CHAPTER IV : MANUFACTURE AND INDUCTION OF LCA

Objective: To examine and assess whether manufacturing of LCA (AF) including setting up of manufacturing facilities at HAL was completed efficiently and the level of preparedness of IAF to induct LCA into Service and consequent operational impact

4.1 Introduction

In line with the approval of CCPA (February 1991) for development of LCA in two FSED phases as discussed in chapter-II, ADA signed three Memorandums of Understanding (MoUs) with HAL as detailed below:

Sl. No.	FSED Phase	Date of signing MoU	Sanction (₹in crore)	Scope of work	Scheduled date of completion
1	I	January 1992	661.80 (Overall sanction ₹2188 crore)	Detailed Design, Development, Manufacture, Flight Clearance and Testing of Technology Demonstrators (TDs) TD1 and TD2 – Building of PV1 and PV2 was included in 1995[1]	June 1998
2	II	(a) June 2002 (manufacture and creation of facility-LCA), and Amendment-I January 2011	795.23 (Overall sanction ₹3301.78 crore) 1471.52 (Overall sanction ₹5777.56 crore)	Creation of facilities at various divisions of HAL for manufacturing eight LCA *per annum* and eight LSP standard aircraft (LSP1 to LSP 8)	May 2006 to May 2008 Revised to 2007-08 to 2011-12 for manufacture and delivery of aircraft
3		(b) December 2006 (Development-ARDC) Amendment-1 (November 2010)	650.58 (Overall sanction ₹3301.78 crore) ₹732.12 (Overall sanction ₹5777.56 crore)	Design, development, manufacture of three PVs (PV3, PV4 & PV5) and testing of the PVs and TDs to achieve Initial Operation Clearance (IOC) and Final Operation Clearance (FOC)	December 2005 to December 2008 Revised to December 2010 to December 2012

[1] Shifting of PV1 and PV2 from FSED Phase II to FSED Phase I in 1995 and consequent impact on LCA Programme is discussed in Chapter II Para.

Delays in execution of Phase-I activities of LCA programme (covered under the MoU of 1992 at Sl No. 1 of the above table) were highlighted in Para 28 of the Report No. 8 of 1999 of the C&AG of India, Union Government, Defence Services (Air Force & Navy) for the year ended 31 March 1998. In the present Report, MoUs at SL No 2 and 3 of the above Table covering activities under FSED Phase II sanctioned in November 2001 are discussed below in order of their activity i.e. design & development of PVs (MoU 2006) and manufacture of LSPs (MoU 2002).

Premature conclusion (2006, 2010) of two contracts by MoD with HAL for 20 IOC configuration and 20 FOC configuration LCA even before the design of LCA was frozen by ADA, resulted in delays in supply of aircraft against these contracts by HAL due to delay in freezing of design of LCA, which impacted the handing over of Series Production (SP) aircraft to IAF for formation of squadrons, besides blocking up of funds/inventory at HAL as discussed in this chapter.

4.2 Design and development activity

Absence of FTS, low availability of aircraft for flight tests and deficiencies in LSP aircraft affected the Design and development activity

As discussed in Para 2.2 of Chapter II, though sanction for development (FESD phase II) was accorded in November 2001, the MoU for design and development of LCA was signed between ADA and HAL only in December 2006. MOU of December 2006 with HAL envisaged continuance of the development activities of FSED Phase-I along with that of FSED Phase-II. As per MOU 2006 scope of work of HAL broadly included:

- Design, development, fabrication and testing of LCA (PV5) (discussed in Chapter II);
- Fabrication and testing of LCA (PV3 & PV4) (discussed in Chapter II);
- Fatigue Test Specimen (FTS);
- Delivery of LCA (PV3, PV4 & PV5) as per the prescribed timeframe;
- Participation in flight testing of LCA (TD's & PVs) to achieve IOC and FOC; and
- Co-ordination/control of all technical/development activities as envisaged in HAL(AR&DC) projections;

ADA allocated (November 2001) ₹650.58 crore against the MoU activities, which was enhanced (November 2009) to ₹1382.70 crore, out of which, HAL received ₹1006.57 crore and spent ₹1046.43 crore (March 2014).

Audit Scrutiny of the records relating to the above scope of work brought out the following findings:

4.2.1 Absence of Fatigue Test Specimen (FTS)

A Fatigue Test Specimen (FTS) was required to be built for testing the endurance of LCA for determining the total technical life. Audit observed that (February 2014) building of FTS was not taken up by HAL.

When reasons for not building the FTS was enquired (February 2014) in audit, HAL stated (July 2014) that production standard fuselage was required for carrying out the FTS and the same was yet to be manufactured.

