

**PUBLIC ACCOUNTS COMMITTEE  
(1977-78)**

**(SIXTH LOK SABHA)**

**SECOND REPORT**

**DEFENCE SERVICES**

**(MINISTRY OF DEFENCE)**

**[Paragraphs 9 and 10 of the Report of the Comptroller  
and Auditor General of India for the year 1974-75,  
Union Government (Defence Services)].**



*Presented in Lok Sabha on 22-12-1977*

*Laid in Rajya Sabha on 22-12-1977*

**LOK SABHA SECRETARIAT  
NEW DELHI**

*December, 1977/Agrahayana 1899 (S)*

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## \*PART II

Minutes of sittings of the Public Accounts Committee held on

19-10-1976

8-12-1977

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**PUBLIC ACCOUNTS COMMITTEE**  
(1977-78)

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\*Elected w. e. f. 23-11-1977 vice S/Shri Shoo Narsin and Jagdambi Prasad Yadav ceased to be Members of the Committee on their appointment as Ministers of State.

## INTRODUCTION

I, the Chairman of the Public Accounts Committee, as authorised by the Committee, do present on their behalf this Second Report of the Public Accounts Committee (Sixth Lok Sabha) on paragraphs 9 and 10 of the Report of the Comptroller and Auditor General of India for the year 1974-75, Union Government (Defence Services).

The Report of the Comptroller and Auditor General of India for the year 1974-75, Union Government (Defence Services) was laid on the Table of the House on 6 May, 1976. The Public Accounts Committee (1976-77) examined Paragraphs 9 and 10 of the said Audit Report at their sittings held on 12 October, 1976 but could not finalise the Report on account of dissolution of the Lok Sabha on 18 January, 1977. The Public Accounts Committee (1977-78) considered and finalised this Report at their sitting held on 8 December, 1977, based on the evidence taken and the further written information furnished by the Ministry of Defence. The Minutes of these sittings form Part II of the Report.

3. A statement containing conclusions|recommendations of the Committee is appended to this Report (Appendix). For facility of reference these have been printed in thick type in the body of the Report.

4. The Committee place on record their appreciation of the commendable work done by the Chairman and the Members of the Public Accounts Committee (1976-77) in taking evidence and obtaining information for this Report.

5. The Committee also place on record their appreciation of the assistance rendered to them in the examination of these paragraphs by the Comptroller and Auditor General of India.

6. The Committee would also like to express their thanks to the Ministry of Defence, Department of Defence Production and HAL for the cooperation extended by them in giving information to the Committee.

NEW DELHI;  
December 9, 1977.

Agrahayana 18, 1899 (S).

C. M. STEPHEN,  
Chairman,  
Public Accounts Committee.

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# ABANDONMENT OF A PROJECT FOR THE DEVELOPMENT OF AN AERO-ENGINE

## **Audit Paragraph:**

1.1. In February 1960, a public sector undertaking took up the design and development of an aero-engine with the ultimate object of replacing the imported engine for a particular type of aircraft then manufactured by it. The cost of development (including 4 prototypes) was estimated at Rs. 41 lakhs (foreign exchange: Rs. 14 lakhs). The Board of Directors of the undertaking sanctioned for this purpose Rs. 5 lakhs in February 1960, Rs. 10 lakhs in December 1962 and Rs. 5 lakhs in January 1969, aggregating Rs. 20 lakhs.

1.2. On the advice of the Scientific Adviser to the Defence Minister that such long-range development projects should be undertaken by the Research and Development Organisation of the Ministry of Defence, Government had suggested to the public sector undertaking in August 1964 that no further expenditure be incurred on the development of this engine until the proposal had been re-considered by its Board of Directors. However, on the undertaking's request for reconsideration of the suggestion, Government decided in October 1964 to allow the undertaking to continue further development of the engine.

1.3. The first prototype engine was test run in September 1966. In October 1967 the undertaking, on the basis of revised estimates, approached Government for a development grant of Rs. 100 lakhs (foreign exchange: Rs. lakhs). The development of the engine was expected to be completed within 2 years. While examining the proposal, Government found (February 1968) that by the time the engine was developed and productionised, the entire requirement of such engines would have been met through imports and, in the circumstances, the development of the engine would be purely an 'educational project'. While reviewing the progress of the project in March 1968, the undertaking also decided to treat this as an educational project. The Aeronautics Committee which considered this project, recommended in 1969 that the project should be pursued to completion as a development project, even though a definite end use for this engine could not be forecast.

1.4. According to the public sector undertaking the development work could not progress further due, *inter alia*, to lack of funds. In May 1970 the undertaking approached Government with a revised proposal for a development grant of Rs. 150 lakhs (foreign exchange: Rs. 40 lakhs). The time-frame for development was then indicated as 5 years 2 months. Two years later and after the proposal had been cleared by the Aeronautics Research and Development Board, Government sanctioned, in June 1972, a development grant up to Rs. 150 lakhs (excluding the expenditure of Rs. 16.60 lakhs already incurred by the undertaking) with the stipulation that any expenditure in excess of the ceiling of Rs. 150 lakhs would be met by the undertaking from its own resources.

1.5. At about the same time (May 1972), the Aeronautics Research and Development Board appointed a Technical Committee for an evaluation and reappraisal, *inter alia*, of this project. The Committee's report submitted in December 1974 did not, however, deal with this project. Meanwhile, in November 1974 Government released Rs. 6.14 crores in foreign exchange for the import of engines against the extended programme of manufacture of aircraft for which the engine under development was intended.

1.6. In April 1975 the undertaking decided to abandon the project on the ground that the engine would not be available before 1980, that future requirements would be for a different type of aircraft and that the project had achieved its educational objective. The Ministry of Defence stated (January 1976) that Government agreed with the undertaking's proposal for the foreclosure of the project and necessary action in this regard was being taken.

1.7. To the end of September 1975, a total expenditure of Rs. 81.82 lakhs (including Rs. 16.60) lakhs initially financed by the undertaking) was incurred, of which Rs. 65.11 lakhs had been sanctioned for reimbursement by Government from time to time.

[Paragraph 9 of the Report of the C&AG of India for the year 1974-75, Union Government (Defence Services)]

1.8. The Audit para points out that in February 1960, a Public Sector Undertaking took up the design and development of an aero-engine with the ultimate object of replacing the imported (Viper) engine for a particular type of aircraft (Kiran) then manufactured by it. The Board of Directors of the undertaking sanctioned for this purpose Rs. 5 lakhs in February 1960, Rs. 10 lakhs in December 1962 and Rs. 5 lakhs in January 1969, aggregating Rs. 20 lakhs.

1.9. The Committee had learnt from Audit in this regard that the expenditure on the project was in the first instance to be met out of the Research and Development Reserve of the public sector undertaking pending a development grant being sanctioned by Government. The Committee, therefore, desired to know as to who initiated the proposal for the development of the engine in February 1960 and, whether at that point of time, the Management Board of the undertaking were satisfied about the viability of the proposal as a development project. In a note, the Department of Defence Production, have stated:

"The proposal for the development of HJE-2500 was initiated by HAL (then known as Hindustan Aircraft Ltd.). A copy of the proposal as appearing in the Agenda Papers in February, 1960 is enclosed. The Committee of Directors was satisfied about the viability of the proposal."

The relevant extracts from the Note for the Committee of Directors' Meeting held on 23 February, 1960 is reproduced below:

"The project design study was sent to Air Headquarters and DTD & P (Air) for their views. Air Headquarters have stated that they have no comments at this stage, except to suggest that the delivery schedule of the engine should be speeded up as much as possible, so that there is no delay in the production of the Basic Jet Trainer, designed and developed at HAL. They have also added that since Government have approved the development of the Basic Jet Trainer, our proposals regarding the development of the engine should be sent to Government direct.

DTD & P (Air) have also no comments, at this stage. . . . . It is considered necessary to develop 4 prototypes, so that development trial runs and testing could be carried out simultaneously on the test bed and on the aircraft. The revised estimate for developing 4 prototypes is approximately Rs. 35.00 lakhs, of which the foreign exchange content, on account of materials etc. will be of the order of about Rs. 17.00 lakhs. In addition, the estimated expenditure, on account of development flight tests would be approximately Rs. 6.00 lakhs. . . . As in the case of the Basic Jet Trainer, it is suggested the necessary finances for the Turbo Jet Engine may also be made available by the Ministry of Defence as development grant.



In view of what has been stated by Air Headquarters that the delivery schedule of the engine should be speeded up as much as possible, it is necessary to commence the design work without losing much time, in anticipation of the approval of the Government of India. The project will give valuable experience in the design and development of Jet Engines and from this point of view the expenditure involved in development would be justified."

The above proposal was considered at the meeting of the Committee of Directors held on 23 February, 1960. Relevant extracts from the minutes of the meeting are reproduced below:

"It was noted that Air Hqs. and DTD&P (Air) had no comments on the design study of the engine prepared by HAL. Air Marshal ..... confirmed that *prima-facie* the design and performance of the engines should be able to meet the main requirements of the IAF. But this will be gone into in greater detail by technical experts. He further stated that it was intended that the first ten Basic Jet Trainers designed and developed by HAL would be powered by imported engine, the Viper. Later on the HAL developed engine could replace the Viper."

1.10. While tracing the genesis of the HJE-2500 project a reference was made by the Secretary, Defence Production, during evidence, to a letter written in 1960 by the Managing Director of HAL to one of the Directors explaining the justification for and purpose of the engine development project. The Ministry of Defence subsequently furnished a copy of this communication, the contents of which are given below:

"It is of vital importance that we make a start to develop a jet engine immediately. This will enable us not only to expand the scope of the present design team to undertake future projects of advanced nature, but also to produce an engine of the thrust range required for the jet trainer aircraft.

This project is justifiable from two points of view. Firstly, an engine of this specification thrust range is required for the jet trainer aircraft of the type of H.J.T. 16 to be designed and manufactured at HAL. Secondly, the design and prototype manufacture of this engine will establish a design and development team in India to meet future needs."

1.11. The Audit para stated that the cost of Development including 4 prototypes) was originally estimated at Rs. 41 lakhs (foreign exchange: Rs. 11 lakhs). On being enquired whether the project report presented to the Defence Ministry in 1960 was a comprehensive one the Secretary, Defence Production has stated that it was sketchy. Asked what efforts were then made to make it comprehensive the witness has explained:

"The reasons for sketchiness was that they did not understand the development processes involved in this engine. Since Gas Turbine Research Establishment (GTRE) of Defence Research and Development Organisation was in its infancy there was no cross-check available from them at that time. The estimates of man-hours required for fabrication were based on the best guesses of the process involved. The subsequently as the process went on the HAL learnt from its mistakes and it is to that we owe the revisions of the estimates of cost."

1.12. Since it had been stated that the cost of development (viz., Rs. 41 lakhs) included Rs. 6 lakhs for flight trials, the Committee asked how the project report could not be called comprehensive, the witness has clarified:

"If you look at the project report you will find all the heads of expenditure have been mentioned. My submission is at that particular point of time HAL was not in a position to estimate these requirements in an authentic and expert manner. This is the reason as to why the estimates went out and also the time frames were completely beyond the initial estimates."

The Chairman of the Undertaking has added:

"As has been stated, in 1960 whatever little expertise was available in the country it was with HAL. Certain test facilities were available but it was only about that stage that we had started an engine factory at Bangalore. So even the design scheme which had come from the factory had very little idea as to how much development work would take place, because it was started with a very small sanctioned amount."

1.13. On being pointed out that sometime in June 1961, GTRE was also developing a similar turbo-jet engine which indicated that

considerable activity in this direction was going on in early 60s, the Scientific Adviser has stated in evidence:

"GTRE was set up specifically to work in the area of Gas turbines for military aircraft.....around 1960 GTRE did not have test facilities. Until we have test facilities (which were not there at that time), we cannot find out about many things ..... It is over the last three years that we are tackling major systems like an aircraft engine, a major Radar, etc. Until recently we handled only extremely small elements as explained earlier.....GTRE did not handle this particular engine-HJE-2500. Actually the first major engine project under GTRE was the Reheat project for HF-24. The rest of its activity, essentially until 1963, was for a certain number of individual components."

On the Committee pointing out that it could, therefore, be summed up that in spite of the need for developing an indigenous engine having been recognised as early as 1960, the Government did not take a conscious decision to proceed rapidly in this direction, the Secretary, Defence Production stated:

"I agree with you."

1.14. Asked what type of control Government exercised over the Undertaking and what efforts were made to see that the undertaking keeps to the time schedule for the development of engine, the witness had the following to state:

"HAL is wholly owned by the Government of India and the Defence Ministry is incharge of administering the unit. We are very much there. The Department of Defence Production knows what goes on there. The fact of the situation is that *ab-initio* neither in the Ministry of Defence and nor in HAL was there any expertise for the manufacture of these engines. Therefore, the time frame required for production of engines which appeared to have been un-realistic was not really put right."

To another question whether any thought was given to the problem of non-availability of expertise then existing in the HAL, the Secretary, Defence Production stated:

"In a matter like this when you are going on your own, the philosophy is to learn as you go. That is why this project was educational."

The Committee enquired if the HAL did not have the necessary expertise and facilities why they had embarked on a project costing Rs. 150 lakhs which was not a small amount, the witness has stated:

"The engineers in HAL had an adequate theoretical knowledge of the jet engine but they lacked the practical experience and in these matters there was a great deal of leeway which one had to learn by practical experience on the project, which books do not teach."

When the attention of the witness was drawn to the fact that it took as long as 16 years to gain experience, he has stated:

".....I do agree that monitoring was bad in his particular case. I feel you would be justified in your conclusion that the monitoring was not done."

Asked whether there was any check on how the project was progressing during the years 1960—72, the witness has stated that apart from the review by the Board there was no other monitoring.

Attributing the reasons for not obtaining test facilities to the very small allocation of funds in the early stages of the project the Scientific Adviser has stated in evidence:

"If you look at the actual situation, you will find that the actual allocations of money were exceedingly small—i.e., Rs. 5 lakhs. One could never contemplate (whether it was in the 1960s or 1970s) of an engine development to be accomplished on the basis of this amount of money. Really, this one would have to be regarded as educational or competence building in certain areas."

1.15. The Audit Paragraph has also pointed out that on the advice of the Scientific Adviser that such long range development projects should be undertaken by the Research & Development Organisation of the Ministry of Defence, Government had suggested to the public sector undertaking in August 1964 that no further expenditure be incurred on the development of this engine until the proposal had been reconsidered by its Board of Directors. However, the undertaking made a request for reconsideration of the

suggestion. The letter from the General Manager of the Undertaking to the Department of Defence Production, stated:

"If I may be permitted to express my views on the recommendations of the Scientific Adviser, I may state that in other foreign countries like the UK and USA, design and development of aircraft/aero-engines are not handled by Research and Development Organisation. They are entrusted to manufacturing companies. Research Organisations deal with theoretical analysis of various aerodynamical/thermodynamics calculations and tests either to assist the Air Force in determining the OR or for carrying out certain tests like the wind tunnel tests, engine component tests, analysing the results of the tests in evaluating the performance of the components/product. Research Organisations do not have facilities like design personnel, machinery and equipment for manufacture and inspection of components and test equipment, without which it will not be possible to make prototypes, nor is it worthwhile to establish a duplicate set up for this purpose. It is for this reason that in foreign countries, design and development of airframes/aero-engines are not entrusted to Research Establishments—although the manufacturing organisations work in close collaboration with Research and Development Establishments. Such manufacturing organisations invariably have—as in HAL—a design group, with a separate prototype shop. The extent to which each prototype shop should be self-contained is determined by the number of projects and the scope of the projects to be handled simultaneously. The capacity of the prototype shop is also supplemented by the available spare capacity in other manufacturing shops.

I am enclosing a time schedule for the Basic Jet Trainer programme, showing alongside the schedule for the production of HAL SJE-2500. It will be seen from the time schedule that we may have to go in for another 50 Viper engines. The balances could be met by HAL production. There is also advantage in meeting the subsequent requirements of spares from HAL production.

May I, therefore, suggest that the proposal to entrust the development of HJE-2500 to Research and Development Organisation be reconsidered and HAL authorised to proceed with the development work as originally planned."

Government decided in October 1964 to allow the undertaking to continue further development of the engine.

During evidence, the Scientific Adviser has explained that the approach of his predecessor in giving advice in August 1964 was that "advance technology items with long gestation periods which involved higher contemporary levels of competence should initially be handled at GTRE." However, on a representation made by the management of HAL that they should be allowed to continue the development project and also the fact that "no such facility was available at the relevant time in the Defence Research & Development Organisation for undertaking a project of this nature," the public sector undertaking was allowed to continue further development of the engine.

1.16. The Committee desired to know when Government was approached for the grant. In a written note furnished to the Committee, the Department of Defence Production have stated that Government was formally approached for the grant in October, 1967. On an examination of the proposal, Government found that on account of the delay in the development the total requirements of the indigenously developed engine would be negligible and the manufacturing cost exorbitant. As such it was considered in February 1968 that the project could be taken up only as an educational one.

1.17. Asked what transpired between February 1960 when the project was initiated by the undertaking and August 1964 when the Scientific Adviser is stated to have expressed his opinion, the witness has stated:

"Actually we tried to find out what happened between 1960—64. Unfortunately the papers are deficient in the sense that there is no record of any discussion as to whether the Government considered this request for funds. Initially, the Board was supposed to finance this and it is likely that at that particular point of time, since the Board was providing the money for this project Government had not paid all that attention as to whether all this money should be reimbursed to the HAL."

Assuring the Committee that the progress of the project was not hampered because of Scientific Adviser's views, the witness has deposed:

"In 1964 August, the SA expressed the opinion which you just quoted. In September 1964, that is, the very next month.

he had reconsidered this matter at the instance of HAL and the development in the HAL was allowed to continue. So, the expression of opinion by SA at that stage was a sort of a brief interlude at best, but the progress of development at HAL was not discontinued because of this. As a matter of fact, the first prototype engine was test run in September 1966 though it did not achieve all that which was expected to achieve. The fact of the matter is that the development had gone on."

1.18. In this connection, the Committee enquired whether any concrete proposal for the licensed manufacture of the Viper engine in India was under consideration at that time and if so, what further action was taken in pursuance of that suggestion. In a note, the Ministry of Defence, have stated:

"From the beginning, Kiran aircraft (Jet Trainer) had been designed around the Viper engine. It was envisaged that if the HJE-2500 development project succeeded, then the Viper Engine could be replaced by HJE-2500. Once a decision was taken not to pursue the development of HJE-2500 by HAL it was felt that HAL should consider the possibility of licence manufacture of Viper instead.

There was, however, no concrete proposal in this regard. The matter was also not pursued, presumably, consequent on the reversal of the earlier decision to suspend further expenditure by HAL on HJE-2500."

1.19. The Audit para states that the first prototype engine was test run in September 1966. This meant that no tangible progress had been made by then as against the initial proposal of developing 4 prototypes and envisaged completion of the project within three years. As regards the air-frame the first Kiran aircraft was delivered in 1967-68 and very few were delivered till 1970-71. In view of the fact that production of the aircraft was lagging behind, the Committee desired to know whether any efforts were made to review the whole situation and match dovetail the engine and the air-frame projects. The Secretary, Defence Production has stated in evidence:

"...It would be very difficult to say whether by proper monitoring or even by giving a much higher priority, the engine could have been made ready for the Kiran programme.... from 1960 to 1967 given all the facilities it

as perhaps right to say that an engine could have been developed but that would have required a type of effort which HAL was not in a position to mount at that point of time. Their philosophy of development on which comments were made in the Aeronautics Committee later were out of tune with the existing practice. In matters like this components had to be developed themselves, tested and then assembled. The HAL assembled the engine, put the engine to test but it did not run up to expectations whereupon they reversed the process for designing, rectifying things which ultimately prolonged the development cycle considerably."

