04/1216/M/01/91/ S/D(R&D) dated 29 September 2005	116.02/154.74	March 2011/ December 2014	System developed by DARE will not be fitted on LCA Mk-I due to space constraints	LCA Mk-I is deficient in a self - protection jammer
2	Radar Warning Receiver	It alerts pilots of the various types of hostile emitters employed by other countries and enables pilots to initiate suitable action, which is crucial for the success of missions and survival of aircraft deployed for such missions.	ADA letter No ADA/PD (S)/TARANG-1B/2010 dated 15 May 2010	7.12	December 2010	RWR fitted on LCA Mk-I is having issues such as degradation of direction finding accuracy, reset in air, etc and DARE is in the process of resolving these issues.	LCA Mk-I is deficient of a fully functional RWR
3	Counter Measure Dispensing System	It is a mission critical system to protect the aircraft against radar and heat seeking missiles and Radar Guided Anti-Aircraft Missiles	ADA letter No ADA/PD(S)/CMDS /08/06 dated 27 October 2006	1.58	April 2008/ May 2010	CMDS fitted on LCA Mk-I exhibited deficiency in misguiding enemy missiles and ADA/BDL are in the process of modifying the design to overcome the flaw.	LCA Mk-I is deficient of a fully functional CMDS

It can be seen from the above Table that development of SPJ by DARE was not successful, and as a result, the LCA Mk-I will be deficient of this system. As regards the other two EW components - RWR and CMDS - till the performance issues are resolved, these two systems will also have performance shortfalls as indicated in the above Table. Consequently, LCA Mk-I remains deficient in full EW capabilities as specified in the ASR.

### **2.3.5 Shortfall in creation of Manufacture and repair facilities**

ASR also envisaged establishment of manufacture and repair facilities at HAL. However, there were shortfalls in creation of manufacture and repair facilities at HAL as discussed in Chapter-IV.

## **2.4 Work-packages for LCA programme**

As per the Memorandum of Association (1984), ADA was to execute the LCA development by utilising the capabilities of national agencies/ institutions (referred as work centers) working in Aerospace technology. There were/are 152 work centres in all, viz. DRDO labs (38), Public Sector Undertakings (PSUs) (22), Government organizations (36), educational institutes (14) and other private agencies (42). Audit examination of the work packages awarded to work centres by ADA and results thereof are discussed below:

### **2.4.1 Non-maintenance of complete data in respect of Work-packages for FSED Phase-I**

ADA had not maintained the work package-wise complete details of FSED Phase I as confirmed by it (January 2015) in its reply to draft Audit report (December 2014). Thus, analysis of the work packages (WPs) undertaken by ADA under FSED Phase-I could not be carried out in the present Audit.

### **2.4.2 Work-packages for FSED Phase-II**

The details of the WPs awarded by ADA for FSED Phase II and its completion are indicated in the **Table** below:

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Type	Number of work packages	Value (₹ in crore)	Work packages completed				Ongoing Work Packages
			Within schedule	With delay ranging			
				< one year	1-3 years	> 3 years	
Critical	110	630.21	14	32	16	29	19
Non-Critical	393	482.18	119	89	46	96	43
Total	503	1112.39	133	121	62	125	62
Percentage to total packages			27	24	12	25	12

Delay in completion of work packages by work centres contributed to the overall delays of the LCA programme

As per the Table, ADA had awarded 503 WPs amounting to ₹1,112.39 crore for FSED Phase-II. Out of 503 WPs, ADA had identified 110 WPs valuing ₹630.21 crore as critical based on the basic functionality requirement for the safe flight of the aircraft. ADA entrusted all the work packages (from 2002 to 2013) to 152 work centres and out of which, only 27 per cent of the WPs were completed within the schedule and remaining 73 per cent of the WPs were delayed. Among the critical WPs, only 13 per cent were completed within schedule. Even the on-going 62 WPs (related to FOC activities) were also behind schedule with delays ranging from 2 months to 11 years.

Audit on a sample review of execution of 194 WPs (51 critical, 143 non-critical) valuing ₹632.23 crore (₹338.37 crore - critical, ₹293.86 crore - non-critical) noticed instances of delayed completion of work packages, which are shown in the Table below:

(₹ in crore)

Sl. No.	Item description	Name of the work centre	Sanction No. and date	Sanctioned cost/ revised cost (₹)	Original PDC/ revised PDC	Actual date of completion	Delay in month
1	Digital Flight Control Computer	Aeronautical Development Establishment, Bangalore	ADA sanction letter No ADA/LCA/IFCS/DFCC/PM/99 dated 27 May 1999	8.30/12.84	May 2001/ September 2009	September 2009	100
2	Multi-Mode Radar	Electronic & Radar Development Establishment (LRDE),	ADA letter No ADA/PD(S)/192/91/631 dated 17 June 1991	62.27	December 1997/ December 1999	MMR developed by LRDE/HAL found short of expectations and joint development of MMR with a	