Reply of HAL is not tenable in audit as the FTS was to be built under the MoU of 2006 covering developmental activities and not after building production standard aircraft as stated by HAL now.

Thus, in the absence of FTS, technical life of LCA could not be determined and ADA/HAL had to obtain concession at the time of IOC (December 2013) from Air HQ which limited the life of airframe to 1000 hours as against the ASR specification of more than 3000 hours.

4.2.2 Low availability of LCA for flight testing towards achieving IOC/FOC

HAL was to provide TDs and PVs for flight testing to achieve IOC and FOC as per the MoU (December 2006). However, due to deficiencies in the PVs as discussed in Chapter II Para 2.1, LSPs were included for flight testing activities by an amendment in November 2010.

Audit observed from minutes of EC meetings (December 2006 to July 2014) that low availability of LCA for flight testing was a critical issue delaying the achievement of IOC. The reasons pointed out in the EC meetings were mainly delay in snags analysis, slow recovery of aircraft from rectification, shortage of critical LRUs at flight hangar, aircraft being used as test rigs, large number

of unproductive sorties[2], production quality issues affecting flight safety, non-availability of aircraft in the correct SOP. Serviceability of LSP 7 and 8 aircraft had remained low even though both of them were the representative aircraft closest to production series. However, it was observed that no solutions/timelines were advised for analysis and rectification of snags even though the EC had representation from MoD, Air Force and HAL.

Audit examination from HAL records brought out that the number of flights undertaken with each aircraft, average number of flights achieved per month and the number of days for which the aircraft were not available for conducting flight tests as per details indicated in **Annexure-III**.

It could be seen from the annexure that the average number of sorties per month ranged between one and five sorties and were well short of the minimum of 22 sorties per month desired by ADA. The LCA was not made available for flight trials at several occasions resulting in low availability of aircraft for flight testing for 18891 days. Out of 12 aircraft (except PV5 trainer aircraft) utilised for conducting tests, five had performed their last flights for 20 to 72 months prior to the date of IOC.

To an audit query (October 2014) seeking reasons for low availability of LCA for flight testing, HAL stated (November 2014) that TD 1 and TD 2 were taken off from the development test flight phase by ADA as their SOP was not upgradable to sustain the level of requirement for current flight testing. HAL further stated that the shortfalls in sorties per month were attributable to the delay in the developmental programme in implementing the improvements to clear the test points envisaged as an evolution process.

HAL's Reply is not acceptable as the reasons stated by HAL now are different from those observed by the EC in its various meetings where HAL was also represented.

Thus, low availability of LCA for flight testing impacted the timely achievement of IOC/FOC.

[2] Sorties used for display and fly pasts.

4.2.3 Deficiencies in the HAL manufactured LSP aircraft

Audit observed (October 2014) from the Empowered Committee (EC) meetings (September 2012 to July 2014) that the LSP aircraft manufactured by HAL had the following deficiencies:

(a) Design deficiencies in fuel system, brake management system, brake parachute, undercarriage system;

(b) Quality problems (September 2012) on the MMR with HAL manufactured Radome (also discussed in Chapter III Para 3.1);

(c) Water seepage observed during the flight testing to prove all weather clearance, in critical areas of aircraft including cockpit, radar, DFCC, avionics bay, etc. which required design solutions;

(d) Structural problems like fuel leak, cracking of turkey feathers, de-lamination, and contour deviation;

(e) The performance of aircraft was affected by low reliability of critical LRUs like Jet Fuel Starter (JFS), Cockpit Pressure Transducer[3] (CPTCV) on the aircraft.

In reply to audit query, HAL informed (November 2014) that the deficiencies noticed in fuel system, brake management system etc were part of developmental issues and resolved subsequently. While Radomes manufactured by HAL were as per the technology provided by ADA, shortfall in performance was due to material selection and not due to production process and CPTCV and JFS were new units which were under certification.

HAL's contention to have resolved the deficiencies in fuel system and brake management system is not tenable as permanent waiver for deficiencies in fuel system and concession for deficiencies in the brake parachute system were obtained from Air HQ at the time of achieving IOC of LCA (December 2013).

Thus, all the LCA Mk-I would have deficiencies in Fuel System, being a permanent waiver. As regards deficiencies in Brake Parachute System (under concession), LCA Mk-I will fly with this deficiency till the issue is resolved.

[3] Used for providing position feedback information of flight control surfaces to the cockpit.

4.3 Creation of production facilities and manufacture of LSPs

Creation of facilities for manufacturing eight aircraft per annum was not achieved.