The Committee desired to know whether Government reviewed the position from time to time. The Secretary, Defence Production has stated:

"The review was done but their review was always with the expectation of Kiran deliveries coming off at a particular point of time.....these were small programmes which would not have justified laying down a line for HJE-2500 engines. The conclusion was that we would have to treat the engine development programme as educational one."

1.20. The Committee learnt from Audit that in July 1967, HAL Board approved Revised Estimates at Rs. 145.50 lakhs (FE Rs. 15 Lakhs) with 6 prototype engines and directed that the number of prototypes be reduced to the minimum. In this connection, the Audit para states that in October 1967, the undertaking on the basis of revised estimates, approached Government for a development grant of Rs. 100 lakhs (Foreign exchange Rs. 12 lakhs) with 4 prototype engines. The development of the engine was then expected to be completed within two years. The Committee desired to know the specification taken by Government on this request as well as the reasons for not sanctioning the amount immediately thereafter, particularly in the context of the assessment made that if the engine was successfully produced, it could serve as a power plant for at least some of the Kiran aircraft and the development of the engine was also not progressing expeditiously on account of paucity of funds. The Ministry of Defence, in a note, have stated:

"It has been already brought out that on receipt of HAL's request for the grant of Rs. 100 lakhs in October 1967, the assessment was made of the commercial viability of the



project and it was found that the project could be taken up only as an educational project. While question whether the project should be taken as the educational project was under examination, Government appointed Aeronautics Committee. It was, therefore, felt proper to await the recommendations of this Committee. The matter was once again taken up after recommendations of Aeronautics Committee were available. Meanwhile in May 1970, HAL had revised their requirements on development expenditure from Rs. 100 lakhs to Rs. 150 lakhs. The question then was as to whether this project should be taken as educational project at the cost of Rs. 150 lakhs. There was also a question of availability of funds. Discussions continued between this Ministry and the Ministry of Finance and the Scientific Adviser right upto June 1972 when it became possible to sanction the funds."

1.21. It transpires from the copy of the minutes of the meeting of the Board of Directors of HAL held on 8 March, 1967, furnished to the Committee that when HJE-2500 project was first approved it was envisaged that the first 60 HJT-16 (Kiran) aircraft would be powered by the imported Viper engines and thereafter the HJE-2500 would be used on the remaining aircraft. The Managing Director of the undertaking had explained during that meeting that at that stage of the engine development, he could not make a categorical statement about its future use and that it was difficult to say whether it could be developed and produced in quantity in time for the Kiran programme. Nevertheless, he felt that its further development was of very considerable educational value and should be allowed to go ahead as proposed. The then Scientific Adviser to the Ministry of Defence had suggested during the meeting the production of the minimum number of prototype engines to enable an early evaluation to be made. He was of the view that if the design was successful, a decision could then be taken to go ahead with quantity production, otherwise it could be dropped. The Board of Directors agreed with the Scientific Adviser's suggestion and desired that the proposal be reviewed accordingly.

During evidence, the Secretary, Defence Production read out the following extracts from a paper placed before the Board of Directors of HAL at their meeting on 8 July, 1967:

"It will be seen that HJE-2500 could be used in approximately 54 Kiran. In addition approximately 50 per cent of the

reserve engines i.e. 20 could be supplied making a total of approximately 75 engines.

The HJE-2500 is at present designed to operate at a low TET of 1050°K. This has been done intentionally to provide large developmental potential. By material variation and the increase of TET it would be possible to provide higher thrust and may pass turbo fan engine variants and for other aeronautical ground applications. Thus developed versions derived from basic engines could follow and be utilised in future projects covering improved jet trainers, executive light personal transport aircraft etc.

The estimates for productionising have been included as an indication of the magnitude of expenditure involved. It is proposed to approach the Board in this respect with full details in April 1968 dependent on progress with development running and results.

The Directors are requested to approve the proposal to manufacture prototype HJE-2500 engine and to complete development of jet type certification engine at an estimated cost of Rs. 144.5 lakhs with a foreign exchange complement of Rs. 15 lakhs."

In a note, the Ministry of Defence have stated that HAL *vide* their letter dated 3 October, 1967 had made a request for grant of Rs. 100 lakhs for the development of this engine. This led to the assessment of the project in November-December 1967. Giving details of the assessment made and the action taken in pursuance thereof, the Ministry have, in a note, stated:

"The letter from HAL requesting for the grant of Rs. 100 lakhs accompanied the Board papers for the 24th meeting of the Board of Directors scheduled to be held on 8 May, 1967. According to HAL's assessment as contained in the Board papers the HJE-2500 engine would have been available in May 1971. Considering the production programme of Kiran aircraft as envisaged then HAL had assessed that only 54 HJE-2500 engine could be used for Kiran aircraft, and the balance requirement was to be met by import of Viper Engine. It was confirmed that only about 50 engines will ultimately be required. On this basis it was felt that amortisation of the tooling and development cost would be around Rs. 5.25 lakhs per engine which would make the

entire proposal uneconomical. It was in this context that the project was considered as an educational project."

1.22. Asked whether a definite production programme in respect of HJE-2500 was ever considered and drawn up, the Ministry of Defence, in a note, have stated:

"No definite production programme in respect of HJE-2500 engine was considered and drawn up. The engine was still under development. Unless the engine had achieved the required parameters, no purpose would have been served by drawing the detailed production programme. The tentative programme, however, had been drawn which is shown in the Board papers."

It is however noted from the information furnished by the Ministry in April, 1977 that the production programme was drawn up in 1964 itself and a revised production schedule was subsequently drawn up in 1967.

1.23. The Audit para has stated that while examining the request of the undertaking for a development grant of Rs. 100 lakhs Government came to the conclusion (February 1968) that by the time the engine was developed and productionised, the entire requirement of such engines would have been met through imports and in the circumstances the development of the engine would be purely an 'educational project'.

On being asked whether from the long range point of view the idea was that we should be self-sufficient in the matter of engines, the witness has deposed:

"If we had waited for the HJE-2500 engines the deliveries would have been delayed... Development of engines as a production exercise did not have enough attraction."

Explaining when this decision was taken and what was the basis thereof, the Ministry, in a note, furnished to the Committee subsequently, have stated:

"The decision that the project could be carried only as an educational project was made in February 1968. The decision was taken on assessment of the availability of the indigenously developed engine and the production programme of Kiran aircraft, which led to the conclusion that the engine would not go into production as the entire requirement

would have been met by the time the production could start."

To another question whether it was spelt out in specific terms, at any time prior to 1968 that this was only in the nature of an educational project, the Ministry of Defence, in a note, have stated:

"Prior to 1968, it was not spelt out in specific terms that this was only in the nature of educational project. The educational aspect of the project, however, was always there as indicated in the letter from the Managing Director, HAL to Shri JRD Tata."

1.24. The Audit para also points out that the Aeronautics Committee which considered this project recommended in April 1969 that it should be pursued to completion as a development project regardless of the end use. The specific comments in the Aeronautics Committee's Report on the engine project and the action taken by Government thereon as furnished by the Ministry of Defence are reproduced below:

"We would like to make a special reference to the HJE-2500 and the agricultural engine projects. The history of development of HJE-2500 is a good lesson for future; we endorse the observations of the Rolls Royce Team that it is 'an example of how engine development should not be undertaken'. Even though a definite end use of HJE-2500 cannot be forecast now, it should be pursued to completion as a development project, the experience in components development and their production would considerably help the major engine project which we have recommended, should be undertaken to establish a self-supporting engine industry in India. We recommend that the necessary sanction be given by the Department of Defence Production for the completion of the HJE-2500 project. The existence of two separate teams was an impediment to the sanction of the expenditure; acceptance of our recommendation for the merger of the two teams should remove this impediment.

The recommendation to continue development of HJE-2500 was accepted by the Government. Subsequently, an amount of Rs. 150 lakhs was granted to HAL for this purpose vide Government letter No. F.(1)70[D(HAL-I) dated 9 June, 1972."

125. The Aeronautics Committee had, in their report submitted in April 1969, recommended the merger of the GTRE and the Aero-Engine Design Division of the public sector undertaking. During evidence, the Scientific Adviser indicated the latest position in this regard as follows:

"From the view point of research and development that was accepted in principle by the Government but... that has not taken place. In fact there have been several discussions on the question relating to the engine area concerning the totality of production and of research and development and how these should be completed; the present position, as it stands, after consideration of all the aspects, is that the two should still remain separate. As far as this particular engine was concerned, there was no duplication in any sense. The effort was entirely within HAL; and as far as the Defence Research is concerned it did not undertake any responsibility or take any executive action in regard to this."

In a note furnished to the Committee subsequently, the Ministry of Defence have stated:

"The implementation of the recommendation was discussed in the room of Defence Secretary, in July|August 1972. There was general agreement on the respective roles of GTRE and HAL. It was decided that in order to give a practical definition to this agreement, the details of respective programmes on work schedule for 1972-73 should be drawn and a scheme of co-ordination and integration of efforts in common fields should be presented. On this basis the respective programmes of these two organisations were chalked out. HAL Aero-engine Design Division and GTRE have been since functioning in their respective assigned roles in a cordial and healthy atmosphere and there has not been any overlapping of efforts. Over the years substantial investment of resources have been made in GTRE where a strong nucleus Air Engine Design Team has been created. In comparison the manpower and resources available at HAL Aero-Engine Design Centre are modest. It has been felt that a major project of *ab initio* development of advanced technology, Aero-engine should be handled by GTRE where sufficient facility and expertise in handling such projects are available. Recently, Rajadhyaksha Committee have

recommended that the Design and Development of Aero-engines may be exclusively left to GTRE. As such the merger of these two teams would no more be necessary."

126. The Audit para points out that in May 1970 the undertaking submitted revised proposal for Rs. 150 lakhs (Foreign exchange Rs. 40 lakhs) and a time-frame of 5 years 2 months (i.e. July 1975). The Committee desired to know the reasons for the increase in the estimated cost of development (with 4 prototypes) from Rs. 41 lakhs as originally envisaged in February 1960 to Rs. 150 lakhs in May 1970 and the actual expenditure incurred upto date. The Ministry of Defence, in a note, have stated:

"The estimates for the development of HVE-2500 on the basis of 4 prototypes with development testing were made in February 1960, October 1967 and May 1970. These estimates were for Rs. 41 lakhs, Rs. 100 lakhs and Rs. 150 lakhs respectively. As the jet engine factory in Bangalore had just taken up work on production of jet engines, sufficient knowledge was not available in 1960 to make a very realistic estimate of the machine hours required for fabrication of prototype components. From the information available at that time, an estimate was made of the manhours required for prototype fabrication and the manhour rate as applicable in 1960 was utilised for arriving at the cost of fabrication. By 1967, sufficient experience had been gained by the Engine Design Department and the Production Engg. Section of Engine Division in making a realistic analysis of the hours required for fabrication of components for the prototypes. More accurate information was available as one prototype of the engine had been constructed and test run. There had been increase in cost of material and manhours in the period of 7 years by which the estimate of fabrication and development of 4 prototypes of the engine had gone up from Rs. 41 lakhs to Rs. 100 lakhs. The estimate made of the testing required in 1960 was very low compared to the estimate made in 1967. This was due to the fact that by 1966, the first prototype had been run and unforeseen problems had been encountered in the development of the engine. As such, the cost of development had to be increased. The estimates made in 1970 for the development of the engine was Rs. 150 lakhs. The reasons for the increase in the development cost

from Rs. 100 lakhs to Rs. 150 lakhs can be enumerated as follows:

- (a) increase in the manhour rate noted and the anticipated increase in the next 5 years (Rs. 6 was taken for the original estimate, the present estimate being Rs. 12.50).
- (b) estimated increase in cost of fabrication of forgings and castings—the original estimate was based on data available before some important forgings and castings were developed for Orpheus engine. This experience has given a more realistic data on cost of development of forgings and castings.
- (c) Price escalation for raw material since the original proposal was made.
- (d) Increase in price for bought out items like accessories which have to be specially suited for the design of the engine.

The actual expenditure incurred on the project upto date is Rs. 81.98 lakhs."

1.27. According to the October 1967 projections of the undertaking, the development of the engine was expected to be completed within two years. Subsequently in May 1970 it was revised to 5 years 2 months. The Committee desired to know the reasons for this sharp increase in the projected time schedule. The Ministry of Defence have, in a note, stated:

"The new time schedule of 62 months for development was projected on the basis of the experience so far gained. The first prototype had encountered certain difficulties during the initial test bed running. Upto 1970 it had not been possible to run the engine at the designed speed. It was realised by 1970 that it was difficult to achieve the successful development of major components of this engine such as Turbine, Combustion Chamber accessories on the engine itself as originally planned. It was considered better to test these components individually on separate test facilities instead of testing them on the engine."

On the Committee enquiring that having indicated a firm schedule, what specific efforts were made by the undertaking as well as the Departments of Defence and Defence Production to ensure

that the schedule was adhered to, the Ministry in another note have stated that after the sanction was given by the Government, a periodical review of the progress of the project was made by the Board of Directors of the undertaking.

1.28. It is seen from the Audit para that after the revised proposal put up by the undertaking in May 1970 had been cleared in January 1972 by the Aeronautics Research and Development Board, Government granted in June 1972 an amount of Rs. 150 lakhs to the undertaking for this purpose. The Audit para also points out that according to the public sector undertaking the development work could not progress due, *inter alia* to lack of funds. In this connection, the Committee drew attention of the representative of the Ministry of Defence to the recommendation of the Aeronautics Committee made in April 1969 that the project should be pursued to completion and desired to know the reason for a delay of more than 3 years (April 1969—June 1972) to sanction the grant. The Secretary, Defence Production has started in evidence:

“This was apparently due only to discussions with the Ministry of Finance and others as to where the funds would come from. The amount sanctioned ultimately was Rs. 150 lakhs. The question was whether it should be from the Aeronautics Research and Development Board. Ultimately Government sanctioned from its own sources and not from the Board.”

1.29. On the Committee pointing out that whereas funds for importing engines to meet the requirements of IAF were readily available, funds for the indigenous project which could give boost to the nation's prestige were delayed, the witness has the following to state:

“As far as the imports are concerned, they were related to the airframes manufactured by HAL. Engines were brought in phases to meet the manufacturing programme; and also to meet the requirements of the Air Force. Therefore, in a sense it acquired a priority, which an educational project would not. The source of obtaining funds was a matter for the Ministry of Finance to consider. They ultimately gave us funds from Government sources. It was budgeted for and sanctioned. Apparently what had happened was that because it was an educational project, it had to a certain extent slipped in the order of priorities..... There was a lot of discussion with Finance at that time which could have been avoided. It was a fact that it took so much time. I think, perso-



nally, that it was a pity. I can only say that perhaps because it was not of any immediate practical application, it slipped in the order of priorities."

1.30. The Aeronautics Committee had, in April 1969, recommended that this project should be pursued to completion. The undertaking, however, approached Government with a revised proposal for a development grant of Rs. 150 lakhs (Foreign exchange: Rs. 40 lakhs) in May 1970. The Committee enquired why it took the undertaking over a year to submit revised proposals. The Ministry of Defence have, in a note, stated:

"Though the recommendations of the Aeronautics Committee were available in April 1969, HAL were not specifically required to resubmit the revised proposal. The matter was examined by the Board of Directors in February 1970 and the Directors called for the technical assessment of the usefulness of HJE-2500 engine. It was in the course of this assessment that HAL reworked out the estimated cost of development at Rs. 150 lakhs, which was presented to the Board of Directors on 5 May 1970 and later on communicated to the Government by their letter dated 28 May, 1970."

Explaining reasons for taking more than 12 years from the launching of the engine project (February 1960) and nearly 5 years from the time the first request was received (October 1967) for a grant from the undertaking, to sanction (in June 1972) a grant of Rs. 150 lakhs, the Ministry, in another note, stated:

"HAL's request for grant of funds was received in October 1967. The reasons for delay in sanctioning the funds have already been explained. It may, however, be added that the uncertainty of the end use of this engine remained throughout the period as a major factor for delay in sanctioning the funds. Even in 1964 on the facts as found then it was felt that the engine would not be available for use in Kiran aircraft by the time it was developed and productionised."

1.31. Since one of the stipulations made while sanctioning the grant of Rs. 150 lakhs in June 1972 was that the undertaking would submit periodical progress reports to Government—no time-frame was, however, specified in the sanction for the development of the engine—the Committee enquired whether this stipulation was ac-

tually complied with. The Ministry of Defence have replied in the affirmative and added:

"The progress report on the project submitted to the Board of Directors alongwith the minutes of the meeting were sent to the Ministry for Information."

As regards reasons for non-specification of time frame in the sanction, the Ministry stated that nothing was available on record in that respect.

1.32. The Committee desired to know the role assigned to the Aeronautics Research and Development Board in this project. The Ministry stated:

"Aeronautics Research and Development Board (ARDB) was set up on the recommendations of Aeronautics Committee. The ARDB examines all major project proposals in the field of Aeronautics irrespective of whether they emanate from public sector undertakings, R&D organisation or academic institutions. When AR&DB was set up the HJE-2500 project was already under implementation. This project was scrutinised by AR&DB in its meeting held on 8 January 1972 who approved the same."

1.33. The Audit para states that the Aeronautics Research and Development Board had set up in May 1972 a Technical Committee to assess various projects of propulsion systems including this project. The Committee's report submitted in December 1974 did not however, deal with this project. An explanatory note furnished by the Ministry to Audit in February 1976 in this regard is reproduced below:

"While this project was originally intended to be an item of reference to the Committee, the terms of reference for the guidance of the Committee as communicated by Air Headquarters did not refer to this project and that the Committee based their deliberations on the terms of reference made by Air Headquarters. The reasons for not dealing with this project by the Technical Committee have been given by the Directorate of Aeronautics (R&D) in April 1976 as follows:

- (a) Consideration of HF-24 was of immediate importance at that time.
- (b) It was not possible to complete the proceedings within the time-frame because of the preoccupation of

the Chairman of the Committee in his very many responsibilities as well as that of the members."

When the Committee referred to a letter dated 22 May, 1972 from the Director, A.R.D.B. addressed to the Technical Committee of which Dr. Ramachandran was the Chairman, which, *inter alia*, stated that "A technical committee has been formed to assess design and development proposals received from the Industry, R&D Organisation and other agencies in the form of propellant system and make suitable recommendations", the Scientific Adviser has clarified:

"It is certainly true that consideration of HJE-2500 engine, which we have been discussing, was one of the items given in the original terms of reference to the Ramachandran Committee by the ARDB. However, the Ramachandran Committee received a communication from the Air Headquarters in which they stated that their particular interest was in a comparison of the engines which have been proposed by GTRE and HAL for the Marut aircraft, HF-24. The Ramachandran Committee seems to have confined itself to this later communication from Air Headquarters namely what engines would be suitable for HF-24 aircraft. They did not consider and made no recommendations relating to HJE-2500."