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		Bangalore & HAL, Hyderabad Division				foreign firm discussed in Chapter III	
3	Hydraulic System LRUs	HAL, Lucknow Division	ADA sanction letter No ADA:GS:9438: S09 dated 07 October 2000	3.69	March 2002/ December 2009	December 2009	93
4	LRUs for fuel system sensors, Hydraulic systems, etc	HAL, Lucknow Division	ADA Sanction No ADA:GS:16712: 080/S103(A) dated 28 January 2006	3.40	June 2007/ April 2012	April 2012	58

Audit enquired (September 2014) about delays in completing the WPs by the entrusted work centres and basis for selection of work centres. In reply, ADA stated (September 2014) that it had no authority/control on the working of work centres. ADA also admitted (October 2014) that the delay in development of WPs had affected the LCA programme schedule. ADA also stated (January 2015) that work packages/ project sanctions were continuously reviewed and monitored by ADA through participation in Project Review Committee (PRC) meetings. However, the priority accorded by these work centres was depending upon the production targets set by their management on which ADA had no authority. As regards the basis for selection of work centres, ADA stated (October 2014) that during 1990s selection of vendor for development of strategic aviation equipment was very limited in the country, hence it had no choice but to go with the vendors who had past experience in the related field.

ADA's contention that they had no authority/control on the working of the work centres is not tenable in audit as the LCA programme was being monitored by MoD and ADA had representation at all levels in the decision making of the Government. The work centres, majority of which were DRDO labs, PSUs and Government organizations, should have accorded due importance to the LCA development programme due to its national importance. As such, delays in completion of work packages which affected the LCA programme schedules indicates that coordination of efforts at various levels and monitoring of the programme by all the agencies involved, has not been as envisaged.

## **2.5 Lack of user involvement**

Involvement of user (Air HQ) commenced only after 2006 even though LCA programme commenced in 1983 and need for a liaison group between Air HQ and ADA had been expressed by the LCA PDP Review Committee as early as in 1989

Audit observed (September 2014) from the LCA PDP Review Committee, which examined the work done at Project Definition Phase, had strongly recommended (September 1989) early establishment of a standing Liaison Group between Air HQ and ADA to ensure closer interaction between the design team and the user for better appreciation of mutual perception, including appropriate trade-offs in performance, weight, time frame, cost, technological complexity and operational considerations of LCA.

However, audit observed (September 2014) that no such liaison group was formed. As a result, IAF played limited role as a member in Governing Body and General Body meetings. The active user participation in the LCA Programme was started only after the formation of an Empowered Committee (November 2006), LCA Review Committee consisting of ADA, HAL and IAF (November 2006) and LCA Project Management Team (LCA-PMT) at ADA (August 2007). The Empowered Committee chaired by Chief of Air Staff and co-chaired by Secretary (DP) and SA to RM/DG ADA met Quarterly to review the complete programme with the sole objective to monitor the flight development activities. The LCA Review Committee headed by Deputy Chief of Air Staff met every month to review all the issues concerning the programme. LCA Project Management Team (LCA-PMT) headed by Air Vice Marshal to function as a single point interface between the IAF and ADA/NFTC/HAL for co-ordination of flight test activities, positioning of weapons stores for LCA, etc.

Audit sought (September 2014) the reasons for non-formation of standing Liaison Group between Air HQ and ADA to ensure closer interaction between the design team and the user as recommended (September 1989) by the LCA PDP Review Committee. In reply, Air HQ stated (December 2014) that expertise of IAF personnel was not in the area of design of aircraft, but in capability to guide the programme in terms of user requirement of operations and maintainability. Hence formation of standing Liaison Group earlier than 2007 may not have been fruitful. It was also stated that IAF test pilots and test engineers were involved in the project as part of National Flight Test Centre (NFTC), Bangalore since 2001.

However, Air HQ reply is not tenable as user involvement would be essential right from inception for effective and efficient completion of any project. This is evident from the fact that as soon as Empowered Committee was formed (November 2006), in its very first meeting (December 2006), need for foreign consultancy in flight testing was emphasized (as discussed at Chapter II Para 2.2.1) and in its fourth meeting (October 2007), need for going in for LCA Mk-II was highlighted (as discussed at Chapter I Para 1.3) based on which FSED Phase III was sanctioned (November 2009).

Thus, non-formation of a standing Liaison Group between Air HQ and ADA to ensure closer interaction between the design team and the user for better appreciation of mutual perception, including appropriate trade-offs in performance, weight, time frame, cost, technological complexity and operational considerations of LCA also impacted the LCA development timelines.