MoU of June 2002 between ADA and HAL envisaged creation of manufacturing facilities under FSED Phase II at the rate of eight aircraft per annum by May 2006 and production of eight LSP aircraft during May 2006 to May 2008. (As discussed in Chapter II Para 2.2)

Audit scrutiny of the records relating to MoU implementation brought out delay in completion of manufacturing facilities as discussed in the following paragraphs:

4.3.1 Delay in creation of production facilities:

Audit observed that HAL had been utilizing the existing facilities available with it for manufacture of LCA. Even though HAL initiated action in April 2006 to form a dedicated LCA facility, LCA Project Group was established as a full-fledged Division only in March 2014 as seen from HAL's 371st Board Meeting papers.

MoU of 2002 sanctioned ₹391.18 crore towards creation of facility i.e. Capital[4] expenditure Rs. 188.71 crore and DRE[5] ₹202.47 crore. Audit noticed that as of March 2014, HAL had incurred an amount of ₹118.99 crore (63 *per cent*) towards capital expenditure and ₹139.12 crore (69 *per cent*) towards DRE.

When reasons for delay in creation of manufacturing facility was enquired (October 2014) in audit, HAL stated (November 2014) that extensive changes in the design and development post 2006 had resulted in reviewing the facility requirement and a capacity augmentation plan was being put up for meeting the objectives. It was also stated that non-finalisation of configuration of LCA had led to the postponement of establishment of production facilities.

Reply is not acceptable as the GoI sanction of November 2001 stipulated that the facilities for manufacture of eight LCA were to be created and the first LCA was to be delivered within 4 ½ years from the date of sanction i.e. by May 2006. Further, the delay in creation of manufacturing facility of eight

[4] Capital expenditure consists of expenditure towards Plant & machinery and civil works.
[5] Deferred Revenue Expenditure (DRE) consists of expenditure towards tooling, test equipments, technical assistance, training, project management, publications and long and series tests.

aircraft per annum impacted the production of LSPs, as discussed in Para 4.3.4 as well as the Series Production Aircraft.

4.3.2 Delay in procurement of plant and machinery

As against the target date of May 2006 for creation of facilities for manufacture of eight aircraft per annum, HAL placed 308 purchase orders valued ₹73.85 crore during the years 2006-07 to 2013-14. Of these, 203 purchase orders valuing ₹70.84 crore were placed only between 2011-12 and 2013-14. Further, the sanctioned cost of the project was revised (January 2011) to include procurement of five machines for ₹54.50 crore to enhance quality and productivity. The details of purchase orders placed and progress made (December 2014) in respect of these five machines are as given below:

Sl No	Purchase Order date and Machine name	Value ₹in crore	Scheduled delivery	Date of receipt	Date of Installation/ commissioning	Delay (in months)
1	6.11.2012-Laser tracker	1.93	January 2013	January 2013	commissioned in January 2013	-
2	14.6.2011-Automatic wing drilling LOXIN Machine	14.95	June 2012	December 2012	Installed in May 2013 but not commissioned.	5
3	18.2.2013-5 Axis skin Router	12.32	March 2014	June 2014	Installed in May 2013 but not commissioned	18
4	HSM Profiler	7.00	Purchase Order yet to be placed			24
5	30.1.2014 - CNC Profiler	5.41	January 2015	Yet to be received	-	24

Source: compiled from HAL records.

It could be seen from the above table, that against the order of four machines between June 2011 and January 2014, three machines valued ₹29.20 crore were received between December 2012 and June 2014. However, only one machine has been commissioned so far (November 2014) while two machines even though installed in May 2013 could not be commissioned as the supplier had to prove wing drilling on one aircraft. The fourth machine valued ₹5.41 crore was expected to be received in January 2015. Action to procure one machine i.e. HSM profiler was yet to be initiated (November 2014).

In response to audit observation (October 2014) regarding delay in creation of manufacturing facilities for LCA, HAL while admitting the fact stated

(November 2014) that the establishment of facilities was accelerated after 2011.

Thus, on account of delayed creation of manufacturing facilities, and that too limited to four aircraft per annum as against required eight aircraft per annum the production of 20 IOC LCA has been delayed although IOC was achieved in December 2013. HAL had not supplied any aircraft (IOC standard) to Air Force so far (January 2015).

4.3.3 Delay in completion of LCA hangars

While according (July 2003) approval for completion of hangars for LCA production by HAL Board, one of the benefits expected to be realised was contiguous location of assembly shops with related departments to reduce movements, handling and reduce the cycle time, etc. Audit observed that the hangars were completed in April 2009 against the scheduled date of completion by September 2007. Due to delay in completion of LCA hangars, certain machines[6] (costing ₹30.56 crore) procured during 2004 to 2006 out of LCA funds and installed in the Aircraft Division (Jaguar Machine Shop) continued to remain in the Aircraft Division even after construction of new hangars for LCA production. Hence, the intended benefit from construction of the new building was not realised by HAL completely.