The Committee wanted to know the reasons for the Ramachandran Committee confining itself only to the later communication from Air Headquarters when its terms of reference had already been notified earlier by the ARDB. The Ministry, in another note, stated:

"The exact reasons are not available on record. There was a need to get clear picture about the engine proposals in respect of HF-24 aircraft. The deliberations of the Technical Committee had to be completed at an early date and, therefore, the Committee appears to have confined itself to the terms of reference suggested by Air Headquarters."

The Ministry of Defence had informed the Audit that the Directorate of Aeronautics (R&D) had stated in April 1976 that one of the reasons for the Technical Committee not dealing with the HJE-2500 project was that the proceedings could not be completed within the time-frame on account of preoccupation of the Chairman of the Committee in his very many responsibilities as well as that of the members. During evidence, an observation was made that if the Chairman had too many responsibilities, then he should have been

shifted elsewhere and someone else should have been brought in. In this connection, the Scientific Adviser has stated:

"Here there is nothing that I can really offer. I fully agree with you that there might be delays of the order of days or weeks as a result of extra work that might have to be done. But, one cannot certainly offer this as an excuse."

The Committee desired to know the basis on which the Directorate had come to this conclusion and whether any time-frame was specified for the completion of the Committee's deliberations. The Ministry in a note stated that this was based on a D.O. letter received from the then Secretary, ARDB and that no time-frame was specified. Answering another question whether ARDB was kept informed periodically of the progress of the Committee's work, the Ministry replied: 'Yes'.

1.34. Asked to give a detailed note indicating what part of the import of Viper engines to power the Kiran aircraft could have been avoided, if the HJE-2500 project had been pursued energetically to its finality and given the necessary financial inputs and encouragement, as proposed by HAL in 1967 and as recommended by the Aeronautics Committee in 1969 and what would have been the cost of the engine as compared with the cost of the Viper engine, the Ministry have replied:

"According to the Agenda paper for the HAL Board meeting held in May 1967, production cost was tentatively estimated at Rs. 3.4 lakhs per engine for production run of 200 engines. In any development project, even if it is pursued energetically the success can never be taken for granted. Unless it is known as to when exactly the engine would have been developed and thereafter productionised, it would not be possible to calculate how many engines actually could have been utilised to power the Kiran aircraft and thereby avoiding import of viper engine. It is also, therefore, not possible to calculate what exactly would have been the cost of indigenous engine and how would it have compared with the cost of Viper engine."

1.35. According to Audit paragraph in April 1975 HAL decided to abandon the project on the ground that the engine would not be available before 1980, that future requirement would be for a different type of aircraft and that the project had achieved its educational objective. The Ministry of Defence stated (January 1976)

that Government agreed with the undertaking's proposal for the foreclosure of the project.

Since the HAL Board while reviewing the position of the project in July 1974 had decided to progress the same energetically in view of extended programme for manufacture of Kiran aircraft, the Committee enquired into the circumstances in which it had been decided subsequently (April 1975) barely nine months thereafter, to foreclose the project. The Secretary, Defence Production has stated in evidence "A monitoring Committee consisting of all experts had gone into it. The Director of Development and Design was also there. I will read out this portion. Here it says:

"An estimated 91,000 machine-hours per annum are required for manufacturing the prototype engines. Since there is no capacity available for this purpose in the prototype shop of the Engine Design Department it was planned that the work could be done at the Engine division. Due to heavy pressure of work on the existing manufacturing programme the engine division is unable to accept this commitment. The possibility of getting the machine hours from other divisions of Bangalore complex was also examined but none of them has any special capacity for undertaking this work. As such work on the fabrication of the prototype engines has been almost at a standstill during the last 6 months.

A new fuel control system is required for the engine. Two firms in UK, namely Lucas Aerospace Ltd. and Dowty Fuel Systems Ltd. have shown some interest in the matter but the expenditure quoted for the development work is very high.

The weight of the present prototype is 20 per cent higher than the targeted value. Weight reduction would involve 34 components and would therefore require a greater deal of effort and time.

There is no commercial value in this project since the engine cannot be 'productionised' in time for fitment to Kiran aircraft which is being further developed as an armed version for which an engine with a thrust of..... is required.

The project was undertaken for deriving an educational value. This requirement has been met to a certain extent since the first prototype has developed a design.

thrust of..... at the required SFC. As such the HJE-2500 project need not be pursued further."

The report of the Monitoring Committee was accepted by the Board and this was closed. He has added:

"I happened to be Chairman of HAL at that time. I am glad to say that this has gone on very well. First prototype has come out; orders have come already. If Kiran production line had gone on, it would have produced good results."

Asked whether it meant that, at that point of time, if HAL's point of view was sympathetically accepted, much better results could have been produced, the witness has stated:

"No, Sir. The HAL's Monitoring Committee's view was accepted by the Board. The view was that the project should be closed."

It is seen that though the HAL Board had decided in April 1975, to foreclose the project, Government had agreed to the proposal only in January 1976. Giving reasons for this delay of nine months in taking the decision, the Ministry have, in a note, stated:

"HAL's request for Government approval to foreclose HJE-2500 project was received in the end of July 1975. HAL's proposal was not only for the foreclosure of the project but also to allow it to spend the unutilised amount against other projects. The other projects had not been specified. HAL was required to specify the projects against which they proposed to utilise the amount. The actual expenditure incurred, the amount reimbursable to HAL in terms of Government letter of June 1972 and the unutilised amount needed certain clarification. The processing of this case took about 5 months."

The Committee enquired whether Government have since sanctioned the foreclosure of the project and if so, what was the total expenditure incurred and reimbursed by Government upto-date on the project, the Ministry have replied:

"Government have since sanctioned the foreclosure of the project vide Government letter No. 8/1/70/D (HAL-1) Vol. II dated 27-8-76. Total expenditure incurred so far on the project is Rs. 81.98 lakhs of which Government would, subject to Audit verification, reimburse about

Rs. 65.37 lakhs. Amount so far reimbursed to HAL is Rs. 65,11,277."

136. To another observation of the Committee that apart from delay, quite a substantial amount had been spent in carrying out experiments on this engine when there was no chance of success, the witness had the following to state:

"While you may put it that way, I am quite certain that the realisation that the Orpheus engine would stretch beyond 1976-77 into the 80's was known to HAL before, but having treated this as an educational project, we had to pursue it up to a particular point which would prove to us that our engineers had indeed derived benefit from this project. The final bench testing, whatever the engine they had made, had to be gone through. There was no question of closing down the project. The final testing of the engine was made in April-May 1974. Before that, I could not close down the project. If I had done so, then we would have left the things half way. At that particular point of time, having gone into all these things, we had to take a decision whether to continue it or not. This engine, we think, would never have given us the power and we closed down the project having acquired all the benefits that we would hope to achieve out of this engine."

Asked when it had been realised in 1967 itself that this was not going to succeed, what was Government's reaction at that time, the witness has stated:

"That realisation had come, because at that point of time, the Kiran had a delivery schedule and we were thinking of the delivery scheduled for the HJE-2500 also. To match the two would mean that we were falling beyond the Kiran delivery. Then we came to the conclusion that this engine would enter into production, which strengthened our belief that this would have gone through as a development exercise, as a rectification exercise further than it was necessary at a particular point of time. When we made a final engine, it gave a certain thrust and we felt that the engine would teach us something. Beyond that any further expenditure on it by lowering the weight and bringing down the engine to dimensions etc. would have been justified only if it would have been possible to use the engine on any aircraft. But since that use was not there, therefore, we cut down the expenditure and closed the project.... I do

admit that if the HJE 2500 had gone according to schedule, if it had been manufactured in three years' time, there would have been a good case for using it on the Kiran aircraft. In fact, it did not happen. The fact that the Kiran aircraft had slipped for its own reason is a different matter."

Asked whether the Finance had stood in the way, the witness replied:

"This was the first project that we were handling of this nature and it went the way as you have seen. Ultimately, with the money which we have spent, the results by world standards are a fairly creditable achievement. People outside India have spent far larger amount on such type of projects."

The Chairman of the Public Sector Undertaking (HAL) has stated in this context:

"As Mr. Sen has explained, it is not only the question of money which we require for production of an aero engine which we could use, but it is also the question of manpower resources. Manpower resources have to be built up to produce and carry out development work. As it is, this engine finally ran and it did meet the parameters as far as the horse-power and fuel consumption are concerned. Eventually, it did not meet the other parameters such as weight."

1.37. When the Committee pointed out that from the information furnished by Government so far in this connection, it could be concluded that the failure of the project was because of lack of funds, expertise and coordination, the Secretary, Defence Production has stated:

"To summarise what we have been trying to say, the fact of the matter is that at that time, i.e. in the early 1960s. there was a small number of trained staff in the HAL. With that staff, the board of the HAL felt brave enough to go in for that exercise although, in my view, the team that they were trying to build up was certainly far too small for a project of this nature, despite the fact that the pace of sanctions from the Board more or less followed the pace of expenditure. So, going by the records, one cannot say that there was always a shortage of



funds. But then, it can be argued the other way—an institution spends as much funds as are made available to it. One cannot really pass an opinion in 1976 on what happened in the 60s, whether the HAL should have been given more funds. This is a matter on which one can only conjecture; one cannot express a definite opinion.”

When the Committee expressed doubts about the educational objectives achieved after having put in fifteen years time and spending Rs. 82 lakhs which were big things for a poor developing country like ours, the Scientific Adviser has stated:

“As I have mentioned earlier, right at the beginning itself, when it was started with a very small amount of Rs. 5 lakhs, one could not really have regarded it as a major engine development programme. The period of two years be regarded really and essentially as a study. One should remember that aircraft engines, uptill now, have either come in aircraft which have been imported or for aircraft manufactured in the country that have been produced under licence. This was the first engine development project and that relating to a jet engine. At that time when they started on it, it was the first axial flow gas turbine engine project in the country. So, I would certainly say that it was the initial step in getting into gas turbine technology, and the various fall outs resulting from it have been mentioned in a paper which is ready for submission to the Committee..... This was a paper which was prepared in the Department of Defence Production. When we talk of the development of an engine of this nature, we have to work on a variety of individual components, then the assembly and putting them together, running them on test benches etc.; there is a great deal that people who have worked on it have learnt and carried it over to other areas of development and manufacture. We could certainly give the list to the Committee mentioning those items which have resulted in saving of foreign exchange.”

1.39. The Committee referred to an earlier statement made by the Secretary, Defence Production, during evidence that the absence of a prototype shop and adequate testing facilities as well as the lack of adequate expertise in the field were some of the factors responsible for the HJE-2500 and other development

projects not progressing expeditiously and desired to know the steps taken to remedy these deficiencies and to place R&D activity on a firmer footing. In a note furnished to the Committee in this regard, the Ministry of Defence have stated:

“In order to make optimum use of talent and resources and to ensure speedy execution of development projects, the design and development organisations have been strengthened. The entire design and development effort in HAL, Bangalore Complex as well as other Divisions will be under the control of Managing Director (Design and Development) assisted by separate Chief Design Engineers. It has been decided to set up a well-equipped prototype shop to cater to various activities of the Design Bureau. Testing facilities are being stepped up to facilitate R&D activities. But as far as the engine development is concerned, in pursuance of recommendation of Rajadhyaksha Committee, this field has been exclusively left to GTRE.”

The Committee desired to know whether the Ministry of Defence|DRDO had carried out any objective and critical appraisal of the progress of the HJE-2500 project, spanning a period of 15 years (1960—75) with a view to determining what went wrong at various stages of a vital defence project and taking remedial measures at least for the future. The Committee also wanted to know whether any guidelines had been framed for future for the scrutiny, sanction and regular monitoring of vital R&D projects. The Ministry of Defence, in note, have stated:

“The objective and critical appraisal of the HJE-2500 project was made once by the Aeronautics Committee and another time by the ARDB. The observations of the Aeronautics Committee have been reproduced. The ARDB had occasion to examine the project in June 1972\* when the continuance of the project was approved. It has been a normal practice to appoint Steering Committees in the Ministry to supervise and monitor the progress of the projects. As such Committees were appointed in case of HF-24 and Kiran development projects and this practice has been followed in case of every major development project.”

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\*At the time of factual verification, Audit have pointed out that it should be ‘January, 1972’.

1.41. The Committee desired to know how effective coordination and liaison were maintained between different Aeronautical Research establishments in the country, viz. Developing of HAL, GTRE, National Aeronautical Laboratory and the Defence R&D Organisation, so as to pool the available resources and to avoid unnecessary duplication of efforts. The Ministry of Defence, in a note have stated:

"All major Research and Development Projects are discussed in depth by Aeronautics Research and Development Board (ARDB) before these are recommended for sanction. All major institutions, industries|R&D organisation in the field of aeronautics are represented in the ARDB and every effort is made to pool all the available resources and avoid unnecessary duplication of effort. The ARDB organised the presentation by all the Aeronautical Space and Missiles R&D and Production Agencies in the country in December 1975. This brought together various organisations engaged in aeronautics, space and missiles which gave the opportunity of making all concerned aware of the expertise and competence available in different institutions. Besides, various Specialists Panels of ARDB hold periodic seminars bringing together specialists in the various aeronautical disciplines. This provide a forum for exchange of views and helps in active interaction between the different institutions. Before any major experimental facility like Wind Tunnel of Fatigue Testfacility is sanctioned a Committee consisting of members drawn from various aeronautical establishments and institutions examines the proposal to avoid duplication and to ensure that the facility meets the requirements of all institutions. A continuous review of the activities of aeronautical establishments like National Aeronautical Laboratory and Aeronautical Development Establishment etc. is being made so that there is proper coordination and liaison among them. National Aeronautical Laboratory, HAL, Air Headquarters and Directorate of Aeronautics are fully associated with technical evaluation of any major programme e.g. recently a detailed analysis about certain aspects of a medium tactical transport aircraft (METAC) was carried out by a Specialist Group with members from NAL, HAL, Air Headquarters, GTRE and Directorate of Aeronautics."

1.42. The Committee were given to understand by Audit that the Ministry of Defence had also stated in January 1976 that a viable proposal to modify Orpheus 701 engine to make it suitable for Kiran aircraft had been formulated and that with successful completion of this project, need to import the engine for Kiran aircraft would no longer exist. In a note, furnished at the instance of the Committee, indicating when and with what result the proposal was considered earlier, the Department of Defence Production have stated:

“The proposal for use of derated Orpheus engine to power Kiran was considered at the inception of Kiran Development Project (July 1958) while making selection of engines. The derated Orpheus engine was not considered suitable as the engine would have been too powerful for this aircraft. The proposal was once again examined in HAL, Design Bureau in 1970 but the same was not found attractive. Subsequently, however, when it was decided to undertake Kiran MK. II wherein the higher power thrust was required, the proposal for de-rated Orpheus was reconsidered and accepted.”

On the Committee enquiring during evidence as to when the proposal was actually formulated, how far it had progressed and what was the present status of the scheme, the Secretary, Defence Production had the following to state:

“The requirement for the de-rated Orpheus, as we have explained earlier, arose at a particular time when the Air Force had slightly changed the design of the trainer aircraft. They had also armed the Kiran for training and other particular purposes. At that time they indicated to us their requirement for...such machines, for which orders have been given to us. These...machines, for which we have got orders on 22 March, 1976, will all be powered by the derated Orpheus. The prototype has been built as far as development is concerned, and it has been flown and we believe successfully so. Some more testing is going on. We may remain confident that this will meet the bill.”

In a written note furnished to the Committee in this regard subsequently, the Ministry stated:

**"The proposal to use de-rated Orpheus engine for Kiran MK. II was put up to the Board of Directors in August 1975 and was accepted by the Board.**

**The proposal for Kiran MK. II was approved by the Government in December 1975 at a cost of Rs. 2.08 crores. The cost covers the design and development work both for the air-frame and the de-rated Orpheus engine. The time-frame envisaged was 3 years from 'Go-ahead'."**

1.43. Since it was stated that the de-rated Orpheus engine could fulfil the requirements of Kiran, the committee enquired whether there was any particular need to release Rs. 6.14 crores in November 1974 to import engines for Kiran. The Secretary, Defence Production during evidence has stated:

**"The Orpheus engine could not get straight into the Kiran. There was an element of development work involved in this...If we had stalled the execution of the Kiran orders, we could have possibly attended to this work. But that could have meant delay in the supply of the Kiran aircraft to the Air Force."**

1.44. Explaining the nature of the delay involved and the advantage the suppliers had taken of our position, the witness has deposed:

**"That the British had raised the prices for Viper engines is known. They raised it considerably. To that extent, we have paid proportionately more by way of sterling costs, than we used to do earlier for the Viper engines...."**

1.45. Having considered the written as well as oral evidence submitted to them, the Committee are led to the conclusion that the project for development of an indigenous engine to replace the Viper engines being imported for the Kiran air-frame being manufactured by HAL, involving an expenditure of nearly Rs. 82 lakhs, failed due to a variety of factors, the principal among them being the lack of a clear objective of the whole project, the inability of the Government in making available adequate funds in time and absence of adequate expertise in HAL leading to considerable delays in development. The vacillation displayed by Government right

from the time the project was conceived till its abandonment is inexcusable. The various lacunae and deficiencies in the implementation of the project have been discussed in the following paragraphs.

1.46. The proposal for the design and development of the aero-engine (HJE-2500 Turbo Jet) was initiated by HAL (then known as Hindustan Aircraft Ltd.) in February, 1960 with the object of replacing the imported Viper engine for the Basic Jet Trainer then being manufactured by it. Since the aircraft was meant for service in the IAF, the Air Headquarters and the Directorate of Technical Development and Production (Air) were also consulted at the project report stage who had suggested that the delivery schedule of the engine should be speeded up as much as possible so that there was no delay in the production of the jet trainer aircraft. This shows that the prime objective of the project was to get an indigenous engine for the aircraft as early as possible. The other purpose of 'competence building for future needs' appears to have been only secondary, if not incidental, which would have been achieved as the development work proceeded. However, in course of time as the project proceeded, it became clear that development of the engine could not be completed and production scheduled to synchronise with the production schedule of the Kiran Airframe which was then under production and to which the engine being developed (HJE-2500) was to be fitted in. Consequently the authorities chose to designate it as an 'educational' project thereby affecting its priority in the matter of allotment of funds. It was not that this project was ab initio 'educational'. It appears to the Committee that it was made to look as an 'educational project' when the chances of its materialisation appeared remote. In the opinion of the Committee the decision to accord this project a low priority in the matter of allotment of funds on the ground that it was 'educational' was wholly unjustified, particularly in view of the fact that the Kiran production itself was running several years behind schedule.

1.47. The Committee observe that the project report prepared by the undertaking suffered from many deficiencies. It did not assess correctly the cost of development of the project, so much so that the cost of development of the engine assessed originally at Rs. 41 lakhs) (F.E.—Rs. 11 lakhs) had to be revised to Rs. 100 lakhs (FE—Rs. 12 lakhs) in October, 1967 and to Rs. 150 lakhs (FE—Rs. 40 lakhs) in May, 1970. Moreover, it did not set any firm time targets for the completion of the project. It is admitted that the reasons for

the 'sketchiness' of the project report was due to lack of technical expertise and also because there was no cross-check available. The Committee feel that while entrusting the project of such magnitude and importance to HAL, Government should have taken care that technical competence was available in the undertaking to execute the project. The sketchy nature of the project report and its other deficiencies should have forewarned the Government of the inadequacies of technical talent with the undertaking and steps should have been taken to overcome the shortcomings. This was not done.

1.48. The Committee also note that no machinery was created for regularly monitoring the progress of this important project and that the entire exercise was left to HAL. The Committee hope that Government will learn a lesson from the fate of this project, and see that while undertaking any major project, monitoring agencies are invariably established and if any bottleneck is observed by them, immediate remedial action should be taken so that the progress is not clogged unnecessarily.

1.49. The Committee have been informed that against the estimated cost of development of the project of Rs. 41 lakhs, the Board of Directors of HAL sanctioned for the project Rs. 5 lakhs in February, 1960, Rs. 10 lakhs in December, 1962 and Rs. 5 lakhs in January, 1969, aggregating Rs. 20 lakhs, pending the sanction of the development grant by the Government. It was only in June, 1972 that the development grant of Rs. 150 lakhs was sanctioned by Government. This indicates that Government were not attaching to the development project the importance that it deserved right from the very beginning. If it was desired that the undertaking should develop an engine quickly so that its production could be synchronised with the production schedule of the Kiran engine air-frame, Government should have placed at the disposal of the undertaking adequate resources to bring the development project to early fruition. Having denied to the undertaking adequate resources for the development project, Government have to bear the blame for the delay in the execution of the project which rendered the initial objective of the project, namely, to replace the imported Viper engine by an indigenous engine, completely out of focus. The Committee feel that if Government had shown a little more enthusiasm and keenness to have the project successfully executed and to achieve its desired objective, by making available adequate resources to the undertaking in time, perhaps the project would not have ended in a fiasco and the country would have achieved a

breakthrough in the manufacture of aero-engine which could replace the imported engines for aircraft being manufactured by us.

1.50. In this context, the Committee take a serious note of the comments of the Aeronautics Committee in their report (April 1969) that "the existence of two separate teams (GTRE and HAL) was an impediment to the sanction of expenditure (for the development project)". They are also unhappy to note that it took the Government as long as three years even after the development project was recommended by the Aeronautics Committee in April 1969 to sanction the grant of Rs. 150 lakhs for the project in June 1972.

1.51. It transpired during evidence that the delay in the execution of the project was also due to inadequate expertise available with HAL in the matter of development of aero-engines and wrong system procedures adopted for testing of the prototype engine. While the Committee can appreciate the pace of development being retarded on account of inadequate expertise and technical know-how, they find it rather disquieting that no guidance was available to those responsible for executing the development project regarding testing of individual components and systems in the first instance before final assembly of the engine and putting it to final tests which is held out to be partially responsible for the delay in development. That such a venture was undertaken without the assurance of an inflow of technical know-how and expertise speaks poorly of the mechanism for project planning and execution that was then prevalent.

1.52. HJE-2500 project was recommended by the Aeronautics Committee in April, 1969. The Aeronautics Research and Development Board (ARDB) which was set up on the recommendations of the Aeronautics Committee also scrutinised and approved this project at its meeting held on the 8 January, 1972. In May 1972, the Board appointed a Technical Committee to assess various projects of propulsion systems including the HJE-2500 project. The Technical Committee, however, in its report submitted in December 1974, did not deal with this project. During evidence, the Committee were informed that the Technical Committee had, on the advice of the Air Headquarters, confined itself to the consideration of engine proposals in respect of another aircraft and due to paucity of time the consideration of HJE-2500 project could not be taken up by them. The Committee are unhappy at the Technical Committee skipping over the HJE-2500 project although it was



within the terms of reference drawn up for the Technical Committee.

1.53. The Committee were informed during evidence that the development project for HJE-2500 was taken up by HAL in 1960 because at that time it was only there that whatever technical know-how for engine development that the country had was available. Gas Turbine Research Establishment was then in its infancy and was incapable of taking up the project. In April 1960 the Aeronautics Committee had in their report recommended the merger of the GTRE and the Aero-engine Design Division of HAL with a view to pool at one place the technical know-how and expertise available in the field of engine development. This recommendation of the Aeronautics Committee came to be discussed at a high level only in July/August 1972, i.e. after a lapse of more than three years. A decision was then reached not to merge the two establishments. It was argued that over the years substantial investment of resources had been made in GTRE where a nucleus aero-engine design team had been created and that in comparison the man-power and resources available at HAL aero-engine design centre were modest. It was further argued that a major project involving development of advance technology for aero-engines should be handled by GTRE where sufficient facility and expertise in handling such projects were available. The Committee note that while in 1960 the state of technical competence as between GTRE and the aero-engine design centre of the HAL was weighted in favour of the latter, by 1972 GTRE had been built up with Central Government funds into a strong nucleus aero-engine design team, so much so that it claimed an exclusive role in the development of the aero-engines. At this stage the Committee can hardly do anything more than emphasise that there is need for effective coordination and liaison between all major institutions, industries and R&D organisations in the field of aeronautics including the Development and Research Wing of HAL and GTRE and to make every effort to pool all the available technical know-how in identical and even related fields so as to avoid unnecessary duplication of effort. The Committee have no doubt that if the technical know-how available in different institutions/organisations in the country in the field of aeronautics engineering is pooled and development jobs are assigned to those who are technically competent to execute the same, the country will soon be able to develop self-reliance and obviate the necessity of imports.

1.54. The Committee have been informed that a viable proposal to develop a modified (de-rated) version of Orphans 1 engine to suit Kiran Mark-II had been formulated in 1975. The cost of this

project is estimated as Rs. 2.08 crores and the time-frame as three years from 'go-ahead'. It is claimed that with the successful completion of this project the need to import the engines for jet trainer aircraft will be eliminated. In view of the fact that the foreign suppliers of the engine for Kiran aircraft have, taking advantage of our total dependence upon them, substantially raised the prices for this engine, there is need for redoubling our developmental efforts to produce indigenous replacement for the imported engines. The Committee hope that Government will commit adequate resources for this project and devise suitable control and monitoring systems so as to ensure that the project does not suffer from any deficiencies which had marred the successful completion of the earlier project.

1.55. In the light of the shortcomings and lacunae noticed in regard to this project, the Committee would like to make the following suggestions for formulation and implementation of development projects:

- (i) The aims and objectives of the development project should be clearly defined.
- (ii) The project report should be comprehensive, covering all aspects. The technical and management problems in the implementation of the project should be clearly envisaged and an attempt should be made in the report itself to find possible solutions for them.
- iii) The cost estimates for the project should be worked out carefully and as realistically as possible so as to obviate the need for its revision from time to time.
- iv) Once the project and the cost estimates therefor have been approved and the project finally cleared, it should not be allowed to languish for want of funds. The flow of the funds should be free and regular.
- (v) Firm targets for stage-by-stage completion of the project should be laid and these should be adhered to.
- (vi) Proper control mechanism and procedures should be evolved for monitoring the progress of the implementation of the project. If any bottleneck is observed, the

matter should be considered of the appropriate level and remedial measures should be taken promptly.

(vii) The assessment of the utility of the project should be made in the 'light' of the results contemporaneously being obtained, after a period of 2 years from 'go-ahead' and a decision regarding further continuance of the project taken accordingly.

(viii) As the foreclosure|abandonment of a continuing project renders the amount expended upon it and resources built up, largely infructuous, such a course should be decided upon after a very careful consideration at the highest level.

### **Project for the development of an indigenous aircraft.**

#### *Audit Paragraph*

2.1. In 1956 Government approved a project for the design, development and production of an indigenous aircraft by a public sector undertaking. The time for development was initially estimated at 4 years and the cost at Rs. 1.09 crores. The aircraft (MK II) was to be designed around and engine 'B' then under development by a foreign firm. In the interim period it was decided to develop and produce the aircraft (M I) with a readily available but less powerful engine 'A'.

2.2. The development project for engine 'B' was given up by the foreign firms in 1959. In 1960 Government decided to continue the development in collaboration with the foreign firms at an estimated cost of Rs. 4.67 crores (foreign exchange: Rs. 2.34 crores). The foreign firms, however, withdrew in 1961 and the project was left without a suitable engine.

2.3. In July, 1962, an agreement was entered into with a foreign Government for the development and licensed manufacture of another engine 'C'. The agreement was foreclosed in February 1964 after an expenditure of Rs. 2.38 crores had been incurred (paragraph 10 of the Audit Report, Defence Services, 1966 refers). The Public Accounts Committee (70th Report 3rd Lok Sabha—1966-67) had commented on the infructuous expenditure and the fact that a costly project had been undertaken without ensuring the availability of a suitable engine.

2.4. The search for a suitable engine continued. Another engine 'D' under development in another foreign country was considered and a collaboration agreement concluded in September 1964. This agreement was also foreclosed in 1968 after an expenditure of Rs. 94.29 lakhs had been incurred. In June 1971, yet another engine 'E' was considered but was not found suitable after an expenditure of Rs. 1.12 lakhs had been incurred.

2.5. The first prototype of MK-I aircraft was flown in 1961. The cost of development initially estimated at Rs. 1.09 crores in 1956 was revised to Rs. 1.44 crores in 1959, Rs. 4.50 crores in 1961, Rs. 5.56 crores in 1965 and Rs. 700 crores in 1967. An additional expenditure up to Rs. 70 lakhs was authorised in March 1973. Actual expenditure up to March 1975, however, amounted to Rs. 8.12 crores.

2.6. As against the MK-I aircraft ordered in 1960 and scheduled for delivery by the end of 1963, the first aircraft was delivered by the public sector undertaking in May 1964 and the aircraft was inducted into service in 1968.

2.7. The development of a trainer version of MK-I aircraft was approved in May 1964 at an estimated cost of Rs. 78 lakhs which was revised to Rs. 3.70 crores in May 1971. The first prototype flew in 1970. Actual expenditure up to March 1975 amounted to Rs. 3.27 crores. As against the trainer aircraft ordered in November 1970 and scheduled for delivery by January 1972, the first aircraft was delivered by the undertaking in March 1975.

2.8. Concurrently with the manufacture of the MK-I aircraft and the search for a suitable engine to meet the projected requirements of the MK-II aircraft Government sanctioned in January 1963 the development of a reheat variant of engine 'A' by a Research and Development establishment under the Ministry of Defence. This variant was a temporary expedient for boosting the power of the engine and thus improving the performance of MK-I aircraft. The cost of the development initially estimated at Rs. 14 lakhs (for one prototype engine) was revised from time to time and finally to Rs. 78.50 lakhs (for 11 prototype engines) in March 1974.

2.9. Simultaneously, the development of different types of airframe to suit the reheat engine and other engines under consideration was taken up by the public sector undertaking for which sanctions/'on account' payment aggregating Rs. 5.71 crores were issued/authorised against which a total expenditure of Rs. 5.67 crores was incurred up to March 1975.

2.10. A profit margin on the development expenditure at the rate of 5 per cent up to March 1970 and 7½ per cent thereafter was allowed to the public sector undertaking by a sanction issued in January 1970.

2.11. The Aeronautics Committee appointed by Government reviewed, *inter alia*, this project and assessed (1969) that in the aircraft and its variants there existed an aircraft with promise and that the basic design should be stretched to its full capability and the matter pursued vigorously during the next 2-3 years. The Committee recommended that every effort should be made to ensure that the aircraft with the reheat engine variant became available by early 1973, and its further improved version by 1975-76 at the latest. In regard to the wide variations in the cost and time schedules the Committee pointed, *inter alia*, to the lack of critical examination of the initial project reports and inadequate monitoring of development projects. Mention was also made of policy changes regarding the choice of the engine throughout the history of development of the aircraft involving considerable design effort and diverted attention and to a lack of understanding between the Research and Development establishment responsible for the development of the engine and the public sector undertaking responsible for the installation in the aircraft. The organisational arrangement of reporting to different authorities was stated to be the most important cause for this lack of understanding. The Committee recommended that the aero-engine design teams of the Research and Development establishment and the public sector undertaking should be merged and made an integral part of the public sector undertaking. This recommendation was accepted by Government in November 1970 but has not yet been implemented (February 1976).

2.12. The first prototype aircraft built by the public sector undertaking (with the reheat engine developed by the Research and Development establishment) carried out test flights during 1964—1969. The prototype was however lost in an accident in January 1970; the production of the second prototype was thereafter abandoned. Test trials of the reheat engine were, however, continued and completed in October 1970 and a provisional type approval accorded in December 1971.

2.13. After a detailed review in June 1971, Air Headquarters recommended the reheat engine and accordingly (July 1971) finalised the operational requirements of the aircraft incorporating this engine. These were formally notified in January 1972 and envisaged the manufacture of a large number of such aircraft to be inducted into

service by mid-1970's. In December 1971 the public sector undertaking, on the basis of a feasibility study, estimated the cost of development at Rs. 8.07 crores (revised in 1972 to Rs. 8.90 crores with Rs. 2.65 crores in foreign exchange) and indicated that the first aircraft would be delivered in about 5 years.

2.14. Concurrently, in May 1972, the Aeronautics Research and Development Board set up a Technical Committee to assess, *inter alia*, the engine development projects of the Research and Development establishment and the public sector undertaking.

2.15. In February 1973, however, Air Headquarters suggested abandonment of the project for the manufacture of the aircraft with reheat engine on the ground, *inter alia*, of financial stringency and proposed instead retromodification of MH-I aircraft. In March 1973, the public sector undertaking submitted the time frame and cost implications of the Air Headquarters proposal as well as two additional alternatives envisaging development of variants of engine 'A', one by the public sector undertaking and the other by the Research and Development establishment.

2.16. In May 1973, Air Headquarters suggested that the project (limited to retromodification) with the reheat engine be held in abeyance. In June 1973, the terms of reference of the Technical Committee (set up in May 1972) were enlarged at the instance of Air Headquarters to cover all the three alternative engine variants proposed for the MK-II aircraft.

2.17. Meanwhile, the matter was considered by the APEX Planning Group which accepted the Air Headquarters' proposal for retromodification of MK-I aircraft with a provision of Rs. 10.74 crores for development and Rs. 59.40 crores for retromodification. The proposal was approved by Government in May 1973.

2.18. In July 1973 Air Headquarters indicated that retromodification of the aircraft would be required to a standard higher than that notified in January 1972. This was confirmed in September 1973 and conveyed to the Technical Committee in February 1974 for their consideration. The standard of preparation issued in January 1972 has, however, not yet been modified.

2.19. The alternative engine variant proposals were also considered at a high level meeting in the Ministry of Defence in July 1973 when it was decided to continue work on the reheat engine developed by the Research and Development establishment as well as to

immediately authorised development of the alternative variant proposed by the public sector undertaking. Both projects were to be monitored by the existing steering committee for the aircraft. No formal sanction or approval for the development of the alternative variant by the public sector undertaking was, however, issued.

2.20. In December 1973, after further test flights/trials, the Research and Development establishment secured the final type approval to the reheat engine developed by it at a cost of about Rs. 2.02 crores.

2.21. At about the same time, the Technical Committee in its draft report (December 1973) recommended that the two new engine variants be taken up. In February 1974, the Aeronautics Research and Development Board asked the Technical Committee to submit its report taking into account the final type approval since accorded to the reheat engine.

2.22. In a meeting held in the Ministry of Defence on 3rd August, 1974, Air Headquarters stated, *inter alia*, that the aircraft fitted with the reheat engine would not meet the operational requirements (as re-defined in July/September 1973). The alternative proposals of engine development (with high costs and long gestation periods) were not considered justifiable in the context of the then limited requirement of retromodification. It was, therefore, decided that the retromodification programme should be given up and the orders placed in September 1971 and July 1972 for trainer aircraft should also be cancelled. Consequential redundancy on account of labour and materials is estimated at Rs. 3.64 crores. In September 1974, Air Headquarters recommended that further efforts on the improved version of the aircraft be abandoned.

2.23. Meanwhile, the Technical Committee in its final report submitted in December 1974 reiterated its earlier recommendation (December 1973) that the proposed development of the engine variants by the Research and Development establishment and the public sector undertaking at a cost of Rs. 4.00 crores and Rs. 0.93 crore respectively be approved and that suitable monitoring committees be set up to review the progress of the projects.

2.24. Total expenditure on the development of the aircraft and further development of the engine variants amounted to Rs. 21.48 crores to the end of March 1975.

2.25. A final decision on the abandonment of the project has not yet been notified by Government (February 1976).

2.26. The Ministry of Defence stated (February 1976) that the outcome of the expenditure incurred on the project was the development of two variants—MK I and trainer aircraft—both of which are in squadron service.

[Paragraph 10 of the Report of the Comptroller and Auditor General of India for the year 1974-75, Union Government (Defence Services)].

2.27. The P.A.C. had earlier in their 70th Report (3rd Lok Sabha) on para 10 of the Audit Report (Defence Services) 1966—Manufacture of Engines—already highlighted the unsatisfactory features of the project for the design, development and production of the aircraft approved in 1956. Unrealistic estimates of expenditure on the project, undertaking of development of airframe without ensuring the availability of the engine therefor, scheduling of test trials on uncertain availability of the engine from a foreign private firm, defective nature of the agreement entered into with a foreign country in July 1962 for development of an engine suitable to Indian requirements and its subsequent foreclosure in February 1964 when it was reported that it was not possible for that country to develop the engine to Indian requirements, were some of the aspects criticised and commented upon by the Committee. In their 38th Report (4th Lok Sabha) on action taken by Government on the recommendations and observations contained in their 70th Report (3rd Lok Sabha), the Committee had, *inter alia*, the occasion to observe:

“In view of the fact that Committee on Public Undertakings have examined comprehensively the matters relating to manufacture of aircraft by Hindustan Aeronautics Ltd., Committee do not wish to pursue these matters. The Committee would, however, like to sound a note of caution against the over-optimistic manner in which this project was conceived and hope that the Ministry would be more realistic in planning such projects in future. The Committee would also like to emphasise the necessity for developing a sound indigenous base for manufacture of aero-engine so that the country may achieve self-reliance in this sector in course of time.”

#### *Development of HF-24 MK I Aircraft by HAL*

2.28. According to Audit Paragraph, in 1956 Government approved a project for the design, development and production of an indigenous aircraft by Hindustan Aircraft Ltd., Bangalore—Public Sector Undertaking. The time for development was initially estimated



at 4 years and the cost at Rs. 1.09 crores. The cost of development was revised to Rs. 1.44 crores in 1959, Rs. 4.50 crores in 1961, Rs. 5.56 crores in 1965 and Rs. 7 crores in 1967. Additional expenditure upto Rs. 70 lakhs was authorised in March 1973. The actual expenditure upto March 1975 amounted to Rs. 8.12 crores.

2.29. As already stated, the time for development of the HF-24 MK I aircraft was estimated at 4 years. The first prototype of MK I aircraft was, however, flown in 1961. In all, 3 prototypes of MK I were authorised and manufactured. As against the MK I ordered in 1960 and scheduled for delivery by the end of 1963, the first aircraft was delivered by the Public Sector Undertaking in May 1964 and the aircraft was inducted into service in 1968.

*Development of HF-24 MK I—Trainer Aircraft by HAL*

2.30. The HAL had also undertaken the development of a trainer version of MK I aircraft. This was approved in May 1964 at an estimated cost of Rs. 78 lakhs which was revised to Rs. 3.70 crores in May 1971. The actual expenditure on the project upto March 1975 amounted to Rs. 3.27 crores. The first prototype flew in 1970. As against trainer aircraft ordered in November 1970 and scheduled for delivery by January 1972, the first aircraft was delivered by the Undertaking in March 1975.

2.31. In March 1975, the two development projects (namely, MK I and MK I trainer) were combined into a single estimate for Rs. 11.40 crores and on 1 July 1976 a further expenditure of Rs. 1.02 crores was authorised by Government on further improvements/modifications to HF-24 MK I and HF-24 MK I—Trainer Aircraft, already in service.