In reply to an audit observation (October 2014), HAL stated (November 2014) that the new hangars built was planned for structural assembly and final assembly and hence, the machines could not be shifted from Aircraft Division to new LCA division.

Reply is not acceptable as the envisaged benefits of having a dedicated hangar facility for LCA to have contiguous location of assembly shops with related departments to reduce movements and handling and thereby to reduce the cycle time had not been achieved.

[6] 5-axis Profiler, 3-axis Profiler, 5-axis machining centre, 2.5m x 6m CM machine, CNC jig-borer, controlled heating/quenching furnace and chrome-plating facility etc.

4.3.4 Delay in procurement of tools and jigs

The rate of manufacture of LCA depended on availability of the main assembly jigs. The time chart prepared by the division showed that 66 weeks were required for completion of the main assembly activity subject to availability of the required jigs and man power. The Methods Engineering Group of LCA division, reassessed (October 2012) the total jig requirement as 57 for manufacturing of eight LCA per annum out of which it already had 32 jigs and balance 25 were to be procured. However, the production plan of the Division for the year 2014-15 stipulated manufacture of only four LCA.

LCA Division had placed a total of 932 purchase orders (value: ₹43.40 crore) for tools and jigs required for assembly of LCA from May 2006 (scheduled date for delivery of first LSP) to as late as March 2014. 43 purchase orders for a total value of ₹2 crore were yet to be placed (December 2014). As per GoI sanction (November 2001), the creation of facilities for eight LSP aircraft per annum and delivery of the first LSP standard LCA was 4 ½ years from the date of sanction i.e. by May 2006.

Audit scrutiny (October 2014) of purchase orders revealed that the purchase order for procurement of 25 jigs were placed between February 2008 to January 2014. Out of this, 10 have been received and commissioned (one in March 2014 and nine in November 2014). Commissioning of eight jigs received (December 2010 to January 2013) were under progress. The balance seven jigs were under fabrication at vendor's premises (November 2014).

HAL in response to audit observation (October 2014) while concurring with (November 2014) the fact regarding lack of facility to produce eight aircraft per annum stated that even the current structural assembly operations on the jigs were not continuous due to breakage in supply of parts due to changes in the acceptance standards by certification agency vis-à-vis the procedure adopted in the LSP program.

The fact remains that HAL had estimated that 66 weeks were required for completion of main assembly activity of LCA aircraft and considering the lead time of one year for procurement of jigs, the purchase orders should have been placed at least by January 2004. Further, HAL's reply is silent on the issue of delayed placement of orders for jigs.

Thus, due to delay in placement of purchase orders in time, HAL could not ensure timely creation of facility to adhere to the committed delivery schedule.

4.4 Delay in creation of facilities for Repair and Overhaul (ROH)

ASR stipulated that manufacturer would be responsible for defect investigation, repair and overhaul of the aircraft, engine and components. Repair and overhaul of certain equipment may be undertaken by IAF. However, during the interim period, before IAF facilities are established, repair and servicing of all rotables will be manufacturer's responsibility. Development/manufacturing agency should be prepared to maintain the repair facility for selected equipment and sub assemblies for the proposed lifespan of the aircraft or as required by IAF.

LCA comprises 344 Line Replaceable Units (LRUs). Of these, 90 LRUs were considered non-repairable. While Repair and Overhaul (ROH) facility in respect of 185 was available with HAL. For the remaining 69 LRUs, ROH facilities were required to be established in HAL. Audit observed (October 2014) that proposals received (between May 2008 and May 2009) from Original Equipment Manufacturers (OEM) for creating ROH facilities in respect of 40 LRUs were under evaluation (October 2014) and proposals for ROH facilities for the remaining 29 LRUs were awaited (October 2014).

HAL, while concurring with the audit observation (October 2014) replied (November 2014) that for the remaining 69 repairable LRUs, Long Term Repair Agreement (LTRA) was planned for 29 LRUs, ROH establishment was planned for 39 LRUs and one LRU had been deleted from ESOP[7]. Respective Divisions were taking up the matter with the OEMs and the establishment of the ROH facilities would be completed by December 2016.

The fact remains that HAL delayed finalising the proposals received in May 2009 from vendors. As a result, establishment of the ROH facilities for the repairable LRU's was yet to be fully accomplished[8] by HAL (January 2015).

[7] Equipment Standard of Preparation (ESOP) envisages the standard specification of the aircraft.

[8] HAL Bangalore letter No.HAL/CM/LCA-LMG/97/2015 dated 05.02.2015.