2.32. The Ministry were asked to indicate the considerations on which the estimates for the two development projects were combined into a single estimate. In reply, it has been stated that the "main consideration was the fact that modifications proposed for the outstanding development work were mostly common to these two aircraft" and that "in view of the overlapping nature of the two projects, it was considered easier to book the expenditure for both the projects under a common head."

*Revision of cost estimates*

2.33. The Ministry were asked to state as to why the original estimates of the two development projects were so much underestimated necessitating revision of estimates from time to time. It

may be recalled that original estimated cost of Rs. 1.09 crores for development of MK I aircraft came to be revised to Rs. 7.70 crores whereas the cost of development of MK I trainer aircraft had to be revised from Rs. 78 lakhs to as much as Rs. 3.70 crores. In this connection, the Ministry have stated that the project for development of HF-24 MK I the initial estimates for which were prepared in 1956 was the first project undertaken in India for the development of jet fighter aircraft. HAL did not have enough expertise and experience to anticipate the nature of problems that would be encountered in development of this aircraft. As a result, it was found that time and efforts required in successful development of this aircraft was much more than originally anticipated. During developments, numerous technical problems were encountered requiring repeated modifications to the original design concepts. The scope of efforts required for important areas of development such as fatigue testing, test flights etc. was also not properly appreciated.

*Time targets for development projects*

2.34. The Ministry were asked whether any time-frame was prescribed for the projects for development of MK I and MK I trainer aircraft. In reply, it has been stated that in the project report prepared in 1956, it was indicated that the first prototype of HF-24 would be ready for flight by January 1960 and second by July 1960. The Audit has, however, reported that the first prototype MK I aircraft was flown in 1961.

2.35. As regards MK I trainer aircraft, the time schedule indicated by HAL in August 1963 was that the development of this version would take 3 to 4 years based on the assumption that no serious difficulties would be encountered during the development. According to information given to the Committee, however, the first prototype of this aircraft flew in 1970, i.e., after 6 years from the date of approval of the project.

2.36. The Committee note that the project, approved by Government in 1956, to develop and produce the aircraft (Mark I) with a readily available but less powerful engine to be undertaken by the Hindustan Aircraft Ltd. (HAL), was an interim arrangement pending the development of a more powerful engine for which an improved version (Mark II) was to be designed. Since the various proposals and project for a more powerful engine could not materialise, HAL continued to work on the development of Mark I aircraft. The Committee also observe that the cost of this project,

which was initially estimated at Rs. 1.09 crores, was revised from time to time so much so that the total expenditure by March 1975 reached the figure of Rs. 8.12 crores.

2.37. The Committee note that in 1964 another project for the development of a trainer version of Mark I aircraft was approved at an estimated cost of Rs. 78 lakhs. The estimated cost of this project also was revised to Rs. 3.70 crores in May 1971 and the actual expenditure on the project upto March 1975 amounted to Rs. 3.27 crores. In March 1975 the two development projects (viz. Mark I and Mark I trainer) were combined into a single project with an estimated cost of Rs. 11.40 crores. A further expenditure of Rs. 1.02 crores was authorised by Government on improvements to this aircraft making a total of Rs. 12.42 crores. The Committee are not satisfied with the plea advanced before them for multi-fold escalation of cost estimates that "enough expertise and experience to anticipate with the nature of problems that would be encountered with the development of this aircraft" was not available with HAL. They feel that in the course of implementation of the project which was spread over a long time, HAL should have developed adequate expertise and technical know-how to assess fairly the technological and financial implications of the project.

2.38. The Committee also observe that though the development project for HF-24 Mark I had a time-frame of 4 years ending in 1960, the project has continued and even on the 1 July 1976, an expenditure of Rs. 1.02 crores was authorised for further improvements and modifications. The Committee emphasise the need for laying down definite time-schedules for completion of projects and for their observance in actual practice by means of proper controls and monitoring systems.

2.39. The Committee find that in July 1976 a further expenditure of Rs. 1.02 crores was sanctioned by Government to carry out "certain essential improvements and modifications in the Marut (HF-24) fleet now in service with the IAF." The Committee would like Government to exercise strict control on expenditure on this account so as to ensure that further expenditure on improvements and modifications to HF-24 (Marut fleet) produces definite results and is not allowed to go waste as heretofore.

*Abandonment of Retromodification Project for HF-24 and cancellation of orders for Trainer Aircraft.*

2.40. The project for development of a reheat variant of the Orpheus 703 engine for fitment in the HF-24 airframe being manu-

factured by HAL has been discussed in subsequent paragraphs. It was decided in 1974 that the project for retromodification should be given up. It was also then decided that the orders placed in September 1971 and July 1972 upon HAL for the manufacture of trainer aircraft should also be cancelled. Government sanction for the cancellation of the orders for trainer aircraft placed upon HAL was issued on the 24 March 1976. Audit has pointed out that as a result of the cancellation of the orders for trainer aircraft, redundancy on account of labour and material is estimated at Rs. 3.64 crores.

*Redundancy upon cancellation of orders for Trainer Aircraft*

2.41. The Ministry were asked to intimate the total redundancy consequent on the abandonment of the project and manufacturing programme and the extent to which Government considered these to have been inescapable. They have stated that the redundancy on the trainer manufacturing project has arisen as a result of the curtailment of the order for HF-24 MK I—Trainer aircraft. The total redundancy on this account inclusive of materials and amortisation portion of development and tooling comes to Rs. 3.64 crores. This amount has been worked out after taking into account the anticipated requirement of spare parts production to maintain the fleet of Marut MK I and trainer aircraft in the service of the I.A.F. If the requirement of spare parts is higher than anticipated the redundancy would go down to that extent.

2.42. Taking all factors into account, Government considers that the extent of redundancy on this account was inescapable and arose mainly out of the difficulties involved in successful development of an improved version in Marut MK II.

2.43. The Ministry was subsequently asked to indicate the latest position in regard to the redundancy. They have, however, in May 1977, stated that "the detailed assessment is being made by HAL."

2.44. The Committee find that as a result of cancellation of orders placed on HAL for HF-24 trainer aircraft, the redundancy on account of material and labour is estimated at Rs. 3.64 crores. The detailed assessment of the redundancy is being made by HAL. It is stated that this redundancy was 'inescapable and arose mainly out of the difficulties involved in successful development of an improved version of Marut MK II.' The Committee hope that it would be possible for the Undertaking to gainfully utilise the material rendered redundant on account of cancellation of orders.

*Other development efforts in HAL*

2.45. The Audit paragraph points out that simultaneously with the development of the reheat engine (which has been dealt with in subsequent paragraphs), the development of different types of airframes to suit the reheat engine and other engines under consideration was taken up by HAL against which a total expenditure of Rs. 5.67 crores was incurred upto March 1975.

2.46. The break-up of the sanctions/on-account payments and actual expenditure on different projects undertaken by HAL has been furnished to the Committee by the Department of Defence Production as follows:

	(Rupees in lakhs)	
	'On account payment/ sanctions	Expendi- diture as 31-3-76.
HF-24 MK IA . . . . .	107'00	99'02
HF-24 MK II—Old . . . . .	7'47	8'17
HF-24 MK II—New . . . . .	29'66	29'66
HF-24 MK IB . . . . .	19'62	19'62
HF-24 MK IBX . . . . .	94'38	94'29
HF-24 MK IR . . . . .	312'58	312'58
HF-24 MK II/Adour Engine . . . . .	..	1'12
HF-24 TS-16 Engine . . . . .	..	0'52
TOTAL . . . . .	570'71	564'98

2.47. It is noted from the above data that sanctions/on-account payments approved by the Government do not cover the following expenditures:

HF-24 MK II Adour Engine . . . . .	Rs. 1'12 lakhs.
HF-24 TS-16 Engine . . . . .	Rs. 0'52 lakh.
HF-24 MK II Old . . . . .	Rs. 0'70 lakh.

2.48. It has been stated that the expenditure on the above project was incurred by HAL initially from their own resources and that recently they have requested for the reimbursement of the expenditure which is under the examination of the Department of Defence Production.

2.49. It is noted from the information furnished by Audit that large on-account payments amounting to about Rs. 3.50 crores (covering projects MK IR, MK II old and MK II new) have been made though the project estimates had not been sanctioned.

2.50. The Committee note that an expenditure of about Rs. 2.34 lakhs incurred up to March, 1976 by HAL on certain projects under execution remained uncovered by sanctions/'on account' payments approved by Government. It has been pointed out to the Committee that HAL had incurred this expenditure out of its own resources and had recently requested the Government for reimbursement. They also note that large payments of about Rs. 3.50 crores were made by way of 'on account' payment though the project estimate had not been sanctioned. The Committee would like Government to examine the propriety of making such large payments without sanction of the project estimates.

*Profit margin on development expenditure*

2.51. It is seen from the Audit paragraph that a profit margin on a development expenditure at the rate of 5 per cent upto March 1970 and 7½ per cent thereafter was allowed to HAL. The Ministry were asked to indicate the considerations for allowing profit to the Public Sector Undertaking on development expenditure. In reply, it is stated:

It has always been accepted by the Government that a margin of profit is admissible to HAL on a development project undertaken at the instance of Government. This is a justifiable approach because HAL would be required to invest their manpower and other resources on the development project and in this respect execution of a development project cannot be distinguished from that of a manufacturing project. Keeping this in view a decision was taken in November 1966 to allow a small profit margin to HAL on the Marut project. This decision was subsequently reviewed in March 1970 when the rates of profit margin were revised. . . ."

2.52. Giving justification for enhancing the profit margin to HAL during evidence, the representative of the Department of Defence Production has stated:

"HAL said that their investment in other areas including manufacture would earn much greater profits and 5 per cent was thought to be low and therefore 7½ per cent was

worked out as a compromise. It is a very small figure. There is a lot of development work in HAL. This profit which they earn would help finance much of their work for which Government would have to find them funds."

2.53. The witness agreed with the suggestion that this indirectly enhanced the cost of development, but stated that "if you do not give incentive, there is no incentive for them to put any money for development. . . . HAL being a large aircraft concern have to do research and development."

#### *Agreement with a foreign country*

2.54. As already stated in 1956, Government approved a project for the design, development and production of an indigenous aircraft by a public sector undertaking. The aircraft (MK II) was to be designed around an engine then under development by a foreign firm. The foreign firm, however, withdrew in 1961 and the project was left without a suitable engine. In July 1962, an agreement was entered into with a foreign Government for the development and manufacture of another engine. The agreement was foreclosed in February 1964. The research for a suitable engine, however, continued.

2.55. In early 1963 it was known that a foreign country was engaged in the development of a super-sonic engine. The engine was proposed for development in three stages. The first stage was scheduled for completion during 1965. Adequate information on this project was made available by the foreign country during exchange of visits at technical level between the two countries. Based on this information, it was considered that the possibility of incorporating this engine in HF-24 aircraft should be explored. Accordingly, with the approval of the Emergency Committee of the Cabinet, a collaboration agreement was concluded in September 1964 between the two Governments for this purpose.

2.56. The progress of the joint project of fitment of the engine on the HF-24 was reviewed in 1968. It was then realised that the engine under development in the foreign country was designed for optimum performance at high altitudes and was not an ideal power plant for an aircraft meant for the ground attack role which was then our principal requirement. Further, it would have taken several years for the development of HF-24 fitted with the engine under development and that by the time such an aircraft came into squadron service of the IAF, its concept of design would become out of date. For these reasons it was decided to foreclose the collaboration agreement of September 1964.

2.57. While foreclosing the agreement, the Government of India extended, *inter alia*, the following concessions to the foreign country "as a gesture of goodwill":

- (i) HF-24 IBX airframe, which was being used for testing the engine was handed over to the foreign country without any charge.
- (ii) There was to be no charge for the services and supplies made by India for development of the engine in the foreign country. The cost of these services and supplies was estimated to have been Rs. 22 lakhs. This included the cost of 2 Orpheus engines loaned to the foreign country.

2.58. During evidence the representatives of the Ministry of Defence and the Air Force gave the following facts:

- (i) The development of the supersonic engine in the foreign country was being done by technicians of another developed country.
- (ii) We did not have any idea about the cost and we proceeded on the basis of such information as we had received from the country concerned.
- (iii) At the time of entering into the agreement "nothing more than an engine was available".

2.59. It was pointed out to the Secretary, Department of Defence Production, during evidence that when it was known that the first stage of the project was to be completed during 1965, we could have waited until 1965 and if the results of the completion of the first stage justified, only then we should have entered into the agreement with the foreign country. He replied: "I suppose, we could have waited, but there was no payment involved in this. It was considered advantageous from political angle to get into a relationship with... (the country)."

2.60. Subsequently, in a note furnished to the Committee, Government have stated that "no information is available" in regard to the use which the air-frame left by us was put to by the foreign country. In regard to the point whether any consideration was given to the possible security risk involved, present or future, in leaving the air-frame and the engines in the foreign country, it has been stated that "no such security risk was stipulated."



2.61. As indicated in the Audit para, the collaboration agreement with the foreign country foreclosed in 1968 entailed an expenditure of Rs. 94.29 lakhs.

2.62. From the facts placed before them, the Committee cannot help concluding that the agreement with a foreign country entered into in 1964 in regard to the use of the aero-engine under development in that country in the air-frame being produced in this country was, to say the least, not economic or mutually advantageous. The fact that it had to be foreclosed four years later in 1968 after incurring an expenditure to the tune of Rs. 94.29 lakhs goes to show that the joint venture project had been undertaken without a proper assessment of the economic advantage likely to accrue to the country. The most disturbing aspect of the venture is the fact that while foreclosing the agreement, we left with the foreign Government an air-frame and two Orpheus engines of the type even now in service with the Air Force. The Committee are unable to appreciate the contention of the Government that in leaving the air-frame and the engines in the foreign country "no security risk was stipulated." The Committee also note that no information is available with the Government as to the use and ultimate disposition of the air-frame and engines left by them with the foreign country. The Committee are of the opinion that the Government's decision in leaving the air-frame and the engines was not in keeping with the national interest.

*Project for reheating Orpheus 703 engine*

2.63. Consequent on the non-availability of a more powerful engine for the proposed aircraft HF-24 MK II, HF-24 continued to be powered by Orpheus 703 engine (hereafter referred to as MK I). In 1960-61, it became evident that the Orpheus 703 engine powered aircraft fell considerably short of the operational requirements then in force. Therefore, concurrently with the manufacture of MK I aircraft, search for a suitable engine to meet the projected requirements of MK II aircraft continued. In July 1962, Gas Turbine Research Establishment (GTRE) of the Defence Research and Development Organisation prepared a feasibility study of reheat variant of Orpheus 703. Sanction for this development project by GTRE was issued in January 1963. This variant was a temporary expedient for boosting the power of the engine and thus improving the performance of MK I aircraft. The cost of the project initially estimated and approved was Rs. 14 lakhs for building one demonstrator engineering system. As an interim solution, installing the 703 reheat engine was proposed in a paper for the Emergency Committee of the Cabinet

and was approved in April 1964. In February 1965, a Technical Study Group reported that MK I aircraft with reheat engine (hereafter referred to as MK IR) would meet the operational requirements then in force. It accepted reheat variant of Orpheus 703 (1700°K) "as the only expeditious solution." In July 1965, decision was taken on the report of the Technical Study Group that MK IR be proceeded with on a high priority basis. The specifications of HF-24 MK IR were finalised by Air Headquarters in August 1965. However, in March 1966, it came to light that the performance of MKIA\* was inferior even to MK I in dry climb and cruise due to base drag although the reheat system as designed by GTRE is stated to have "met the full specifications in respect of thrust, specific fuel consumption etc." In 1969, a prototype of MK IR was flown and this prototype also showed some shortcomings. Before the matter could be analysed further, the only prototype of MK IR crashed during its 10th flight in January 1970. However, the development work was continued, though at a reduced tempo. The test trials of the reheat engine were completed in October 1970 and in June 1971, Air Headquarters accepted the aircraft with Orpheus 703 reheat (1700°K) engine. In January 1972 Air Headquarters issued "Requirement Standard I of 1972" which the Orpheus 703 reheat engine is stated to have met. The minutes of the high-level meeting held in the room of the Minister of Defence Production in July 1973 reveal that the reheat engine developed by GTRE still had the problem of "base drag" when fitted to the airframe. At this meeting the Air Headquarters indicated that the aircraft was required to be of a standard higher than that notified in January 1972. This was confirmed by the Air Headquarters in September 1973.

*Competence of GTRE to take up Project for development of Reheat Engine*

264. The Department of Defence Production were asked to indicate the facilities and expertise available in GTRE at the time of assigning the job of development of reheat system to it. In reply, it is stated that GTRE was utilising the workshop and other facilities available at HAL, as and when necessary, and was fully equipped to undertake the task. It is further stated that "the fact that this task was successfully completed proves their competence in the matter." The Ministry have, however, stated that the information sought regarding facilities and expertise available at GTRE at the time of commencement of reheat project "can be answered only after specific examination in depth which will entail a great deal of work."

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\*MK IA after development was referred to as MK-IR.

2.65. In reply to a question whether all necessary inputs—financial and physical—were timely made available to ensure that the project did not languish on this account, the Ministry have stated:

“The necessary inputs were made in stages, depending on successful demonstration of phase-wise project objectives. The various stages were clearly indicated in the listing on the milestones of the Project. This approach was necessary because this was the first major task which the establishment was handling and hence a cautious approach was taken with regard to the money to be spent and facilities to be built up.”

*Coordination between HAL and GTRE*

2.66. Simultaneously with the development project for Orpheus 703 reheat engine (MK IR) undertaken by GTRE, development of different types of airframes to suit the reheat engine was going on in HAL. The representative of the Department of Defence Production was asked, during evidence, whether there was proper coordination between the HAL and the GTRE at all stages of the reheat project. Denying that there was any lack of coordination between the two agencies, he stated:

“As far as installation of the reheat engine on the airframe is concerned both sides were in complete accord. What actually took place was that due to structure of the airframe the real area of the fuselage was so constructed that it was unable to accommodate the enlarged cross-section of the reheat engine. It produced a sort of hump-shaped protuberance because of the configuration and the fitment of the tail. The upshot of all this was that it lowered its range. We did our best to overcome this defect. The assistance of HAL was taken to reduce this phenomenon but it was of no avail. So, the aircraft which was powered with the Orpheus 703 reheat engine had this deficiency and we had to live with it. Ultimately, this resulted in the non-fulfilment of the Air Force requirements thus resulting in its rejection. The Steering Committee under the Chairmanship of the Chief of Air Staff looked after both these projects. So, to that extent coordination between these two institutions was overseen by this Committee. The defects which came up in the design and which led to increase of drag etc., were

inherent in the design of the HF-24 airframe itself and cannot be ascribed to any lack of coordination between the two development agencies."

### *Delay in Development of Reheat Engine*

2.67. Government had sanctioned the development of reheat system for Orpheus 703 engine by GTRE in January 1963. The test trials of the reheat engine were completed in October 1970. The Ministry were asked whether any time-frame was envisaged for the development of the reheat engine and what were the reasons for the long time taken in its development. In reply it has been stated that no formal date for the development of the reheat system could be specified because the development work was progressed at various stages taking into account the success made in the earlier stages. Even though some estimates were made they could not be formally laid down. The development of the reheat system was to be done in two essential parts, viz., (a) Research and the Bench development of the engine (on ground), and (b) flight development on a suitable prototype aircraft. While the Bench development for the reheat could be proceeded broadly as per expectations, the time required for the flight development could not be assessed primarily because, initially only one prototype aircraft was used for the development of both the engine and the airframe. The airframe changes and developments were very extensive, such as extended chord wings, supersonic intake, slab tail, duplicated systems, rear and modifications for improved base drag and so on. All these airframe changes were incorporated in the prototype aircraft progressively and trials with regard to these changes were conducted in addition to the trials on the reheat system.

2.68. It is further stated that the time taken for the Bench development of reheat was 4 years which considering the resources invested and complexity of the tasks was not excessive. A formal 150 hours development test was completed on the 703—1700°K reheat system in May 1967. The main reason for the time taken was the fact that the flight trials with only one prototype aircraft covering the whole range of development on both airframe and engine activities took a long time. In order to accelerate the flight development for this project a second prototype aircraft was built in late 1969. Unfortunately this prototype crashed in January 1970 after only 9 flights. However, the development work was continued on the original prototype though at a somewhat reduced tempo. The test trials of the reheat engine were completed in October 1970 and in June 1971. Air Headquarters accepted the aircraft with Orpheus 703 reheat (1700°K) engine.

2.69. It may be mentioned in this connection that the Study Group of the Aeronautics Committee set up in 1969 to study HF-24 development project had in its report observed that "the consensus of studies carried out in U. K., France and U.S.A. was that the alternative of production of a large number of prototype followed by regular production would yield better results."

*Escalation of cost of development of Reheat Engine*

2.70. The Audit paragraph points out that the development cost of the Orpheus 703 reheat engine by the GTRE initially sanctioned in 1963 at Rs. 14.00 lakhs was revised from time to time, the final revised cost being Rs. 7850 lakhs in March 1974 representing an increase of 461 per cent. It has also been pointed out that the total cost of development of the reheat engine which was accorded provisional type approval in December 1971 and final type approval in December 1973 came to Rs. 2.02 crores.

2.71. Explaining the position, the Department of Defence Production have stated that the Project for the design and development of reheat system to production stage was not sanctioned in its entirety right at the beginning. The project was carried out in progressive stages and each stage was taken up only after successful execution of the preceding phases of activity. The initial sanction of Rs. 14 lakhs was accorded for manufacture of only one prototype. The total sanction of Rs. 78.50 lakhs was given in seven successive stages with reference to increase in scope of activity and was for a total of 11 prototype engines. The total cost of development of the reheat engine was only Rs. 77.41 lakhs and the figure of Rs. 2.02 crores mentioned in the paragraph included the cost of engines which were on loan from HAL to be returned to them as well as the cost towards establishment of the R&D Establishment.

2.72. Regarding the procedure of excluding these charges while computing costs of projects, during evidence, the Scientific Adviser to the Ministry of Defence stated:

"This is the standard procedure which has been worked out in consultation with CGDA. applicable to all Defence Laboratories."

2.73. As against the total sanction of Rs. 78.50 lakhs, a total sum of Rs. 77.41 lakhs is stated to have been spent on the project. Out of this, an amount of Rs. 76.4 lakhs is stated to have been paid to HAL while the remaining Rs. 1 lakh was spent on local purchase of items

from sources other than HAL. The amount paid to HAL was for the following services:

- (i) Test bed facilities for development testing of engines.
- (ii) Procurement of raw materials and components, particularly of aeronautical standard.
- (iii) Overhaul of engines taken on loan for reheat development as per norms laid down for the 703 engines.
- (iv) Manufacturing facilities not available in GTRE including specialised facilities such as process shop, automatic welding standards rooms, laboratory etc.
- (v) Miscellaneous services as fork lifter, cranes etc.

2.74. The Ministry were asked to state whether it was not necessary and desirable for a proper perspective to include the element of cost of establishment in the total cost of such projects. In reply, the Ministry have stated that the Defence Research & Development Organisation is not a production agency but it has to render technical assistance in evaluating new weapon system for the three Services as also undertake tasks relating to development of new systems. For this purpose permanent establishment of manpower, machinery/equipment and accommodation have been sanctioned to R&D Laboratories/Establishments which are reviewed from time to time. It is not appropriate to include this permanent manpower cost in the "Project Costs" since even without any specific project the expenditure on regular establishment would have been incurred. If additional manpower or machines/equipment are specially needed for a project their cost is included within the cost of the Project. Similarly, travel costs etc. incurred specifically in connection with the project are included in the total project cost though they form a small element of the total outlay.

2.75. It is further stated that it is certainly possible to assign to a project, costs relating to the use of manpower, facilities etc. but this involves considerable accounting work, and will need additional manpower on the administrative side—since accounts/establishment matters are not computerised. This would not be justified at this stage since in the case of any major project the development costs incurred by DRDO will be a very small part (10 percent) of the total cost of the project up to the point where a successful product is delivered to the user.

2.76. Justifying the expenditure on the development project during evidence, the representative of the Ministry of Defence (R&D

Organisation) has stated:

“It is extremely unlikely that you can start out R&D on a complex system with one set of requirements and reach a certain conclusion on the basis of an originally estimated cost and time-frame...Mortality in these projects is very very high, particularly in a complex project and many have mothballed as far as the final utilisation is concerned... If we want to compress the time-schedule and want to ensure a lower mortality rate, we will have to put in much more money into it at the beginning, because the lesser the quantum of finance in the beginning, the more expensive and time consuming it will turn out to be ultimately.”

#### *Retromodification*

2.77. As already stated, the prototype of HF-24 MK I with Orpheus 703 reheat engine crashed in 1970. After a series of discussions, a proposal was formulated for development of HF-24 MK II at an estimated cost of Rs. 8.90 crores. It was originally envisaged that the additional MK-II aircraft should be ordered but the matter was re-examined in the light of the constraint of resources. In February 1973, however, Air Headquarters suggested abandonment of the project for the manufacture of the aircraft with reheat engine on the ground *inter alia* of financial stringency and proposed instead retro-modification of the existing MK I aircraft already in service with the Air Force.

2.78. Explaining the reasons during evidence for the abandonment of the project for the manufacture of MK I aircraft with reheat engine, the representative of the Ministry of Defence has stated:

“When the reheat engine was available and a comparison made with the performance of other possible engines from abroad, a clear decision had been arrived at that this reheat engine would be suitable for fitment on to HF-24; yet for various other reasons it was found that with this particular air-frame, there was a certain problem relating to drag which affected the range of the aircraft. This was not completely acceptable to the Air Force—not in terms of the old context of requirements but in terms of the new context of their operational requirements. It was for this reason that it was finally decided that one could not go ahead to put this reheat engine on the aircraft. This was a decision taken essentially on an analysis made by the users of their operational requirements. That is something which we have to accept. It can be stated that the Research & Development

had come to fruition, and the end-product had become fully usable. However, we have to remember that this has to serve a purpose; that the user must make use of it effectively. In this particular case, the analysis made by the user revealed that this was not satisfactory from the view-point of their current operational needs."

Supplementing the reply of the representative of the Department of Defence Production, the representative of the Air Force stated:

"We found after the 1971 war that... aircraft which was already therewith us was going to be used plus the aircraft which was coming, namely... and this would meet the close-support requirements. We looked for an aircraft with a deeper range. We wanted longer radiouss and when Mark II fitted with reheated engine figure was given to us it looked promising and we said, yes, we would like to have requirement standards slightly revised. At the time this was being considered we were going ahead with another proposal received from HAL... engine proposed by HAL was a little more promising... a little more attractive than Mark II fitted with reheat engine developed by GTRE. We thought we would ask HAL not to proceed with Mark II but to go in for this... model and... injected in the HF-24 project some element of imponderables. We did not really anticipate before that we would at that point of time go in for these two aircraft which would do the same job as HF-24 was doing."

2.79. In March 1973, the public sector undertaking submitted the time-frame and cost implications of the Air Headquarters proposal as well as two additional alternatives envisaging development of variants of the original engine, one by public sector undertaking and the other by the Research & Development Organisation.

2.80. In May 1973, Air Headquarters suggested that the project (limited to retro-modification) with the reheat engine be held in abeyance. The Ministry of Defence was asked to indicate the reasons therefor. In reply they have stated that the Air Headquarters had accepted the development of HF-24 MK II powered by Orpheus 703 reheat engine as per their requirement standard I of 1972. Subsequently, however, the lessons learnt from the Indo-Pak conflict of 1971 indicated the need for an aircraft having a longer range than the one prescribed in the requirement standard I of 1972. On the other hand it had become clear during the development of HF-24 MK



II (with Orpheus 703 reheat engine) that there was no possibility of improving the range of this version to the extent required by the Air Headquarters. An alternative proposal had been submitted by HAL for consideration which involved development of this aircraft powered by another engine (which was another variant of Orpheus 703 engine). On preliminary considerations it appeared that this variant could be easily developed and would meet the improved performance desired by the Air Headquarters. In view of this, Air Headquarters had suggested not to pursue with the project to develop Marut MK II with Orpheus reheat engine.

2.81. Meanwhile, the matter was considered by the APEX Planning Group which accepted Air Headquarters proposal for retromodification of MK I aircraft with a provision of Rs. 10.41 crores for development and Rs. 59.40 crores for retromodification. The proposal was approved by Government in May 1973.

2.82. In July 1973, the proposal for retromodification with alternative engine variants was also considered at a high level meeting in the room of the Raksha Utpadan Mantri (Minister of Defence Production).

It is stated in the Audit paragraph that no formal sanction or approval for the development of the alternative variant by the public sector undertaking was issued.

#### *Change in Requirement Standard*

2.83. Audit has informed the Committee that at the meeting held in the room of the Raksha Utpadan Mantri in July 1973, Air Headquarters indicated that retromodification of the aircraft would be required to a standard higher than that defined in January 1972. This was confirmed in September 1973. It is further stated by Audit that the standard of preparation issued in January 1972 has, however, not yet been modified.

2.84. The representative of the Department of Defence Production was, during evidence, asked as to why the Air Force accepted the reheat engine in 1972 when their experience of Indo-Pakistan hostilities in 1971 was different. He replied:

"I believe Standard I of 1972 was issued thereafter. Possibly the lessons of 1971 had not been absorbed. Subsequent resistance on the range took concrete form about six months later. They do insist on range parameter."

2.85. Subsequently, the Ministry of Defence were asked to state the reasons for the standard of requirement not being decided by:

the Air Headquarters before the acceptance of the retromodification proposal in May 1973. They have stated

"The change in standard of preparation became necessary only after assessment of Air Force requirement became available in the light of experience of Indo-Pak war. The new standard of preparation had no direct connection with the retromodification proposal. The retromodification proposal came in only on account of financial constraints."

The main difference in standards is stated to be "longer radius of action."

2.86. In reply to the question as to whether any formal amendment to the requirement standard was made, it is stated that it was not considered necessary "since the only manufacturing agency in the country had confirmed the possibility of radius of action even higher than the Air Force requirement.... by new engine."

2.87. A point was raised during evidence whether the Air Headquarters communicated their views in regard to suitability of the reheat engine in writing. The representative of the Air Force stated that "this was pointed in the various Steering Committee meetings we used to hold periodically." Supplementing him, the representative of the Department of Defence Production has stated in this connection:

"A statement was made by the Chief of Air Staff in a meeting held in Minister's room.....It was a formal meeting of which there are records."

On being asked whether the Chief of Air Staff had concurrent approval of the Defence Secretary when he made that statement, the representative of the Department of Defence Production has stated:

"I find that the Defence Ministry was represented by the Deputy Secretary."

In reply to the question whether this meeting should not have been attended by the Defence Secretary himself as a major decision was being taken, he stated:

"One would have thought so. I cannot now recollect what were the circumstances in which he was unable to attend but I have no doubt that all this was fully within his knowledge, because these things were repeatedly mentioned in the debates which went round in the apex group. The Defence Secretary was himself very actively associated in all the decision."

Subsequently replying to the question whether discussion of the question in various Steering Committee meetings obviated the need for keeping Government fully informed by formal communications recommending closure of the project, the Ministry have stated that "the Steering Committee consisted of the representatives of the Ministry and other organisations concerned with the development project. The decision taken in the Steering Committee meeting constituted informing the Government. It may be recalled that the final decision was taken in the meeting held under the chairmanship of Raksha Utpadan Mantri where again the representatives of the various Departments were present."

2.88. The Audit paragraph states that in a meeting held in the Ministry of Defence on 3 August 1974, Air Headquarters stated, *inter alia*, that the aircraft fitted with the reheat engine would not meet the operational requirements (as defined in July/September 1973). The alternative proposals of engine development (with high cost and long gestation periods) were not considered justifiable in the context of the then limited requirement of retromodification. It was, therefore, decided that the retromodification programme should be given up and the orders placed in September 1971 and July 1972 upon HAL for the manufacture of trainer aircraft should also be cancelled. In September 1974, Air Headquarters recommended that further efforts on the improved version of the aircraft be abandoned. Government sanction for the cancellation of the orders on HAL for the manufacture of trainer aircraft was issued on the 24 March 1976. The formal Government orders closing the project to develop MK II however, have, according to the Ministry, not so far been issued but no expenditure is being incurred by any agency on this behalf.

2.89. Explaining the reasons for abandoning the project, the representative of the Department of Defence Production has, during evidence, stated:

"The reheat system was given up by the Air Force principally on account of the limitations which it imposed on the aircraft itself...in the discussions that have been held in the Department of Defence Production, it was said that the limitation of range was the principal item which had always been brought up to the notice of the Air Headquarters. That is what we have always accepted as the reason for not going in for reheat system. The reheat system development cost can also be compared with the other systems. It is about Rs. 650.0 lakhs compared to a much smaller figure of about Rs. 250.0 lakhs added on the

....(engine proposed by HAL) and about Rs. 560.0 lakhs added on.... (another engine variant proposed by GTRE). The reason for these small figures is that....(these) do not involve much change in the airframe and the engines, whereas in the reheat system, a fair amount of engineering on the airframe would have been required. Moreover, the reheat system was given up for reasons of performance. Subsequently after the examination by the Apex Committee, it was found that the overall finances would only permit the allocation of about Rs. 10.0 crores which was quite enough for the retromodification to a number of Marut aircraft then held by Air Force...and the time-factor for the modification also became quite large under each of these schemes... (engine proposed by H.A.L. for instance was about five years, the reheat system required a little less time, about 4 years and 9 months or so and .... (the one proposed by GTRE) required about 5 years and a few months. If we waited for any of these schemes, the number of aircraft held by the Air Force would have come down. In view of that, in all these schemes, none was actually worthy of consideration."

### *Total Expenditure*

2.90. Audit has reported that the total expenditure on the development of the aircraft and further development of the engine variants has been Rs. 21.46 crores to the end of March 1975. Government were asked to state whether any further development work has been done on these engine variants and if so, what was the expenditure incurred thereon to-date. The Department of Defence Production have, in reply, stated that no further development work has been done on any of the engine variants reflected in the Audit paragraph. An expenditure of Rs. 1.02 crores has, however, been sanctioned by the Government in July 1976 to carry out certain essential improvements and modifications in the Marut fleet now in service with the IAF. The total expenditure on the development of the Marut Project including its variants is, therefore, expected to be of the order of Rs. 22.48 crores (Rs. 21.46 crores plus Rs. 1.02 crores). Expenditure incurred upto March 1976 is stated to be Rs. 11.95 crores in respect of Marut MK I and Marut MK I trainer development.

### **Critical Review after abandonment of Project**

2.91. From the information placed before the Committee, it would appear that a costly project has been foreclosed after a period of nearly 18 years without achieving the desired objective.

Government were asked to indicate whether a critical review has been made of the project particularly of the organisational inadequacies, the decision making processes determination and adequate monitoring of time and cost estimates etc., with a view to evolving guidelines for the future. In reply Government have stated:

"Every development project has necessarily to end at one time or the other. The project for development of HF-24 resulted in successful development of HF-24 MK I and MK I trainer which are both in squadron service. The project is not being foreclosed but closed after the completion of required number of aircraft for which order had been placed on HAL. It is true that the aircraft did not achieve the required speed on account of non-availability of suitable power plant. But for this reason the project cannot be considered as having not achieved desired objective. In fact, HF-24 airframe has good aero-dynamics, good weapon platform and good structural integrity. It has also got growth potential. It was for this reason that HAL continued to endeavour to improve operational capability by fitting engines more powerful than the existing ones.

HF-24 Project was reviewed by HAL/Government from time to time. The Steering Committee was constituted by the Government in 1963 to remove with despatch technical/administrative bottlenecks and to coordinate action of the various authorities on the spot.

The Steering Committee met from time to time and reviewed the progress of the Department Project."

2.92. The Ministry of Defence were asked as to what would be the effect of the decision to abandon the project on the operational efficiency of the Air Force for which the aircraft under development was intended. In reply, it has been stated:

"Operational necessity for induction of aircraft with an adequate range still remains. None of the variants considered in connection with the Marut MK II project fulfil this requirement. Therefore, the decision to induct such a variant into IAF has not affected the operational requirements."

2.93. The Committee observe that since the existing HF-24 aircraft fell considerably short of the then operational requirements of the Air Force, Gas Turbine Research Establishment (GTRE) of the Research and Development Organisation of the Ministry of Defence took up a project for the development of reheat variant of Orpheus 703 engine (already in use) for fitment to the HF-24 air-frame. They also note that as early as in February 1965, the Technical Study Group (headed by Air Cdr. Moolgavakar) reported that although the reheat engine would meet the then existing operational requirements, it would have "some deficiency in the radius of action." The Study Group had accepted the reheat variant of Orpheus 703 engine as "the only expeditious solution." It has been admitted that in March 1966 it came to light that the test-bed performance of HF-24 MK I A (later redesigned as MK IR) fitted with reheat version of Orpheus 702 engine "was inferior even to MK I fitted with Orpheus 703 engine in dry climb and cruise due to base drag." It is further admitted that in 1969 the prototype aircraft fitted with reheat variant of Orpheus 703 engine was flown and this prototype also showed some shortcomings. This prototype finally crashed in January 1970. The Committee find that in spite of these results, the GTRE was allowed to continue with the reheat development project incurring expenditure which ultimately proved largely infructuous. In February 1973, when Air Headquarters suggested abandonment of the project for manufacture of MK II aircraft with reheat engine on the grounds, inter alia, of financial stringency and instead proposed retromodification of the existing MK I aircraft, the retromodification of the existing aircraft with reheat variant of Orpheus 703 engine continued to be a subject of research and development in the GTRE even though it was well-known that reheat variant of Orpheus 703 engine had the problem of base drag. The Committee are unable to appreciate as to why the Government persisted with the project for development of reheat variant of Orpheus 703 engine and its fitment in the HF-24 air-frame when it came to their notice as early as 1965 that it caused the problem of base drag which reduced the performance of the aircraft far below the operational requirements.

2.94. The Committee also fail to understand why the proposals for development of other variants, such as the one conceived by HAL was not given a chance to prove its efficacy when it came to be known that the reheat variant developed by GTRE had not proved a success.