4.5 Delay in manufacture and supply of LSP aircraft

HAL did not supply the LSP aircraft according to the delivery schedule and as per the weight and speed envisaged in the ASR

MoU of June 2002 stipulated manufacture and supply of eight LCA (LSP) between 2006 and 2008, which was revised (January 2011) to 2007-08 to 2011-12. HAL manufactured and supplied seven LSP between 2007 and 2013. Audit reviewed (October 2014) the planning, actual manufacture and supply of LCA and cost of manufacture as discussed below:

4.5.1 Frequent changes in design after release of standard of preparation

Audit observed (October 2014) that frequent changes to SOP were made from time to time by ADA which required changes to design of the aircraft resulting in changes in Drawing Applicability Lists[9] (DAL).

Details of the number of design changes effected in each of the seven LSP standards LCA are tabulated below:

Aircraft	Date of release of ESOP	Configuration/ modifications added further in comparison to respective previous aircraft	Number of design changes after ESOP
LSP-1	29.12.2005	Basic	2337
LSP-2	24.05.2007	Open Architecture Computers	891
LSP-3	16.07.2007	Major changes in Avionics Sensors	646
LSP-4	31.10.2008	CMDS	2954
LSP-5	12.02.2010	Night Vision LRUs	1046
LSP-6	Aircraft not manufactured		
LSP-7	23.09.2011	Major changes in fuel system and all weather clearance LRUs was added	150
LSP-8	31.08.2012	Fully configured	874

Source: compiled from HAL records

Due to frequent and continuous changes in design, each of the aircraft differed in its configuration and as a result even LSP-8 fell short of the standard required for achievement of IOC. These design changes resulted in addition of 3041 new drawings, 3965 changed drawings and cancellation of 245 drawings with additional cost implications besides time overrun impacting the delivery schedules.

[9] List containing systems wise detailed drawings of an aircraft.

In reply, HAL stated (November 2014) that the changes in the SOP of the LSP aircraft vis-à-vis TD and PV aircraft were introduced by the program manager ADA. ADA, had released the SOP for LSP 6 as IOC standard in January 2014. The design and development of aircraft of the class of LCA without the availability of a similar class indigenous aircraft was an ambitious program. Concurrent development and production would be successful only if the user accepted the aircraft in smaller batches (say 4 to 5 aircraft) as per the SOP frozen at regular intervals of development cycle. It further stated IOC is precursor for production agency to deliver the aircraft and due to the delay in IOC, the concurrent development and production approach was not fully met in the program.

Thus, fact remains that the design, development and productionisation of LCA through concurrent engineering did not compress the development time as was envisaged in the FSED-II sanction of November 2011 and even LSP-8 fell short of the standard required for achievement of IOC. It also resulted in time overrun and substantial delay in achieving IOC apart from having a cascading effect on the supply of Series Production LCA to IAF.

4.5.2 Delay in supply of aircraft to ADA

The following Table shows the dates of stipulated and the actual delivery of aircraft:

Sl. No. of the LSP aircraft	Stipulated date of delivery (MoU June 2002)	Revised Delivery (Amendment (January 2011)	Actual date of delivery	Delay in delivery from stipulated dates (months)	Delay in delivery from amended dates (months)
1	2006	2007-08	25.04.2007	4	-
2	2007	2008-09	16.06.2008	6	-
3	2007	2010-11	23.04.2010	28	-
4	2008	2010-11	02.06.2010	17	-
5	2008	2010-11	19.11.2010	23	-
6	2008	2011-12	Aircraft not manufactured		
7	2008	2010-11	09.03.2012	38	12
8	2008	2011-12	31.03.2013	51	12

Source: compiled from HAL records

It can be seen that none of the aircraft was delivered within the stipulated date and the delay ranged from 4 to 51 months.

In reply to audit observation (October 2014), HAL stated (November 2014) that production of LSP-1 to LSP-8 (except LSP-6) had to be progressed at HAL for different SOP standards. Even as on date, final ESOP for full IOC configuration was yet to be frozen which is evident from the concessions given by IAF at the time of achieving (December 2013) IOC.

Fact remains that there had been delay of 12 months in adhering to even the extended delivery schedule. Thus, reduction in production lead time envisaged in adopting concurrent engineering was not accomplished.

4.5.3 Stipulated weight not achieved

ASR specified that basic weight of LCA should not exceed 5500 kg. The MoU (June 2002) stipulated the basic weight of the aircraft (with fuel) to be 8485 kg and the empty weight (without fuel) to be 5365 kg. The basic and empty weights achieved in respect of each of the LSP aircraft are tabulated below:

(weight in kg)

Aircraft No.	Empty weight			Basic weight		
	Stipulated	Actual	Excess	Stipulated	Actual	Excess
LSP 1	5365	6707	1342	8485	9799	1314
LSP 2	5365	6696	1331	8485	9855	1370
LSP 3	5365	6802	1437	8485	9949	1464
LSP 4	5365	6755	1390	8485	9911	1426
LSP 5	5365	6683	1318	8485	9861	1376
LSP 7	5365	6682	1317	8485	9852	1367
LSP 8	5365	6735	1370	8485	9851	1366

Source: compiled with HAL records

It can be seen that the parameters of both empty weight and basic weight were not achieved in any of the LSP aircraft.

Audit observed (October 2014) that the low weight envisioned to maximise the combat capabilities of this aircraft had not been achieved. In reply, HAL stated (November 2014) that the aircraft were produced as per the SOP released by ADA.

Fact remains that the LSP aircraft did not meet the prescribed parameters of weight as envisaged in the MoU (June 2002). Consequently, ADA/HAL had to obtain permanent waiver towards this from Air HQ at the time of achieving IOC (December 2013). It is also pertinent to mention that increased weight of LCA had necessitated ADA going in for LCA Mk-II development with a higher capacity engine, as discussed in Chapter II.

4.5.4 Envisaged speed not achieved

ASR specified that the LCA should have maximum speed in excess of 1300 kmph and minimum touch down speed of 240 kmph. The MoU (June 2002) specified the maximum speed at sea level as 1325 kmph and touchdown speed of 240 kmph. However, the maximum speed achieved was 1204 kmph and touchdown speed of 308 kmph (December 2013). Thus, there was shortfall in achievement of maximum speed as well as in touchdown speed with reference to MoU specifications.

In reply to audit observation (October 2014), HAL stated (November 2014) that LSP aircraft were produced as per the Standard of Preparation (SOP) issued by ADA. The parts have been realized as per the drawings and in case of deviations, necessary design concurrences had been obtained as part of the production process.

Fact remains that the aircraft could not achieve the speed range specified in the MoU. Consequently, ADA had to obtain permanent waiver from Air HQ at the time of achieving IOC (December 2013) towards the limitation of LCA.

4.6 Premature conclusion of contracts for LCA (IOC and FOC) before freezing of design

Premature conclusion of IOC and FOC contracts before freezing of designs affected the formation of squadrons

The Equipment Standard of Preparation (ESOP) for IOC[10] aircraft was jointly released (September 2005) by ADA and HAL. Based on the ESOP, MoD concluded a contract (March 2006) with HAL for manufacture and supply of 20 LCA of IOC standard to IAF. Notwithstanding the delay in implementation of this contract, MoD concluded (December 2010) another contract for 20 LCA of FOC standard. However, ADA could freeze the design for IOC standard LCA only in December 2013 and freezing of design for FOC standard aircraft was still pending (January 2015).

[10] Design specification for LCA with IOC standard.

Therefore, conclusion (March 2006, December 2010) of two contracts by MoD pending freezing of design for IOC and FOC was premature. This had resulted in HAL's inability to effect deliveries against the two contracts for 40 LCA and their consequent induction into IAF as discussed below:

4.6.1 Manufacture and supply of LCA(IOC standard) under Series Production

MoD concluded (March 2006) a contract with HAL for supply of 20 LCA built to IOC standard (16 fighter and 4 trainer) along with role equipment and support equipment consisting of spares and Tools, Testers and Ground Equipment (TTGE) items, training devices and maintenance simulators, four reserve engines, engine support package and engine test bed at a total cost of ₹2701.70 crore. The above deliverables were to be supplied between April 2009 and December 2011. The contract was amended in May 2008 to ₹2812.91 crore to include escalation in price of engines. Up to March 2014, HAL had claimed[11] and received ₹2104.11 crore after achievement of milestones against which HAL had spent ₹2039.13 crore and committed further expenditure of ₹709.26 crore**.**

Audit observed that conclusion (March 2006) of contract for supply of 20 IOC aircraft by MoD even before freezing of design of LCA, had a cascading effect on manufacture and supply of IOC configuration aircraft to IAF (which affected operational preparedness of the Air Force, discussed at sub-para 4.7 and 4.9) besides extra cost due to cost overrun and holding of inventory as brought out below:

- HAL has not supplied (January 2015) aircraft of the IOC configuration but supplied reserve engines valuing ₹87.21 crore.
- HAL completed (December 2011) the construction of Engine Test Bed[12] at Sulur at a cost of ₹46 crore even though LCA squadrons were yet to be set up (as discussed in sub-para 4.7).
- HAL held warranty expired inventory[13] valuing ₹521.14 crore at its divisions which were procured prior to 2012.

---

11 For 20 aircraft on start of manufacturing activity, for 16 aircraft on start of structural assembly and for 8 aircraft on commencement of equipping.