2.95. The Committee find that Government had sanctioned the development of reheat system for Orpheus 703 engine which was

then in use in HF-24 aircraft by GTRE in January 1963. The test trials of the reheat engine were, however, completed only in October 1970. It has been explained that though Bench development of the engine proceeded according to schedule and was completed in 4 years' time in May 1967, the flight development on a suitable prototype aircraft took a long time on account of the fact that there was initially one prototype aircraft available and extensive changes and developments had to be made in the airframe. The Committee feel that the execution of the project was done in a leisurely fashion and the development could have been expedited by a well-organised monitoring system. They consider that if the availability of only one prototype aircraft for trial purposes was found to be handicap resulting in inordinate delays in development, GTRE should have pointed it out to Government at the appropriate time so that Government could have thought of meeting the requirement in the interest of speedy development of the required engine.

2.96. The Committee note that the development cost of the Orpheus 703 reheat engine was initially (January 1963) estimated by GTRE at Rs. 14 lakhs. However, according to Audit, the total cost of development of the reheat variant by December 1973, had come to Rs. 2.02 crores. It is held that the sum of Rs. 2.02 crores includes also the cost of establishment and the cost of the engines which were loaned by HAL which were to be returned to them. According to Government, the expenditure on the project had been only Rs. 77.41 lakhs out of which Rs. 76.4 lakhs is stated to have been paid to HAL for various facilities and services while the remaining Rs. 1 lakh was spent on local purchase of items from sources other than HAL. As for escalation of cost from 14 lakhs in January 1963 to Rs. 77.41 lakhs in December 1973, it is stated that the project was not sanctioned in its entirety right at the very beginning. It was carried out in progressive stages and each stage was taken up only after the successful execution of the preceding stage. As regards the exclusion of the cost of establishment from the cost of the project, it is stated that since the Defence Research and Development Organisation is an agency for evaluating and developing weapon system for all the three Services and since even without any specific project the expenditure on regular establishment would have been incurred, it is not proper to include this manpower cost in project cost. The Committee do not consider this plea as tenable and feel that for correct appreciation of cost of development of a project, it is desirable to include in the cost of the project the cost of establishment allocated for the project. This procedure for computation of cost is also desirable in order to have a fair assess-

ment of comparative economics of development project being proposed by GTRE and HAL. It may be pointed out that HAL being a commercial organisation has to include in the cost of the development project not only the cost of establishment committed for the project but also profit margins.

2.97. The Committee note that in February, 1973, the Air Headquarters suggested abandonment of the project for the manufacture of HF-24 aircraft with Orpheus 703 reheat engine on the ground, inter alia, of financial stringency and proposed instead retromodification of the existing HF-24 MK I aircraft already in service with the Air Force. The proposal for retromodification of the existing HF-24 MK I aircraft to a higher standard involving an outlay of Rs. 70.14 crores was approved by the Apex Planning Group and Government in May 1973. A couple of months later in July 1973, the various proposals for development of a suitable engine to be used in retromodification were considered at a meeting in the room of Raksha Utpadan Mantri and certain decisions regarding various alternative proposals for engine development were taken. At this meeting, Air Headquarters indicated that the aircraft was required to be of a standard higher than that notified in January, 1972, and that this was confirmed by them in September, 1973. Subsequently, at a meeting in August, 1974, the Air Headquarters stated that the aircraft fitted with reheat engine would not meet the current operational requirements. The alternative proposals of engine development were not considered justifiable in view of "high costs and long gestation periods" and the "Limited requirement of retromodification." It was, therefore, decided that the retromodification programme should be given up. A month later, i.e., in September, 1974, the Air Headquarters recommended that further effort on the improved version of HF-24 aircraft be abandoned and since then no expenditure is being incurred by any agency on this behalf, although no formal Government orders closing the project have so far been issued. The closure of the project has thus rendered largely infructuous a total expenditure to be of the order of Rs. 21.46 crores upto the end of March, 1975. The Committee are unable to appreciate the reasons advanced before them for a sudden foreclosure of the project specially when huge expenditure had already been incurred on the project and, as stated by the Ministry of Defence themselves, "Operational necessity for induction of an aircraft with an adequate range still remains."

2.98. The Committee also note that the requirement standard I of 1972 for MK II with reheat engine was issued by the Air Headquarters in January 1972. The reheat variant of Orpheus 703 engine



developed by GTRE met this requirement, but when fitted to the HF-24 air frame it caused the problem of base drag which reduced the performance of the aircraft to even lower than that of HF-24 fitted with ordinary Orpheus 703 engine. In July-September 1973, the requirement standard was raised upwards by the Air Headquarters rendering the reheat variant developed by GTRE far short of the new requirements. It was explained to the Committee that the raising of the requirement standard became necessary as a result of the experience of the December, 1971 War, the import of certain types of aircraft from abroad and a new role envisaged for the HF-24 aircraft. The Committee feel that the action of the Air Headquarters in issuing the "Requirement Standard I of 1972" for MK II with reheat engine in January 1972, when the experience of 1971 War were still being analysed, was a little hasty. The Committee would, however, like to point out that the revision of the operational requirement in July-September, 1973 could not have had any decisive impact on the development project as even with the Requirement Standard I of 1972, which the GTRE-developed reheat engine is claimed to have met, the aircraft had experienced the problem of base drag which had rendered it below the mark from operational point of view. Since the project was for development of an engine of required specifications and standard for fitment in a particular airframe, the claim that "the reheat system designed by GTRE had met the full specifications in respect of thrust, specific fuel consumption etc." is pointless inasmuch as the engine could not produce the required results when fitted in the particular airframe.

2.99. The Committee have been informed that the Air Headquarters have not been communicating their views in regard to the suitability of reheat engine for the HF-24 aircraft in writing. It is maintained that the expression of views by the representatives of the Air Force at the Steering Committee meetings was thought sufficient. This is rather unusual. The Committee feel that as the development project was to cater for the operational requirements of the Air Force, the Air Headquarters had a special responsibility in regard to the development project and their views in regard to the suitability of the end-product should have received the importance that they deserved. The Air Headquarters should also have followed up the views expressed during Steering Committee meetings by written communication to that effect to the Defence Ministry so as not to leave ambiguity of any sort as far as the stand of the Air Headquarters was concerned. That this was not done is regrettable.

*Further Development work on reheat system*

2.100. Audit has informed the Committee that further development work on the reheat system was sanctioned by the Aeronautics Research and Development Board in March, 1972 and a total amount of Rs. 35 lakhs was sanctioned upto February, 1976, therefor. In view of the long time taken for completion of the earlier project for reheat system and little headway made in the development of the aircraft (MK II), the Ministry were asked to indicate the considerations for sanctioning the new project. In reply, it has been stated that a project on development of 2000 K reheat system on the Orpheus 703 engine was sanctioned by Aeronautics R & D Board as an independent research project. (The reheat project for HF-24 was upto a reheat temperature of 1700 K). This project was not taken up as a direct requirement for aircraft installation and was not specifically related to development of HF-24 MK II. The aim was study the feasibility of incorporating a high degree reheat system on an actual engine as is required in advanced technology engines. The task envisaged at the time of sanction of project was to design and develop the system upto demonstrator stage to established technical feasibility.

2.101. As for the achievements under the project it has been stated that the demonstrator engine has been successfully tested and performance confirmed. In addition, the system has been successfully tested under simulated flight conditions in the high altitude test facilities at National Gas Turbine Establishment, U.K. Out of a total sanction of Rs. 22 lakhs, an amount of Rs. 19.65 lakhs has been committed/expended. An additional sum of Rs. 13 lakhs which had been originally recommended by Aeronautics R & D Board, was not actually sanctioned. (A sum of Rs. 13 lakhs was separately sanctioned for simulated testing in U.K., against which the expenditure is Rs. 12.85 lakhs).

2.102. The Ministry have claimed that the primary aim of the project has been successfully achieved. A few more tests to obtain more data are proposed to be taken up within the sanctioned amount. This 2000 K system is being adopted for another engine development project now in hand.

2.103. Although it was known as early as in 1969 that the fitment of Orpheus 703 reheat engine developed by GTRE on HF-24 airframe had the problem of drag, the Aeronautics Research and Development Board sanctioned in March, 1972 further development work on the reheat system and a total amount of Rs. 35 lakhs was sanctioned upto February, 1976 for the purpose. The Committee are informed

that this project was for the development of 2000 K reheat system on the Orpheus 703 engine and it was sanctioned by Aeronautics R&D Board as an independent research project and was not specifically related to development of HF-24 MK II. The task envisaged at the time of sanctioning the project is stated to be "to design and develop the system upto demonstrator stage to establish technical feasibility."

2.104. As to the achievements under the project, it is stated that "the system has been successfully tested under simulated life condition in the high altitude test facilities at National Gas Turbine Establishment, U.K." It is further stated that this 2000 K system is being adopted for another engine development project now in hand. The Committee would like Government to assess this project in the light of their experience in regard to the other project for the development of the reheat system for HF-24 aircraft and ensure that the amount spent on the project is purposefully directed to achieve definite fruitful results.

*Findings of Aeronautics Committee and action taken in pursuance thereof.*

2.105. The Audit paragraph has stated that the Aeronautics Committee appointed by Government, reviewed, *inter alia*, the HF-24 project in 1969 and assessed that in the aircraft and its variants there existed an aircraft with promise and that the basic design should be stretched to its full capacity and the matter pursued vigorously during the next two-three years. The Committee had also made some far-reaching observations and specific recommendations. Asked to state the action taken by Government on the recommendations of the Committee, the Government have stated that in pursuance of the recommendations of the Committee, development of HF-24 MK I was vigorously pursued.

2.106. The note of the Government has also revealed that the Study Group constituted by the Aeronautics Committee had made a careful study of HF-24 development project and made certain observations explaining the wide variations in the cost and time-schedule of this project. The observations of the Study Group have been summarised in the note as follows:

- (i) The magnitude of the work had not been properly appreciated while preparing the initial estimates.
- (ii) The elements of material and labour costs had not been properly allowed for the initial estimates.

- (iii) The Indian design staff had not been experienced enough to make effective contribution in the earlier years. The absence of previous experience in the development of aircraft was a serious handicap and a necessary allowance for this deficiency had not been made in the estimates of cost and time.
- (iv) In the Government, there was no critical examination of the project reports submitted by HAL in 1957 and 1960. There was also a failure to keep a close watch on the progress in the development of HF-24.
- (v) The management organisation in HAL for the project was inadequate.
- (vi) The organisation in the Ministry of Defence to monitor development projects was adequate.
- (vii) The methodology followed of a small number of prototypes followed by comparatively large-number of preproduction aircraft has not given satisfactory results. The consensus of studies carried out in UK, France and USA was that the alternative of production of larger number of prototypes followed by regular production would yield better results.
- (viii) The decision to relate the development of an aircraft to the successful completion of an engine under development abroad was not wise.
- (ix) Throughout the history of the development of HF-24 aircraft, policy changes were made regarding the choice of the engine. Each of the changes involved considerable design effort and diverted attention from the development of HF-24 MK I. Also concurrent with the programme of development of the HF-24 MK I aircraft, HAL had been engaged in building and supporting the flight development of several versions including HF-24 MK I with airpass, HF-24 MK IA, HF-24 MK IBX and HF-24 MK IR.

The note states that the observations of the Aeronautics Committee have been carefully studied by the Government and the HAL. In regard to action taken on the observations, the note says:

"The criticism contained in these observations is accepted. Lessons learnt from the experience gained over these

projects are being applied to the new development projects under execution and it is hoped that the deficiencies brought out.....would be avoided in implementing the new projects."

**2.107. The Committee note that the Aeronautics Committee and later on a Study Group constituted by it had made a careful study of HF-24 development project and have made certain observations. The more important of these observations have been summarised as follows:**

- (i) The magnitude of the work had not been properly appreciated while preparing the initial estimates.
- (ii) The elements of material and labour costs had not been properly allowed for in the initial estimates.
- (iii) The Indian design staff had not been experienced enough to make effective contribution in the earlier years. The absence of previous experience in the development of aircraft was a serious handicap and a necessary allowance for this deficiency had not been made in the estimates of cost and time.
- (iv) In the Government, there was no critical examination of the project reports submitted by HAL in 1957 and 1960. There was also a failure to keep a close watch on the progress in the development of HF-24.
- (v) The management organisation in HAL for the project was inadequate.
- (vi) The organisation in the Ministry of Defence to monitor development projects was inadequate.
- (vii) The methodology followed of a small number of prototypes followed by comparatively large-number of pre-production aircraft has not given satisfactory results. The consensus of studies carried out in U.K., France and USA was that the alternative of production of a larger number of prototypes followed by regular production would yield better results.
- (viii) The decision to relate the development of an aircraft to the successful completion of an engine under development abroad was not wise.
- (ix) Throughout the history of the development of HF-24 aircraft, policy changes were made regarding the choice of

the engine. Each of the changes involved considerable design effort and diverted attention from the development of HF-24 MK I. Also concurrent with the programme of development of the HF-24 MK I aircraft, HAL had been engaged in building and supporting the flight development of several versions including HF-24 MK I with airpass, HF-24 MK IA, HF-24 MK IBX and HF-24 MK IR.

2.108. Indicating the action taken on the observations of the Aeronautics Committee, Government have stated that "the criticism contained in the observations is accepted and that the lessons learnt from the experience gained over these projects are being applied to new development projects under execution." The Committee are in agreement with the observations made by the Study Group and would like Government to ensure that the defects pointed out are not repeated in formulating and executing development projects in future.

2.109. They would, however, like to add that the Government should ensure that the development projects are not allowed to be dragged on for years together with the result that more and more money is pumped in the project and by the time the scheme materialises the model may become obsolete. The progress and achievements of a development project should be analysed and appraised after every 2 years by a technical team and the continuance of the project should be decided upon in the light of the findings of the technical team indicating a distinct progress and a clear possibility of fructification of the developmental effort in the near future.

C. M. STEPHEN,  
Chairman,  
Public Accounts Committee.

NEW DELHI;  
December 9, 1977.  

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Agrahayana 18, 1899 (S).

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## **APPENDIX**

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**APPENDIX**

**STATEMENT OF CONCLUSIONS/RECOMMENDATIONS**

Sl. Para No of Ministry/Department No. the Report Concerned	Conclusion/Recommendation
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1	3
2	4

1	1.45	Department of Defence Production
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Having considered the written as well as oral evidence submitted to them the Committee are led to the conclusion that the project for development of an indigenous engine to replace the Viper engine being imported for the Kiran airframe being manufactured by HAL, involving an expenditure of nearly Rs. 82 lakhs, failed due to a variety of factors, the principal among them being the lack of a clear objective of the whole project the inability of the Government in making available adequate funds in time and absence of adequate expertise in HAL leading to considerable delays in development. The vacillation displayed by Government right from the time the project was conceived till its abandonment is inexcusable. The various lacunae and deficiencies in the implementation of the project have been discussed in the following paragraphs.



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Department of Defence  
Production

The proposal for the design and development of the aero-engine (HJE-2500 Turbo Jet) was initiated by HAL (then known as Hindustan Aircraft Ltd.) in February 1960 with the object of replacing the imported Viper engine for the Basic Jet Trainer then being manufactured by it. Since the aircraft was meant for service in the IAF, the Air Headquarters and the Directorate of Technical Development and Production (Air) were also consulted at the project report stage who had suggested that the delivery schedule of the engine should be speeded up as much as possible so that there was no delay in the production of the jet trainer aircraft. This shows that the prime objective of the project was to get an indigenous engine for the aircraft as early as possible. The other purpose of 'competence building for future needs' appears to have been only secondary, if not incidental, which would have been achieved as the development work proceeded. However, in course of time as the project proceeded, it became clear that development of the engine could not be completed and productionised to synchronise with the production schedule of the Kiran Airframe which was then under production and to which the engine being developed (HJE-2500) was to be fitted in. Consequently the authorities chose to designate it as an 'educational' project thereby affecting its priority in the matter of allotment of funds. It was not that this project was *ab initio* 'educational': It appears to the Committee that it was made to look as an 'educational project' when the chances of its materialisation

appeared remote. In the opinion of the Committee the decision to accord this project a low priority in the matter of allotment of funds on the ground that it was 'educational' was wholly unjustified, particularly in view of the fact that Kiran Production itself was running several years behind schedule.

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The Committee observe that the project report prepared by the undertaking suffered from many deficiencies. It did not assess correctly the cost of development of the project, so much so that the cost of development of the engine assessed originally at Rs. 41 lakhs (F.E.—Rs. 11 lakhs) had to be revised to Rs. 100 lakhs (FE—Rs. 12 lakhs) in October 1967 and to Rs. 150 lakhs (FE—Rs. 40 lakhs) in May 1970. Moreover, it did not set any firm time targets for the completion of the project. It is admitted that the reasons for the 'sketchiness' of the project report was due to lack of technical expertise and also because there was no cross-check available. The Committee feel that while entrusting the project of such magnitude and importance to HAL, Government should have taken care that technical competence was available in the undertaking to execute the project. The sketchy nature of the project report and its other deficiencies should have forewarned the Government of the inadequacies of technical talent with the undertaking and steps should have been taken to overcome the shortcomings. This was not done.

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The Committee also note that no machinery was created for regularly monitoring the progress of this important project and that the entire exercise was left to HAL. The Committee hope that

Government will learn a lesson from the fate of this project and see that while undertaking any major project, monitoring agencies are invariably established and if any bottleneck is observed by them, immediate remedial action should be taken so that the progress is not clogged unnecessarily.

The Committee have been informed that against the estimated cost of development of the project of Rs. 41 lakhs, the Board of Directors of HAL sanctioned for the project Rs. 5 lakhs in February 1960, Rs. 10 lakhs in December 1962 and Rs. 5 lakhs in January 1969, aggregating Rs. 20 lakhs, pending the sanction of the development grant by the Government. It was only in June 1972 that the development grant of Rs. 150 lakhs was sanctioned by Government. This indicates that Government were not attaching to the development project the importance that it deserved right from the very beginning. If it was desired that the undertaking should develop an engine quickly so that its production could be synchronised with the production schedule of the Kiran engine airframe, Government should have placed at the disposal of the undertaking adequate resources to bring the development project to early fruition. Having denied to the undertaking adequate resources for the development project, Government have to bear the blame for the delay in the execution of the project which rendered the initial objective of the project, namely, to replace the imported Viper engine by an indigenous engine, completely out of focus. The Committee feel that

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if Government had shown a little more enthusiasm and keenness to have the project successfully executed and to achieve its desired objective, by making available adequate resources to the undertaking in time, perhaps the project would not have ended in a fiasco and the country would have achieved a breakthrough in the manufacture of aero-engine which could replace the imported engines for aircraft being manufactured by us.

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In this context, the Committee take a serious note of the comments of the Aeronautics Committee in their report (April 1969) that "the existence of two separate teams (GTRE and HAL) was an impediment to the sanction of expenditure (for the development project)". They are also unhappy to note that it took the Government as long as three years even after the development project was recommended by the Aeronautics Committee in April 1969 to sanction the grant of Rs. 150 lakhs for the project in June 1972.

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It transpired during evidence that the delay in the execution of the project was also due to inadequate expertise available with HAL in the matter of development of aero-engines and wrong system procedures adopted for testing of the prototype engine. While the Committee can appreciate the pace of development being retarded on account of inadequate expertise and technical know-how, they find it rather disquieting that no guidance was available to those responsible for executing the development project regarding testing of individual components and systems in the first instance before final assembly of the engine and putting it to final tests which is held out to be partially responsible for the delay in development.

That such a venture was undertaken without the assurance of an inflow of technical know-how and expertise speaks poorly of the mechanism for project planning and execution that was then prevalent.