12 Engine Test Bed are used for testing the engines for conducting tests before fitment on the aircraft.

13 Engine Division ₹443.16 crore, LCA Division ₹65.70 crore and Hyderabad Division ₹12.28 crore.

- Retro modification of LRUs were to be carried out by OEM's on LRUs (20 types) to enable them to be integrated along with other LRUs in the aircraft. Out of 20 types of LRUs, HAL incurred an expenditure of ₹10.63 crore on 5 types of LRU's and the cost of retro modification would further increase as the balance 15 types of LRUs are yet to be taken up.
- HAL supplied spares valuing ₹97.36 crore (up to March 2014) where as the aircraft was yet to be delivered, and these spares will remain unutilized till LCA get inducted into IAF squadron.
- Against the above supplies, IAF deducted (July 2013) liquidated damages (LD) of ₹9.83 crore towards delayed supplies as per the terms of the contract and the LD amount would further increase on supply of aircraft, even though this situation has arisen due to premature conclusion of contract by MoD.
- HAL sought (October 2011) additional funds of ₹1381.98 crore towards meeting the extra costs of manufacture[14].

HAL replied (November 2014) that the delayed finalisation of SOP due to delay in achievement of IOC (December 2013) contributed to delayed procurement of materials and postponement of production activities. Regarding the cost overrun of the IOC contract, HAL further stated that the detailed cost revision proposal covering all the design changes effected from 2006 in the basic build of the aircraft, LRUs, GHE/GSE, testers had been submitted to ADA for vetting which was still under progress (December 2014).

Thus, awarding of the contract for delivery of 20 IOC configuration aircraft by MoD to HAL in March 2006, when only two TD's and PV's (development stages as discussed in Chapter II) were flying and LCA design was nowhere near maturity, was premature. Further, HAL is yet to supply (January 2015) the IOC configured aircraft. Delay in productionisation of LCA impacted the induction of LCA and formation of IAF squadrons, besides cost overrun of the contract as discussed above.

14 Towards changes in drawings (₹564.64 crore), escalation in procurement and increase in labour cost (₹516.85 crore), Statutory levies on indigenous procurement ₹43.89 crore), additional scope towards supply of floats of LRU's ₹90.70 crore) and technical publications ₹65.90 crore.

4.6.2 Supply of LCA (FOC standard) under Series Production

MoD concluded (December 2010) a contract with HAL for supply of 20 LCA FOC standard (16 fighter and 4 trainer) along with role equipment, engineering support package consisting of spares/TTGE/GHE/GSE, training aggregates, four reserve engines, engine support package, operational support equipment, etc. at a total price of ₹5989.39 crore. The delivery of 20 FOC aircraft was to commence within 42 months from the date of signing the contract i.e., by June 2014 and to be completed gradually by 72 months i.e., by December 2016.

Audit observed (October 2014) that in accordance with the terms of payment, HAL claimed and received ₹1810.59 crore against the stipulated milestones. Out of ₹1810.59 crore received since 2010, HAL had (March 2014) spent only ₹287.59 crore and committed ₹1099.51 crore. However, HAL has not supplied any aircraft (January 2015)

HAL stated (November 2014) that it had drawn the advance as per the activity based milestones stipulated in the contract. Further, commitment aggregating about ₹1200 crore had been made towards start of the manufacturing activity of FOC Aircraft. Further HAL stated that the FOC was yet to be accorded and delivery of 20 FOC aircraft could commence only after achieving FOC. A change order to the FOC contract would be put up after the FOC certification was accorded by ADA.

Thus, awarding of contract by MoD for supply of 20 FOC configuration aircraft even before supply of IOC configuration aircraft, freezing of designs and achieving of FOC was premature. Further, HAL had not utilised advances to the tune of ₹1509.22 crore drawn since 2010 against the contract. (January 2015).

4.7 LCA induction Plan

The Air Staff Requirement (ASR) (October 1985) envisaged that LCA was required to be inducted in IAF squadrons by 1994 as a replacement of Mig-21. The requirement projected by Air HQ was for 200 fighters and 20 trainers, with a view to form 11 squadrons of LCA in order to overcome depletion of squadrons due to phasing out of ageing fleet. However, inordinate delay in

development of LCA (as discussed in Chapter II) has delayed the induction of LCA into service and impacted formation of the squadron as discussed below:

I) IAF had to resort to alternate measures to maintain the force level

Audit enquired (June 2014) regarding steps taken by Air HQ to overcome the depletion of squadron level in view of delay in induction of LCA. In reply, Air HQ stated (February 2015) that the following measures had been taken by them, apart from revising the phasing out of MiG-21 squadrons:

a. Up-gradation (November 1995) of 125 MiG BIS aircraft at a cost of 626 million USD (equivalent to ₹2135 crore)

b. Up-gradation (March 2008) of 62 MiG-29 aircraft into multi role MiG-29UPG standard aircraft at a cost of 964 million USD (₹3841.87 crore). Upgradation was in progress (February 2015)

c. Up-gradation (December 2009) of 61 Jaguar Aircraft at a cost of ₹3113.02 crore. Upgradation was in progress (February 2015)

d. Up-gradation (2011) of Mirage 2000 aircraft through OEM and HAL at a total cost of ₹10947 crore. Upgradation was in progress (February 2015)

Thus, due to delay in development and induction of LCA, IAF had to up-grade other aircraft at a cost of ₹20,037 crore. Besides, phasing out of MiG-21 was also revised (January 2013) to utilise the ageing fleet for extended period.