HJE-2500 project was recommended by the Aeronautics Committee in April 1969. The Aeronautics Research and Development Board (ARDB) which was set up on the recommendations of the Aeronautics Committee also scrutinised and approved this project at its meeting held on the 8 January, 1972. In May 1972, the Board appointed a Technical Committee to assess various projects of propulsion systems including the HJE-2500 project. The Technical Committee, however, in its report submitted in December 1974, did not deal with this project. During evidence the Committee were informed that the Technical Committee had, on the advice of the Air Headquarters, confined itself to the consideration of engine proposals in respect of another aircraft and due to paucity of time the consideration of HJE-2500 project could not be taken up by them. The Committee are unhappy at the Technical Committee skipping over the HJE-2500 project although it was within the terms of reference drawn up for the Technical Committee.

The Committee were informed during evidence that the development project for HJE-2500 was taken up by HAL in 1960 because at that time it was only there that whatever technical know-how for

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Production

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engine development that the country had was available. Gas Turbine Research Establishment was then in its infancy and was incapable of taking up the project. In April 1969 the Aeronautics Committee had in their report recommended the merger of the GTRE and the Aero-engine Design Division of HAL with a view to pool at one place the technical know-how and expertise available in the field of engine development. This recommendation of the Aeronautics Committee came to be discussed at a high level only in July/August 1972, i.e. after a lapse of more than three years. A decision was then reached not to merge the two establishments. It was argued that over the years substantial investment of resources had been made in GTRE where a nucleus aero-engine design team had been created and that in comparison the man-power and resources available at HAL aero-engine design centre were modest. It was further argued that a major project involving development of advance technology for aero-engines should be handled by GTRE where sufficient facility and expertise in handling such projects were available. The Committee note that while in 1960 the state of technical competence as between GTRE and the aero-engine design centre of the HAL was weighted in favour of the latter, by 1972 GTRE had been built up with Central Government funds into a strong nucleus aero-engine design team, so much so that it claimed an exclusive role in the development of the aero-engines. At this stage the Committee can hardly do anything more than emphasise that there is a need for effective coordination and liaison between all major institutions, industries and R&D organisations in the field of aeronautics including the Development and Research Wing of HAL

and GTRE and to make every effort to pool all the available technical know-how in identical and related fields so as to avoid unnecessary duplication of effort. The Committee have no doubt that if the technical know-how available in different institutions/organisations in the country in the field of aeronautics engineering is pooled and development jobs are assigned to those who are technically competent to execute the same, the country will soon be able to develop self-reliance and obviate the necessity of imports.

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The Committee have been informed that a viable proposal to develop a modified (de-rated) version of Orpheus 701 engine to suit Kiran Mark-II had been formulated in 1975. The cost of this project is estimated as Rs. 2.08 crores and the time-frame as three years from 'go-ahead'. It is claimed that with the successful completion of this project the need to import the engines for jet trainer aircraft will be eliminated. In view of the fact that the foreign suppliers of the engine for Kiran aircraft have taken advantage of our total dependence upon them, substantially raised the prices for this engine, there is need for redoubling our developmental efforts to produce indigenous replacement for the imported engines. The Committee hope that Government will commit adequate resources for this project and devise suitable control and monitoring systems so as to ensure that the project does not suffer from any deficiencies which had marred the successful completion of the earlier project.

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In the light of the shortcomings and lacunae noticed in regard to this project, the Committee would like to make the following suggestions for formulation and implementation of development projects:

- (i) The aims and objectives of the development project should be clearly defined.
  - (ii) The project report should be comprehensive, covering all aspects. The technical and management problems in the implementation of the project should be clearly envisaged and an attempt should be made in the report itself to find possible solutions for them.
  - (iii) The cost estimates for the project should be worked out carefully and as realistically as possible so as to obviate the need for its revision from time to time.
  - (iv) Once the project and the cost estimates therefor have been approved and the project finally cleared, it should not be allowed to languish for want of funds. The flow of the funds should be free and regular.
  - (v) Firm targets for stage-by-stage completion of the project should be laid and these should be adhered to.
  - (vi) Proper control mechanism and procedures should be evolved for monitoring the progress of the implementation of the project. If any bottleneck is observed, the matter
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should be considered at the appropriate level and remedial measures should be taken promptly.

(viii) The assessment of the utility of the project should be made in the light of the results contemporaneously being obtained, after a period of 2 years from 'go-ahead' and a decision regarding further continuance of the project taken accordingly.

(viii) As the foreclosure/abandonment of a continuing project renders the amount expended upon it and resources built up, largely infructuous, such a course should be decided upon after a very careful consideration at the highest level.

#### **12      Department of Defence             Production**

**2-36**      The Committee note that the project, approved by Government in 1956, to develop and produce the aircraft (Mark I) with a readily available but less powerful engine to be undertaken by the Hindustan Aircraft Ltd. (HAL), was an interim arrangement pending the development of a more powerful engine for which an improved version (Mark II) was to be designed. Since the various proposals and project for a more powerful engine could not materialise, HAL continued to work on the development of Mark I aircraft. The Committee also observe that the cost of this project, which was initially estimated at Rs. 1.09 crores, was revised from time to time

so much so that the total expenditure by March 1975 reached the figure of Rs. 8.12 crores.

The Committee note that in 1964 another project for the development of a trainer version of Mark I aircraft was approved at an estimated cost of Rs. 78 lakhs. The estimated cost of this project also was revised to Rs. 3.70 crores in May 1971 and the actual expenditure on the project upto March 1975 amounted to Rs. 3.27 crores. In March 1975 the two development projects (viz. Mark I and Mark I trainer) were combined into a single project with an estimated cost of Rs. 11.40 crores. A further expenditure of Rs. 1.02 crores was authorised by Government on improvements to this aircraft making a total of Rs. 12.42 crores. The Committee are not satisfied with the plea advanced before them for multi-fold escalation of cost estimates that "enough expertise and experience with the development of this aircraft" would be encountered with the development of this aircraft" was not available with HAL. They feel that in the course of implementation of the project which was spread over a long time HAL should have developed adequate expertise and technical know-how to assess fairly the technological and financial implications of the project.

The Committee also observe that though the development project for HF-24 Mark I had a time-frame of 4 years ending in 1960. the project has continued and even on the 1 July 1976, an expenditure of Rs. 1.02 crores was authorised for further improvements and modifications. The Committee emphasise the need for laying down definite time-schedules for completion of projects and for their ob-

servance in actual practice by means of proper controls and monitoring systems.

15 2.39 Department of Defence  
Production

The Committee find that in July 1976 a further expenditure of Rs. 1.02 crores was sanctioned by Government to carry out "certain essential improvements and modifications in the Marut (HF-24) fleet now in service with the IAF." The Committee would like Government to exercise strict control on expenditure on this account so as to ensure that further expenditure on improvements and modifications to HF-24 (Marut fleet) produces definite results and is not allowed to go waste as heretofore.

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The Committee find that as a result of cancellation of orders placed on HAL for HF-24 trainer aircraft, the redundancy on account of material and labour is estimated at Rs. 3.64 crores. The detailed assessment of the redundancy is being made by HAL. It is stated that this redundancy was "inescapable and arose mainly out of the difficulties involved in successful development of an improved version of Marut MK II." The Committee hope that it would be possible for the Undertaking to gainfully utilise the material rendered redundant on account of cancellation of orders.

17 2.50 -do-

The Committee note that an expenditure of about Rs. 2.34 lakhs incurred upto March, 1976 by HAL on certain projects under execution remained uncovered by sanctions/'on account' payments approved by Government. It has been pointed out to the Committee

that HAL had incurred this expenditure out of its own resources and had recently requested the Government for reimbursement. They also note that large payments of about Rs. 3.50 crores were made by way of 'on account' payment though the project estimate had not been sanctioned. The Committee would like Government to examine the propriety of making such large payments without sanction of the project estimates.

From the facts placed before them, the Committee cannot help concluding that the agreement with a foreign country entered into in 1964 in regard to the use of the aero-engine under development in that country in the air-frame being produced in this country was, to say the least, not economic or mutually advantageous. The fact that it had to be foreclosed four years later in 1968 after incurring an expenditure to the tune of Rs. 94.29 lakhs goes to show that the joint venture project had been undertaken without a proper assessment of the economic advantage likely to accrue to the country. The most disturbing aspect of the venture is the fact that while foreclosing the agreement, we left with the foreign Government an air-frame and two Orpheus engines of the type even now in service with the Air Force. The Committee are unable to appreciate the contention of the Government that in leaving the air-frame and the engines in the foreign country "no security risk was stipulated." The Committee also note that no information is available with the Government as to the use and ultimate disposition of the air-frame and engines left by them with the foreign country. The Committee are

of the opinion that the Government's decision in leaving the air-frame and the engines was not in keeping with the national interest.

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Production

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The Committee observe that since the existing HF-24 aircraft fell considerably short of the then operational requirements of the Air Force, Gas Turbine Research Establishment (GTRE) of the Research and Development Organisation of the Ministry of Defence took up a project for the development of reheat variant of Orpheus 703 engine (already in use) for fitment to the HF-24 air-frame. They also note that as early as in February 1965, the Technical Study Group (headed by Air Cdr. Moolgavakar) reported that although the reheat engine would meet the then existing operational requirements, it would have "some deficiency in the radius of action." The Study Group had accepted the reheat variant of Orpheus 703 engine as "the only expeditious solution." It has been admitted that in March 1966 it came to light that the test-bed performance of HF-24 MK I A (later redesigned as MK-1 R) fitted with reheat version of Orpheus 703 engine "was inferior even to MK I fitted with Orpheus 703 engine in dry climb and cruise due to base drag." It is further admitted that in 1969 the prototype aircraft fitted with reheat variant of Orpheus 703 engine was flown and this prototype also showed some shortcomings. This prototype finally crashed in January 1970. The Committee find that in spite of these results, the GTRE was allowed to continue with the reheat development project incurring expenditure which ultimately proved largely infructu-

ous. In February 1973, when Air Headquarters suggested abandonment of the project for manufacture of MK II aircraft with reheat engine on the grounds, *inter alia*, of financial stringency and instead proposed retromodification of the existing MK I aircraft, the retromodification of the existing aircraft with reheat variant of Orpheus 703 engine continued to be a subject of research and development in the GTRE even though it was well-known that reheat variant of Orpheus 703 engine had the problem of base drag. The Committee are unable to appreciate as to why the Government persisted with the project for development of reheat variant of Orpheus 703 engine and its fitment in the HF-24 air-frame when it came to their notice as early as 1965 that it caused the problem of base drag which reduced the performance of the aircraft far below the operational requirements.

The Committee also fail to understand why the proposals for development of other variants, such as the one conceived by HAL was not given a chance to prove its efficacy when it came to be known that the reheat variant developed by GTRE had not proved a success.

The Committee find that Government had sanctioned the development of reheat system for Orpheus 703 engine which was then in use in HF-24 aircraft by GTRE in January 1963. The test trials of the reheat engine were, however, completed only in October 1970. It has been explained that though Bench development of the engine proceeded according to schedule and was completed in 4 years' time in



for escalation of cost from Rs. 14 lakhs in January 1963 to Rs. 77.41 lakhs in December 1973, it is stated that the project was not sanctioned in its entirety right at the very beginning. It was carried out in progressive stages and each stage was taken up only after the successful execution of the preceding stage. As regards the exclusion of the cost of establishment from the cost of the project, it is stated that since the Defence Research and Development Organisation is an agency for evaluating and developing weapon systems for all the three Services and since even without any specific project the expenditure on regular establishment would have been incurred, it is not proper to include this man-power cost in project cost. The Committee do not consider this plea as tenable and feel that for correct appreciation of cost of development of a project, it is desirable to include in the cost of the project the cost of establishment allocated for the project. This procedure for computation of cost is also desirable in order to have a fair assessment of comparative economics of development projects being proposed by GTRE and HAL. It may be pointed out that HAL being a commercial organisation has to include in the cost of the development project not only the cost of establishment committed for the project but also profit margins.

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The Committee note that in February 1973, the Air Headquarters suggested abandonment of the project for the manufacture of HF-24 aircraft with Orpheus 703 reheat engine on the ground, *inter alia*, of financial stringency and proposed instead retromodification of the existing HF-24 MK I aircraft already in service with the Air Force. The proposal for retromodification of the existing HF-24 MK I air-



craft to a higher standard involving an outlay of Rs. 70.14 crores was approved by the Apex Planning Group and Government in May 1973. A couple of months later in July 1973, the various proposals for development of a suitable engine to be used in retromodification were considered at a meeting in the room of Raksha Utpadan Mantri and certain decisions regarding various alternative proposals for engine development were taken. At this meeting, Air Headquarters indicated that the aircraft was required to be of a standard higher than that notified in January 1972 and that this was confirmed by them in September 1973. Subsequently, at a meeting in August 1974, the Air Headquarters stated that the aircraft fitted with reheat engine would not meet the current operational requirements. The alternative proposals of engine development were not considered justifiable in view of "high costs and long gestation periods" and the "limited requirement of retromodification." It was, therefore, decided that the retro-modification programme should be given up. A month later, i.e., in September 1974, the Air Headquarters recommended that further effort on the improved version of HF-24 aircraft be abandoned and since then no expenditure is being incurred by any agency on this behalf, although no formal Government orders closing the project have so far been issued. The closure of the project has thus rendered largely infructuous a total expenditure to be of the order of Rs. 21.46 crores upto the end of March 1975. The Committee are unable to appreciate the reasons advanced before them for a sudden foreclosure of the project specially when huge expenditure had already been

incurred on the project and, as stated by the Ministry of Defence themselves, "operational necessity for induction of an aircraft with an adequate range still remains."

The Committee also note that the requirement standard I of 1972 for MK II with reheat engine was issued by the Air Headquarters in January 1972. The reheat variant of Orpheus 703 engine developed by GTRÉ met this requirement, but when fitted to the HF-24 aircraft frame it caused the problem of base drag which reduced the performance of the aircraft to even lower than that of HF-24 fitted with ordinary Orpheus 703 engine. In July—September 1973, the requirement standard was raised upwards by the Air Headquarters rendering the reheat variant developed by GTRÉ far short of the new requirements. It was explained to the Committee that the raising of the requirement standard became necessary as a result of the experience of the December 1971 War, the import of certain types of aircraft from abroad and a new role envisaged for the HF-24 aircraft. The Committee feel that the action of the Air Headquarters in issuing the "Requirement Standard I of 1972" for MK II with reheat engine in January 1972, when the experiences of 1971 War were still being analysed, was a little hasty. The Committee would, however, like to point out that the revision of the operational requirement in July-September 1973 could not have had any decisive impact on the development project as even with the requirement standard I of 1972 which the GTRÉ-developed reheat engine is claimed to have met, the aircraft had experienced the problem of base drag which had render-

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Production

ed it below the mark from operational point of view. Since the project was for development of an engine of required specifications and standard for fitment in a particular airframe the claim that "the reheat system designed by GTRE had met the full specifications in respect of thrust, specific fuel consumption etc." is pointless inasmuch as the engine could not produce the required results when fitted in the particular airframe.

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2.99 Department of Defence  
Production

The Committee have been informed that the Air Headquarters have not been communicating their views in regard to the suitability of reheat engine for the HF-24 aircraft in writing. It is maintained that the expression of views by the representatives of the Air Force at the Steering Committee meetings was thought sufficient. This is rather unusual. The Committee feel that as the development project was to cater for the operational requirements of the Air Force, the Air Headquarters had a special responsibility in regard to the development project and their views in regard to the suitability of the end-product should have received the importance that they deserved. The Air Headquarters should also have followed up the views expressed during Steering Committee meetings by written communication to that effect to the Defence Ministry so as not to leave ambiguity of any sort as far as the stand of the Air Headquarters was concerned. That this was not done is regrettable.

Although it was known as early as in 1969 that the fitment of Orpheus 703 reheat engine developed by CTRE on HF-24 airframe had the problem of drag, the Aeronautics Research & Development Board sanctioned in March 1972 further development work on the reheat system and a total amount of Rs. 35 lakhs was sanctioned upto February 1976 for the purpose. The Committee are informed that this project was for the development of 2000°K reheat system on the Orpheus 703 engine and it was sanctioned by Aeronautics R&D Board as an independent research project and was not specifically related to development of HF-24 MK II. The task envisaged at the time of sanctioning the project is stated to be "to design and develop the system upto demonstrator stage to establish technical feasibility."

As to the achievements under the project, it is stated that "the system has been successfully tested under simulated life condition in the high altitude test facilities at National Gas Turbine Establishment, U.K." It is further stated that this 2000°K system is being adopted for another engine development project now in hand. The Committee would like Government to assess this project in the light of their experience in regard to the other project for the development of the reheat system for HF-24 aircraft and ensure that the amount spent on the project is purposefully directed to achieve definite fruitful results.

The Committee note that the Aeronautics Committee and later on a Study Group constituted by it had made a careful study of HF-24

development project and have made certain observations. The more important of these observations have been summarised as follows:

- (i) The magnitude of the work had not been properly appreciated while preparing the initial estimates
- (ii) The elements of material and labour costs had not been properly allowed for in the initial estimates.
- (iii) The Indian design staff had not been experienced enough to make effective contribution in the earlier years. The absence of previous experience in the development of aircraft was a serious handicap and a necessary allowance for this deficiency had not been made in the estimates of cost and time.
- (iv) In the Government, there was no critical examination of the project reports submitted by HAL in 1957 and 1960. There was also a failure to keep a close watch on the progress in the development of HF-24.
- (v) The management organisation in HAL for the project was inadequate.
- (vi) The organisation in the Ministry of Defence to monitor development projects was inadequate.

(vii) The methodology followed of a small number of prototypes followed by comparatively large-number of preproduction aircraft has not given satisfactory results. The consensus of studies carried out in UK, France and USA was that the alternative of production of a larger number of prototypes followed by regular production would yield better results.

(viii) The decision to relate the development of an aircraft to the successful completion of an engine under development abroad was not wise.

(ix) Throughout the history of the development of HF-24 aircraft, policy changes were made regarding the choice of the engine. Each of the changes involved considerable design effort and diverted attention from the development of HF-24 MK I. Also concurrent with the programme of development of the HF-24 MK I aircraft, HAL had been engaged in building and supporting the flight development of several versions including HF-24 MK I with airpass, HF-24 MK IA, HF-24 MK IBX and HF-24 MK IR.

Indicating the action taken on the observations of the Aeronautics Committee, Government have stated that "the criticism contained in the observations is accepted and that the lessons learnt from the experience gained over these projects are being applied to new development projects under execution." The Committee are in agreement with the observations made by the Study Group and would like Government to ensure that the defects pointed out are not repeated in formulating and executing development projects in future.

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They would, however, like to add that the Government should ensure that the development projects are not allowed to be dragged on for years together with the result that more and more money is pumped in the project and by the time the scheme materialises the model may become obsolete. The progress and achievements of a development project should be analysed and appraised after every 2 years by a technical team and the continuance of the project should be a decided upon in the light of the findings of the technical team indicating a distinct progress and a clear possibility of fructification of the developmental effort in the near future.

CORRIGENDA TO SECOND REPORT OF PAC (SIXTH LOK SABHA)  
ON DEFENCE SERVICES.

<u>Page</u>	<u>Para</u>	<u>Line</u>	<u>For</u>	<u>Read</u>
32	1.45	bottom	developmnt	development
33	1.46	17	productionised	productionised
34	1.49	19	engine	engine
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73	2.107 (ix)	7	airpass. HF-24	airpass HF-24
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