II) Delay in formation of LCA squadron

Air HQ had planned to have two squadrons of LCA and placed two contracts (March 2006, December 2010) for supply of 40 aircraft (20 IOC and 20 FOC aircraft). However, forming of LCA squadrons could not materialize (January 2015) due to delay in LCA programme (as discussed in Chapter II) as delivery of aircraft was pending (January 2015).

Audit observed from the ADA documents that IAF had planned (September 2010) to initially operate the first squadron of LCA (No 45 Squadron) from Bangalore for a period of two years to complete first 50 sorties per aircraft, for timely product and maintenance support in order to resolve teething problems,

before relocating the Squadron at Sulur. However, operation of No.45 Squadron from Bangalore was still pending (January 2015).

In the meanwhile, based on a proposal submitted (October 2013) by Air HQ, MoD sanctioned (December 2013) the necessary work services for construction of new infrastructure for induction of two LCA squadrons at Air Force Station, Sulur at an estimated cost of ₹524.05 crore. The tendering action for the work services was in progress (December 2014).

Thus, formation of the first squadron at Bangalore, its consequent operation for two years before relocating to Sulur and synchronization with the infrastructure being created at Air Force Station Sulur remains to be seen.

4.8 Shortfall in creation of production facilities impacted Induction of LCA

Audit observed that due to delays in development and achieving IOC (December 2013) of LCA, HAL had indicated (July 2014) supply of 20 IOC aircraft during 2014-15 to 2016-17. Consequently, HAL production lines would be engaged in manufacturing of 20 IOC aircraft up to 2016-17. In case FOC of LCA Mark-I is achieved by December 2015 (as projected by ADA) the production of FOC aircraft cannot commence before 2016-17.

On the similar lines, even if LCA Mark-II would be developed by 2018 (as per the delivery schedule of FSED Phase III), the production of LCA Mark-II could commence only in 2020-21, as production line of HAL would be occupied with the production of LCA Mark-I FOC aircraft from 2017-18 to 2019-20.

In response to an audit observation (September 2014), HAL stated (October 2014) that in-principle approval was obtained (2012) from the GoI for capacity augmentation of LCA production line and CCS approval envisaging a total outlay of ₹1259.80 crore was under process (October 2014). Thus, with the anticipated capacity augmentation, HAL planned to increase progressively the rate of production to 16 aircraft per annum in three years to take up manufacture and delivery of aircraft in FOC configuration from 2016-17.

Reply of HAL is not acceptable due to the fact that in spite of obtaining in principle approval (2012) from the GoI, HAL was yet (October 2014) to get CCS approval for the proposed augmentation of LCA production line. In view

of this, HAL would continue to encounter production capacity constraints which would further delay the induction of LCA into IAF.

4.9 Operational Impact

Audit enquired (June 2014) regarding the operational impact of delay in development and productionisation of LCA on the formation of squadrons of IAF. In reply, operational impact brought out by Air HQ (July - October 2014) was as under:

i. IAF is operating with 35 squadrons as against 42 squadrons sanctioned. Against this, squadrons for MiG 21 aircraft and MiG 27 aircraft would retire over the next ten years. Therefore, it was crucial for an early induction of LCA for maintaining the operational preparedness of IAF. The formation of the first Squadron was being continuously postponed due to delay in LCA development.

ii. Air HQ further added that the measures taken to import/upgrade other aircraft were of temporary nature to prevent the decline of squadron strength of IAF. Therefore LCA's induction into IAF was necessary to overcome the drawdown of the squadrons permanently.

Thus, in view of depleting squadrons, delay in development of LCA and its consequent delay in induction into IAF was a cause of concern to IAF. The first two squadrons, even if inducted with LCA Mark-I, would not be provided with complete EW capabilities[15]. Besides, 20 LCA of IOC configuration (forming the first squadron of LCA), would not have BVR missiles till the aircraft were upgraded to FOC configuration at a later date. Also, IAF would be constrained to use LCA Mk-I having reduced survivability, lower performance, lower range and endurance, reduced pilot protection, reduced operational capability and reduced weapon accuracy as discussed in Chapter II.

[15] Only RWR and CMDS would be provided without SPJ.